DOE/CF-0086
Volume 3

Department of Energy
FY 2014 Congressional Budget Request

Energy Efficiency and Renewable Energy
Electricity Delivery and Energy Reliability
Nuclear Energy
Race to the Top for Energy Efficiency and Grid Modernization
Fossil Energy Research and Development
Naval Petroleum and Oil Shale Reserves
Strategic Petroleum Reserve
Northeast Home Heating Oil Reserve
Ultra-Deepwater Unconventional Natural Gas
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Title 17 Innovative Tech. Loan Guarantee Program
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April 2013 Office of Chief Financial Officer Volume 3

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[redacted] Energy Efficiency and Renewable Energy

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The Department of Energy's Congressional Budget justification is available on the Office of Chief Financial Officer, Office of Budget homepage at http://www.cfo.doe.gov/crorg/cf30.htm.

For the latest details on the Department of Energy's implementation of the Recovery Act, please visit: http://www.energy.gov/recovery

DEPARTMENT OF ENERGY
Appropriation Account Summary
(dollars in thousands – OMB Scoring)

(discretionary dollars in thousands)

	FY 2012 Current	FY 2013 Annualized CR	FY 2014 Request	FY 2014 vs. FY 2012	
				$	%
Energy and Water Development and Related Agencies					
Energy Programs					
Energy Efficiency and Renewable Energy	1,780,548	1,820,713	2,775,700	+995,152	+55.9%
Electricity Delivery and Energy Reliability	136,178	139,954	169,015	+32,837	+24.1%
Nuclear Energy	760,466	770,075	735,460	-25,006	-3.3%
Race to the Top for Energy Efficiency and Grid Modernization	0	0	200,000	+200,000	N/A
Fossil Energy Programs					
Fossil Energy Research and Development	337,074	494,969	420,575	+83,501	+24.8%
Naval Petroleum and Oil Shale Reserves	14,909	15,000	20,000	+5,091	+34.1%
Strategic Petroleum Reserve	192,704	193,883	189,400	-3,304	-1.7%
Northeast Home Heating Oil Reserve	10,119	10,181	8,000	-2,119	-20.9%
Subtotal, Fossil Energy Programs	***554,806***	***714,033***	***637,975***	**+83,169**	***+15.0%***
Uranium Enrichment D&D Fund	472,180	475,070	554,823	+82,643	+17.5%
Energy Information Administration	105,000	105,643	117,000	+12,000	+11.4%
Non-Defense Environmental Cleanup	235,381	236,746	212,956	-22,425	-9.5%
Science	4,934,980	4,903,461	5,152,752	+217,772	+4.4%
Advanced Research Projects Agency - Energy	275,000	276,683	379,000	+104,000	+37.8%
Departmental Administration	126,000	126,772	118,392	-7,608	-6.0%
Inspector General	42,000	42,257	42,120	+120	+0.3%
Advanced Technology Vehicles Manufacturing Loan	6,000	6,037	6,000	0	N/A
Total, Energy Programs	***9,428,539***	***9,617,444***	***11,101,193***	**+1,672,654**	***+17.7%***
Atomic Energy Defense Activities					
National Nuclear Security Administration:					
Weapons Activities*	7,214,834	7,557,342	7,868,409	+311,067	+4.1%
Defense Nuclear Nonproliferation	2,300,950	2,409,930	2,140,142	-160,808	-7.0%
Naval Reactors	1,080,000	1,086,610	1,246,134	+166,134	+15.4%
Office of the Administrator	410,000	412,509	397,784	-12,216	-3.0%
Total, National Nuclear Security Administration	***11,005,784***	***11,466,391***	***11,652,469***	**+304,177**	***+2.8%***
Environmental and Other Defense Activities					
Defense Environmental Cleanup	5,002,847	5,033,568	5,316,909	+314,062	+6.3%
Other Defense Activities	823,364	828,402	749,080	-74,284	-9.0%
Total, Environmental & Other Defense Activities	***5,826,211***	***5,861,970***	***6,065,989***	**+239,778**	***+4.1%***
Total, Atomic Energy Defense Activities	***16,831,995***	***17,328,361***	***17,718,458***	**+543,955**	***+3.2%***
Power Marketing Administration					
Southeastern Power Administration	0	0	0	0	N/A
Southwestern Power Administration	11,892	11,965	11,892	0	N/A
Western Area Power Administration	95,978	96,556	95,930	-48	-0.1%
Falcon & Amistad Operating & Maintenance Fund	220	221	420	+200	+90.9%
Colorado River Basins	-23,000	-23,141	-23,000	0	N/A
Transmission Infrastructure Program	0	0	0	0	N/A
Total, Power Marketing Administrations	***85,090***	***85,601***	***85,242***	**+152**	***+0.2%***
Subtotal, Energy and Water Development and Related Agencies	***26,345,624***	***27,031,406***	***28,904,893***	**+2,216,761**	***+8.4%***
Uranium Enrichment D&D (UED&D) Fund Discretionary	0	0	-463,000	-463,000	N/A
Excess Fees and Recoveries, FERC	-25,534	-27,479	-26,236	-702	-2.7%
Total, Discretionary Funding by Appropriation	**26,320,090**	**27,003,927**	**28,415,657**	**+1,753,059**	**+6.7%**

Note: For Weapons Activities, the FY 2014 Request is compared against the FY 2013 Annualized Continuing Resolution level.

Energy Efficiency and Renewable Energy

Energy Efficiency and Renewable Energy

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Energy Efficiency and Renewable Energy
Proposed Appropriation Language

For Department of Energy expenses including the purchase, construction, and acquisition of plant and capital equipment, and other expenses necessary for energy efficiency and renewable energy activities in carrying out the purposes of the Department of Energy Organization Act (42 U.S.C. 7101 et seq.), including the acquisition or condemnation of any real property or any facility or for plant or facility acquisition, construction, or expansion, $2,775,700,000, to remain available until expended: Provided, That $185,000,000 shall be available until September 30, 2015 for program direction: Provided further, That, of the amount provided under this heading, the Secretary may transfer up to $95,000,000 to the Defense Production Act Fund for activities of the Department of Energy pursuant to the Defense Production Act of 1950 (50 U.S.C. App. 2061, et seq.).

Explanation of Change

No change

Energy Efficiency and Renewable Energy

Overview
Appropriation Summary by Program

(dollars in thousands)

	FY 2012 Current	FY 2013 Annualized CR	FY 2014 Request
Energy Efficiency and Renewable Energy			
Vehicle Technologies	320,966	330,819	575,000
Bioenergy Technologies	0	0	282,000
Biomass & Biorefinery Systems R&D[a]	194,995	200,496	0
Hydrogen & Fuel Cell Technologies	101,326	104,258	100,000
Solar Energy	284,702	290,719	356,500
Wind Energy	91,813	93,825	144,000
Water Power	58,076	59,147	55,000
Geothermal Technologies	36,979	38,094	60,000
Advanced Manufacturing	0	0	365,000
Industrial Technologies[b]	112,692	116,287	0
Federal Energy Management Program	29,891	30,074	36,000
Building Technologies	214,706	220,546	300,000
Weatherization and Intergovernmental Programs	128,000	128,783	248,000
Program Direction	165,000	166,010	185,000
Strategic Programs	25,000	25,153	36,000
Facilities and Infrastructure	26,311	26,472	46,000
Subtotal, EERE	1,790,457	1,830,683	2,788,500
Use of Prior Year Balances	-9,909	-9,970	-12,800
Total, EERE	1,780,548	1,820,713	2,775,700

SBIR/STTR

- FY 2012 Transferred: SBIR: $25,637,070; STTR: $3,454,380
- FY 2013 Annualized CR Transferred: SBIR: $3,352,620
- FY 2013 Annualized CR: SBIR: $26,306,139; STTR: $3,673,044
- FY 2014 Request: SBIR: $45,730,628; STTR: $6,374,172

Legislative Authorities

P.L. 81–774 "Defense Production Act" (1950)
P.L. 93-275, "Federal Energy Administration Act" (1974)
P.L. 93-410, "Geothermal Energy Research, Development, and Demonstration Act" (1974)
P.L. 93-577, "Federal Non-Nuclear Energy Research and Development Act" (1974)
P.L. 94 163, "Energy Policy and Conservation Act" (EPCA) (1975)
P.L. 94-385, "Energy Conservation and Production Act" (ECPA) (1976)
P.L. 94-413, "Electric and Hybrid Vehicle Research, Development and Demonstration Act" (1976)
P.L. 95-91, "Department of Energy Organization Act" (1977)
P.L. 95-238, Title III – "Automotive Propulsion Research and Development Act" (1978)
P.L. 95-618, "Energy Tax Act" (1978)
P.L. 95-619, "National Energy Conservation Policy Act" (NECPA) (1978)

[a] Biomass & Biorefinery Systems R&D, renamed Bioenergy Technologies in FY 2014.
[b] Industrial Technologies, renamed Advanced Manufacturing in FY 2014.

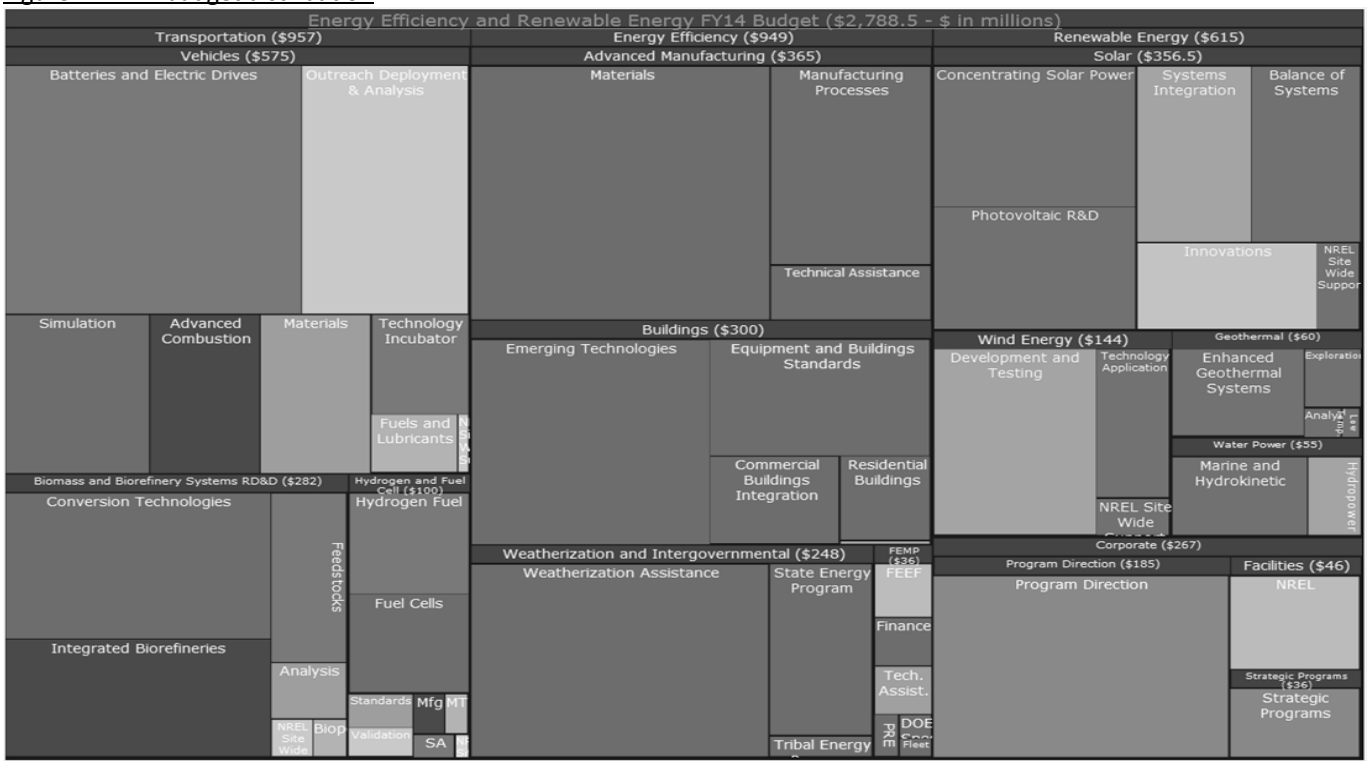
P.L. 95 620, “Power Plant and Industrial Fuel Use Act” (1978)
P.L. 96 294, “Energy Security Act” (1980)
P.L. 96-512, “Methane Transportation Research, Development and Demonstration Act” (1980)
P.L. 100 12, “National Appliance Energy Conservation Act” (1987)
P.L. 100-357, “National Appliance Energy Conservation Amendments” (1988)
P.L. 100-494, “Alternative Motor Fuels Act” (1988)
P.L. 100 615, “Federal Energy Management Improvement Act” (1988)
P.L. 101-218, “Renewable Energy and Energy Efficiency Technology Competitiveness Act of 1989”
P.L. 101-566, “Spark M. Matsunaga Hydrogen Research, Development, and Demonstration Act of 1990”
P.L. 101-575, “Solar, Wind, Waste, and Geothermal Power Production Incentives Act of 1990”
P.L. 102-486, “Energy Policy Act (EPACT, EPAct) of 1992”
P.L. 104-271, “Hydrogen Future Act of 1996”
P.L. 106-224, “Biomass Research and Development Act” (2000)
P.L. 109-58, “Energy Policy Act of 2005”
P.L. 110-140, “Energy Independence and Security Act of 2007
P.L. 110-234, “The Food, Conservation, and Energy Act of 2008”
P.L. 111-5, “American Recovery and Reinvestment Act of 2009”
P.L. 111-358, “America Competes Reauthorization Act of 2010”
P.L. 112-210, “American Energy Manufacturing Technical Corrects Act” (2012)

Energy Efficiency and Renewable Energy (EERE)'s Budget Organization and Distribution

The figure below represents our total planned budget for FY2014 of $2.8 billion. Its distribution is represented by the size of each rectangle. Our individual technology areas are organized around key energy sectors:

- Transportation-Focused Programs ($957 million) including the Vehicle Technologies, Bioenergy Technologies, and Hydrogen and Fuel Cell Technologies Programs
- End-Use Efficiency Focused Programs ($949 million), including the Advanced Manufacturing Office; Building Technologies; Weatherization and Intergovernmental Programs; and the Federal Energy Management Program
- Renewable Electricity Focused Programs ($616 million), including the Solar Energy; Wind Energy and Water Power, and Geothermal Technologies
- Corporate Support ($267 million), including Program Direction, Facilities and Infrastructure, and Strategic Programs.

Figure A: EERE budget distribution



EERE Overview and Accomplishments

The Department of Energy's (DOE) Office of Energy Efficiency and Renewable Energy (EERE) seeks to ensure American leadership in the transition to a global clean energy economy. EERE supports high-impact applied research, development, demonstration, and deployment (RDD&D) in the fields of sustainable transportation, renewable electricity, and energy efficiency in homes, buildings, and factories. EERE funds RDD&D at some of America's most innovative businesses and research institutions with the explicit goal of making clean energy technologies directly cost-competitive, without subsidies, with the energy technologies we use today.

Our nation stands at a critical point in time when it comes to the opportunity in clean energy. Americans are paying more than $3.50/gallon at the pump; the United States continues to spend nearly $1 billion a day on foreign oil, and we are wasting hundreds of billions of dollars every year through inefficient energy use in our homes, buildings, and factories.

In spite of the tremendous and urgent strategic and economic opportunity in clean energy, the U.S. energy industry has systematically underinvested in innovation—investing just 0.4% of its sales in research and development (R&D) (as compared to

pharmaceuticals at 20.5% and aerospace/defense at 11.5%) according to one estimate.[a] There is also a continued need to break down market barriers that clean energy technologies face. Therefore, there continues to be an important and appropriate role for government investment in innovation in the clean energy sector.

After decades of targeted EERE investments into American clean energy innovation, we have made tremendous progress. We are now in the unique position where a wide array of technologies—from solar power, wind power, and plug-in electric vehicles, to solid-state lighting and cellulosic biofuels—are within 5–10 years of being directly price-competitive without subsidies.

EERE's goals are to:

- Reduce American dependence on oil
- Reduce energy costs for American families and businesses
- Create American economic leadership in the industries and jobs of the clean energy future
- Reduce energy-related environmental impacts on human health and our planet.

Through this budget, EERE is positioned to achieve these goals by developing and accelerating the adoption of a new generation of energy technologies that are clean, safe, efficient, and cost effective.

In FY 2014, EERE will continue to base its investments upon our internal and independent economic analysis and assessments of potential technology impacts on energy usage, market penetration, manufacturing competitiveness, and possibility of success. This approach focuses efforts on the most promising opportunities across a full spectrum of sectors and maturation timeframes to ensure a full pipeline of efficiency and renewable technologies in both the near and longer term. EERE's strategic investments in clean energy technologies complement those of the private sector. The EERE portfolio consists primarily of competitively selected projects with the largest potential to help achieve national economic, strategic, environmental, and energy goals. It balances investments in higher-risk, early stage R&D with public-private partnerships that accelerate the transfer of innovations into the marketplace. In addition to investments in new promising areas, the portfolio maintains critical activities in focused technology areas identified by past requests, including offshore wind, drop-in biofuels, and solar manufacturing.

EERE Continues to Deliver on its Record of Accomplishment in Clean Energy Technology Development

Through decades of committed, forward-leaning RDD&D, EERE has made tremendous progress toward its goal of making a wide array of clean energy technologies directly cost-competitive with traditional forms of energy without subsidies. Some of the most noteworthy accomplishments across the EERE portfolio provide firm evidence that EERE can deliver on its plans and investments. They include the following:

- The investments EERE made in combustion engine efficiency R&D over the 20-year period from 1986–2007 resulted in $70.2 billion dollars in monetized benefits, representing a nearly 70:1 return on the taxpayer investment.
- Virtually every hybrid electric vehicle on the road today has EERE-developed technology inside—an improved nickel-metal hydride battery—providing up to a 50% increase in fuel economy compared to non-hybrid vehicles. The United States now has more than 2.5 million of hybrid electric vehicles on the road today.
- Supported by EERE RD&D investments, the production cost of electric vehicle batteries has been reduced by 50% in just the last 4 years. In addition, plug-in electric vehicle sales increased to more than 50,000 last year, representing a more than tripling of sales year-on-year.
- EERE-supported battery R&D at Argonne National Laboratory initiated in the early 1990s has resulted in the development of a revolutionary new battery cathode material that is now being used commercially in six plug-in electric vehicle models. This technology could support an additional 50% increase in capacity. It was also a crucial component of the recently announced "world record energy density" lithium-ion battery developed by a California based startup company under an ARPA-E award.
- Supported by EERE RD&D investments, the modeled high-volume production cost of fuel cells has been decreased by more than 35% since 2008.
- In 2012, EERE successfully achieved its 10-year goal of demonstrating cellulosic ethanol at the pilot scale at an estimated production-scale cost of $2.15/gallon.

[a] American Energy Innovation Council, *Catalyzing American Ingenuity,* 2012.

- EERE has supported first-of-a kind integrated biorefineries across the United States through public-private partnerships, the first of which is expected to be operating commercially in 2013.
- EERE's RDD&D efforts in solar photovoltaics (PV) are estimated to have accelerated the solar industry's technological progress by approximately 12 years, based on independent evaluation.
- EERE supported the development and deployment of the first grid-connected tidal energy project in the Unites States in 2012.
- Since 2009, EERE has issued 16 new or updated appliance and equipment standards covering more than 30 products. Cumulative consumer utility bill savings associated with these recently enacted standards are projected to be $180 billion (undiscounted) through 2030.
- EERE has worked with states, local governments, and community action agencies to weatherize more than 1,000,000 homes since 2009, providing annual energy bill savings of in the range of $250 to $450 per household.
- EERE has joined with more than 100 leading public and private organizations who are committing more than $2 billion to meet the Better Buildings Challenge of saving 20% on commercial and industrial energy bills by 2020.
- EERE through the Federal Energy Management Program has helped the Federal Government with aggressive energy, water, and greenhouse gas reduction targets and meeting the President's directive to enter a combined $2 billion in performance-based contracts in Federal building energy efficiency by 2013.
- These and similar programmatic accomplishments are detailed in each program summary—demonstrating the value of EERE's core programs and their ability to achieve results.

Key Cross-Cutting EERE Initiatives in FY 2014

This budget request also reflects increased focus on high-impact internal cross-cutting initiatives:

- The EV-Everywhere Grand Challenge is an initiative focused on making the United States the first nation in the world to develop and produce plug-in electric vehicles that are as affordable and convenient as gasoline powered vehicles by the year 2022. EERE's FY 2014 budget includes more than $300 million for this Initiative.
- The Clean Energy Manufacturing Initiative, anchored by the Advanced Manufacturing Office and with strong involvement and dedicated funding through several EERE Technology Offices, is focused on the urgent economic opportunity in U.S. clean energy manufacturing. The goals of this effort are both to increase U.S. competitiveness in the production of clean energy products and to boost U.S. manufacturing competitiveness across the board by increasing manufacturing energy productivity. Among other activities, in FY 2013 EERE initiated a "clean energy manufacturing strategic analysis" effort that will be continued in FY 2014 and will serve as the key analytical basis for strategic decisions/priorities related to the Initiative. EERE's Advanced Manufacturing Office FY 2014 budget of $365 million provides the core of this initiative. In addition, this Initiative includes budgeted manufacturing competitiveness activities of $158 million across six EERE programs: Vehicles Technologies, Bioenergy Technologies, Hydrogen and Fuel Cell Technologies, Solar Energy, Wind Energy, and Water Power. (See end pages in overview entitled "Clean Energy Manufacturing Initiative" for additional detail.)
- The SunShot Grand Challenge is focused on making solar power directly price-competitive with other forms of electricity by 2020. EERE's FY 2014 budget includes $357 million for this Initiative.
- The Wide Bandgap Semiconductors for Clean Energy Initiative led by the Advanced Manufacturing office with coordinated activities in Vehicles and the Hydrogen/Fuel Cells offices is an EERE effort focused on capturing the significant, urgent, and cross-cutting opportunities in clean energy related to emerging wide bandgap (WBG) semiconductor technologies. Wide bandgap semiconductors are considered one of the next major semiconductor technologies. This class of technologies, developed initially for military and solid-state lighting uses, enables electronics to operate at much higher voltages, temperatures, and switching frequencies and has applications in next-generation power electronics for solar power, wind power, plug-in electric vehicles, variable drive motors, and other clean energy technologies, in addition to being key materials for next-generation efficient solid-state lighting, with the potential to dramatically increase the performance/efficiency and lower cost. Prior Department of Defense and other R&D efforts have created an opportunity for American leadership in WBG, and EERE believes there is an urgent competitive opportunity to leverage this work to further develop and transition these technologies into the commercial clean energy marketplace.

EERE's FY 2014 budget includes more than $120 million for this Initiative.

- The EERE Grid Integration Initiative is focused on ensuring the seamless integration of EERE technologies into the electrical grid. As EERE-funded technologies, after decades of high-impact RDD&D, approach direct cost -competitiveness with other energy technologies, we expect them to be rapidly deployed into the market within the next 5–10 years. As large amounts of cost-competitive wind power, solar power, and plug-in electric vehicles are connected to the grid, new technologies and business models will need to be developed and deployed to ensure continued grid reliability and continued market penetration of these technologies. This will require new technology development to address grid integration barriers and opportunities associated with variable, distributed renewable energy generators, electric vehicle charging, and building efficiency and controls, including "grid-responsive" building technologies , behind-the-meter storage technologies, and solid-state power electronics, as well as developing the industry insights needed to enable these devices to meet communication and control protocols to interface and transact at the lowest cost possible while maintaining or improving grid reliability. EERE's FY 2014 budget includes more than $159 million for this Initiative. A key part of the FY 2014 funding proposed for EERE's cross-cutting Grid Integration Initiative is an $80 million funding opportunity co-led by our Vehicle Technologies, Solar Energy Technologies, and Building Technologies Offices to develop and demonstrate these technologies. (See section entitled "Grid Integration Initiative" for additional detail at the end of the overview.)
- The Energy Systems Integration Facility (ESIF) is a "Technology User Facility" at the National Renewable Energy Laboratory (NREL) that comes on line in FY 2013. ESIF is the nation's first facility that can conduct integrated megawatt-scale research, development, and testing of the components and strategies needed to safely move clean renewable energy technologies onto the electrical grid at the speed and scale required to meet national goals. EERE will maintain metrics on ESIF, including its "Work for Others," CRADAs, and other partnerships. All ESIF work will be performed in close consultation with the Office of Electricity Delivery and Energy Reliability (OE) through the DOE Grid Tech Team to ensure synergy and leveraging of all relevant DOE efforts. EERE's FY 2014 budget request includes $20 million to operate the ESIF. (See the "Facilities and Infrastructure" budget for additional details.)

Other Important New FY 2014 Budget Changes

Incubator Programs: The great majority of EERE's investments, both currently and going forward, are primarily driven by detailed short, medium, and long-term RDD&D roadmaps. However, the new Incubator Programs proposed by a number of EERE technology programs in the FY 2014 budget are designed to use a small fraction of these programs' annual R&D budget to regularly introduce potentially high-impact "off-roadmap" emerging technology and innovations, such as those initially successfully proven at ARPA-E, into the technology program's portfolio. At that point, the performance of these new technology approaches can be further improved and evaluated enabling EERE technology program's RDD&D roadmaps to be rapidly responsive to emerging technology developments and exceed program targets or reduce costs to meet them. These Incubator Programs will enable the rapid on-ramping of potentially transformational new energy technologies into the EERE portfolio, dramatically increasing the rate of technology innovation.

These Incubator Programs build off of an already implemented innovative effort that the Solar Program piloted with a specific focus on partnering with businesses and researchers to bring "off-roadmap" impactful new technologies into the EERE portfolio. Since its inception in 2007, the SunShot Incubator Program (FY14 $21 million) has awarded 54 cooperative agreements totaling $92 million in funding for proof-of-concept and prototype ideas. These early prototypes were developed into manufacturing and commercially relevant prototypes designed around pilot-stage process development in the program. After completing the 12–18 month projects, the technologies were sufficiently de-risked to be attractive to private sources of funding, and the companies cumulatively have gone on to raise more than $1 billion in private funding, while creating hundreds of jobs. Based upon this highly successful model, the Vehicles ($30 million), Bioenergy ($20 million), Advanced Manufacturing ($20 million), Hydrogen ($8 million), Buildings ($5 million) and Wind ($5 million) and Water ($2 million) Offices are planning to create Incubator Programs in FY 2014. EERE will assess the impact and success of this expansion of the Incubator Program approach to determine whether to continue it for each of its technology programs where appropriate. (Please see individual program descriptions for additional detail.)

Site-Wide Facility Support for NREL: EERE will begin to directly fund NREL site-wide facility support that has been traditionally part of the lab's overhead; these costs are complimentary to the "Operations and Maintenance" portion of the "Facilities and Infrastructure" budget line. This practice is consistent with the budgeting practice of other national laboratories and provides more transparency into funding that EERE provides for facilities at NREL. NREL Site-Wide Facility Support funding of $30 million is identified in the various program budgets: Solar ($12 million), Wind ($9 million), Bioenergy ($5 million), Fuel Cells ($1 million), Vehicles ($2 million), and Buildings ($1 million). Individual program contributions are allocated in line with the major NREL facilities serving each program; this is an accounting change that does not change the amount of work done at NREL for the same amount of program funding, and reallocates "indirect" funding as "direct".

Elements of the NREL site-wide facility support include:

- Facilities maintenance and engineering support
- Fire, emergency, and custodial services
- General utilities
- Network infrastructure and licenses
- Environment, safety, and health support
- Sustainability.

By moving $30 million from laboratory indirect to direct funding, NREL's labor rate will be reduced by 15%–20%, thereby reducing cost barriers to industry and universities in accessing unique NREL facilities and expertise. This change in accounting practice will also make sites' operating costs more transparent and better facilitate cost control.

This change will allow NREL to attract more private sector partnerships and funding, which is critical to increasing the utilization rate of existing taxpayer-funded facilities at NREL. Examples of the facilities that will see increased utilization are discussed in each of the relevant program budgets. While these facilities are not designated as formal user facilities like ESIF, the lower labor rate will help increase the utilization of unique NREL facilities.

Alignment to DOE Strategic Plan

EERE is a major contributor to both the Administration's and the Department's strategic goals by "catalyzing the timely, material, and efficient transformation of the Nation's energy systems" and securing U.S. leadership in clean energy technologies. EERE pursues three core pathways to those goals:

- Deploy the technologies we have
- Discover the new solutions we need
- Lead the national conversation on energy.

Pursuing these three core pathways affords EERE an opportunity to directly and positively impact the Administration's goals as described below.

Administration Goals:

- Transport – Reduce net oil imports by half by the end of the decade, relative to 2008 levels.
- Stationary – Double U.S. renewable electricity generation from wind, solar, and geothermal sources by 2020, relative to 2012 levels. By 2035, generate 80% of electricity from a diverse set of clean energy sources. Double American energy productivity (the economic output per unit of energy consumed) by 2030, relative to 2010 levels. Make non-residential buildings 20% more energy efficient by 2020. Deploy 40 gigawatts of new, cost effective industrial CHP in the United States by the end of 2020.
- Environmental – Reduce energy-related greenhouse gas (GHG) emissions in the range of 17% below 2005 levels by 2020 and 83% by 2050.
- Federal leadership — Reduce Federal GHG emissions by 28% by 2020. Enter into a minimum of $2 billion in performance-based contracts in Federal building energy efficiency by December 2013.

EERE program goals in support of the Administration goals are as follows.

Transportation Goals: Reduce net oil imports by half by 2020 (from 2008 levels).

- Vehicles – Reduce battery costs from today's cost of approximately $500/kWh to $300/kWh by 2015 and to $125/kWh by 2022.
- Vehicles – Improve engine efficiency to demonstrate a 23% fuel economy improvement for passenger vehicles and 18% engine efficiency improvement for commercial vehicles compared to 2009 baseline. Commercial vehicle engine efficiency improvements contribute to a fuel economy improvement of 50% for SuperTruck demonstration vehicles in 2015.
- Vehicles – Utilizing multi-material technology, demonstrate the cost-effective 45% weight reduction of passenger vehicles (full vehicle, compared to a 2009 baseline).
- Bioenergy – Reduce the cost of non-food "drop-in" hydrocarbon biofuels to $3.00/gge by 2017.
- Fuel Cells – Reduce fuel cell cost and increase durability for: Micro-CHP: $1,500/kW (equipment

cost), 60,000-hr. durability by 2020; Medium-scale CHP: $2,100/kW (installed cost), 80,000-hr durability by 2020; Vehicles: $30 per kW; 5,000-hr durability by 2017.

Renewable Electricity Goals: Double renewable electricity generation from wind, solar, and geothermal sources by 2020 (from 2012 levels). Generate 80% of electricity from a diverse set of clean energy sources by 2035.

- Solar – Achieve directly cost-competitive solar power without subsidies by 2020; Utility PV and CSP: achieve an installed cost of $1/W ($0.06/kWh); Commercial Rooftop PV: achieve an installed cost of $1.25/W; Residential Rooftop PV: achieve an installed cost of $1.50/W.
- Wind – Reach directly cost-competitive, land-based wind power without subsidies by 2020 ($0.06/kWh). Offshore wind targets for fixed bottom installations are targeted to be $0.14 /kWh and competitive with local hurdle rates by 2030.
- Water – Reach directly cost-competitive, new hydropower by 2020 ($0.06/kWh) and competitive with local hurdle rates by 2030 for MHK ($0.12-0.15/kWh).
- Geothermal – Reduce the levelized cost of electricity (LCOE) of hydrothermal geothermal power to $0.06/kWh by 2020; reduce the LCOE of newly developed enhanced geothermal systems to $0.06/kWh by 2030.

Energy Efficiency Goals: Double American energy productivity by 2030 (from 2010 levels) by reducing the amount of energy used per dollar of gross domestic product (GDP) (energy intensity). Make non-residential buildings 20% more energy efficient by 2020. Deploy 40 gigawatts of new, cost effective industrial CHP in the United States by the end of 2020.

- Buildings – Reduce building-related energy use by 50% by 2030. Make non-residential buildings 20% more energy efficient by 2020.
- Advanced Manufacturing – Assist the U.S. industry in applying state-of-the-art energy-related technologies to enable globally cost competitive manufacturing by reducing the life-cycle energy consumption of manufactured goods by 50% over 10 years for Advanced Manufacturing supported R&D project technologies. Encourage a culture of continuous improvement in manufacturing energy efficiency, including through the adoption of combined heat and power through industrial technical assistance partnerships, and thereby assist industry in improving energy intensity by 25% over 10 years.
- Weatherization – Weatherize one million homes by 2013.

EERE expects to achieve these goals by catalyzing the growth of the nation's clean energy economy and infrastructure. This will be accomplished through the development of transformative, innovative, high-impact technologies and means of satisfying energy service demand that compete advantageously with traditional energy services—which will provide all consumers with a favorable value proposition, enabling the economically significant savings noted below.

Analytical Basis

EERE developed its portfolio to make a significant impact in transforming large existing global energy markets and to maximize the value it delivers to the taxpayer. EERE prioritizes its RDD&D work according to its "5 Core Questions".

1) High Impact: Is this a high-impact problem?
2) Additionality: Will the EERE funding make a large difference relative to what the private sector (and other funding entities) is already doing?
3) Openness: Have we made sure to focus on the broad problem we are trying to solve and be open to new ideas, new approaches, and new performers?
4) Enduring Economic Benefit: How will this EERE funding result in enduring economic benefit to the United States?
5) Proper Role of Government: Why is what you are doing a proper high-impact role of government versus something best left to the private sector to address on its own?

Using well-established methodologies, EERE has evaluated key elements of its portfolio of activities in energy efficiency, solar, and vehicles investments to date. EERE's track record has produced a significant positive return on investment in the form of economic, health, and environmental benefits. EERE is proud of this record of driving and accelerating innovative clean energy technologies toward widespread adoption and commercial success. In the near term, EERE is expanding this effort to perform return on investment analyses for all applicable program areas. These studies have documented the value of EERE investments to the taxpayer and provide important feedback to EERE leadership to help identify the most effective investment approaches and allow continual improvement going forward.

The portfolio is informed by these evidence-based assessments directed at our potential and progress toward these goals. EERE is continuously engaged in performance management, evaluation, and a strategic analysis process that ensures the alignment of each program's direction and resources with EERE's goals. EERE continuously compares its performance against its plans and targets. This includes realized impacts compared to estimated potential impacts and performance outcomes compared to national targets for oil use reduction, emissions abatement, electricity supply diversity, and economic savings.

Overall, EERE's prospective analysis finds that

- Renewable energy and energy efficiency technologies and deployment can advance national goals by reducing U.S. carbon dioxide emissions 21% by 2030.
- Renewable energy and energy efficiency technologies and deployment could reduce the amount the United States spends on petroleum, natural gas, and electricity by more than $200 billion annually.
- In the electric sector, water use (withdraws) could be reduced by nearly 15% by 2030.[a]

Since 2005, EERE has undertaken 51 impact assessments and 132 process evaluations. A body of impact assessments of realized results for six EERE programs that constitute a third of EERE's historical portfolio investment of more than $50 billion from 1976 -2008 shows those programs alone have generated more than $400 billion ($2008) in net economic benefits. Examples of EERE return on investment analysis are captured more completely in the program discussion.

Concomitant knowledge benefits in the R&D programs rank EERE in the top tier among our peer research organizations. More information about the results of the program, tools, methods, and inventory evaluations of EERE programs is found at: http://www1.eere.energy.gov/analysis/pe_index.html.

Goal Program Alignment Summary

EERE's performance management planning is informed by EERE's "5 Core Questions" and by its strategic, cross-agency and high priority goals, strategic evaluation planning and performance, and hierarchical performance planning, goals, and results. EERE's portfolio planning benefited from the DOE Quadrennial Technology Review (QTR) and a concurrent review of the most promising technologies that cut across the DOE programs. The investment portfolio continues to reflect the findings of the QTR by emphasizing technologies with the following:

- Maturity – Technologies that have significant technical headroom yet could be demonstrated at commercial scale within a decade.
- Materiality – Technologies that could have a consequential impact on meeting national energy goals within two decades (where "consequential" is defined as roughly 1% per year of U.S. primary energy).
- Market Potential – Technologies that could be expected to be adopted by the relevant markets understanding that these markets are driven by economics but shaped by the private sector.

Each program's outcomes and performance goals are focused on competitive market pricing and reducing barriers to entry. The results are targeted directly at annual, endpoint, and final goals (described in the program chapters and performance plan) that provide government's highest leverage and added value. EERE is responsible for four of the DOE's eight Priority Goals shown on the following page. These are high-level targets featured and reported publicly through the White House-led website www.performance.gov.

[a] Additional expected benefits, information, methodology description, baselines and analytical tools are available at: http://www1.eere.energy.gov/analysis.

High Priority Goals

Goal	Goal Description
Battery Performance	Reduce the cost of batteries for electric drive vehicles to help increase the market for Plug-In Hybrids and All-Electric Vehicles and thereby reduce petroleum use and GHG emissions. By October 2013, demonstrate a prototype Plug-In Hybrid battery technology that is capable of achieving a cost of $400/kWh (useable energy) during high volume manufacturing (100,000 packs per year) compared to a 2008 baseline of $1,000/kWh.
SunShot	Make solar energy as cheap as traditional sources of electricity. By the end of the decade, drive the cost of solar electricity down to: $1/W at utility scale; $1.25/W at commercial scale; and $1.50/W at residential scale. By December 2013, demonstrate a prototype thin film or film silicon module with an efficiency of greater than 21% and a balance of system with a 50% reduction of the permitting and installation costs to $1.50/W.
Appliance Standards	Reduce consumer energy use and costs for household appliances. By December 31, 2013, issue at least 9 new energy conservation standards to deliver net consumer savings of hundreds of billions of dollars over 30 years and require efficient products across domestic and international manufacturers.
Weatherization Retrofits	Save low-income families money and energy through weatherization retrofits. From FY 2010 through FY 2013, in collaboration with the U.S. Department of Housing and Urban Development, enable the cost-effective energy retrofits of a total of 1.2 million housing units, of which more than 75% are low income.

Explanation of Changes

The FY 2014 EERE Budget Request is $2.8 billion, an increase of $995 million, or 56% above the FY 2012 Current Appropriation. The FY 2014 budget request directly supports the President's energy goals and initiatives.

In the current time of fiscal constraints, it is more important now than ever before that EERE uses the funds appropriated by the Congress as efficiently and carefully as possible. For this reason, and at the direction of Congress, starting in FY 2014 EERE will be fully and uniformly implementing Active Project Management, under which every single competitive project EERE awards going forward will be a cooperative agreement, not a grant, to enable greater EERE oversight; and each will be subject to aggressive annual "go-no go" milestones, rigorous quarterly reviews, and early-termination in the event of insufficient technical performance. The EERE Budget Request includes a modest increase of $20 million to its Program Direction budget to implement these Active Project Management activities and to realize other elements of EERE's Strengthening Operations for Accountability and Results (SOAR) initiative, which is intended to achieve the strongest possible operational efficiency and outcomes, and to ensure that every dollar invested by EERE results in the highest impact possible.

EERE looks forward to working with Congress and other stakeholders to make sure that every dollar spent at EERE is invested in activities that are of the highest impact possible and help ensure that the United States wins the global race for the clean energy manufacturing industries and jobs of the future. The opportunity for the United States to lead the transition to a global clean energy economy is vast and urgent and the need for sustained, strong Federal investment in this area is more important now than it has ever been before.

The principal differences in investments and funding levels from the prior year enacted budget are shown below; additional detail is provided in the respective budget chapters:

Transportation

Vehicles

- Increased funding for battery cost reduction through Innovative manufacturing R&D, scale-up of advanced battery component materials and next-generation "beyond lithium" research (+$70.5 million).
- Increased funding for R&D in higher performance electric drive systems using wide bandgap semiconductors for advanced power electronics (+$35.8 million).
- Increased funding to develop and demonstrate the necessary technologies for transactive communications and controls among electric vehicles, demand responsive buildings, and rooftop solar photovoltaic (PV) behind-the-meter on the distribution grid (+$20.0 million).
- Increased funding to develop integrated computational materials engineering tools for carbon fiber composites and to support advanced aluminum alloy and process development (+$12.6 million).
- Increased funding for Alternative Fuel Vehicle Community Partner Projects (+$90.0 million).
- Increased funding for Vehicle Technologies Incubator to enable the introduction of innovative new technologies into the VT portfolio (+$30.0 million).

Bioenergy

- Additional Feedstock Logistics R&D projects from the FY 2013 FOA, targeting commercial-scale deployment and demonstration equipment, technologies, and systems to deliver high-quality feedstocks (+$11.5 million).
- The Low-Cost Carbon Fiber FOA Initiative will fund R&D on the utilization of components of biomass for the manufacturing of low cost carbon fiber (+20.0 million).
- Defense Production Act (DPA) will support commercial demonstration-scale, military-grade fuel production from biomass in collaboration with USDA and DOE (+$45.0 million).
- Decreased funding for algae and advanced feedstocks activities is the result of fully funding FY 2013 FOA for three-year R&D projects aiming to increase productivity of algae systems and innovative pilot testing on mixotrophic algae technology (-$13.6 million).

Hydrogen

- Increased funding for Hydrogen Fuel research and development (R&D) to focus on improving renewable hydrogen production technologies (e.g., improving electrolyzer stack efficiency and lowering the cost of longer-term technologies using solar resources, including wide bandgap semiconductors) and lowering the carbon fiber composite cost for hydrogen storage vessels (+$4.7 million).

Renewable Electricity

Solar

- Concentrating Solar Power (CSP) funding increase will enable front funding work focusing on thermal storage for solar systems to stabilize input into the grid and smooth out intermittencies; and on development of advanced component technologies' reliability (+$45.1 million).
- Systems Integration funding increase will help develop improved solar power grid integration technologies including power electronics and systems level research on renewables integration, such as a collaboration with the Buildings and Vehicles Technologies programs (with $30.0 million from Solar) to coordinate a systems approach to grid integration (+$16.4 million).
- Balance of Systems Soft Cost Reduction: This funding increase will enable work with state and local governments to reduce permitting, interconnection, inspection, and other soft costs which now account for more than 50% of residential systems costs (+$29.2 million).
- Innovations in Manufacturing Competitiveness: SUNPATH, a program to support Scaling Up Nascent Photovoltaics (PV) At Home with projects fully funded and just underway in FY 2013, will not be run again in FY 2014, pending assessment of the impacts of the existing awards. In FY 2014, the subprogram will continue to fund high priority areas to ensure defensible competitive advantages for domestic manufacturing (-$34.4 million).

Wind

- Technology Development and Testing –This funding increase enables greater focus on wind plant optimization modeling including complex flow analysis, component and system design impacts, and test campaigns, and includes a new initiative on next-generation advanced rotors, including very-large-scale wind rotors. On offshore wind, it includes a new activity

targeted at analysis and development of next-generation offshore wind substructure elements, such as foundations and innovative anchoring, mooring, and cabling solutions (+$26.0 million).
- Technology Application – Technology Application activities will address barriers that will decrease permitting time and costs and will enable realistic estimates for financing purposes through activities such as resource characterization and wind plant optimization, including meso-scale data acquisition and power system flexibility assessment; a grid optimization R&D effort on characterization of current power system flexibility and how to improve the system's ability to integrate more wind energy; new multi-year initiatives to support the research necessary to overcome permitting challenges, develop clear wildlife mitigation plans, and assess potential environmental impacts of first of a kind offshore wind installations (+$17.2 million).

Water
- Marine and Hydrokinetic (MHK) Technologies – Increased funding for RDD&D of full-scale MHK components and systems, the development of world-class test and demonstration infrastructure, and activities supporting the Advanced Manufacturing for MHK Initiative including light-weighting of systems and components (+$5.8 million).
- Hydropower Technologies – Funding will focus on technologies, tools, and sensors to co-optimize generation, flexibility, and environmental performance, and innovative technology development through the Advanced Hydropower funding opportunity announcement. DOE is de-emphasizing activities centered on technology upgrades for the existing hydropower fleet, the Basin Scale Opportunity Assessment, and the Hydropower Research Fellowship (-$8.9 million).

Geothermal
- Increased funding to optimize and validate Enhanced Geothermal Systems (EGS) by initiating a government-managed EGS field lab in addition to strategic EGS research and development (R&D) (+$26.4 million).

End-Use Efficiency

Advanced Manufacturing
- Advanced Manufacturing R&D Facilities subprogram funding increases will support the creation of Clean Energy Manufacturing Innovation Institutes, consistent with the President's vision for a larger multi-agency National Network for Manufacturing Innovation (NNMI). These are shared research facilities where industry and research institutions come together to develop and leverage cutting-edge cross-cutting advanced manufacturing capabilities to develop high-impact commercial manufacturing innovations. This funding increase also supports +$5.6 million for the Critical Materials Energy Innovation Hub relative to the FY 2012 level to develop solutions across the lifecycle of critical materials (+$183.0 million).
- Next Generation R&D Projects subprogram funding increases focus on Advanced Manufacturing R&D projects in foundational cross-cutting manufacturing technologies to dramatically increase U.S. manufacturing energy productivity at the bench and prototype scale (+$60.0 million).
- Industrial Technical Assistance funding increases will help enable the increased deployment of energy efficient manufacturing technologies, including combined heat and power (CHP), across American industry through training programs, site assessments, and standards development (+$9.8 million).

Buildings
- Grid Integration Initiative funding will address the role of buildings in grid integration, focusing on the interrelated barriers associated with variable, distributed renewable energy generators; building efficiency, demand response and electric vehicle charging; and controls (+$30.0 million).
- Emerging Technologies increases will also address high-impact technologies and techniques associated with sensors and controls and with HVAC, lighting, plug and subsystem loads which typically drive energy consumption in buildings (+$35.0 million).
- Equipment and Buildings Standards increases will make a first time investment to explore the potential benefits of commercial product labeling, which can provide purchasers with information on expected product energy performance, expected energy expenditures, and other related material (+$15.0 million).

Weatherization and Intergovernmental

- Weatherization Assistance Program – Formula grants would support 14,000 additional energy retrofits; and full-time employment for a large number of skilled weatherization retrofit professionals will continue with nationwide service delivery and professional retrofit worker training programs (+$92.0 million).
- Weatherization Assistance Program – Competitively select and manage 9–15 high-impact projects on financing models for the retrofit of low-income, multi-family buildings (+$24.0 million).

Corporate Programs

Program Direction

- Increased funding is necessary to promote the federalization of the EERE workforce; to support the Strengthening Operations for Accountability and Results (SOAR) management initiative; and to increase qualified technical and active project management personnel to oversee existing competitively awarded grants and cooperative agreements in all EERE programs (particularly programs with significant additional funding in FY 2014) and the concomitant administrative management costs (+$20.0 million).

Strategic Programs

- The Technology-to-Market (formerly Innovation and Deployment) subprogram will launch a new effort to dramatically increase the rate of clean energy technology commercialization from the national laboratories, including implementation of a new competitive initiative to replicate, enhance, and expand the "LabStart" model (+$7.0 million).
- The Strategic Priorities and Impact Analysis subprogram will ramp up efforts to evaluate EERE's impacts and returns on investments, and support the Clean Energy Manufacturing Initiative's "Clean Energy Manufacturing Strategic Analysis" work (+$4.0 million).

Facilities

- Facilities and Infrastructure program is establishing base support for the NREL Energy Systems Integration Facility (ESIF), including for operations and maintenance, utilities, and core technical staff, to increase facility competitiveness and in turn leverage Federal investment through expanded use by external users (+$20.0 million).

Facilities Maintenance and Repair

The Department's Facilities Maintenance and Repair activities are tied to its programmatic missions, goals, and objectives. Facilities Maintenance and Repair activities funded by this budget are displayed below.

Direct-Funded Maintenance and Repair

(dollars in thousands)

	FY 2012 Actual Cost	FY 2012 Planned Cost	FY 2013 Planned Cost	FY 2014 Request
National Renewable Energy Laboratory	3,300	3,300	—	5,400
Total, Direct-Funded Maintenance and Repair	3,300	3,300	—	5,400

*FY 2013 amount shown reflect the P.L. 112 175 continuing resolution level annualized to a full year. These amounts are shown only at the "congressional control" level and above; below that level, a dash (-) is shown.

Indirect-Funded Maintenance and Repair

(dollars in thousands)

	FY 2012 Actual Cost	FY 2012 Planned Cost	FY 2013 Planned Cost	FY 2014 Request
National Renewable Energy Laboratory	4,000	4,000	—	4,000
Total, Indirect-Funded Maintenance and Repair	4,000	4,000	—	4,000

*FY 2013 amount shown reflect the P.L. 112 175 continuing resolution level annualized to a full year. These amounts are shown only at the "congressional control" level and above; below that level, a dash (-) is shown.

Report on FY 2012 Expenditures for Maintenance and Repair

This report responds to legislative language set forth in Conference Report (H.R. Conf. Rep. No. 108-10) accompanying the Consolidated Appropriations Resolution, 2003 (Public Law 108-7) (pages 886-887), which requests the Department of Energy provide an annual year-end report on maintenance expenditures to the Committees on Appropriations. This report compares the actual maintenance expenditures in FY 2012 to the amount planned for FY 2012, including directed changes.

Total Costs for Maintenance and Repair

(dollars in thousands)

	FY 2012 Actual Cost	FY 2012 Planned Cost
National Renewable Energy Laboratory	7,300	7,300
Total, Maintenance and Repair	7,300	7,300

Small Business Innovation Research/Small Business Technology Transfer (SBIR/STTR)

(dollars in thousands)

	FY 2012 Current	FY 2013 Annualized CR	FY 2014 Request
Vehicle Technologies	7,842	—	13,149
Bioenergy Technologies	0	—	5,088
Biomass & Biorefinery Systems R&D	4,281	—	0
Hydrogen & Fuel Cell Technologies	2,298	—	2,404
Solar Energy	4,249	—	5,905
Wind Energy	1,441	—	4,608
Water Energy	711	—	1,760
Geothermal Technologies	883	—	1,920
Advanced Manufacturing	0	—	10,295
Industrial Technologies	2,888	—	0
Federal Energy Management Program	0	—	0
Building Technologies	4,498	—	6,976
Weatherization and Intergovernmental Programs	0	—	0
Program Direction	0	—	0
Strategic Program	0	—	0
Facilities and Infrastructure	0	—	0
Total, SBIR/STTR	29,091	33,332	52,105

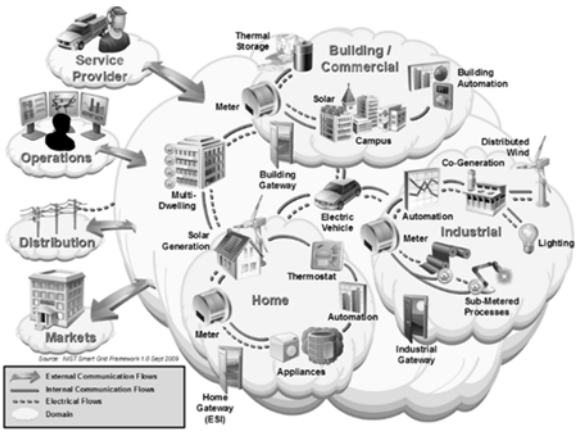
Supplemental Information

Grid Integration Initiative: Programs within EERE are working diligently with industry to make clean energy technologies, such as solar, wind, electric vehicles, and building energy technologies, more commercially viable in the marketplace. However, cost reduction alone will not enable large-scale deployment. During the DOE Distribution Workshop, presented by the DOE's interoffice Grid Tech Team on September 24-26, 2012 in Washington, D.C., national stakeholders emphasized the need to develop a more flexible distribution system. Elements of this system include:

- Interoperability,
- Communication,
- Dynamic Models,
- Distribution Optimization, and
- Value Propositions.

EERE's role is to develop and validate technologies, tools, and approaches that overcome barriers associated with integration of EERE technologies into this distribution system, so that key stakeholders achieve the confidence within their risk tolerance necessary to install high penetrations of clean energy technologies while maintaining grid reliability.

As clean energy and energy-efficient technologies become more prevalent on the customer side of the meter, seamlessly integrating the many EERE technologies into the electrical grid is critical to ensure that utilities can continue to operate the grid in a safe, reliable, and cost-effective manner. The NIST figure shows the envisioned interaction and balancing of supply and load amongst commercial buildings, homes, electric vehicles, distributed generation and/or co-generation and industrial processes for a modernized grid.



If we do not develop a holistic approach to integrate clean energy and energy-efficient technologies into distribution systems, they will not be adopted by utilities or the marketplace at the scale necessary to achieve significant energy, economic, and environmental benefits.

To address this immediate challenge, EERE has developed a high-priority, multi-program initiative in the FY 2014 budget that includes $80 million for addressing barriers associated with the deployment of variable, distributed renewable energy generators, electric vehicle charging, and building efficiency and controls. See individual program budgets (Solar, Vehicles, Buildings) for further details. An enhanced and robust distribution system will be a critical enabler for the increased deployment of these clean energy resources and energy-efficient systems. The technical and institutional challenges of grid integration are amplified by the need to simultaneously deploy existing technologies in a legacy system, while establishing conditions that can best incorporate emerging technologies into a cohesive distribution system. EERE's investment is essential to demonstrate that "grid integration barriers" associated with EERE technologies can be overcome so that utilities, public utility commissions, and other stakeholders will have confidence that clean energy technologies can be installed at a relevant scale, while maintaining or improving grid reliability. The activity proposed here will be coordinated with the DOE Grid Technical Team and OE to ensure optimal use of total DOE resources.

EERE proposes a joint funding opportunity announcement (FOA) sponsored by various programs and offices to solicit key market participants, such as both investor and publicly owned utilities with a substantial deployment of PV systems, electric vehicles, and building energy technologies. These entities will partner with national laboratories, industry, and other innovators to develop and further advance the platform of technologies necessary to address grid integration barriers and opportunities associated with EERE technologies. Applicants with significant deployment of EERE technologies, an effective project plan, a replicable and scalable model, and defined deliverables will be given a higher priority in the selection criteria of the solicitation. No funding will be available for the purchase of distributed generation, electric vehicles, or charging stations. Funding will only be available for technologies, tools, and system integration activities that enable the integration of clean energy technologies such as upgrades to building management systems. Awardees will be required to provide a minimum of 50% cost share with higher priority given to those who exceed this requirement. In addition to the solicitation, DOE proposes work directly with the national laboratories

based on an evaluation of how their capabilities and research facilities can help solve this grid integration challenge. For instance, the FY 2013 completion of the Energy Systems Integration Facility at NREL makes available new capabilities for improving clean energy integration into the distribution system. Through this joint effort, DOE will maximize the beneficial impact of its R&D investments, enabling widespread deployment of clean energy technologies across the distribution system.

The solicitation will emphasize the following topic areas:

- Systems Optimization: Develop controls and associated system architectures for clean energy systems needed to manage a diverse set of customer-side resources and grid assets, in order to improve their integration into the distribution system; develop associated algorithms that enable optimization across multiple objectives, including, but not limited to, conservation voltage reduction and ensuring power quality.
- High Resolution Data: Building-wide or system-wide data will not be sufficient for a highly automated building. The metrics are too broad and vague. To optimize building performance and to transact with the grid, successful solutions require building data that is relevant to the product or service that is being provided with regard to the purpose the building serves (e.g., a refrigerated distribution center for foods vs multi-family housing unit);
- Data Analytics/Tools: Data 'mining' to improve performance or forecast the value of transactions is necessary to support a fluid and vibrant building-to-grid (B2G) data sharing network. A critical component of any solution in building automation is predictive analytics that identifies trends in how the building is performing or being used inferring relationships between variables and creating rules to predict how the building performs under different scenarios;
- Sensors: Collect higher resolution measurements on clean energy systems at strategic locations to determine real-time impacts on the feeder. Customer-side assets and managements systems will also need additional sensors and metering. A key issue that impedes broad scale deployment of even existing sensors is total cost (both device and installation). Scalable solutions that develop accurate, reliable, and low cost, wireless, and power harvesting sensors would be needed;
- Open Architecture Building Energy Control Systems: A comprehensive, open architecture building energy control system solution would provide capabilities that enable properly implemented applications to run on a variety of platforms from multiple vendors, interoperate with other systems applications, and present a consistent style of interaction with the user.
- Owner Economics: Explore and evaluate the value proposition presented by the various clean energy technologies in terms of grid reliability, ancillary services, etc. observed over the course of the project; explore mechanisms to incentivize owner market participations to create grid support business opportunities.
- Protection and Restoration: Develop protection schemes associated with the various clean energy technologies that can accommodate two-way power flow with existing protection equipment (fuses, circuit breakers, reclosers, etc.); management algorithms, which improve restoration times or mitigate failures are also desired.

Clean Energy Manufacturing Initiative (CEMI): The American manufacturing sector as a whole is a significant and strategic sector for U.S. competitiveness. This sector fuels 12% of U.S. GDP, provides good jobs, and makes an outsized contribution to the technological leadership of the nation, accounting for 70% of private-sector R&D investment, 60% of exports, and the largest portion of patents issued. It is crucial that we leverage clean energy manufacturing innovations and practices to benefit the manufacturing sector as a whole, including investments in advanced manufacturing R&D that give the United States a clear technological advantage, as well as investments that help manufacturers to grow their energy productivity and become more energy competitive.

CEMI represents a strategic integration of manufacturing efforts across EERE's technology programs and includes an increase in funding for the Advanced Manufacturing Office, and it focuses on American competitiveness in clean energy manufacturing. CEMI objectives are to:

- Increase U.S. competiveness in the production of clean energy products – Strategically invest in technologies that leverage American competitive advantages and overcome competitive disadvantages.
- Increase U.S. manufacturing competitiveness across the board by increasing energy productivity – Strategically invest in technologies and practices to enable U.S. manufacturers to increase their competitiveness through energy efficiency,

combined heat and power, and taking more efficient advantage of low-cost domestic energy sources.

CEMI will conduct the following activities in FY 2014:

- Manufacturing R&D: Provide increased funding for manufacturing R&D across the board, specifically with the goal of growing clean energy manufacturing in the U.S., including new Clean Energy Manufacturing Innovation Institutes, and new funding opportunities in several of EERE's technology programs. These include the following:
  - R&D investments to reduce manufacturing costs of specific clean energy products.
    - Solar: Funds for SolarMat II that focuses on innovations in manufacturing technologies that can provide the US defensible competitive advantages across the solar energy value chain
    - Wind: Funds for next generation components and assembly automation techniques
    - Water: Funds for a "design for manufacturing" initiative which will reduce LCOE and help increase volume production by testing and applying high strength, light-weight materials
    - Hydrogen and Fuel Cells: Funds for efforts to develop improved fabrication processes for low-cost high volume production.
    - Vehicles: Funds for efforts in lower cost battery and electric vehicle components' manufacturing.
    - Buildings: Funds for efforts to achieve a 15% reduction in manufacturing cost of a warm-light LED package and other manufacturing cost reduction high-impact technologies.
  - R&D in cross-cutting manufacturing platform technologies to make U.S. manufacturers more competitive.
    - Next Generation Manufacturing R&D projects focuses on foundational manufacturing processes and materials.
    - New Clean Energy Manufacturing Innovation Institutes.
    - Funding for Bioenergy efforts in supply chain analysis and bio-based product development such as carbon fiber.

- Energy Productivity in the Manufacturing Sector: Ensure an increased focus on energy productivity resources for manufacturers through a suite of technical assistance and market leadership programs that include the following:
  - Better Buildings, Better Plants Program
  - ISO/ANSI Standards Certification
  - Combined Heat and Power (CHP) Technical Assistance Partnerships (formerly known as the Clean Energy Application Centers)
  - Industrial Assessment Centers.
- Competitiveness Analysis: Continued implementation of EERE's "Clean Energy Manufacturing Strategic Analysis" effort. This unprecedented analysis evaluates the costs of producing clean energy products in the United States compared to competitor nations to understand factory location decisions and identify key drivers to U.S. clean energy manufacturing competitiveness. It will inform EERE R&D investments and other efforts needed to address key barriers to growing U.S. clean energy manufacturing competitiveness.
- Clean Energy Manufacturing Portal: Deploy a Clean Energy Manufacturing Portal that will aggregate resources to help U.S. manufacturers succeed in clean energy sectors.
- Regional Summits: Hold a limited number of regional and national summits to gain input on national and regional priorities, identify key gaps and opportunities for growing U.S. clean energy manufacturing competitiveness, showcase U.S. clean energy manufacturing activity, and explore national and regional models addressing these priorities.
- Inter-Agency & Thought Leader Partnerships: Engage in new partnerships to improve U.S. clean energy manufacturing competitiveness. Growing U.S. clean energy manufacturing competitiveness requires an "all hands on deck" approach, with the nation's private and public sectors, universities, think tanks, and labor leaders working together to identify and commit to a path forward. EERE has already established an initial partnership with the Council on Competitiveness to convene the nation's private and public-sector leaders around energy and manufacturing competitiveness

By making smart investments to grow competitive advantages and overcome competitive disadvantages, EERE can increase U.S. competitiveness in manufacturing, helping industry create and sustain good jobs, returning economic value to the American taxpayer, and accelerating the innovation cycle to drive down the costs of renewable energy and energy efficiency technologies.

Office of Energy Efficiency and Renewable Energy
Funding by Site by Program

(dollars in Thousands)

	FY 2012 Current	FY 2013 Annualized CR[a]	FY 2014 Request
Ames Laboratory			
Vehicle Technologies	2,750	—	2,400
Industrial Technologies	0		0
Advanced Manufacturing[b]	0	—	25,000
Total, Ames Laboratory	2,750	—	27,400
Argonne National Laboratory			
Vehicle Technologies	42,657	—	40,000
Biomass and Biorefinery Systems R&D	2,595	—	0
Bioenergy Technologies[c]	0	—	3,000
Hydrogen & Fuel Cell Technologies	7,020	—	6,900
Solar Energy	3,558	—	331
Wind Energy	540	—	847
Water Power	3,135	—	1,200
Geothermal Technology	645	—	367
Industrial Technologies	1,750	—	0
Advanced Manufacturing	0	—	1,500
Building Technologies	871	—	200
Strategic Programs	150	—	200
Total, Argonne National Laboratory	62,921	—	54,545
Brookhaven National Laboratory			
Vehicle Technologies	1,854	—	1,800
Biomass and Biorefinery Systems R&D	351	—	0
Hydrogen & Fuel Cell Technologies	1,500	—	1,500
Geothermal Technology	327	—	186
Total, Brookhaven National Laboratory	4,032	—	3,486
Chicago Operations Office			
Vehicle Technologies	124	—	0
Wind Energy	50	—	50
Total, Chicago Operations Office	174	—	50
Golden Field Office			
Biomass and Biorefinery Systems R&D	133,746	—	0
Bioenergy Technologies	0	—	199,500
Hydrogen & Fuel Cell Technologies	49,340	—	48,700

[a] FY 2013 amounts shown reflect the P.L. 112 175 continuing resolution level annualized to a full year. These amounts are shown only at the "congressional control" level and above; below that level, a dash (—) is shown.
[b] Industrial Technologies, renamed Advanced Manufacturing in FY 2014.
[c] Biomass & Biorefinery Systems R&D, renamed Bioenergy Technologies in FY 2014.

	(dollars in Thousands)		
	FY 2012 Current	FY 2013 Annualized CR[a]	FY 2014 Request
Solar Energy	182,532	—	244,889
Wind Energy	33,154	—	51,840
Water Power	30,703	—	34,725
Geothermal Technology	5,333	—	42,000
Industrial Technologies	62,451	—	0
Advanced Manufacturing	0	—	55,000
Federal Energy Management Program	2,008	—	2,596
Building Technologies	3,340	—	18,781
Weatherization & Intergovernmental Programs	78,795	—	49,100
Program Direction	30,944	—	36,200
Strategic Programs	2,325	—	13,275
Total, Golden Field Office	614,671	—	796,606
Idaho National Laboratory			
Vehicle Technologies	10,410	—	11,000
Biomass and Biorefinery Systems R&D	8,530	—	0
Bioenergy Technologies	0	—	7,000
Wind Energy	400	—	626
Water Power	300	—	0
Geothermal Technology	1,648	—	938
Industrial Technologies	402	—	0
Advanced Manufacturing	0	—	2,500
Federal Energy Management Program	310	—	401
Strategic Programs	100	—	0
Total, Idaho National Laboratory	22,100	—	22,465
Lawrence Berkeley National Laboratory			
Vehicle Technologies	15,136	—	17,000
Biomass and Biorefinery Systems R&D	3,000	—	0
Bioenergy Technologies	0	—	1,500
Hydrogen & Fuel Cell Technologies	3,800	—	3,800
Solar Energy	0	—	1,724
Wind Energy	500	—	785
Geothermal Technology	5,013	—	2,851
Industrial Technologies	2,562	—	0
Advanced Manufacturing	0	—	1,200
Federal Energy Management Program	3,440	—	4,447
Building Technologies	29,000	—	21,058
Weatherization & Intergovernmental Programs	477	—	550
Strategic Programs	825	—	3,265
Total, Lawrence Berkeley National Laboratory	63,753	—	58,180
Lawrence Livermore National Laboratory			
Geothermal Technology	2,728	—	1,552
Hydrogen & Fuel Cell Technologies	1,490	—	1,500

	(dollars in Thousands)		
	FY 2012 Current	FY 2013 Annualized CR[a]	FY 2014 Request
Industrial Technologies	0	—	0
Advanced Manufacturing	0	—	2,000
Wind Energy	350	—	0
Vehicle Technologies	3,650	—	3,000
Total, Lawrence Livermore National Laboratory	8,218	—	8,052
Los Alamos National Laboratory			
Vehicle Technologies	1,070	—	800
Biomass and Biorefinery Systems R&D	0	—	0
Bioenergy Technologies	0	—	2,000
Hydrogen & Fuel Cell Technologies	7,700	—	7,600
Solar Energy	0	—	818
Wind Energy	400	—	0
Geothermal Technology	1,387	—	789
Advanced Manufacturing	0	—	2,000
Weatherization & Intergovernmental Programs	100	—	0
Total, Los Alamos National Laboratory	10,657	—	14,007
National Energy Technology Laboratory			
Vehicle Technologies	139,749	—	140,000
Geothermal Technology	3,103	—	1,765
Industrial Technologies	17,833	—	0
Advanced Manufacturing	0	—	4,500
Building Technologies	42,445	—	36,441
Weatherization & Intergovernmental Programs	500	—	0
Program Direction	15,508	—	13,900
Strategic Programs	0	—	0
Total, National Energy Technology Laboratory	219,138	—	196,606
National Renewable Energy Laboratory			
Vehicle Technologies	23,815	—	25,000
Biomass and Biorefinery Systems R&D	29,657	—	0
Bioenergy Technologies	0	—	40,000
Hydrogen & Fuel Cell Technologies	12,070	—	11,900
Solar Energy	56,378	—	57,713
Wind Energy	35,902	—	56,160
Water Power	4,843	—	4,750
Geothermal Technology	4,465	—	2,540
Industrial Technologies	732	—	0
Advanced Manufacturing	0	—	1,200
Federal Energy Management Program	6,010	—	7,770
Building Technologies	34,612	—	15,257
Weatherization & Intergovernmental Programs	2,125	—	1,650
Strategic Programs	9,164	—	8,610
Facilities and Infrastructure	26,311	—	46,000

	(dollars in Thousands)		
	FY 2012 Current	FY 2013 Annualized CR[a]	FY 2014 Request
Total, National Renewable Energy Laboratory	246,084	—	278,550
Oak Ridge Institute for Science and Education			
Vehicle Technologies	443	—	0
Strategic Programs	2,281	—	0
Total, Oak Ridge Institute for Science and Education	2,724	—	0
Oak Ridge National Laboratory			
Vehicle Technologies	47,273	—	45,000
Biomass and Biorefinery Systems R&D	2,847	—	0
Bioenergy Technologies	0	—	4,500
Hydrogen & Fuel Cell Technologies	4,620	—	4,600
Solar Energy	0	—	1,297
Wind Energy	250	—	400
Water Power	5,255	—	1,510
Geothermal Technology	941	—	535
Industrial Technologies	24,811	—	0
Advanced Manufacturing	0	—	21,000
Federal Energy Management Program	2,124	—	2,746
Building Technologies	17,190	—	11,771
Weatherization & Intergovernmental Programs	300	—	1,400
Strategic Programs	1,005	—	625
Total, Oak Ridge National Laboratory	106,616	—	95,384
Oak Ridge Operations Office			
Vehicle Technologies	399	—	0
Biomass and Biorefinery Systems R&D	618	—	0
Bioenergy Technologies	0	—	0
Wind Energy	0	—	900
Water Power	0	—	230
Geothermal Technology	654	—	372
Industrial Technologies	0	—	0
Advanced Manufacturing	0	—	650
Building Technologies	1,533	—	0
Strategic Programs	300	—	390
Total, Oak Ridge Operations Office	3,504	—	2,542
Pacific Northwest National Laboratory			
Vehicle Technologies	9,897	—	9,000
Biomass and Biorefinery Systems R&D	12,650	—	0
Bioenergy Technologies	0	—	18,000
Hydrogen & Fuel Cell Technologies	3,580	—	3,500
Wind Energy	999	—	2,200
Water Power	3,867	—	1,448
Geothermal Technology	1,239	—	705

	(dollars in Thousands)		
	FY 2012 Current	FY 2013 Annualized CR[a]	FY 2014 Request
Industrial Technologies	350	—	0
Advanced Manufacturing	0	—	200
Federal Energy Management Program	2,478	—	3,204
Building Technologies	33,691	—	21,694
Strategic Programs	767	—	1,820
Total, Pacific Northwest National Laboratory	69,518	—	61,771
Sandia National Laboratories			
Vehicle Technologies	11,130	—	11,000
Biomass and Biorefinery Systems R&D	0	—	0
Bioenergy Technologies	0	—	4,000
Hydrogen & Fuel Cell Technologies	3,380	—	3,300
Solar Energy	19,525	—	14,943
Wind Energy	9,540	—	14,400
Water Power	7,159	—	4,435
Geothermal Technology	6,290	—	3,578
Industrial Technologies	1,425	—	0
Federal Energy Management Program	154	—	199
Building Technologies	1,063	—	566
Weatherization & Intergovernmental Programs	825	—	500
Total, Sandia National Laboratories	60,491		56,921
Savannah River National Laboratory			
Vehicle Technologies	300	—	0
Biomass and Biorefinery Systems R&D	0	—	0
Bioenergy Technologies	0	—	500
Hydrogen & Fuel Cell Technologies	3,790	—	3,700
Solar Energy	0	—	1,360
Wind Energy	191	—	300
Federal Energy Management Program	15	—	19
Total, Savannah River National Laboratory	4,296	—	5,879
Washington Headquarters			
Vehicle Technologies	10,309	—	269,000
Biomass and Biorefinery Systems R&D	1,001	—	0
Bioenergy Technologies	0	—	2,000
Hydrogen & Fuel Cell Technologies	3,036	—	3,000
Solar Energy	22,709	—	33,425
Wind Energy	9,537	—	15,492
Water Power	2,814	—	6,702
Geothermal Technology	3,206	—	1,822
Industrial Technologies	376	—	0
Advanced Manufacturing	0	—	248,250
Federal Energy Management Program	13,352	—	14,618
Building Technologies	50,961	—	174,232

(dollars in Thousands)

	FY 2012 Current	FY 2013 Annualized CR[a]	FY 2014 Request
Weatherization & Intergovernmental Programs	44,878	—	194,800
Program Direction	118,548	—	134,900
Strategic Programs	8,083	—	7,815
Total, Washington Headquarters	288,810	—	1,106,056
Total, Energy Efficiency and Renewable Energy	1,790,457	1,830,683	2,788,500

Vehicle Technologies
Funding Profile by Subprogram and Activities

(dollars in thousands)

	FY 2012 Current	FY 2013 Annualized CR*	FY 2014 Request
Batteries and Electric Drive Technology			
Battery/Energy Storage R&D	89,934	—	170,500
Advanced Power Electronics and Electric Motors R&D	27,806	—	69,700
Total, Batteries and Electric Drive Technology	117,740	—	240,200
Vehicle and Systems Simulation & Testing	47,198	—	70,000
Advanced Combustion Engine R&D			
Combustion and Emission Control	49,320	—	54,500
Solid State Energy Conversion	8,707	—	5,000
Total, Advanced Combustion Engine R&D	58,027	—	59,500
Materials Technology			
Propulsion Materials Technology	12,576	—	10,000
Lightweight Materials Technology	27,284	—	49,500
High Temperature Materials Laboratory	970	—	0
Total, Materials Technology	40,830	—	59,500
Fuels and Lubricant Technologies	17,904	—	17,500
Outreach, Deployment and Analysis			
Graduate Automotive Technology Education (GATE)	995	—	0
Advanced Vehicle Competitions	1,992	—	2,000
Legislative and Rulemaking	1,992	—	2,000
Vehicle Technologies Deployment	27,876	—	118,800
Biennial Peer Reviews	3,500	—	500
Legacy Fleet Improvements	2,912	—	3,000
Total, Outreach, Deployment and Analysis	39,267	—	126,300
NREL Site-Wide Facility Support	0	—	2,000
Total, Vehicle Technologies	320,966	330,819	575,000

*FY 2013 amounts shown reflect the P.L. 112 175 continuing resolution level annualized to a full year. These amounts are shown only at the "congressional control" level and above; below that level, a dash (—) is shown.

SBIR/STTR:
- FY 2012 Transferred: SBIR: $6,911,990; STTR: $930,460
- FY 2013 Annualized CR Transferred: SBIR: $150,000
- FY 2013 Annualized CR: SBIR: $7,156,713; STTR: $947,167
- FY 2014 Request: SBIR: $11,505,200; STTR: $1,643,600

FY 2014 Program Summary

- Increased funding for battery cost reduction through Innovative manufacturing R&D, scale-up of advanced battery component materials and next-generation "beyond lithium" research (+$70.5 million).
- Increased funding for R&D in higher performance electric drive systems using wide bandgap semiconductors for advanced power electronics (+$35.8 million).
- Increased funding to develop and demonstrate the necessary technologies for transactive communications and controls among electric vehicles, demand responsive buildings, and rooftop solar photovoltaic (PV) behind-the-meter on the distribution grid (+$20.0 million).
- Complete wind-down of High Temperature Materials Laboratory User Facility, which is no longer central to meeting VT objectives (-$1.0 million).
- Increased funding to develop integrated computational materials engineering tools for carbon fiber composites and to support advanced aluminum alloy and process development (+$12.6 million).

- Increased funding for Alternative Fuel Vehicle Community Partner Projects (+$90.0 million).
- Increased funding for Vehicle Technologies Incubator to enable the introduction of innovative new technologies into the VT portfolio (+$30.0 million).

Overview

Transportation accounts for two-thirds of U.S. petroleum use, and on-road vehicles are responsible for 80 percent of this amount. Our dependence on oil for transportation affects our national economy and individual wallets. We continue to send nearly $1 billion a day overseas for oil, and Americans currently pay nearly $4 per gallon at the pump. The U.S. Department of Energy's (DOE's) first Quadrennial Technology Review clearly states that, "dependence on petroleum creates significant economic, security, and environmental challenges."[a]

To address this pressing energy and economic challenge and help Americans reduce their energy costs, there are two solution pathways: we could use conventional fuels more efficiently or replace them with less expensive, domestically-produced alternatives. In support of DOE's goal to provide clean and secure energy in the future, the program invests in R&D that advances both solutions—by developing and deploying cutting-edge advanced highway transportation technologies that reduce petroleum consumption and greenhouse gas emissions, while meeting or exceeding vehicle performance and cost expectations. Public investment in these technologies will improve our nation's energy security and strengthen our economic competiveness in the global clean energy race.

Aligning with the President's all-of-the-above approach to American energy, the program supports a broad technology portfolio; adheres to a comprehensive and analysis-based strategy of research, development, demonstration, and technology-to-market activities; and relies on strategic partnerships to accelerate the movement of technologies from the laboratory to the showroom and onto the road. Key elements of the program's approach include the following:

- Research and development that focuses on reducing the cost and improving the performance of a mix of near- and long-term vehicle technologies including advanced batteries, power electronics and electric motors, lightweight and propulsion materials, advanced combustion engines, advanced fuels and lubricants, and other enabling technologies; the program is coordinating and supporting advanced vehicle manufacturing investments as part of EERE's cross-program Clean Energy Manufacturing Initiative (CEMI).
- Modeling, evaluation, and demonstration activities that provide objective, publicly-available data to identify pathways for technology improvements and lessons learned cost-effective future deployment.
- Outreach and deployment that provides technical assistance, tools, and resources to help local communities accelerate alternative fuel vehicle and infrastructure market growth, and help consumers and fleets understand their options for saving money on fuel.
- Research partnerships with industry that leverage technical expertise, prevent duplication, ensure public funding remains focused on the most critical barriers to technology commercialization, and accelerate progress, while strategic partnerships with end-users and other key stakeholders focus on market barriers and catalyze action to enable the widespread use of advanced technology vehicles – at no additional cost to the government.
- Close coordination with others across the DOE complex – national laboratories, and DOE's Office of Science, Office of Electricity Delivery and Energy Reliability, and the Advanced Research Projects Agency – Energy ARPA - E – ensures the effective use of resources while avoiding duplication, and enables the transfer of successful technologies across the research and development continuum.

Collectively, program activities focus on achieving the following high-level goals:

- Saving 1.8 million barrels per day of highway petroleum use by 2020 (compared to EIA's AEO-projected baseline in 2020 of 11.2 million barrels per day).
- Developing cost-effective technologies to improve new vehicle fuel efficiency and achieve a corporate average fuel economy (CAFE) standard of 144 gCO_2/mi (61.6 miles per gallon (mpg)) for cars and 203 gCO_2/mi (43.7 mpg) for light trucks by 2025 (54.5 mpg light duty average).

The program's budget request supports several key cross-cutting initiatives that contribute to achieving its high-level goals:

- The EV Everywhere Grand Challenge, a bold DOE-wide initiative which seeks to make the United States the first country to produce a wide array of plug-in electric vehicle models (PEVs, including plug-in hybrids and all-electric vehicles) that are as

[a] http://energy.gov/sites/prod/files/ReportOnTheFirstQTR.pdf

affordable and convenient as the gasoline powered vehicles we drive today by 2022.
  - Accelerates research and development (R&D) on advanced battery technology, with a major concentration on advanced battery materials, design optimization, and manufacturing innovations to significantly improve performance and reduce system cost. Current PEV battery costs are approximately $500/kWh, while our analysis indicates that costs in the range of $300-$125/kWh are required for a broad range of PEVs to be cost-competitive with gasoline powered vehicles. Achieving these aggressive cost targets will require significant research, development, and innovation going forward.
  - Pursues new opportunities in additional research to dramatically improve the performance and lower the cost of power electronics through wide bandgap semiconductors (in support of the EERE Wide Bandgap Semiconductors for Clean Energy Initiative and in coordination with CEMI), and improved motor technologies that eliminate and/or reduce the use of critical materials, like rare earth metals.
  - Includes the Workplace Charging Challenge, one of the newest activities in this portfolio, which aims to enable a tenfold increase in the number of U.S. employers offering workplace charging over the next 5 years – significantly increasing the convenience of PEVs and providing consumers with a variety of charging options.
- The SuperTruck Initiative aims to develop technologies to improve the fuel economy (freight hauling efficiency) of heavy-duty, class 8 long-haul vehicles by 50 percent by 2015 with respect to a comparable 2009 vehicle. SuperTruck project teams are using a variety of approaches to meet this goal, and have made significant progress in the areas of engine efficiency and emission control, advanced transmissions and hybridization, aerodynamic drag of the tractor and trailer, tire rolling resistance, light-weight materials, and Auxiliary Power Units to reduce engine idling.
- Alternative Fuel Vehicle Community Partner Projects, a new effort the program proposes in FY 2014, will greatly accelerate the introduction and adoption of natural gas vehicles, PEVs, and other alternative fuels through community-based, highly-leveraged government/industry partnerships to introduce alternative fuel and advanced vehicles at scale. These competitively-awarded projects will establish model communities that can be replicated across the country, demonstrate sustainability beyond the initial Federal commitment, and encourage private-sector leadership and investment. (Details are provided in program's Outreach, Deployment and Analysis subprogram justification.)
- Grid Integration Initiative: The program will coordinate with EERE's Building Technologies Program and Solar Energy Technologies Program to develop and advance the platform of technologies necessary to fully integrate PEVs and other clean energy technologies into the distribution system in a safe, reliable, and cost-effective manner. (Details are provided in the grid integration introduction in the EERE budget highlights as well as Vehicle Technologies' Vehicle and Systems Simulation & Testing subprogram justification).
- Incubator Programs: The great majority of EERE investments are currently, and must going forward, be primarily driven by detailed short, medium, and long-term RDD&D roadmaps. EERE proposes Incubator activities in the FY 2014 budget, and designed them to use a small fraction of EERE's technology office's annual R&D budget to regularly introduce potentially high-impact "off-roadmap" new technologies. These Incubator activities will enable the "rapid on-ramping" of potentially transformational new energy technologies into the EERE portfolio, dramatically increasing the rate of technology innovation.

Technology Status, Program Accomplishments and Near-Term Milestones[a]

Technological achievements the program supports are helping to transform the U.S. transportation sector, saving U.S. families and businesses money by reducing fuel costs and providing them with a range of fuel choices that are more efficient and environmentally friendly. Accomplishments include the following:

- Most hybrid electric vehicles sold in the United States today use EERE-developed battery technology.[b] The program's efforts to improve nickel-metal hydride (NiMH) batteries resulted in fuel efficiency improvements of up to 50 percent compared to similar non-hybrid vehicles. Additionally, R&D the program supported has helped discover and optimize new technologies for lithium-ion batteries that reduce battery size and weight

[a] For a list of milestones please see "Strategic Performance Management by Program" section.

[b] "Linkages of DOE's Energy Storage R&D to Batteries and Ultracapacitors for Hybrid, Plug-in Hybrid and Electric Vehicles." U.S. DOE, February 2008

compared to NiMH technology by 25-35 percent; these technologies are entering the market.

- PEV battery technologies' cost-competitiveness has improved. Program-supported R&D enabled a greater than 50 percent cost reduction for automotive lithium-ion batteries between 2008 and 2012.[a] The program has helped reduce the high volume production cost of high-energy, high-power batteries from $1,200/kWh in 2008 to $500/kWh in 2012, with a goal of reaching $300/kWh by 2014 and $125/kWh by 2022—which if achieved, will make a wide range of PEVs directly cost-competitive with conventional vehicles in the next 5-10 years. Breakthrough mixed-metal cathode material invented at DOE's Argonne National Laboratory through a decade of sustained program support is enabling 50% more energy storage capacity. Material has been licensed by several companies including a startup company that announced it had achieved a breakthrough that would enable twice the battery energy density of current lithium-ion batteries and, as a result, has the potential to reduce their cost by more than half.
- Reduced fuel costs for heavy-duty trucks to help U.S. businesses save money. The program's SuperTruck Initiative demonstrated a 20% engine efficiency improvement in the laboratory and one SuperTruck awardee showed a 54% improvement in fuel economy and a 61% improvement in freight efficiency. The SuperTruck Initiative is on track and expects to exceed its 50% freight efficiency improvement goal by 2015.
- Generated $70.2 billion (2008 dollars) in total benefits from vehicles combustion engine R&D due to fuel savings for users of heavy-duty diesel trucks and associated monetized health benefits, based on $931 million invested by DOE from 1986 to 2007.[b]
- Decreased the dependence on oil for transportation in many local communities. Since 1993, the EERE-supported Clean Cities Initiative has grown to a national network of nearly one hundred local coalitions, which have collectively displaced more than 4.5 billion gallons of gasoline.[c] These coalitions have helped deploy thousands of alternative fuel vehicles and the fueling stations needed to serve them, aided in the elimination of millions of hours of vehicle idling, and helped accelerate the entry of electric-drive vehicles into the marketplace.
- Established public/private partnerships to accelerate advanced transportation technologies. The program has worked with stakeholders to identify critical needs and establish partnerships that accelerate progress by leveraging expertise and catalyzing action–at no additional cost to the government.
  - Through the National Clean Fleets Partnership, the Clean Cities initiative collaborates with large private vehicle fleets to reduce their fuel use and save money. To achieve the highest impact, the partnership focuses on the nation's largest corporate fleets and has grown from less than 5 partners at its launch in April 2011 to include 21 partners as of March 2013.
  - The Workplace Charging Challenge calls upon America's employers in all sectors of the economy to provide PEV charging access at worksites across the country. Launched in January 2013 with 13 partners and 8 ambassador stakeholder groups, the challenge more than doubled its participation in its first two months.

Program Planning and Management

In order for clean highway technologies to make an appreciable reduction in petroleum consumption and GHG emissions, advanced vehicle technology performance must be improved and costs must be reduced. Analysis shows (see chart) that the program's combined portfolio of technologies could reduce petroleum consumption by nearly 40 percent from projected 2030 levels in the Annual Energy Outlook (AEO) 2011.[d] Investment in advanced vehicle technologies, like vehicle electrification, will yield the technologies necessary for alternative fuel vehicles with sufficiently long ranges, sufficiently low costs, and broad consumer appeal to result in significant market penetration potential. For example, based on program

[a] Based on projection to high volume manufacturing of battery prototypes that meet or exceed performance requirements using a peer reviewed cost model, and on proprietary data submitted by battery companies participating in the U.S. Advanced Battery Consortium.

[b] Valued in inflation adjusted 2008 dollars; "Retrospective Benefit-Cost Evaluation of U.S. DOE Vehicle Combustion Engine R&D Investments: Impacts of a Cluster of Energy Technologies," U.S. DOE, May 2010. The investment of $931M includes some funds from the Office of Science.

[c] As reported by program partners and based on measured and estimated impacts. http://www1.eere.energy.gov/cleancities/accomplishments.html

[d] Available at: http://www.eia.gov/forecasts/aeo/.

analyses of technology and cost potential and subsequent vehicle system modeling and simulation, the superior on-board efficiencies of PEVs could contribute to an 18 percent reduction in petroleum consumption compared to an AEO-projected 2030 baseline case assuming the use of low-carbon electricity.

Through strategic planning, analysis, and stakeholder engagement, the program identifies primary technical barriers and high-impact opportunities for improved vehicle efficiency and petroleum displacement that are most appropriate for Federal funding. The program prioritizes its work according to EERE's "5 Core Questions":

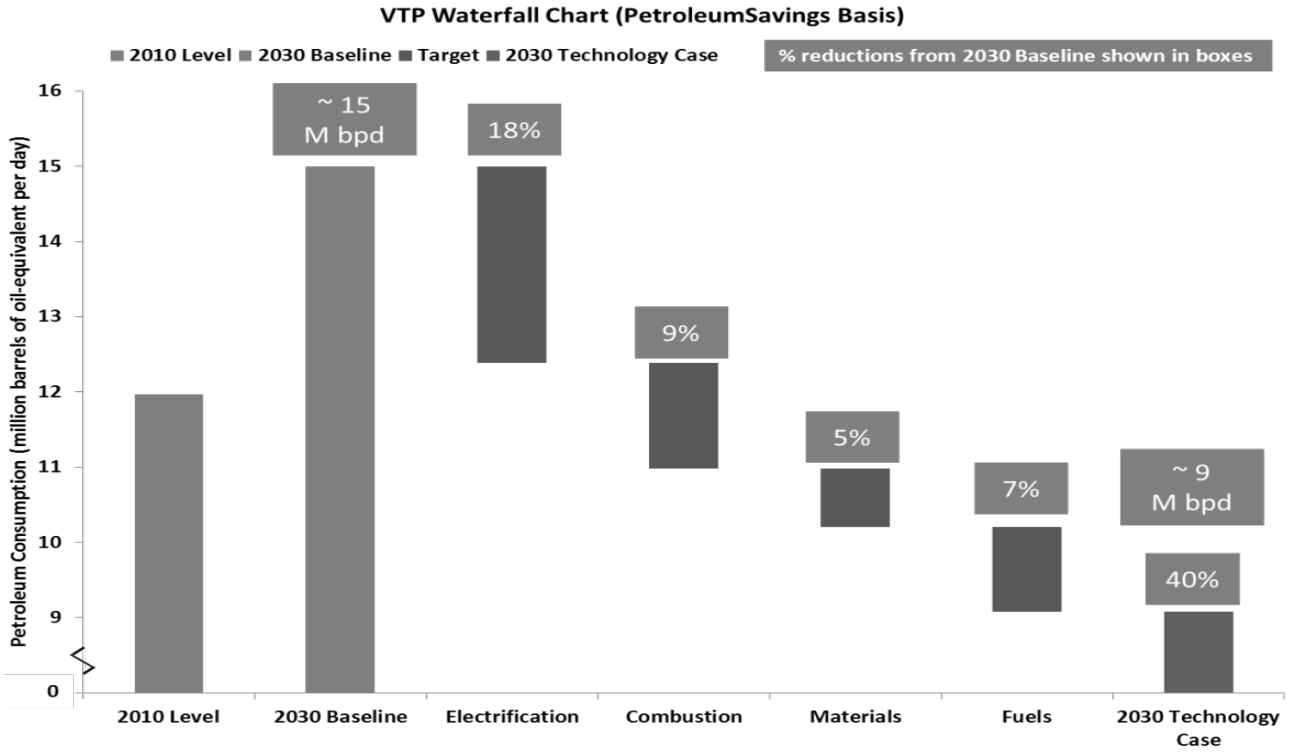
1) High Impact: Is this a high-impact problem?
2) Additionality: Will the EERE funding make a large difference relative to what the private sector (and other funding entities) is already doing?
3) Openness: Have we made sure to focus on the broad problem we are trying to solve and be open to new ideas, new approaches, and new performers?
4) Enduring Economic Benefit: How will this EERE funding result in enduring economic benefit to the United States?
5) Proper Role of Government: Why is what you are doing a proper high-impact role of government versus something best left to the private sector to address on its own?

The program chooses projects through an open and competitive process using independent experts who evaluate proposals for their technical merit against criteria defined in the solicitation. New competitive multi-year awards to industry and others are typically fully funded in the year they are awarded, per Congressional direction. Project management improvements and greater emphasis on project cost-effectiveness implemented in FY 2013, will continue and expand in FY 2014. In alignment with EERE core principles, the program is committed to active project management with rigorous monitoring, meaningful milestones and go-no-go decisions, review, and engagement to prevent waste, fraud, or abuse and to ensure that the agreed-upon goals and objectives are achieved in the most effective manner.

Strategic Performance Management by Program

Performance Measure	**Vehicles - Batteries** - Reduce the modeled cost of energy storage for Plug-In Hybrid Electric Vehicles (PHEVs). ($/kWh)		
Fiscal Year	**2012**	**2013***	**2014**
Target	500 $/kWh	400 $/kWh	300 $/kWh
Result	485 $/kWh		
Endpoint Target	$125/kWh by 2022		

Performance Measure	**Vehicles – Petroleum Use** – Reduce the use of petroleum through the adoption of alternative fuel vehicles and infrastructure (million gallons per year)		
Fiscal Year	**2012**	**2013***	**2014**
Target	700	800	850



Result	750 million gallons petroleum reduction		
Endpoint Target	By 2015, 1B gal/yr. (gge) of petroleum reduction with alternative fuel vehicles and infrastructure. By 2020, 2.5B gal/yr. (gge) of petroleum reduction with alternative fuel vehicles and infrastructure.		

*2013 targets represent DOE's FY 2013 Budget Request to Congress. FY 2013 target updates can be found in the upcoming FY 2012-2014 Annual Performance Plan & Report.

Batteries and Electric Drive Technology
Funding Profile by Activity

(dollars in thousands)

	FY 2012 Current	FY 2013 Annualized CR*	FY 2014 Request
Battery/Energy Storage R&D	89,934	—	170,500
Advanced Power Electronics and Electric Motors R&D	27,806	—	69,700
Total, Batteries and Electric Drive Technology	117,740	—	240,200

*FY 2013 amounts shown reflect the P.L. 112 175 continuing resolution level annualized to a full year. These amounts are shown only at the "congressional control" level and above; below that level, a dash (—) is shown.

The Battery and Electric Drive subprogram addresses the development of low-cost, high energy batteries and research and development of low-cost, efficient electric drive systems needed for plug-in electric vehicles (PEVs, including all-electric vehicles and plug-in hybrid electric vehicles). Battery/Energy Storage R&D supports the development of advanced batteries for PEVs and advanced materials to enable the development of next generation batteries and systems. Advanced Power Electronics and Electric Motors R&D supports cost reduction and performance and reliability improvements of power electronics, electric motors, and other electric propulsion components as well as thermal management technologies necessary for increased vehicle electrification.

Battery/Energy Storage R&D: In FY 2014, the activity will focus on long-term research in the area of extremely high energy density battery chemistries for use in PEVs, and will also support the development of transformational technologies that can significantly reduce the cost of high power systems for hybrid electric vehicles (HEVs).

An important step for the electrification of the nation's light duty transportation sector is the development of more cost-effective, long lasting, and abuse-tolerant PEV batteries. The cost of today's batteries is over four times too high, compared to the program's goal to reach cost-competitiveness. The focus of the battery R&D activity is to develop the technologies that will reduce battery costs from their current $500/kWh to $125/kWh by 2022 In addition, vehicle design optimization and performance is often hindered by the battery's size and weight. Current battery technology is far from its theoretical energy density limit. In the near-term (2012 – 2017), with advances in lithium-ion technology, there is an opportunity to more than double the battery pack energy density from 100 Wh/kg to 250 Wh/kg through the use of new high-capacity cathode materials, higher voltage electrolytes, and high capacity silicon or tin-based intermetallic alloys to replace graphite anodes. Despite current promising advances, much more R&D will be needed to achieve the performance and lifetime requirements for deployment of these advanced technologies in PEVs. In the longer term (2017 – 2027), "beyond lithium-ion" battery chemistries, such as lithium-sulfur, magnesium-ion, zinc-air, and lithium-air, offer the possibility of energy densities that are significantly greater than current lithium-ion batteries, as well as the potential for greatly reducing battery cost. However, major shortcomings in cycle life, power density, energy efficiency, and/or other critical performance parameters currently stand in the way of commercial introduction of state-of-the-art "beyond lithium-ion" battery systems. Breakthrough innovation will be required for these new battery technologies to enter the PEV market.

Advanced Materials ($72.5 million): Higher energy and higher power electrode materials promise to significantly lower battery system cost by reducing the amount of material and the number of cells needed for the entire battery pack. The focus of this work will be on the development of new materials and electrode couples that offer a significant improvement in either energy or power over today's technologies. Some specific technologies which are of interest include, but are not limited to, 2nd generation lithium ion batteries that contain high voltage (5V) and/or high capacity (>300mAh/g) cathode materials; 3nd generation lithium ion batteries that contain advanced metal alloy and composite anodes such as silicon carbon that offer 2-4 times the capacity as today's graphite anodes; and high voltage and solid polymer composite electrolytes. Also, research efforts will be devoted to the development of novel electrolyte formulations and additives to form a stable solid electrolyte interphase for improved safety, longer life, low temperature operation, and fast charge

capability. In FY 2014, the activity will further expand battery research in beyond lithium ion, next generation battery technologies that offer the potential for extremely high-energy and low cost such as solid-state (lithium metal with solid electrolytes), lithium sulfur batteries, and lithium air batteries. All of these promise energy densities from two to five times that of traditional lithium ion. In addition, some non-lithium couples (e.g., magnesium, zinc) show promise for viable cost reduction in the long-term. Activities will focus on research that will advance these next generation technologies from the university and national laboratory arena to the first stages of industry development through the development and testing of full cells.

Advanced Battery Development ($48.0 million): The activity will continue to develop advanced electric drive vehicle batteries in cooperation with industry through contracts that are awarded under a competitive process and are cost-shared by developers. Work is underway to accelerate the development of batteries for PEVs. The focus of this work will be on the development of robust prototype cells that contain new materials and electrodes that offer a significant reduction in battery cost over existing technologies. The activity will fund research to expedite the development of more efficient electrode and cell designs and fabrication processes to reduce the cost for high-volume production of large format lithium ion batteries. This work will result in electric drive vehicles that meet our cost and performance goals. Pack-level innovations will focus on the development of technology to reduce the weight and the cost of thermal management systems, structural and safety components, and system electronics. Currently, these "non-active" components of a battery increase the volume, weight (approximately 70% by weight of the battery), and cost of the finished product. Approaches to reduce the size of these inactive components in the cell and battery will be pursued to reduce weight and volume, resulting in improved energy densities and reduced costs. The additional funds requested will support a new activity to design and develop preproduction electric vehicle battery prototypes. This activity will use battery pack level computer aided engineering design tools to drive down battery cost through optimization of battery cell and pack designs, and improve safety and durability of battery packs. Optimized battery packs will be designed, built, and tested to demonstrate innovations in cost and safety.

Advanced Processing ($40.0 million): The activity will accelerate the market entry of advanced batteries by supporting the scale-up, pilot production, and commercial validation of new battery materials and processes. The activity is supporting the development of new materials for advanced cathodes, anodes, and electrolytes by universities, national laboratories, and industry to address barriers such as battery cost, life, and safety, but the commercial scale-up of such materials is often limited in scope. Studies of recycling and reuse of lithium batteries will continue as part of the battery development industry and national laboratory projects. This activity will also continue to validate requirements and refine standardized testing procedures to evaluate performance and life of PEV batteries, as well as identify areas requiring additional R&D. The activity will support high-power battery development on transformational technologies with the potential to significantly reduce the cost of HEVs. This activity accelerates the timetable for technologies to reach commercialization, to help meet economic, environmental, and energy security goals.

Batteries/Energy Storage Incubator Activities ($10 million): EERE's Incubator activities are an expansion of an already proven innovative program that EERE's Solar Energy Technologies Program piloted with a specific focus on partnering with businesses and researchers to bring "off-roadmap" impactful new technologies into the EERE portfolio. These early prototypes were developed into manufacturing and commercially relevant prototypes designed around pilot-stage process development. Based upon this highly successful model, the program plans to invest in the creation of Incubator Programs in FY 2014.

Advanced Power Electronics and Electric Motors R&D Longer term R&D in this activity will focus on cost reduction and improved reliability of power electronics, electric motors and other electric propulsion components as well as thermal management technologies necessary for increased vehicle electrification. The activity funds R&D of traction inverters and motors (permanent magnet and non-permanent magnet), DC/DC power converters, chargers, semiconductor components, innovative topologies and devices, advanced thermal systems, and motor control systems. These R&D efforts will reduce electric drive system costs, weight and volume, while meeting stringent performance and reliability requirements. Subcomponent R&D concentration areas are high-temperature capacitors, improved magnets including non-rare-earth magnets, and increased implementation of wide band-gap materials and devices (such as silicon carbide and gallium nitride). Emphasis will continue on reducing the use of rare earth materials in electric

motors, and long-term research to develop novel, low cost magnetic materials without any rare earth content that can meet automotive requirements. Activities will be closely coordinated with the magnet work that EERE's Advanced Manufacturing Office funds through its Critical Materials Hub.

R&D efforts will continue to develop power electronics and electric motors with a focus on advanced, low cost technologies and topologies compatible with the high-volume manufacturing of motors, inverters, and DC/DC converters for electric drive vehicles. These activities will enable substantial reductions in cost, weight, and volume while ensuring a secure domestic supply chain for electric drive vehicle components.

In FY 2014, the program, through cooperative agreements, will collaborate with industry to develop advanced power electronics and electric motors technologies required for vehicle electrification. With the increase in requested funds, new applied R&D activities with industry will further enable substantial reductions in cost, weight, and volume while ensuring a domestic supply chain. Emphasis will be on R&D of advanced packaging and materials, improved reliability, and manufacturability. Efforts will also accelerate technology transfer from research organizations to domestic manufacturers and suppliers, aiding increased commercialization into the market.

To maximize the return on DOE's technology investments in this area, the power electronics and electric motors activity coordinates its activities across the DOE complex and with other Federal agencies. Interagency coordination is conducted through the Interagency Advanced Power Group (IAPG), whose members include the Departments of the Army, Navy, and Air Force as well the National Aeronautics and Space Administration, the National Institute of Standards and Technology, and DOE. The synergies of technologies for advanced electric-drive vehicles, including PHEVs, HEVs, and EVs, will be achieved by maintaining close collaboration among researchers, device manufacturers, and users of the technologies. The national laboratories will test developed technologies for validation of performance relative to targets and goals.

Advanced Power Electronics and Electric Motors Incubator Activities ($6.0 million): EERE's Incubator activities are an expansion of an already proven innovative program that EERE's Solar Energy Technologies Program piloted with a specific focus on partnering with businesses and researchers to bring "off-roadmap" impactful new technologies into the EERE portfolio. These early prototypes were developed into manufacturing and commercially relevant prototypes designed around pilot-stage process development. Based upon this highly successful model, the program plans to invest in the creation of Incubator Programs in FY 2014.

Explanation of Funding Changes

(dollars in thousands)

	FY 2012 Current	FY 2014 Request	FY 2014 Request vs. FY 2012 Current
Battery/Energy Storage R&D — Funding increases will support Battery R&D initiatives for the EV Everywhere Grand Challenge in the following areas: (1) support for battery manufacturing innovations R&D, (2) support for the scale-up of advanced battery materials, (3) support for next generation "beyond lithium" research; Increased funding will enable additional projects to be pursued to reduce risk and to establish projects through a competitive solicitation for the program's incubator activity. In addition, pre-production plug-in electric vehicle battery prototype development will be initiated, focused on coupling battery pack level computer aided engineering design tools with hardware development to demonstrate design innovation, significant cost reduction, and safety improvements at the battery pack level.	89,934	170,500	+80,566
Advanced Power Electronics and Electric Motors R&D — Funding increases will support (1) R&D activities for the EV Everywhere Grand Challenge that accelerate R&D on advanced designs, components, and materials to meet targets and goals; (2) Activities to eliminate and/or reduce rare earth magnets in motors, and enable implementation of wide bandgap materials (such as			

silicon carbide and gallium nitride) and devices to eliminate barriers to market adoption; (3) A new funding opportunity for development of first-of-a-kind wide bandgap semiconductor-based electric drive systems with potential for major system level cost reduction. Increased funding will enable additional projects to be pursued to reduce risk and to establish projects through a competitive solicitation for the program's incubator activity.	27,806	69,700	+41,894
Total, Batteries and Electric Drive Technology	117,740	240,200	+122,460

Funding Schedule

Fiscal Year	Activity	Funding (dollars in thousands)
FY 2012	Battery/Energy Storage R&D: • Awarded 2nd Generation Electric Drive Vehicle Battery development contracts using higher capacity lithium ion cathodes focused on achieving the 2014 cost target of $300/kWh. • Initiated research on 3rd Generation battery materials & cells focused on metal alloy or silicon composite anode technology. • Initiated R&D to develop lower cost manufacturing processes for lithium ion batteries. Advanced Power Electronics and Electric Motors R&D: • Initiated new industry cost-shared R&D of inverter and electric motors. • Emphasized magnetic materials R&D for electric motors to reduce or eliminate rare earth content. • Continued benchmarking at national laboratories of motor, inverter, and wide band gap devices to confirm state-of-the-art. • R&D of advanced thermal management technologies to enable increased heat transfer.	117,740
FY 2013	Planned activities in the FY 2013 Budget (final allocations have not yet been determined): Battery/Energy Storage R&D: • Initiate R&D awards to develop lower cost, high voltage, and non-flammable electrolytes. • Increase support to develop materials production processes for high capacity cathodes with the potential to significantly reduce battery material costs. • Initiate the development of computer aided engineering tools to enable safer and more durable battery designs. Advanced Power Electronics and Electric Motors R&D: • Increase support for implementation of wide bandgap devices and advanced packaging materials and technologies, including collaborative development of devices for inverters, converters, and chargers involving the successful implementation and integration of WBG devices with industry. • Industry R&D of advanced inverter and electric motors complete phase 1. • Award new high-temperature capacitor and WBG inverter cost-shared R&D awards. • Continue focus on alternatives to rare earth magnets for electric motors; develop and define next phase of R&D required.	—

FY 2014	Battery/Energy Storage R&D: • Complete the 2nd Generation Electric Drive Vehicle Battery development contracts using higher capacity lithium ion cathodes focused on achieving the 2014 cost target of $300/kWh. Increase support to develop new, lower cost, non-flammable electrolyte materials and production processes. • Increase support for 3rd Generation, Lithium Ion Battery Materials & Cell R&D focused on advanced metal alloy or silicon composite anode technology. • Initiate support to develop lower cost production processes for advanced metal alloy or silicon composite anode materials. • Increase support for fundamental materials research activity including cell hardware development focused on "Beyond Lithium Ion" technologies such as Lithium Metal and Beyond Lithium Battery technologies. • Conduct competitive solicitation for the program's incubator activity. Advanced Power Electronics and Electric Motors R&D: • Additional funding will support a new funding opportunity for development of first-of-a-kind wide bandgap semiconductor-based electric drive systems with potential for major system level cost reduction. • Continue research and development of advanced, wide bandgap power electronics and non-rare earth motors to achieve cost, performance, and reliability targets for electric drive systems incorporating advanced thermal management technologies; increased funding will enable additional projects to be pursued to reduce risk. • Initiate next phase of magnetic material R&D activities as follow-on to efforts that ended in 2013. • Industry R&D of advanced inverter and electric motors continue phase 2. • Conduct competitive solicitation for program incubator activity.	240,200

Vehicle and Systems Simulation & Testing
Funding Profile by Subprogram

(dollars in thousands)

	FY 2012 Current	FY 2013 Annualized CR*	FY 2014 Request
Vehicle and Systems Simulation & Testing	47,198	—	70,000
Total, Vehicle and Systems Simulation & Testing	47,198	—	70,000

*FY 2013 amounts shown reflect the P.L. 112 175 continuing resolution level annualized to a full year. These amounts are shown only at the "congressional control" level and above; below that level, a dash (—) is shown.

The Vehicle and Systems Simulation & Testing (VSST) subprogram provides an overarching vehicle systems perspective in support of the program's R&D activities. The subprogram uses analytical and empirical tools to model and simulate potential vehicle systems, validate component performance in a systems context, verify and benchmark emerging technologies, and validate computer models. Each of these activities is aimed at addressing the fundamental challenge that vehicle component technologies must be considered within the context of the overall vehicle system. The subprogram conducts research to elucidate the interactions between vehicle powertrain subsystems to ensure that our developed technologies result in the maximum impact at the vehicle level.

The subprogram has the objective of providing the simulation tools and testing capabilities to evaluate the impact of advanced vehicle technologies, and to guide the R&D pathways of the other subprograms. A significant challenge in this effort has been the availability of modeling software to accurately represent the potential of advanced vehicle components and systems. To address this challenge, the subprogram supported the development of the Autonomie modeling and simulation tool, currently utilized by over 150 companies and 800 users worldwide. The subprogram continues to improve Autonomie and its component models as the basis for all program vehicle-level analytical studies.

The subprogram also has the objective of evaluating advanced vehicles in laboratory and real-world environments, in order to assess the efficiency characteristics of existing technologies and identify R&D pathways for improvements. To address this challenge, the subprogram has supported the development of capabilities such as the thermal testing chamber at Argonne National Laboratory's Advanced Powertrain Research Facility, and Oak Ridge National Laboratory's Vehicle Systems Integration Laboratory. The subprogram plans to utilize these facilities to identify the areas of vehicle systems research that will result in the greatest reduction of petroleum use in the transportation sector.

Modeling & Simulation ($5.5 million): The subprogram will focus on developing and utilizing advanced vehicle modeling and simulation tools to predict the performance and efficiency benefits of advanced components in a vehicle systems context. These tools are also made available to the automotive and heavy vehicle industries, where they accelerate the development time and reduce the costs of bringing advanced vehicle solutions to market.

Component & Systems Evaluation ($2.5 million): The subprogram will leverage hardware-in-the-loop capabilities to evaluate hardware components in an emulated vehicle environment. This approach integrates simulation and hardware in the laboratory to provide a cost-effective approach to evaluating vehicle propulsion systems as they emerge from the R&D laboratory.

Lab & Field Vehicle Evaluations ($9.0 million): In support of the EV Everywhere Grand Challenge, the subprogram will conduct laboratory, track, and real-world testing of plug-in electric vehicles as they become available, to characterize performance, efficiency, and cost benefits of these advanced technologies. Results from laboratory tests are also used to validate models developed through the Modeling & Simulation focus area and guide further model development.

Codes & Standards Development ($6.0 million): In support of the EV Everywhere Grand Challenge, the subprogram will participate in activities to develop standards and test procedures related to plug-in vehicles and their charging infrastructure. This activity provides technical support to standards development organizations, and is essential to developing a

comprehensive and consistent set of codes and standards to enable the successful market adoption of electric-drive vehicles.

Vehicle Systems Optimization ($27.0 million): The subprogram will develop enabling technologies to improve the efficiency and utility of advanced vehicles. Areas of research include aerodynamic improvements in heavy duty vehicles as well as parasitic load reduction in powertrain components, advanced high-efficiency heating/ventilation/air-conditioning (HVAC) solutions, thermal management, and static wireless charging of electric vehicles in support of the EV Everywhere Grand Challenge.

SuperTruck: The subprogram will fund non-Recovery Act SuperTruck projects in FY 2014, with the objective of developing and demonstrating a 50% improvement in the overall freight efficiency of a heavy-duty Class 8 tractor-trailer combination by 2015, measured in ton-miles per gallon.

Grid Integration Initiative: Customer-owned electric vehicles, distributed renewable generation, and building equipment can be integrated to optimize their overall performance as well as interact with the utility grid to reduce the costs of greater concentrations of grid-connected renewable energy. To provide customer options to address grid integration issues in a comprehensive manner, EERE will implement one or more joint funding opportunity announcements (FOA) totaling $80 million, which would be sponsored by the Solar Energy Technologies Office ($30.0 million), Buildings Technologies Office ($30.0 million), and Vehicle Technologies Office ($20.0 million). The FOA would solicit participation from key market participants such as load serving entities (LSEs-both investor and publically-owned utilities) with a substantial deployment of photovoltaic systems, electric vehicles, and building energy technologies. These LSEs will partner with national laboratories, industry, and other innovators to develop and further advance the platform of technologies, communications, and controls necessary for owners of electric vehicles, renewable generation assets, and building energy management systems to interact with a modernized and more flexible distribution system. In addition to the solicitation, DOE proposes to work directly with the national laboratories based on an evaluation of how their capabilities and research facilities can help solve this customer-to-grid integration challenge. For instance, the Energy Systems Integration Facility at the National Renewable Energy Laboratory brings on-line new capabilities to develop a more flexible distribution system. Through this initiative, DOE will maximize the beneficial impact of its and other parties' R&D investments increasing the value of customer side equipment, modernizing the distribution grid and enabling widespread deployment of clean energy technologies across the distribution system.

While utilities have some incentive to conduct research in this space, given their regulatory requirements to (1) meet Renewable Portfolio Standards (RPSs) that are being adopted in numerous states and (2) maintain grid reliability as more plug-in vehicles and distributed renewable generation are deployed, leaving the effort to utilities alone will result in a piece-meal solution that "stops at the meter", and isn't replicable or scalable, severely limiting the benefits of EERE-developed technologies. This funding will enable a coordinated, holistic approach to the integration of buildings, distributed electricity generation, and plug-in vehicles onto the distribution system, involving multiple stakeholders and resulting in technology solutions that interact *across the meter*, and can be scaled to provide national benefits.

Funding will be available for technologies, tools, and system integration activities to support the deployment of plug-in electric vehicles and other clean energy technologies (i.e. wind and solar), focused on the following vehicle-related topics:

- Grid systems analysis tools: The lack of understanding of the impact that the large-scale market penetration of PEVs may have on the electric grid (such as charging during on-peak hours, coordination of charging events, and time-of-day pricing) represents a challenge that must be overcome in order to achieve market success. Comprehensive grid scenario modeling and analysis tools that incorporate PEVs and charging infrastructure will allow utilities to identify potential issues (e.g., compromised distribution transformer life due to geographic clustering of PEVs) to inform infrastructure development and maintain grid reliability.
- End-to-end communications and control: In order to minimize any adverse grid impacts due to vehicle charging while leveraging synergies among PEVs, distributed renewable generation, and building energy management systems, advanced control algorithms that incorporate all nodes within the distribution system must be developed. Such algorithms will allow PEVs to respond optimally in real-time to a dynamic grid (e.g., by reducing PEV charging during periods of peak electricity demand,

by providing demand during periods of high renewable generation, or by transacting with loads within an associated building management system).

- Interoperability and standards: The energy optimization algorithms described above rely on the development and application of communications protocols and standards to ensure interoperability across all relevant parts of the distribution system, including PEVs and charging infrastructure. While the subprogram continues to support the ongoing development of PEV-related communications standards, these standards must be harmonized with a uniform set of standards that apply to all parts of the distribution grid.
- Owner Economics: To maximize the benefit of the integrated deployment of PEVs and other energy efficiency and renewable energy technologies, a clear value proposition to consumers and stakeholders must be demonstrated not only for each individual technology, but also for the interactions enabled by the overall system. This effort will aim to explore and quantify the multiple value streams that PEVs may provide when fully integrated with distributed solar generation, building energy management systems, and other technologies on a modernized grid. These value streams may include grid reliability, customer empowerment, frequency regulation and other ancillary services, renewables firming, and bidirectional power flow. This activity aids multiple stakeholders and accelerates the introduction of technologies for grid integration.

Explanation of Funding Changes

(dollars in thousands)

	FY 2012 Current	FY 2014 Request	FY 2014 Request vs. FY 2012 Current
Vehicle and Systems Simulation & Testing — The funding increase supports the new Vehicles, Buildings, and Solar programs' grid integration initiative to develop and demonstrate the necessary technologies for transactive communications and controls among electric vehicles, demand-responsive buildings, and rooftop solar PV behind the meter on the distribution grid, as well as the EV Everywhere Grand Challenge. Also, we will demonstrate static wireless charging of electric vehicles using fully integrated systems in real-world operating environments at 6.6kW and 90% efficiency	47,198	70,000	+22,802
Total, Vehicle and Systems Simulation & Testing	47,198	70,000	+22,802

Funding Schedule

Fiscal Year	Line Item	Funding (Dollars in Thousands)
FY 2012	• Completed large-scale deployment of Autonomie vehicle modeling & simulation software with commercialization partner. • Initiated extreme cold and hot weather testing of advanced vehicles utilizing thermal capabilities of the Advanced Powertrain Research Facility. • Initiated "Wireless Charging for Electric Vehicles" contract with industry partner. • Demonstrated a pathway to improve freight efficiency by 50% through simulation with SuperTruck partners.	47,198
FY 2013	Planned activities in the FY 2013 Budget (final allocations have not yet been determined): • Expand coordination on international standards for PEVs and vehicle charging. • Initiate industry contract to develop high-efficiency HVAC solutions for electric-drive vehicles.	—
FY 2014	• Complete data collection, analysis, and reporting on electric-drive vehicles and infrastructure through the Transportation Electrification initiative. • Initiate grid modernization activity to integrate electric vehicles, building energy management systems, and solar generation technologies into the grid distribution system (a new activity representing a $20.0 million increase in the VSST subprogram budget from FY 2013) • Demonstrate static wireless charging of electric vehicles using fully integrated systems in real-world operating environments at 6.6kW and 90% efficiency.	70,000

Advanced Combustion Engine R&D
Funding Profile by Activity

(dollars in thousands)

	FY 2012 Current	FY 2013 Annualized CR*	FY 2014 Request
Combustion and Emission Control	49,320	—	54,500
Solid State Energy Conversion	8,707	—	5,000
Total, Advanced Combustion Engine R&D	58,027	—	59,500

*FY 2013 amounts shown reflect the P.L. 112 175 continuing resolution level annualized to a full year. These amounts are shown only at the "congressional control" level and above; below that level, a dash (—) is shown.

The Advanced Combustion Engine R&D subprogram focuses on removing critical technical barriers to commercializing high efficiency, advanced internal combustion engines for passenger and commercial vehicles. Increasing the efficiency of internal combustion engines is one of the most cost effective approaches to reducing the petroleum consumption of the Nation's fleet of vehicles in the near- to mid-term. A recent colloquium with representatives from industry, academia, and the national labs concluded that engine efficiency can be significantly increased going forward.[a] Research will be conducted to accelerate the development of high-efficiency advanced combustion regimes while reducing emissions. Technologies will be developed to utilize waste energy from the engine exhaust to improve fuel economy. The targets for this subprogram are:

- By 2015, increase the efficiency of engines for passenger vehicles to improve fuel economy by 25% for gasoline vehicles and 40% for diesel vehicles; and by 2020, improve fuel economy by 35% and 50% for gasoline and diesel vehicles, respectively, compared to 2009 gasoline vehicles.
- By 2015, increase the efficiency of engines for commercial vehicles by 20%, from 42% (2009 baseline) to 50%; and by 2020, improve engine efficiency by 30%, from 42% to 55%.
- By 2015, increase the fuel economy of passenger vehicles by 5% by using thermoelectric generators that convert energy from engine waste heat to electricity; and by 2020, increase fuel economy by 10%.

Combustion and Emission Control: This activity will develop technologies for advanced engines with the goal of improving thermal efficiency by optimizing combustion, fuel injection, air handling, emission control, and waste heat recovery systems, along with reducing friction and pumping losses.

Thermal efficiency of passenger and commercial vehicle engines will be improved by investigating innovative combustion processes, including homogeneous charge compression ignition (HCCI) and other modes of low-temperature combustion (LTC), lean-burn gasoline, and multi-fuel operation while also reducing engine-out emissions of nitrogen oxides (NOx) and particulate matter (PM) to near-zero levels. Based on findings from a workshop on modeling and simulation of internal combustion engines that was co-sponsored with DOE's Office of Science, representatives from industry, academia and the national laboratories agreed that research in this area will reduce product development time for industry and significantly increase engine efficiency. These improvements in engine efficiency will increase vehicle fuel economy and will contribute towards meeting future CAFE standards. Prior successful DOE investments in combustion research have yielded a 70:1 return on investment in fuel savings and associated health benefits.[b]

[a] Combustion Engine Efficiency Colloquium 2010. "The performance, low cost, and fuel flexibility of internal combustion engines (ICEs) makes it likely that they will continue to dominate the vehicle fleet for at least the next several decades. ICE improvements can also be applied to both hybrid electric vehicles (HEVs) and vehicles that use alternative hydrocarbon fuels." QTR Report, DOE 2011, p. 39.

[b] Valued in inflation adjusted 2008 dollars; "Retrospective Benefit-Cost Evaluation of U.S. DOE Vehicle Combustion Engine R&D Investments: Impacts of a Cluster of Energy Technologies," U.S. DOE, May 2010. The investment of $931M includes some funds from the Office of Science.

Meeting anticipated future emission standards will be challenging for high efficiency diesel and lean-burn gasoline engines. To address this issue, the activity will conduct research on innovative emission control strategies through projects led by the national laboratories, industry, and universities designed to reduce costs and increase the performance and durability of NOx reduction and PM oxidation systems. Project areas include the development of low-cost base metal catalysts (to replace expensive platinum group metals), catalysts that operate at lower exhaust temperatures, lighter and more compact multifunctional components, and new control strategies.

Advanced Combustion Engine R&D Incubator Activities: EERE's Incubator activities are an expansion of an already proven innovative program that EERE's Solar Energy Technologies Program piloted with a specific focus on partnering with businesses and researchers to bring "off-roadmap" impactful new technologies into the EERE portfolio. These early prototypes were developed into manufacturing and commercially relevant prototypes designed around pilot-stage process development. Based upon this highly successful model, the program plans to invest in the creation of Incubator Programs in FY 2014 ($6.0 million).

Solid State Energy Conversion: This activity develops technologies to convert waste heat from engines and other sources directly to electrical energy to improve overall fuel economy and reduce emissions. This activity will pursue cost-shared cooperative agreements with industry and academia to develop and fabricate high-efficiency thermoelectric generators to produce electricity from waste heat in passenger vehicles. The activity will also investigate scaling up production of thermoelectric modules for demonstration in vehicle applications with the potential to improve vehicle fuel economy by up to 5%.

Explanation of Funding Changes

(dollars in thousands)

	FY 2012 Current	FY 2014 Request	FY 2014 Request vs. FY 2012 Current
Combustion and Emission Control — Funding for fundamental combustion and emission control R&D is slightly reduced - by less than $1 million. Includes increase funding for competitive solicitation for the program's incubator activities to encourage innovative and potentially disruptive advanced combustion technologies.	49,320	54,500	+5,180
Solid State Energy Conversion — Significantly reduce funding for projects to improve the efficiency of thermoelectric generators. The reduction reflects a redirection in resources to support higher priority activities within EERE that have potential for greater efficiency improvements than thermoelectric generators.	8,707	5,000	-3,707
Total, Advanced Combustion Engine R&D	58,027	59,500	+1,473

Funding Schedule

Fiscal Year	Activity	Funding (dollars in thousands)
FY 2012	Combustion and Emission Control: • Conducted research and modeled Low-Temperature Combustion strategies to achieve higher engine efficiencies and lower emissions. • Conducted research on lean-NOx catalysts for direct injection gasoline engines. • Demonstrated multi-cylinder laboratory engine efficiency that enables a 15% passenger vehicle fuel economy improvement. • Awarded cost-shared cooperative agreements to develop enabling technologies for improving engine efficiency.	58,027

Fiscal Year	Activity	Funding (dollars in thousands)
	• Completed health impact study of diesel exhaust emissions. Solid State Energy Conversion: • Developed a high efficiency thermoelectric waste heat recovery device with potential to increase vehicle fuel economy by 5% by 2015. • Developed 2nd generation thermoelectric modules using higher efficiency, lower cost materials.	
FY 2013	Planned activities in the FY 2013 Budget (final allocations have not yet been determined): Combustion and Emission Control: • Award additional cost-shared cooperative agreements from 2012 solicitation to develop enabling technologies that improve engine efficiency. • Utilize high-performance computing to model fuel injection sprays and stochastic flows in engines during low-temperature combustion. • Research and model catalyst formulations to reduce NOx emissions at lower temperatures. • Improve engine efficiency to demonstrate a 20% fuel economy improvement for passenger vehicles compared to a 2009 baseline. Solid State Energy Conversion: • Build and test a cylindrical-shaped thermoelectric generator to improve conductive heat transfer to the exhaust pipe. • Fabricate thermoelectric modules using Half Heusler materials containing 50% less Hafnium.	—
FY 2014	Combustion and Emission Control: • Improve engine efficiency to demonstrate a 23% fuel economy improvement for passenger vehicles and 18% for commercial vehicles compared to a 2009 baseline. • Issue solicitation for cooperative, cost-shared engine R&D with industry, working toward demonstrating a 35% to 50% fuel economy improvement for passenger vehicles by 2020 compared to a 2009 baseline. • Validate engine models with experimental data. • Develop emission control components to reduce NOx, and oxidize particulate matter and hydrocarbons at lower exhaust temperatures. • Award cost-shared cooperative agreements to industry, working toward demonstrating a 35% to 50% fuel economy improvement for passenger vehicles by 2020 compared to a 2009 baseline. • Conduct competitive solicitation for the program's incubator efforts. Solid State Energy Conversion: • Install and demonstrate a high efficiency thermoelectric waste heat recovery device on a passenger vehicle.	59,500

Materials Technology
Funding Profile by Activity

(dollars in thousands)

	FY 2012 Current	FY 2013 Annualized CR*	FY 2014 Request
Propulsion Materials Technology	12,576	—	10,000
Lightweight Materials Technology	27,284	—	49,500
High Temperature Materials Laboratory	970	—	0
Total, Materials Technology	40,830	—	59,500

*FY 2013 amounts shown reflect the P.L. 112 175 continuing resolution level annualized to a full year. These amounts are shown only at the "congressional control" level and above; below that level, a dash (—) is shown.

The Materials Technology subprogram supports discovery, development, and utilization of materials and enabling technologies to reduce weight and improve the propulsion system in light- and heavy-duty vehicles. The subprogram emphasizes a range of material types including carbon fiber composites, advanced high strength steels, ferrous alloys, aluminum alloys, and magnesium alloys. Subprogram-supported work addresses materials systems and technology gaps identified through literature, interaction with industry and research organizations, and the 2011 Advanced Lightweight and Propulsion Materials Workshop that identified requirements for all major lightweight materials and higher efficiency propulsion systems.

Propulsion Materials Technology: The Propulsion Materials Technology activity addresses powertrain-specific technology gaps identified at the VT 2011 Advanced Lightweight and Propulsion Materials Workshop. The activity also addresses out-year powertrain materials requirements assessed from the literature and through industry interaction. In FY 2014, the activity will fund projects to develop materials that enable downsized powertrains with reduced dependence on rare earth magnetic materials. The activity supports efforts to downsize internal combustion engines, including the development of optimization materials for rotating components (crankshafts, camshafts, pistons, connecting rods, and turbocharger compressor/turbine wheels) with the improved performance necessary to meet the requirements of next generation natural gas and high efficiency powertrains. The activity also supports design and validation activities for new engine blocks and cylinder heads that can achieve higher peak cylinder pressures using a portfolio of Integrated Computational Materials Engineering (ICME) tools, new cast alloys, and advanced processing techniques. Materials research supporting EV Everywhere reduces dependence on rare earth magnetic materials by developing new low rare earth magnets and lightweight and enabling processing techniques for higher efficiency induction motors.

Lightweight Materials Technology: The Lightweight Materials Technology activity supports EV Everywhere and addresses technology gaps that currently prevent the further introduction of advanced lightweight materials into vehicles. In FY 2014, the activity will emphasize the development of ICME tools for carbon fiber composites to decrease the weight of both the body and chassis; explore manufacturing approaches to improve high performance aluminum sheet and extrusion components; research fastening, bonding, and corrosion protection techniques for joining dissimilar materials; and design and validate lightweight structures constructed from a mix of lightweight materials.

Materials Technology Incubator Activities: EERE's Incubator activities are an expansion of an already proven innovative program that EERE's Solar Energy Technologies Office piloted with a specific focus on partnering with businesses and researchers to bring "off-roadmap" impactful new technologies into the EERE portfolio. These early prototypes were developed into manufacturing and commercially relevant prototypes designed around pilot-stage process development. Based upon this highly successful model, the Vehicles Program plans to invest in the creation of Incubator Programs in FY 2014 (up to $6.0 million).

High Temperature Materials Laboratory: The High Temperature Materials Laboratory (HTML) user program has provided university researchers and small businesses with free access to advanced materials characterization of high temperature materials for transportation applications since 1987. This effort no longer has the

priority it once did and is therefore discontinued. The transition will allow the subprogram to focus on the highest priority technologies essential to improving the efficiency of ground transportation systems and eliminates the need for future funding of this activity.

Explanation of Funding Changes

(dollars in thousands)

	FY 2012 Current	FY 2014 Request	FY 2014 Request vs. FY 2012 Current
Propulsion Materials Technology — This funding decrease will slightly delay the development of low friction coatings, NOx sensors, and low temperature catalysts necessary for next generation high efficiency internal combustion engines that meet emissions regulations. The funding reductions reflect the decision to redirect resources to support high-priority activities within EERE.	12,576	10,000	-2,576
Lightweight Materials Technology — This funding increase will support improvements in lightweight materials performance as well as address critical needs in design, integration, and manufacturing. The subprogram's efforts will enable the development, validation, and demonstration of ICME techniques for linking predictive capabilities not only for structure and property relationships but also for process and property relationships in carbon fiber composites. The subprogram will explore new options for low-cost manufacturing of ultra-high strength aluminum components that will advance two important materials systems; demonstrate design and manufacturing methods to produce cost effective, extremely light bolts on vehicle assemblies such as doors and hoods, which will offer an opportunity to combine multiple lightweight materials technologies that can be readily integrated into vehicle production; and will conduct targeted development work in advanced steels, magnesium alloys, modeling and simulation, and dissimilar material joining, which will continue to support weight reduction throughout the vehicle. Also, increased funding for competitive solicitation for program incubator will be made available.	27,284	49,500	+22,216
High Temperature Materials Laboratory — No funding provided for High Temperature Materials Laboratory (HTML) and HTML user program as these activities are no longer a priority.	970	0	-970
Total, Materials Technology	40,830	59,500	+18,670

Funding and Activity Schedule

Fiscal Year	Activity	Funding (dollars in thousands)
FY 2012	Propulsion Materials Technology: • Develop cast alloys for high efficiency internal combustion engine blocks and cylinder heads. • Develop materials for advanced catalysts, substrates, and sensors. • Develop materials for electric motors and high temperature power electronics. • Develop materials for high efficiency engine components. • Develop materials for thermoelectric energy conversion. Lightweight Materials Technology: • Develop low-cost carbon fiber, validate predictive capability for carbon fiber composite crash models, and validate long fiber injection molding models. • Design, build, and test a lighter vehicle and a lightweight magnesium front end substructure.	

	• Scale-up a low-cost electrolysis technique for domestic production of primary magnesium. • Support improvements to properties, manufacturability, computational materials science, and enabling technologies for carbon fiber composites, advanced high strength steels, aluminum alloys, and magnesium alloys. High Temperature Materials Laboratory: • To focus on other priority activities within the subprogram, funding for this area was reduced to support the maintenance of equipment.	40,830
FY 2013	Planned activities in the FY 2013 Budget (final allocations have not yet been determined): Propulsion Materials Technology: • Develop cast alloys for high efficiency heavy duty engines. • Develop materials for advanced low temperature catalysts and substrates. • Enable low rare earth electric motors by building fundamental understanding of structure property relationships. • Define requirements by identifying operating conditions for high efficiency engine component materials. • Develop materials for thermoelectric energy conversion. Lightweight Materials Technology: • Continue to develop low-cost carbon fiber and validate predictive capability for carbon fiber composite models. • Continue to design, build, and validate a lightweight multi-material vehicle and a lightweight magnesium front end substructure. • Continue scale-up of a low-cost electrolysis technique for domestic production of primary magnesium. • Apply integrated computational materials techniques towards the development of next generation advanced steels for a lightweight body structure. • Characterize the thermodynamic, kinetic, and structural behavior of advanced automotive magnesium alloys. • Advance technologies in solid-state dissimilar metal joining. • Continue to improve properties, manufacturability, computational materials science, and enabling technologies for carbon fiber composites, advanced high strength steels, aluminum alloys, and magnesium alloys. High Temperature Materials Laboratory: • To focus on other priority activities within the Materials subprogram, the funding for this area supports the maintenance of equipment necessary for core programmatic material activity needs (per full-year Continuing Resolution).	—
FY 2014	Propulsion Materials Technology: • Develop materials to enable low friction/inertia rotating components for combustion engines. • Develop materials to improve turbocharger efficiency. • Develop materials for high efficiency engine components. • Develop low rare earth magnetic materials for electric motors. Lightweight Materials Technology: • Initiate multiple projects to accelerate the development and deployment of structural carbon fiber composites for use in the body-in-white (to reduce weight by more than 35%) and chassis (to reduce weight by more than 25%) by developing and validating predictive capabilities through ICME tools for carbon fiber composites performance based on fiber architecture, design, and conditions of processing linking predictive capabilities not only for structure/property relationships but also for process/property relationships. • Improve corrosion resistance and mechanical performance in dissimilar material joints using combined experimental and computation techniques. • Explore methods for producing strong, light, cost effective vehicle structures from ultra-	59,500

	high strength aluminum alloys. • Design, build, and test extremely lightweight bolts on vehicle assemblies to demonstrate and validate cost effectiveness and compatibility with vehicle manufacturing. • Improve properties, manufacturability, computational materials science, and enabling technologies for carbon fiber composites, advanced high strength steels, aluminum alloys, and magnesium alloys. • Conduct competitive solicitation for the program's incubator efforts.	

Fuels and Lubricant Technologies
Funding Profile by Subprogram

(dollars in thousands)

	FY 2012 Current	FY 2013 Annualized CR*	FY 2014 Request
Fuels and Lubricant Technologies	17,904	—	17,500
Total, Fuels and Lubricant Technologies	17,904	—	17,500

*FY 2013 amounts shown reflect the P.L. 112 175 continuing resolution level annualized to a full year. These amounts are shown only at the "congressional control" level and above; below that level, a dash (—) is shown.

The Fuels and Lubricant Technologies subprogram exploits fuel properties to improve combustion, develops lubricants that can reduce friction losses to improve fuel economy in new and legacy vehicles, and evaluates the potential of alternative fuels to displace significant amounts of petroleum.

The subprogram focuses on developing novel, high-efficiency combustion systems with ultra-low emissions on an engine-out basis. Low-temperature combustion is kinetically controlled and, therefore, inherently dependent on fuel properties. The two current and conventional fuel combustibility measures – cetane and octane – do not capture the critical characteristics of fuels that enable these nascent combustion regimes. Work in this area has been supported both by the Advanced Combustion Engines subprogram and by the Fuels and Lubricants subprogram. This section of the budget focuses on fuel-property exploitation for ignition and control while the engine section focuses on the end result heat release, emissions, and combustion system design.

The subprogram develops advanced lubricants that are compatible with legacy equipment and reduce friction loss. Industry has very little motivation to improve lubricants because the associated increases in fuel economy for new vehicles is incrementally small on a per vehicle basis and will not significantly impact attainment of CAFE. However, the gains when applied across the legacy fleet are significant.

Alternatives to petroleum are frequently proposed and vigorously promoted. It is important to impartially evaluate the technical potential of each candidate fuel to perform as desired without unintended consequences. This specific activity within the program is conducted on an as-needed basis. It is not a continuous function of the subprogram because potential alternative fuels need to reach a level of maturity at which it is feasible for them to be produced cost-effectively at a large scale. Different candidate fuels have different levels of maturity, and cost-effective production at large scale is a very high bar.

The subprogram will conduct fuel-related R&D in order to fully exploit fuel properties to achieve a high-efficiency, clean combustion operating regime for advanced combustion engines.

The subprogram will conduct lubricant-related R&D to continue to improve the knowledge base on lubrication mechanisms and to develop novel low-friction lubricants.

At present, evaluation of alternative fuels and fuel components is restricted to feasibility studies with higher alcohols and several fuels purported to be “drop-in” biofuels – other alternative fuels are not presently available for testing, or are not at a state of readiness to warrant investigation.

Unlike the EERE Bioenergy program, which is concerned with biofuel production, the Vehicles program investigates the way in which alternative fuels affect vehicle efficiency and emissions. The program also supports work involving non-biomass fuels such as natural gas and gas-to-liquid fuels.

Fuels and Lubricant Technologies Incubator Activities: EERE’s Incubator activities are an expansion of an already proven innovative program that EERE’s Solar Energy Technologies Office piloted with a specific focus on partnering with businesses and researchers to bring “off-roadmap” impactful new technologies into the EERE portfolio. These early prototypes were developed into manufacturing and commercially relevant prototypes designed around pilot-stage process development. Based upon this highly successful model, the Vehicles Program plans to invest in the creation of Incubator Programs in FY 2014 (up to $2.0 million).

Explanation of Funding Changes

	(dollars in thousands)		
	FY 2012 Current	FY 2014 Request	FY 2014 Request vs. FY 2012 Current
Fuels and Lubricant Technologies: The program will decrease funding for lubricant R&D on axle lubricants and hydraulic working fluids, and collaborative fuel-property testing with DOE-Tank and Automotive Research, Development and Engineering Center (TARDEC) to redirect resources to support higher priority activities within EERE. The program will establish funding for a competitive solicitation for program incubator to encourage innovative and potentially disruptive advanced fuels and lubricant technologies.	17,904	17,500	-404
Total, Fuels and Lubricant Technologies	17,904	17,500	-404

Funding Schedule

Fiscal Year	Line Item	Funding (dollars in thousands)
FY 2012	• Successfully demonstrated 30% reduction in boundary friction with engine oil with no increase in wear on a laboratory bench-top test; • Evaluated the effect of oxygenated biofuels with direct-injection, turbocharged engines. • Expanded the load range of dual-fuel, reactivity-controlled combustion to greater-than-50% of wide open throttle.	17,904
FY 2013	Planned activities in the FY 2013 Budget (final allocations have not yet been determined): • Expand the load range of dual-fuel, reactivity-controlled combustion to more than 75% of wide open throttle; • Continue to evaluate the potential of low-viscosity lubricants to improve fuel economy combined with a 30% reduction in boundary friction on a floating-liner test bed. • Continue to explore opportunity requirements to use increased octane and cetane fuel components to improve engine efficiency in future down-sized, boosted engines. • Investigate improved fluid for heavy-duty manual transmissions and light-duty automatic gearboxes and axles for both heavy- and light-duty vehicles. • Improve hydraulic working fluids, e.g., power steering and power transfer unit.	—
FY 2014	• Complete eight projects awarded under FY 2011 Broad Agency Announcement. • Continue to evaluate the potential of low-viscosity lubricants to improve fuel economy combined with a 30% reduction in boundary friction on an engine bed. • Continue to expand the load range of dual-fuel, reactivity controlled combustion; • Continue to explore opportunity requirements to use increased octane and cetane fuel components that improve engine efficiency in future down-sized, boosted engines. • Evaluate lubricity additives for natural gas engines to counteract the increased valve recession typically seen on natural gas engines. • Conduct a competitive solicitation for the program incubator.	17,500

Outreach, Deployment and Analysis
Funding Profile by Subprogram

(dollars in thousands)

	FY 2012 Current	FY 2013 Annualized CR*	FY 2014 Request
Graduate Automotive Technology Education (GATE)	995	—	0
Advanced Vehicle Competitions	1,992	—	2,000
Legislative and Rulemaking	1,992	—	2,000
Vehicle Technologies Deployment	27,876	—	118,800
Biennial Peer Reviews	3,500	—	500
Legacy Fleet Improvements	2,912	—	3,000
Total, Outreach, Deployment and Analysis	39,267	—	126,300

*FY 2013 amounts shown reflect the P.L. 112 175 continuing resolution level annualized to a full year. These amounts are shown only at the "congressional control" level and above; below that level, a dash (—) is shown.

The Outreach, Deployment and Analysis subprogram catalyzes the widespread adoption of advanced vehicle technologies. The program implements strategies and projects that displace petroleum use through public/private partnerships between DOE and local coalitions of key stakeholders across the country (such as Clean Cities). In addition, the program produces the annual DOE/EPA Fuel Economy Guide publication and associated website www.fueleconomy.gov, and disseminates related data (required by law) to the public.

In FY 2014, the subprogram will accelerate the introduction and adoption of alternative vehicles, like PEVs, through Alternative Fuel Vehicle Community Partner projects and community-based, highly-leveraged government/industry partnerships. These competitively-awarded projects will establish model communities that demonstrate sustainability beyond the initial Federal commitment, encourage private-sector leadership and investment, and can be replicated across the country. (See below for details)

Advanced vehicle competitions encourage university student engineers to participate in advanced technology development – helping to address the need for more highly trained engineers in hybrid and fuel cell technologies to overcome barriers in the marketplace.

The subprogram will implement a variety of statutory responsibilities placed on DOE by EPAct 2005 and other statutes and legislation. The main responsibilities include overseeing and regulating the requirements for state and alternative fuel providers to operate AFV vehicle fleets.

The subprogram will focus on improving the legacy vehicle fleet by analyzing and fabricating prototypes of an integrated automatic tire inflation system. The subprogram will also work to integrate prototype tires that incorporate novel tread compounds and barrier coatings to increase fuel economy by decreasing rolling resistance. Peer reviews of vehicle research and development activities will continue to inform decisions about program focus.

Graduate Automotive Technology Education (GATE): GATE addressed the need for a highly trained workforce possessing the interest and skills to be successful in the advanced vehicle technologies field. GATE established, developed, and expanded course work and research to support graduate engineering degrees with a focus or certificate in critical automotive technology areas, including energy storage and systems integration and design. As part of the government-wide STEM education consolidation strategy, GATE will be discontinued and replaced by streamlined STEM activities conducted by the National Science Foundation and the Department of Education.

Advanced Vehicle Competitions ($2.0 million): The activity supports a three-year collegiate engineering competition, EcoCAR 2, which provides hands-on, real-world experience to demonstrate a variety of advanced vehicle technologies and designs and to develop a workforce trained in advanced vehicle technologies.

Legislative and Rulemaking ($2.0 million): The activity focuses on implementing the State and Alternative Fuel Provider Regulatory program (10 CFR Part 490); alternative fuel designations; the Private and Local Government Fleet Regulatory program; and other EPAct

2005 requirements including reports and rulemaking, analyses of impacts of other regulatory and pending legislative activities, and the implementation of legislative changes to the EPAct fleet activities as they occur.

Vehicle Technologies Deployment ($118.8 million): The activity, primarily through Clean Cities, supports four main focus areas: 1) DOE helps convene key community and business leaders to develop and implement projects and policies, leverage resources, and address local barriers; 2) DOE-developed tools and information help consumers save money on fuel costs and help fleets understand their options for cost-effective alternatives to gasoline and diesel fuel; 3) DOE experts would help local leaders address permitting and safety issues, technology shortfalls, and other project implementation barriers; and 4) Financial assistance is competitively awarded with Federal cost-share requirements that encourage initial private sector match and long-term investment related to infrastructure development and other vehicle deployment initiatives.

Alternative Fuel Vehicle Community Partner Projects are a significant new initiative that will support more widespread introduction and adoption of advanced vehicle technologies. These competitively-awarded and cost-shared projects would catalyze the adoption of advanced vehicles like plug-in electric vehicles that do not rely on oil. The goal is to catalyze market transformation, disseminate critical data for replication, and explore real world solutions by establishing model communities that can be replicated throughout the country and demonstrate sustainability beyond the initial Federal investment. These projects will capture data and lessons learned to develop best practices, case studies, and success stories that will serve as templates for other communities. This will allow cities to share experiences, develop essential expertise, and establish local service and support industries much more rapidly, while demonstrating to others the viability of adopting alternative fuels and advanced vehicles.
($90.0 million):

- High-impact, state and local community-based efforts will be selected through a competitive solicitation, to implement operating policies and procedures and develop infrastructure to displace on-road vehicle petroleum use with alternatives such as natural gas, electricity, or biofuels. Funds would be provided to build strategically-placed community infrastructure networks and/or deploy alternative fuel vehicles; (Estimate up to 9 awards of up to $10 million each for projects 3-4 years in duration).

Biennial Peer Reviews ($0.5 million): The activity evaluates the progress and direction of government/industry partnerships. An independent third party, such as the National Academy of Science or the National Academy of Engineering, conducts the reviews. The reviews evaluate progress toward achieving the technical and program goals supporting each partnership, and assess the appropriateness of Federal investment in each of the activities. Based on evaluations, resource availability, and other factors, partners will consider new opportunities, make adjustments to technology-specific targets, and set goals as appropriate.

Legacy Fleet Improvements ($3.0 million): Three ongoing projects on tire technology improvements and two ongoing projects on driver feedback are scheduled to be completed in FY 2014. A new funding opportunity announcement (FOA) will be issued to solicit proposals to continue legacy improvement efforts. Depending on the results of the ongoing projects, the new FOA may address technologies beyond tires and driver feedback to reduce fuel use of the existing vehicle fleet.

Explanation of Funding Changes

(dollars in thousands)

	FY 2012 Current	FY 2014 Request	FY 2014 Request vs. FY 2012 Current
Graduate Automotive Technology Education (GATE) — No activities are planned for GATE as part of a government-wide STEM consolidation.	995	0	-995
Advanced Vehicle Competitions — No significant changes.	1,992	2,000	+8
Legislative and Rulemaking — No significant changes	1,992	2,000	+8
Vehicle Technologies Deployment — the activity will initiate Alternative Fuel Vehicle Community Partner projects. These projects will accelerate the adoption of alternative fuels and advanced vehicle technologies. Public/private partnerships will match Federal funds to support high-impact, state and local community-based projects to displace on-road vehicle petroleum use.	27,876	118,800	+90,924
Biennial Peer Reviews — This funding decrease reflects a one-year study conducted by the National Academies in FY 2012 to identify the market barriers slowing the purchase of electric vehicles. No funds are requested for this in FY 2014. Funding reductions reflect a decision to redirect resources to support higher priority activities within EERE.	3,500	500	-3,000
Legacy Fleet Improvements —No significant change.	2,912	3,000	+88
Total, Outreach, Deployment and Analysis	39,267	126,300	+87,033

Funding Schedule

Fiscal Year	Activity	Funding (dollars in thousands)
FY 2012	Graduate Automotive Technology Education (GATE): • Selected 7 new GATE centers addressing critical advanced vehicle technologies. Advanced Vehicle Competitions • Executed Year 1 of the EcoCAR 2 competition focusing on modeling and simulation and design. Legislative and Rulemaking • Provided technical assistance for state and alternative fuel provider rulemaking activities. • Reviewed and processed petitions to designate new alternative fuels under EPAct. • Analyzed the impact of other regulatory and legislative activities and implemented legislative changes to the EPAct fleet activities, as needed. Vehicle Technologies Deployment: • Continued previous support for coalition-building activities and technical assistance. • Initiated new efforts for communities to address barriers, provide safety training, coordinate initiatives and drive market development to increase deployment of alternative fuel vehicles and infrastructure. • Re-launched the Alternative Fuels Data Center website, in concurrence with the White House Digital Government Strategy, and launched a comprehensive cost calculator. • Developed tools for consumers and local government officials to reduce key regulatory, permitting, and technical certification barriers to PEV deployment as recommended by stakeholders. Biennial Peer Reviews: • Conducted an independent critical review of the two collaborative research and	

Fiscal Year	Activity	Funding (dollars in thousands)
	development activities, known as the U.S. Driving Research and Innovation for Vehicle efficiency and Energy sustainability (U.S. DRIVE) and 21st Century Truck partnerships conducted by the program. The reviews are conducted on a staggered basis and are completed over the course of 18 months. • Fully funded a study examining the market barriers to the introduction of PEVs Legacy Fleet Improvements • Initiated three tire R&D projects. • Initiated two drive feedback R&D projects.	39,267
FY 2013	Planned activities in the FY 2013 Budget (final allocations have not yet been determined): Graduate Automotive Technology Education (GATE): • Establish, develop and expand course work and research to support graduate engineering degrees with a focus or certificate in critical automotive technology areas. Advanced Vehicle Competitions: • Plan and execute Year 2 of the EcoCAR 2 competition, focusing on systems integration. • Initiate planning of the next competition series. Legislative and Rulemaking: • Provide technical assistance for state and alternative fuel provider rulemaking activities, including revising the alternative compliance regulations. • Review and process petitions to designate new alternative fuels under EPAct. • Analyze the impact of other regulatory and pending legislative activities and implement legislative changes to the EPAct fleet activities, as needed. Vehicle Technologies Deployment: • Continue previous support for coalition-building activities and technical assistance. • Continue support for communities to address barriers, provide safety training, coordinate initiatives and drive market development to increase deployment of alternative fuel vehicles and infrastructure. • Develop tools to reduce key regulatory, permitting, and technical certification barriers to electric vehicle deployment as recommended by stakeholders. • Establish relationships with major Internet information providers to increase distribution of web-accessible content and data, as per the Digital Government Strategy. • Continue to expand participation in the National Clean Fleets Partnership and support member fleets' implementation of petroleum reduction strategies. Biennial Peer Reviews: • Conduct an independent critical review of the activities known as U.S. DRIVE and 21st Century Truck partnerships. The reviews are conducted on a staggered basis and are completed over the course of 18 months. Legacy Fleet Improvements: • Develop technology building blocks for an automatic tire inflation system. • Test innovative tire materials capable of 2% reduction in vehicle fuel use through rolling resistance improvements. • Down-select signals and driver feedback methods that are capable of reducing fuel consumption by at least 2%.	—
FY 2014	Graduate Automotive Technology Education (GATE): • GATE will be discontinued in lieu of the streamlined activities conducted by the National Science Foundation and the Department of Education. Awards selected in 2011 will be incorporated, as appropriate, into the relevant technology areas to strengthen the ties between academia, the national laboratories, and industry. No future activity is planned. Advanced Vehicle Competitions	

Fiscal Year	Activity	Funding (dollars in thousands)
	• Plan and execute Year 3 of the EcoCAR 2 competition, focusing on the refinement of student-built vehicles. • Select the university teams to participate in the next competition series. Legislative and Rulemaking: • Provide technical assistance for state and alternative fuel provider rulemaking activities, including revising the alternative compliance regulations. • Review and process petitions to designate new alternative fuels under EPAct. • Analyze the impact of other regulatory and pending legislative activities and implement legislative changes to the EPAct fleet activities, as needed. Vehicle Technologies Deployment: • Continue previous support for coalition-building activities and technical assistance. • Continue support for communities to address barriers, provide safety training, coordinate initiatives and drive market development to increase deployment of alternative fuel vehicles and infrastructure. • Develop tools to reduce key regulatory, permitting, and technical certification barriers to electric vehicle deployment as recommended by stakeholders. • Establish relationships with major Internet information providers to increase distribution of web-accessible content and data, as per the Digital Government Strategy. • Continue to expand participation in the National Clean Fleets Partnership and support member fleets' implementation of petroleum reduction strategies. • Complete three-year re-designation process for coalitions to improve planning, project effectiveness, and commitment to key strategic directions, as described in the Clean Cities Strategy. • Initiate the Alternative Fuel Vehicle Community Partner projects (approximately $90.0 million; competitively-awarded and cost-shared). Public/private partnerships will match Federal funds to support high-impact, state and local community-based projects to displace on-road vehicle petroleum use with alternatives such as natural gas, electricity, or biofuels (Est. 9 awards up to $10.0 million each). • Continue to expand work with Natural Gas Vehicle Technologies Forum to identify near-term barriers to infrastructure expansion and vehicle deployment. • Complete data gathering for and analysis of American Reinvestment and Recovery Act projects to develop relevant case studies and educational materials for local communities. Biennial Peer Reviews: • Conduct an independent critical review of the two collaborative research and development activities, known as the U.S. DRIVE and 21st Century Truck partnerships. The reviews are conducted on a staggered basis and are completed over the course of 18 months. Legacy Fleet Improvements: • Successfully complete a vehicle demonstration of an automatic tire inflation system. • Successfully complete a vehicle demonstration of a new tire design and materials leading to 2% reduction in fuel use. • Successfully demonstrate, through a limited field trial, a driver feedback system capable of reducing over-the-road fuel use by 2%.	126,300

NREL Site-Wide Facility Support
Funding Profile by Subprogram

(dollars in thousands)

	FY 2012 Current	FY 2013 Annualized CR*	FY 2014 Request
NREL Site-Wide Facility Support	0	—	2,000
Total, NREL Site-Wide Facility Support	0	—	2,000

*FY 2013 amounts shown reflect the P.L. 112 175 continuing resolution level annualized to a full year. These amounts are shown only at the "congressional control" level and above; below that level, a dash (—) is shown.

EERE will begin to directly fund NREL site-wide facility support costs that are not included in the Facilities and Infrastructure budget rather than continue to fund these costs in the laboratory overhead rate. This practice is consistent with other national laboratories. NREL's labor rate multiplier will be significantly reduced thereby reducing the cost barrier to accessing unique NREL capabilities (such as facilities and staff expertise) by industry and academia. This change in accounting practice will also make site operating costs more transparent better facilitating cost control. With the proposed FY 2014 budget, NREL's labor rate multiplier is expected to be reduced between 15% and 20% by directly funding site-wide facility support. The site-wide facility support funds cover maintenance and engineering support; fire, emergency, and custodial services; general utilities; network infrastructure and licenses; environment, safety, and health support; and sustainability. By moving these costs from laboratory overhead to direct funding, EERE expects to gain a faster and greater impact to the renewable energy and energy efficiency market place.

The program is a significant EERE program in terms of its work at NREL with major capabilities in the Vehicle Test Facility and Renewable Fuels and Lubricants (ReFUEL) laboratory, and is supported by general management and operations housed in buildings such as the Research Support Facility and related site assets. Starting in FY 2014 EERE programs will fund site-wide costs directly in support of EERE's commitment to enhance NREL's competitiveness by providing direct operating funding for all appropriate activities consistent with Generally Accepted Accounting Principles. Subprograms anticipate using the facilities at NREL for developing, testing, and benchmarking technologies and tools related to thermal systems management, vehicle subsystem modeling, fuel characterization, and vehicle test cycle development. The Vehicle Testing and Integration Facility (VTIF), ReFUEL laboratory, and Thermal Test Facility (TTF), including the energy storage and power electronics and electric machines (PEEM) test laboratories, are critical in meeting the Vehicle Technologies program's strategies and goals.

The VTIF is a state-of-the-art facility for the research, development and demonstration of electric and plug-in electric vehicle charging scenarios and vehicle to grid strategies. The VTIF is also used to evaluate pathways to expand renewable energy power generation through vehicle electrification. In addition, the VTIF is used to test, demonstrate and validate advanced cabin thermal management technologies to reduce fuel use by lowering thermal load for both light and heavy-duty vehicles.

The ReFUEL laboratory is a unique facility offering a heavy duty vehicle chassis dynamometer and two research engine dynamometer test cells used to evaluate the efficiency, performance and emission of hybrid electric powertrains and advanced biofuels. The ReFUEL laboratory also includes full combustion and chemical analysis capabilities to evaluate the performance and characterization of advanced biofuels to help advance their adoption.

The TTF and supporting energy storage and PEEM test laboratories offer capabilities for evaluating efficient and reliable designs and thermal management systems for batteries, electric motors, and power electronics to help enhance performance, improve life, and lower the costs, weight, and volume of these components, in order to improve the adoption of electric drive vehicles. These capabilities are critical to testing and validating the performance, durability and cost effectiveness of advanced vehicle technologies and renewable biofuels, and accelerate the adoption of these technologies in the market place.

Explanation of Funding Changes

(dollars in thousands)

	FY 2012 Current	FY 2014 Request	FY 2014 Request vs. FY 2012 Current
NREL Site Wide Facility Support — Provide support for the NREL user facility.	0	2,000	+2,000
Total, NREL Site-Wide Facility Support	0	2,000	+2,000

Funding Schedule

Fiscal Year	Line Item	Funding (dollars in thousands)
FY 2012	N/A	0
FY 2013	N/A	—
FY 2014	Starting in FY 2014, EERE programs will fund site-wide costs directly in support of EERE's commitment to enhance NREL's competitiveness by providing direct operating funding for facilities that support development, testing, and benchmarking technologies and tools related to thermal systems management, vehicle subsystem modeling, fuel characterization, and vehicle test cycle development.	2,000

Bioenergy Technologies[a]
Funding Profile by Subprograms and Activities

(dollars in thousands)

	FY 2012 Current	FY 2013 Annualized CR*	FY 2014 Request
Feedstocks			
Sustainable Production	967	—	8,500
Logistics	5,004	—	16,500
Algae & Advanced Feedstocks	29,067	—	15,500
Total, Feedstocks	35,038	—	40,500
Conversion Technologies			
Thermochemical	51,685	—	64,000
Biochemical	50,733	—	77,000
Total, Conversion Technologies	102,418	—	141,000
Integrated Biorefineries			
Integrated Biorefineries	42,897	—	33,000
Defense Production Act	0	—	45,000
Total, Integrated Biorefineries	42,897	—	78,000
Analysis and Sustainability			
Systems Analysis	3,925	—	5,500
Crosscutting Sustainability	3,925	—	6,500
Systems Integration	1,963	—	1,500
Total, Analysis and Sustainability	9,813	—	13,500
Biopower	4,829	—	4,000
NREL Site Wide Facility Support	0	—	5,000
Total, Bioenergy Technologies Office	194,995	200,496	282,000

*FY 2013 amounts shown reflect the P.L. 112 175 continuing resolution level annualized to a full year. These amounts are shown only at the "congressional control" level and above; below that level, a dash (—) is shown.

SBIR/STTR:

- FY 2012 Transferred: SBIR $3,774,000; STTR: $507,000
- FY 2013 Annualized CR Transferred: SBIR $132,353
- FY 2013 Annualized CR: SBIR $3,858,632; STTR: $518,368
- FY 2014 Request: SBIR $4,485,428; STTR: $602,572

a Biomass & Biorefinery Systems R&D, renamed Bioenergy Technologies in FY 2014.

FY 2014 Program Summary

- Increased funding for the Feedstocks subprogram includes:
  - Expanded Sustainable Production research and development (R&D) efforts in feedstock assessment and characterization to accommodate dedicated energy crops production (+$7.5 million).
  - Additional Feedstock Logistics R&D projects from the FY 2013 FOA, targeting commercial-scale deployment and demonstration equipment, technologies, and systems to deliver high-quality feedstocks (+$11.5 million).
- Increased funding for the Conversion Technologies subprogram includes:
  - The Low-Cost Carbon Fiber FOA Initiative will fund R&D on the utilization of components of biomass for the manufacturing of low cost carbon fiber (+20.0 million).
  - Waste-to-Energy R&D will fund work to enhance understanding of the biodiversity within anaerobic microbial consortia, and investigate techno-economic and life-cycle benefits associated with anaerobic digestion of biomass fuels, products, and power (+$5.3 million).
  - Thermochemical Gasification R&D will investigate syngas conversion pathways to hydrocarbon fuels (+$7.0 million).
- Increased funding for Integrated Biorefinery Development activities:
  - Defense Production Act (DPA) will support commercial demonstration-scale, military-grade fuel production from biomass in collaboration with USDA and DOE (+$45.0 million).
- Increased funding for NREL site-wide facility support will enhance NREL facilities and infrastructure operating needs for the Integrated Biorefinery Research Facility (IBRF) and Thermochemical Users Facility (TCUF) to support capabilities critical to the program's strategies and goals (+$5.0 million).
- Increased funding for Analysis and Sustainability activities will support development of an aviation biofuels roadmap and a first cellulosic biofuels data and market report. Analysis on the use of high-octane blends of ethanol will be conducted, as well as R&D to evaluate technologies to improve the environmental performance of feedstock production and logistics systems (+$3.6 million).
- Decreased funding for algae and advanced feedstocks activities is the result of fully funding FY 2013 FOA for three-year R&D projects aiming to increase productivity of algae systems and innovative pilot testing on mixotrophic algae technology (-$13.6 million).

Overview

The overall mission of the program is to develop technologies that transform the nation's robust renewable biomass resources into commercially viable, high-performance biofuels, bioproducts, and biopower through targeted research, development, demonstration, and deployment (RDD&D) supported through public and private partnerships. Historically, the program's focus has been on RDD&D for ethanol production from lignocellulosic biomass because of the early market entry point. In FY 2012, the program successfully demonstrated technologies to produce cost-competitive cellulosic ethanol—the culmination of two decades of conversion technology R&D.

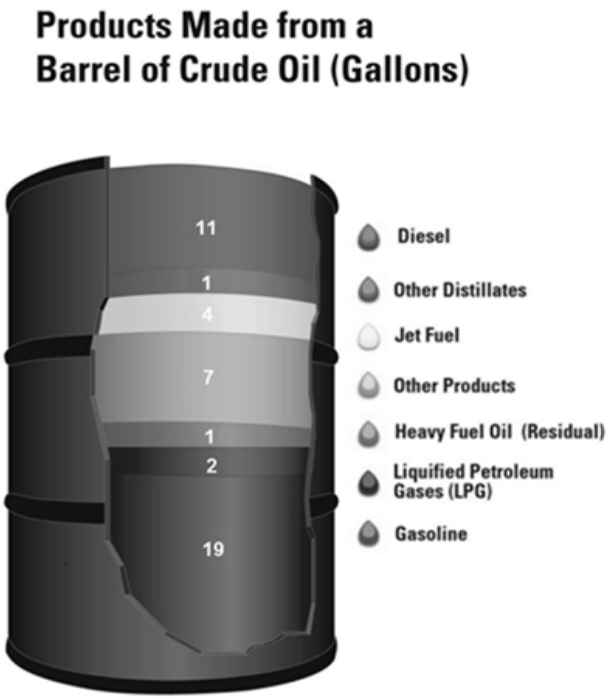
More recent national and DOE goals require the program to expand its scope to include the development of other advanced biofuels that will contribute to the volumetric requirements of the Renewable Fuel Standard (RFS). This includes biofuels such as biomass-based hydrocarbon fuels (renewable gasoline, diesel, and jet fuel), hydrocarbons from algae, and biobutanol. These "drop-in" liquid transportation fuels are largely compatible with existing infrastructure to deliver, blend, and dispense fuels.

America's transportation sector relies almost exclusively on refined petroleum products and accounts for over 70% of oil consumed nationwide. Of the transportation fuel used by the United States, oil accounts for 94%, with biofuels, natural gas, and electricity accounting for the balance. Nearly 9 million barrels of oil are required every day to fuel the 247 million vehicles that constitute the U.S. light-duty transportation fleet.

Biomass is a direct, near-term alternative to oil for supplying liquid transportation fuels to the nation. In the United States, nearly all gasoline is now blended with ethanol, up to 10% by volume (known as E10). In January 2011, the Environmental Protection Agency (EPA) issued partial waivers that permit the use of E15 in model-year 2001 vehicles and newer. While E15 has not yet entered the market at significant volumes, once adopted at the state level, the market for ethanol will increase beyond its current "blend wall" limitations.

In addition to serving as an oil alternative for liquid transportation fuels, biomass can also replace the oil currently used to make products such as plastics,

solvents, and alcohols. Approximately 10% of U.S. crude oil imports are used to make chemicals and products.[a] Many products derived from petrochemicals could be replaced with biomass-derived materials. Today, less than 4% of U.S. chemical sales are biobased[b], suggesting that significant opportunities for innovation exist in this market.



The resulting supply of domestically-produced feedstocks intended to replace the entire barrel of imported petroleum for the manufacturing of biofuels, bio-products, and biopower will keep the full "value chain" investment in America, making the nation more energy secure, and insulating businesses and households from volatile price spikes due to oil price fluctuations.

When considering domestic alternatives to fossil fuels, the United States is adopting an "all of the above" strategy, including multiple clean domestic energy sources that will diversify the U.S. energy supply. However, the specific benefit of a biomass-derived alternative to fossil fuels is an increased level of near-term economic activity and new jobs in the farms and forests of rural America. Farming and forestry are both vital industries today, and robust biomass-based industries can produce food and feed alongside new crops dedicated to energy, thus providing more job opportunities for agriculture and forestry.

In addition, increased use of biofuels, bio-products, and biopower instead of petroleum can substantially decrease life-cycle emissions of greenhouse gases (GHG) and other pollutants, depending on feedstock type, crop management practices, and processing. For liquid transportation fuels, biofuel is one important option for achieving such reductions, especially for diesel trucks and jet aircraft where electrification is currently not a feasible option.

Bioenergy Technologies Program Strategy

There are several challenges that need to be addressed in order for the bioenergy sector to significantly contribute to our national goals to reduce oil dependency and decrease GHG emissions:

- Scalability—To produce meaningful volumes of biomass is not difficult — significant quantities exist today as agricultural and forestry residues and urban wastes. It is not so easy to economically collect and haul these materials to a central processing facility. Bales and bundles and chips are not as economical to transport as crude oil, coal, or corn grain because of their intrinsically higher bulk density and lower energy density.
- Cost reduction—Biofuels and bio-products may soon be price-competitive with conventional fuels, but because they will not soon be cost-competitive, there is substantial risk to the nascent biofuels industry from periodic downward swings in oil prices. Crude oil producers can survive these downward swings because they are balanced by profit margins during other periods; producers of advanced biofuels will have much thinner margins at the outset.
- Stable policies—In order to support the emerging new industry through its early development, stable policies need to be in place to encourage private sector investment and put these new technologies on a level playing field in the market. This will help gather the necessary private capital to build the first-of-a-kind facilities that will validate the technologies for future investment.
- Infrastructure— There is a need to support infrastructure that is able to accept advanced biofuels as they are produced in significant volumes.

Within the mission of the program, the following activities help overcome these fundamental challenges, which reside solely in research, development, and demonstration (RD&D):

[a] Biotechnology Industry Organization. *Biobased Chemicals and Products*. 2010.
[b] Biotechnology Industry Organization. *Biobased Chemicals and Products*. 2010.

- Develop innovative solutions to overcome the technical and cost barriers of feedstock logistics and delivery, including investigating means to provide uniform format and densified feedstocks to reduce the cost of delivery from farm to facility.
- Develop novel technologies that can reduce the cost of feedstocks and still achieve a 50–60% reduction in GHG over petroleum.
- Develop technologies to convert non-food sources of biomass to intermediates, such as low-cost sugar and crude bio-oil to meet the needs of fuels, and bioproducts, enhancing economic and environmental sustainability.
- Determine appropriate characteristics of bio-oils and gases and conduct necessary R&D to enable use of existing infrastructure, thus reducing the need for capital investments in new facilities.
- Enable demonstration activities of the manufacturing of biofuels and bio-products that are critical to proof of performance and lay the groundwork for future commercial deployment.
- Enable infrastructure readiness through analysis and testing of advanced biofuels in preparation of commercial deployment.

This strategy is designed to reduce the technology and financial risks associated with cutting-edge bioenergy technologies and to encourage significant commercialization that would lead to widespread adoption in several industrial sectors. The program's research is driven by the identification of major barrier areas, manufacturability of end products and road mapping through stakeholder interactions.

In order to implement these strategies, the program collaborates with DOE's Office of Science and ARPA-E through the Biofuels Technology Team to take advantage of all available DOE expertise, identify fundamental needs and develop innovative solutions to overcome current technological barriers. In addition, the Biomass Research and Development Initiative (BRDI) fosters collaboration between the program and the U.S. Department of Agriculture (USDA), the Environmental Protection Agency (EPA), the Department of Defense (DOD), and other relevant agencies, ensuring a holistic approach to bioenergy solutions that enhances research and development efforts across the Federal Government.

Incubator Programs: The great majority of EERE investments are currently, and must going forward, be primarily driven by detailed short, medium, and long-term RDD&D roadmaps. EERE proposes Incubator activities in the FY 2014 budget, and designed them to use a small fraction of EERE's technology office's annual R&D budget to regularly introduce potentially high-impact "off-roadmap" new technologies. These Incubator activities will enable the "rapid on-ramping" of potentially transformational new energy technologies into the EERE portfolio, dramatically increasing the rate of technology innovation.

Technology Status, Program Accomplishments, and Near-Term Milestones[a]

In FY 2012, after more than a decade of targeted R&D, the program successfully demonstrated and validated multiple integrated systems for the conversion of biomass to ethanol and other industrial alcohols. Data from the program's efforts directed at alcohol fuels will be available to industry and others looking to commercialize any of these technology pathways by the end of FY 2013.

Specific accomplishments in FY 2012 include:

- Achieved a modeled conversion cost for mature technology of $1.33/gallon of ethanol. When combined with the cost of feedstocks, this equates to a $2.15/gallon minimum ethanol selling price.
- Reduced feedstock logistics costs for dry herbaceous biomass (i.e., field-dried corn stover) from harvest to biochemical conversion plant gate to $0.49 per gallon of ethanol (equivalent to approximately $35/Dry Ton (DT) in 2007 dollars) contributing to the minimum ethanol selling price of $2.15/gallon.
- 6 of 19 ARRA-funded integrated biorefineries completed construction activities and moved into startup, commissioning, and/or operations. These include the 8 million gallons per year (mmgy) Indian River County BioEnergy Center (INEOS-New Planet Energy Florida) biorefinery that is starting to produce cellulosic ethanol from municipal solid waste (MSW)citrus waste ; ICM that is producing cellulosic ethanol from corn fiber at the pilot scale; two algal biorefineries, Sapphire and Solazyme, targeting algal oil for renewable hydrocarbon fuels; a pilot-scale pyrolysis project, Renewable Energy Institute International, which making renewable diesel from wood chips and rice hulls; and Clearfuels, a pilot scale biomass gasification project producing renewable diesel and jet from wood chips.

In addition, deployment efforts are targeting the validation of a total yearly capacity of 60 million gallons

[a] For a list of milestones please see "Strategic Performance Management by Program" section.

of advanced biofuels by the end of FY 2014. These successes are paving the way for private investments in this growing biofuels industry.

In FY 2014, the program expects two of the largest commercial-scale biorefineries in the program's portfolio to complete commissioning, adding a combined annual capacity of 40 million gallons of cellulosic ethanol.

In addition, in FY 2014, planned accomplishments will include the completion and final report delivery of the Sun Grant Regional Feedstock Partnership project that will include high-resolution national yield maps for several herbaceous and woody energy crops (including switchgrass, mixed native grasses, miscanthus giganteus, energycane, annual energy sorghums, hybrid poplar and shrub willow) and agricultural residues (i.e., corn stover and wheat straw), based on field trial data from the last 5 to 6 growing seasons (i.e., 2008–2013). The 5 project awards funded under the FY 2009 logistics Funding Opportunity Announcement (FOA) will also be ending in late FY 2013 or early FY 2014, and each will have demonstrated new logistics supply chain systems that will reduce the delivered cost of a variety of feedstock materials (including loblolly pine, hybrid poplar, shrub willow, corn stover, switchgrass, miscanthus, and mixed native C4 grasses). Oak Ridge National Laboratory (ORNL) and Idaho National Laboratory (INL) will in FY 2013 complete a parallel economic analysis of the technologies developed by these competitively awarded logistics projects. Fully detailed, techno-economic analysis of three additional pathways beyond fast pyrolysis will be completed by the end of FY 2014, diversifying the portfolio to include multiple conversion schemes for multiple feedstocks.

Office Planning and Management

The program prioritizes its RDD&D work according to EERE's "5 Core Questions":

1) High Impact: Is this a high-impact problem?
2) Additionality: Will the EERE funding make a large difference relative to what the private sector (and other funding entities) is already doing?
3) Openness: Have we made sure to focus on the broad problem we are trying to solve and be open to new ideas, new approaches, and new performers?
4) Enduring Economic Benefit: How will this EERE funding result in enduring economic benefit to the United States?
5) Proper Role of Government: Why is what you are doing a proper high-impact role of government versus something best left to the private sector to address on its own?

The program chooses projects through an open and competitive process using independent experts who evaluate proposals for technical merit. New competitive awards to industry and others are typically funded in the year they are awarded, per congressional direction. Project management improvements implemented in FY 2013 and greater emphasize on the cost-effectiveness of the projects themselves will continue in FY 2014. In alignment with EERE core principles, the program is committed to active project management with rigorous monitoring, review, and engagement to prevent waste, fraud, abuse, and to ensure that the agreed-upon goals and objectives are achieved in the most effective manner.

As noted above, the overall goal of the program is to reduce the cost of biofuels to make them directly cost-competitive with petroleum-based fuels in the market. To that end, the program utilizes techno-economic modeling and extensive stakeholder engagement to identify priority pathways that have the greatest promise to achieve our aggressive bioenergy goals. In FY 2013, a diverse set of hydrocarbon fuel pathways will be fully vetted and explored to drive the program's research strategies going forward. In FY 2014, public-private partnerships will be sought to overcome the key identified barriers.

In FY 2014, several new competitive awards will be made that span the entire program portfolio. A solicitation focused on purpose-designed biomass feedstock supply chains addressing biomass stability, densification, and quality and conversion performance aims to reduce the delivered cost of a variety of feedstocks to biorefineries. In addition, the program would announce a solicitation to promote algal strain improvement and domestication, crop protection strategies, regionally and seasonally specific cultivars, and nutrient management techniques to improve algae productivity would be announced.

The program will also bridge DOE's Office of Science, Energy Frontier Research Centers (EFRC), and ARPA-E efforts to applied R&D, specifically in conversion R&D benefiting multiple pathways. FOAs will target fundamental improvements in separations and catalysis, as identified in previous road mapping workshops. Also through competition, the program will explore the feasibility of producing clean characterized sugars from biomass at reasonable cost ($0.15–$0.20/lb.) and cost-effective sugar upgrading to fuels and bio-products.

The program's work in syngas conversion for hydrocarbon fuels and fuel components will be refocused on the technology required to enable the smaller plants

to manufacture cost-effective biofuels, with a focus on process intensification. The program will also extend work in the operation of synthesis catalysts, and techno-economic modeling for design cases for the production of gasoline, diesel, and jet fuel from biomass.

In FY 2014, the program will further fund projects that focus on the organic fraction of MSW and biosolids for waste-to-energy applications. MSW represents a feedstock opportunity previously under-explored for advanced technologies and has the potential to impact bioenergy production on a state level across the nation. The program's initial efforts will target improvements in anaerobic digestion for fuels, products, and power. The program will enhance productivity and reduce costs in the process unit operations associated with anaerobic digestion technology applications and target methane upgrading, effluent refining, and process control and optimization.

Improving environmental performance to increase scale-up potential of technologies remains a program priority. The program is committed to our goal of helping ensure feedstock and fuel producers can sustain their long-term operations. As such, the program continues to seek reductions in GHG emissions, water consumption, fertilizer usage, and criteria air pollutants, while also continuing to reduce overall biofuel and bioproduct production costs. Improved environmental performance increases the scale-up potential necessary for meeting ambitious volume targets by overcoming local resource constraints, increasing siting opportunities, and increasing overall productivity.

Strategic Performance Management by Office

Performance Goal (Measure)	**Bioenergy Technologies Program - Conversion Cost** - Reduce modeled conversion cost for feedstock to gasoline/diesel fuel via a bio-oil pathway ($2011, $/gallons of gasoline equivalent) 2013: Reduce the modeled conversion cost for woody biomass conversion via fast pyrolysis to a gasoline and diesel blend stock, in support the 2017 programmatic total cost goal of less than $3.00/gal gasoline.		
Fiscal Year	**2012**	**2013***	**2014**
Target	$3.95/gge	2.71/gge	$2.70/gge[1]
Result	Baseline		
Endpoint Target	$1.73/gge conversion cost by 2017 $3/gge total fuel cost goal by 2017		

[1] Note, the $3/gge ($2.70/gge conversion cost) program goal is a compilation of feedstock costs and conversion costs to achieve a total fuel production cost. When combined with the feedstock cost target for 2017, the fast pyrolysis pathway supports meeting the 2017 program goal of $3/gge. By September 2013, the 2009 fast pyrolysis design case will be updated, which may increase these cost projections, due to rising capital costs and other factors.

Performance Goal (Measure	**Bioenergy Technologies Program - Feedstock Logistics Cost -** Reduce feedstock logistics cost for delivery to plant ($/dry-matter ton) [2013 & 2014 targets from 2011 baseline] 2013: Reduce non-pulp wood feedstock supply system logistics cost in dollars per dry matter ton ($/dry matter (DM) ton, in $2007, for delivery to plant gate or conversion reactor inlet).		
Fiscal Year	**2012**	**2013***	**2014**
Target	35 $/dry-matter ton	55 $/dry-matter ton	53 $/dry-matter ton
Result	**Met** – 35[2]		
Endpoint Target	$46/DM Ton by 2017		

[2] Target met with dry corn stover to ethanol pathway.

*2013 targets represent DOE's FY 2013 Budget Request to Congress. FY 2013 target updates can be found in the upcoming FY 2012-2014 Annual Performance Plan & Report.

Feedstocks
Funding Profile by Activity

(dollars in thousands)

	FY 2012 Current	FY 2013 Annualized CR*	FY 2014 Request
Sustainable Production	967	—	8,500
Logistics	5,004	—	16,500
Algae & Advanced Feedstocks	29,067	—	15,500
Total, Feedstocks	35,038	—	40,500

*FY 2013 amounts shown reflect the P.L. 112 175 continuing resolution level annualized to a full year. These amounts are shown only at the "congressional control" level and above; below that level, a dash (—) is shown.

The Feedstocks subprogram develops technologies, processes, and engineered systems to cost effectively deliver high quality biomass to the entire spectrum of potential conversion processes. This requires interfacing diverse biomass resources with the different input specifications of the various potential conversion processes.

The subprogram works on three critical program elements. For the first element, Sustainable Production, the subprogram is performing detailed, nationwide, county level feedstock resource assessments and supply characterizations. These efforts will facilitate the development of sustainable, highly productive terrestrial biomass production systems. For the second element, Logistics, the subprogram is developing engineering technologies and supply chain systems capable of delivering commodity quantities of high quality, economically-viable terrestrial biomass feedstocks, which are essential for the scale-up and viability of a national bioenergy industry. For the third element, Algae and Advanced Feedstocks, the subprogram is developing biofuels systems utilizing a variety of algal and cyanobacterial species and it is engineering innovative advanced feedstock solutions that enable high biomass yield per unit area and significantly increase conversion performance characteristics, while reducing delivered feedstock costs.

Sustainable Production: Sustainable Production activities focus on nationwide, county level, sustainable resource assessments at a range of price points. Sustainable Production activities also provide critical data layers to industry partners and the broader bioenergy research community. Sustainable Production provides chemical and physical characterizations of relevant forms of biomass which can impact logistics operations and/or conversion performance. Variability in delivered feedstock quality has emerged as a key challenge for the bioenergy industry, and this work is providing the data, analytical methods, and technologies required to characterize and preserve feedstock quality and provide solutions that satisfy conversion process input parameters. Through the Regional Feedstock Partnership, critical datasets about sustainable productivity potential across a range of bioenergy feedstocks and geographies will be established and made available publicly via the Knowledge Discovery Framework and the Biomass R&D Library. In addition, the subprogram will leverage USDA production projects to achieve more comprehensive project information and additional feedstock materials for testing purposes.

Logistics: Logistics R&D activities will focus on progress toward feedstock cost, quality, and volume targets that support the FY 2017 program target of $3/gge of drop-in hydrocarbon fuels. To accomplish this goal, Logistics activities support efforts in both engineering lab and field-scale supply and logistics technologies for terrestrial biomass that enable the development of highly efficient commodity-scale feedstock supply systems. Logistics is working on three critical constraints currently confronting the emerging industry: delivered feedstock cost; delivered feedstock quality and maintenance of quality characteristics during storage; and accessible feedstock volume. Logistics activities utilize the existing Feedstock Logistics Process Demonstration Unit (PDU) User Facility, a scaled-up research tool developed by Idaho National Laboratory that enables industry and the research community to develop and evaluate technologies and processes that achieve delivered feedstock cost and quality targets, as well as the effect that these technologies may have on conversion performance. The PDU User Facility provides for the investigation of a range of pre-processing strategies, configurations and operating parameters, allowing users

to develop optimized configurations for their specific feedstock and processing requirements. Projects will allow technology developers to insert their systems within the PDU processing train to evaluate key performance characteristics of newly designed or modified equipment.

In FY 2014, the Logistics program element will select additional meritorious projects from the FY 2013 Advanced Bioenergy Feedstock Logistics Systems II FOA that will target commercial scale deployment and demonstration of equipment, technologies, and systems that can reliably deliver high quality feedstocks and accelerate the reduction in delivered feedstock cost. The Logistics element will also continue to support core R&D efforts on biomass preconversion and feedstock formulation technologies through targeted projects with industry, university, and national laboratory partners.

In addition, in FY 2014, the Logistics program element will conduct R&D to demonstrate advanced formulation and blending strategies, and identify the next steps based on the data derived from these R&D efforts.

Another critical component of meeting long term biofuels production goals is developing strategies and processes to produce densified, infrastructure-compatible materials that facilitate commodity scale exchange networks. The Logistics program element in FY 2014 will demonstrate biomass densification process configurations that reduce the cost and energy required to achieve infrastructure compatible material performance characteristics.

Algae & Advanced Feedstocks: technology The Algae and Advanced Feedstocks activity element will continue work on the development of cost effective algal biofuels production and logistics systems. Techno-economic analyses and cost projections show that the algal cultivation costs are among the largest components in the overall algal biofuels production cost, suggesting that improving feedstock traits, such as overall biomass yield, will be an important technological advance.

Beginning in FY 2010, the program has supported algae R&D to produce, handle, and convert algal biomass into renewable replacements for gasoline, diesel and jet fuels that are compatible with current infrastructure. The program defines algae broadly, and considers not only eukaryotic microalgae and macroalgae but also prokaryotic cyanobacteria as promising major subcategories. The primary advantages of algal biomass – the ability to grow fast, use waste resources, and accumulate ideal fuel precursors (e.g. lipids) – are broadly recognized. In recent years, the program has achieved many technological advancements that promise to bring about transformational changes, including the ability to predict, breed and select the best performing strains; the ability to monitor and control system inputs in a dynamic and integrated fashion; the ability to harvest algae at ever higher throughputs; and the ability to extract and convert more algal biomass components into fuels. However, the costs associated with producing, handling and converting these primarily-aquatic feedstocks are still high enough to prohibit large-scale commercial demonstrations of these promising technologies. Thus, the program's algae efforts are geared to fund a portfolio of technologies focused on demonstrating a mature plant, hydrocarbon fuel pathway with a $3/gge minimum fuel selling price by FY 2022.

The challenges and opportunities to commercializing algal biofuels production systems are broad and complex, requiring the close integration and collaborations of many scientific and engineering disciplines to bring about innovations. Largely informed by the National Algal Biofuels Technology Roadmap[a] activity the program undertook in FY 2009, the major activities supported by the program to date include, 1) executing four multidisciplinary and multi-investigator consortia projects, 2) establishing an integrated set of techno-economic, GHG emission, water-use and land-use baselines to benchmark anticipated progress in both technology development and sustainable practices, 3) initiating water and nutrient recycling projects to improve algal growth systems, and 4) leveraging capacities built using public and private funding to initiate algae test beds that can provide not only initial strain and unit-of-operation prototype characterization and testing capabilities, but also to serve as sites to conduct long-term (5-year) cultivation trials in strategic locations across the country.

The FY 2014 algae activity element will continue to maintain support of core national laboratory activities and competitive research endeavors that address these challenges as well as select 2-5 additional projects from

[a] U.S. Department of Energy, Bioenergy Technologies Office. *National Algal Biofuels Technology Roadmap: A technology roadmap resulting from the National Algal Biofuels Workshop*. By Daniel Fishman, Rajita Majumdar, Joanne Morello, Ron Pate, and Joyce Yang. Washington, D.C. May 2010.

the FY 2013 FOA to increase chances of success and add multiple high productivity strains to the effort. Best practices will also emerge in terms of cultivating the best strains in the best geographic location through the continued support for Algal Test-bed Facilities. In addition, novel algal-lignocellulosic hybrid feedstock concepts that that could potentially provide significantly increased conversion process performance will be pursued, by leveraging DOE's investment in the Feedstock Logistics PDU.

In FY 2014, the program will evaluate the progress of the Algae Test Bed User Facility. The Office will also continue to support resource assessment, life-cycle greenhouse gas emissions, techno-economic modeling analyses, and pre-competitive R&D projects at the national laboratories including, but not limited to, novel feedstock blending and formulation strategies, to support the portfolio of competitively awarded projects.

In November, 2012, the program released an update to its Multi-Year Program plan that contains baseline (i.e. 2010, prior to significant program investment in algae) technical targets and cost projections for a mature plant model of open pond algae biomass cultivation. The baseline is based on a joint national laboratory technical report.[a] In the report, the baseline minimum renewable diesel selling price is $18.63/gallon. The high cost is mostly the result of low assumed baseline algae productivity and high capital and operating costs. An aggressive R&D portfolio is expected to make significant progress towards cost-competitiveness with the goal of $3/gge by FY 2022.

Still underway is work initiated by the program to develop detailed experimental data and supporting techno-economic analyses to set a "state-of-technology" and accompanying annual cost projections for algal biofuels. In the interim, based on very promising preliminary results, the program set an interim cost goal of $6 to $7/gge by FY 2018.

Therefore, the program's decreased request for algae reflects a balancing of the portfolio to both ensure achievement of FY 2017 terrestrial feedstock goals while maintaining critical progress towards overcoming longer-term challenges and meeting technical targets by FY 2018 and FY 2022.

[a] ANL; NREL; PNNL. (June 2012). Renewable Diesel from Algal Lipids: An Integrated Baseline for Cost, Emissions, and Resource Potential from a Harmonized Model. ANL/ESD/12-4; NREL/TP-5100-55431; PNNL-21437. http://dx.doi.org/10.2172/1044475.

Explanation of Funding Changes

	(dollars in thousands)		
	FY 2012 Current	FY 2014 Request	FY 2014 Request vs. FY 2012 Current
Sustainable Production — The relative funding increase will be used to intensify activities required for emerging dedicated bioenergy feedstocks and to leverage feedstock investments made at the USDA in collaboration with Cross-Cutting Sustainability, which are expected to provide large quantities of biomass in future years and about which relatively little is known compared to traditional row crops.	967	8,500	+7,533
Logistics — The funding increase will be used to fund 2-3 additional consortia from the FY 2013 FOA that will engage stakeholders: including equipment manufacturers, key laboratory researchers, biorefinery partners, and universities to develop new systems that will overcome many of the challenges facing bioenergy, such as low energy density, moisture and quality issues, equipment limitations, and systems not optimized for biofuel production.	5,004	16,500	+11,496
Algae & Advanced Feedstocks — A decrease in funding represents a balancing of the portfolio between near-term (FY 2017) goals and longer-term goals for algae. Funds requested in FY 2014 will be critical to maintaining progress on algal biofuel technologies in order to achieve 2022 goals. Funds will be used to select 2-5 additional projects from the FY 2013 Algal Bioenergy Yield FOA and to continue ongoing analyses and other core applied R&D activities at the national laboratories. No new FOA is anticipated to be issued in FY 2014.	29,067	15,500	-13,567
Total, Feedstocks	35,038	40,500	+5,462

Funding Schedule

Fiscal Year	Activity	Funding (dollars in thousands)
FY 2012	• Fully delivered the Billion Ton Update resource assessment datasets through the KDF. Feedback from stakeholders has been positive and highlights the value and importance of this community resource. • Released an agricultural residue removal assessment framework that is supporting USDA Natural Resources Conservation Service (NRCS) and industry partners in establishing sustainable row crop residue removal practices nationally. • The Regional Feedstock Partnership delivered productivity data and physical samples for resource assessment and biomass characterization. • Made available to the public the Bioenergy R&D Library, which provides physical and chemical properties of biomass. • Successfully demonstrated technology to produce cost-competitive cellulosic ethanol (culmination of a 10-year effort). • Utilized Logistics PDU to support cellulosic ethanol demonstration. • Confirmed analysis of competitively awarded logistics project designs and results. • Conducted core competency national lab projects. • Initiated Advancements in Sustainable Algal Production (ASAP) FOA projects (Water and Nutrient Sustainability and Algae Test beds). • Algae Topic Area in Innovative Pilot Biorefinery FOA.	35,038
FY 2013	Planned activities in the Fiscal Year 2013 Budget (final allocations have not yet been determined): • Full deployment of R&D sample library. • Update the Billion Ton resource assessment methodology to utilize USDA's cropland data layers to improve land use evaluation. • Establishment of PDU User Facility and protocols for community use. Initial deployment. • Conclude five competitively-funded "high tonnage" logistics projects. • Issue commercial scale industry logistics FOA and make 2-3 awards. • Update logistics design report supporting 2017 programmatic goal of $3/gge of hydrocarbon drop-in fuels. • Conduct core competency national lab projects. • Initiate Advancements in Algal Biomass Yield (ABY) FOA projects to improve algal biofuel feedstock yield. • Initiate 1 algae innovative pilot biorefinery project.	—
FY 2014	• Finalize comprehensive report on Regional Feedstock Partnership Program results, conclusions, and synthesis. • Update national potential resource assessment based on results from Regional Feedstock Partnership and published literature. • Produce national feedstock quality data layers through the Bioenergy R&D Library utilizing Regional Feedstock Partnership and industry partnership physical samples collected from FY 2011 to FY 2013. • Deploy novel predictive tools for conversion performance of select feedstocks within the R&D sample library. • Collect, store, preprocess and deliver on-spec feedstock materials for use in the Conversion Technology Areas. • Leverage ongoing feedstock production activities with the USDA. • Initiate first remote deployments of PDU User Facility. • Award alternate commercial scale industry projects from FY 2013 logistics FOA. • Conduct core R&D efforts on blending and formulation strategies to upgrade feedstock	40,500

Fiscal Year	Activity	Funding (dollars in thousands)
	quality, lower delivered feedstock cost, and access more biomass volume. • Demonstrate integrated preconversion systems at industrial scale that reduce cost and energy associated with biomass densification to meet infrastructure compatible characteristics. • Demonstrate biomass stabilization technologies that reduce mass losses and prevent feedstock quality degradation while also reducing cost and energy inputs. • Conduct core competency national laboratory R&D projects in algae resource assessment modeling; algal biomass characterization; algal feedstock characterization and blending; cultivation, harvest, and conversion process modeling; organism development; and life-cycle assessments directed towards meeting 2014, 2018, and 2022 technical targets for algal biofuels. • Initiate 2-5 additional ABY FOA projects that will work towards the ambitious algae biomass yield goal of 2,500 gallons per acre per year target, which represents a 2.5-fold improvement above baseline technologies. Additional projects will further the diversity of selected technical pathways, regions, and performers to maximize potential for successful R&D outcomes.	

Conversion Technologies
Funding Profile by Activity

(dollars in thousands)

	FY 2012 Current	FY 2013 Annualized CR*	FY 2014 Request
Thermochemical	51,685	—	64,000
Biochemical	50,733	—	77,000
Total, Conversion Technologies	102,418	—	141,000

*FY 2013 amounts shown reflect the P.L. 112 175 continuing resolution level annualized to a full year. These amounts are shown only at the "congressional control" level and above; below that level, a dash (—) is shown.

The strategic goal of the Conversion Technologies subprogram is to develop technologies for converting feedstocks into commercially-viable liquid transportation fuels, as well as bioproducts and biopower. The diversity of biomass resources necessitates the development of multiple conversion technologies that can efficiently deal with the broad range of feedstock materials, as well as their physical and chemical characteristics. Conversion R&D includes biological, catalytic, thermochemical, and hybrid routes to convert biomass into suitable intermediates, including, but not limited to, sugars, bio-oils, and gases. These intermediates are then upgraded into renewable gasoline, diesel, jet fuels, chemicals, and heat and power. Renewable diesel can also be used in place of home heating oil. The program has set a target of $3.00/gge for hydrocarbon fuels and at this early stage, the program will evaluate multiple candidate technologies that can potentially meet this target.

Organizationally, the program splits its conversion R&D efforts into two technical areas: Biochemical Conversion R&D and Thermochemical Conversion R&D. Within each area, there are many possible variations, but the main differences are in the primary catalytic system employed. Thermochemical Conversion R&D pathways are further segregated based on the types of intermediate building blocks produced—bio-oils or syngas.

While the program addresses the conversion R&D needs through two separate technology areas—Biochemical and Thermochemical—it is envisioned that the combined use of technologies from multiple areas offers the greatest opportunity for optimizing biomass conversion into a variety of different fuels, chemicals, and energy products. Initial commercial biorefineries may focus primarily on a small number or even a single product. However, it is anticipated that, as the industry matures, additional technologies and products will be incorporated.

Thermochemical: Thermochemical activities include both bio-oil and syngas conversion pathways to produce finished fuels that meet specifications for gasoline, diesel, jet fuel, heating oil, and other co-products such as chemicals hydrogen or that can be used directly for heat and power. R&D efforts in this area focus on direct substitutes for fossil fuel-based intermediates and products that are compatible with existing fossil fuel processing and distribution infrastructure, such as petroleum refineries and blending stations. When integrated it is expected that these technologies can produce hydrocarbon products at $3/gge.

In general, pyrolysis and liquefaction processes convert biomass to condensable vapors, non-condensable gases, char, and coke. When the condensable vapors are quenched, two liquid phases are formed: a bio-oil phase and an aqueous phase. The bio-oil phase is upgraded through various catalytic hydrotreating, separations, and fractionation steps to produce a finished fuel or an acceptable petroleum refinery feedstock. The non-condensable gases from the conversion and upgrading steps can be used to generate process heat and power and to reform into hydrogen for upgrading. The aqueous phase may contain organic acids, aldehydes, and phenols, which can also be used to produce hydrogen or other fuels. Char and coke can also be used for process heat and power generation or may be steam-reformed to produce additional hydrogen.

Thermochemical activity also includes R&D in syngas conversion pathways using indirect liquefaction (i.e., gasification followed by catalytic upgrading and synthesis).

In FY 2014, R&D funding in the bio-oil pathway is directed at competitive and core national laboratory R&D in the priority areas identified at the Conversion Technologies for Advanced Biofuels (CTAB) Workshop, as well as techno-economic analysis and in the Multi-Year Program Plan. These priority areas include: separation technologies, catalyst development (yield improvement, product quality, and improved lifetime), reactor materials and design, and defining upgrading requirements. This R&D will be conducted on technologies that thermochemically convert biomass to bio-oil intermediates via pyrolysis and direct liquefaction-based processes such as conventional fast pyrolysis, catalytic fast pyrolysis, hydropyrolysis, hydrothermal liquefaction, and solvent liquefaction. R&D activities also include the necessary catalytic upgrading of bio-oil intermediates to produce gasoline, diesel, and jet fuels or to make an acceptable petroleum refinery feedstock, thus leveraging existing capital for fuel finishing.

Additionally, techno-economic analysis and life-cycle assessments will continue to be used to establish technical targets for the newer pathways. Research on conventional fast pyrolysis and the other listed technologies will continue to reduce costs toward achieving the conversion cost target of approximately $1.73/gge by 2017 ($3/gge including feedstock). The $3/gge program goal is a compilation of feedstock costs and conversion costs to achieve a total fuel production cost. When combined with the feedstock cost target for 2017, the fast pyrolysis pathway supports meeting the 2017 program goal of $3/gge. By September 2013, the 2009 fast pyrolysis design case will be updated, which may increase these cost projections, due to rising capital costs and other factors.

The program will complete fully detailed, techno-economic analysis of three additional pathways beyond fast pyrolysis by the end of FY 2014, diversifying the portfolio to include multiple conversion schemes for multiple feedstocks.

The program's FY 2014 funds will support a FOA focused on integrating bio-oil intermediates into petroleum refineries to enable a partnership between refiners, biofuel producers, and technology developers that addresses the challenges to integrating bio-oils into existing refineries such as improving the chemical understanding of intermediates and fuels and their properties.

In FY 2014, R&D in thermochemical conversion will also focus on upgrading synthesis gas, other gaseous intermediates and mixed oxygenates to produce gasoline, diesel, and jet fuel. This work leverages the program's previous successes to cost-effectively produce mixed alcohols via indirect liquefaction. As previously mentioned, the program is conducting research in support of a developing a techno-economic analysis of suitable syngas to liquid pathways to establish targets and research direction, expecting to complete a full techno-economic analysis in FY 2014.

The program's syngas-to-biofuels R&D includes syngas production and cleaning, catalytic liquefaction of these gases to mixed oxygenates and hydrocarbon intermediates, and the synthesis of these intermediates into hydrocarbon fuels and products. Part of this R&D effort will include issuing a FOA to develop indirect liquefaction catalysts, investigate process intensification (combining multiple process steps), improve process yield and efficiency, conduct molecular modeling to understand and improve catalyst performance, and develop analysis methods to perform in situ process stream characterization.

The Incubator Program is intended to be a separate funding opportunity for small and large companies, universities, and national laboratories that explicitly focus on pathways/technologies/approaches that are not supported in a meaningful way on the program's current Multi-Year Program Plan/Roadmap. Therefore, the program is proposing its Incubator Program to identify novel thermochemical conversion technologies/approaches applied to existing or new pathways in its portfolio. Based upon a highly successful model piloted by EERE's Solar Energy Technologies Office, the program plans to invest in the creation of a thermochemical conversion Incubator program in FY 2014.

Biochemical: R&D in the Biochemical conversion sphere continues to focus on drop-in hydrocarbons such as renewable diesel, gasoline, and jet fuels (or additives), cost competitively. Multiple pathways are under consideration and techno-economic models are expected to establish targets for cost competitiveness in FY 2013 and FY 2014.

In FY 2014, the program's Biochemical Conversion R&D will target activities on biomass deconstruction and focus on upgrading the intermediates into fuels and chemicals. Activities associated with biomass deconstruction to sugar intermediates will focus on optimizing the pretreatment and hydrolysis reactions to deliver high-quantity and high-quality sugars, as well as to design

engineering and optimization. The separation technologies necessary to remove impurities from sugar intermediates to optimize downstream fuel and chemical production also remains a critical R&D focus for the program. Other novel areas of interest to the program include combining or eliminating reaction steps and increasing the overall efficiency of the deconstruction process. Enabling technologies and research insights in feedstock chemical and physical characterization and formulation, enzyme kinetics modeling, quantum mechanics, and deconstruction visualization will also be pursued.

FY 2014 R&D to upgrade biomass-derived sugar and lignin streams will include improving the carbon utilization efficiency, resulting in a larger quantity of fuels and chemicals produced from the same unit of biomass, as well as improving the durability, specificity, and productivity of both biological and chemical catalysts. Lignin conversion innovations will be emphasized to allow for this previously under-utilized biomass portion to generate more fuels and chemicals. Innovative technologies aimed at improving carbon efficiency or carbon footprint of biochemical processes will be sought. These include technologies preventing carbon loss or recapturing carbons during the fuel synthesis steps, and those that address the potential loss of product yield resulting from the removal of oxygen present in biomass. The recovery of product streams from the reaction milieu also remains a critical need.

Enabling technologies are being developed in coordination with the Office of Science to apply cutting-edge techniques to target process improvements. These enabling technologies and techniques include genomics, transcriptomics, proteomics, metabolomics, and synthetic and systems biology, alongside research that addresses the principles of catalysts inactivation mechanisms, catalytic reaction modeling optimization, and process engineering principles.

A number of core bioinformatics, life-cycle, and process engineering analyses will be conducted in FY 2014 to understand the feasibility, sustainability, and scalability implications of not only biological, but catalytic, routes to hydrocarbon fuels. Lastly, the emergence of different technological routes to hydrocarbon fuels demands a greater level of attention to interface issues, including the feedstock/deconstruction interface, as well as the intermediate hydrolysate/fuel synthesis interface. The specification of each downstream transformation reaction needs to be considered by upstream activities to ensure optimal outcomes. Similarly, the limitations of upstream processing, in terms of cost and through-put, need to be addressed by downstream processing. Analytical and experimental activities will continue in FY 2014 in terms of understanding these trade-offs at critical interfaces and improvements in process integration will be sought to achieve optimal routes to cost-competitive hydrocarbon fuels.

In FY 2014, the program will seek new activities through a FOA to reduce cost and increase efficiency of hydrocarbon fuels production from lignocellulosic intermediates. Areas being pursued will include, but are not limited to, process improvements in integration, process efficiency, and separations efficiency.

In FY 2014, as part of EERE's Clean Energy Manufacturing Initiative, the program seeks to begin a new $20 million R&D initiative to enable the efficient manufacturing of low cost (less than $5/lb.) carbon fibers. An important element of this initiative is to investigate the utilization of cellulosic sugars and lignin in the manufacturing process. Competitive manufacturing of high-value carbon fiber is important because this is a versatile material that can be used across a number of different manufacturing platforms, from light-weight vehicles to compressed natural gas tanks and advanced wind turbine blades and components.

Current expensive carbon fiber technology relies primarily on a polyacrylonitrile (PAN) chemical intermediate, which is derived from petroleum precursors. This petroleum-based feedstock contributes up to 50% of the manufactured cost of carbon fiber. As the cost of oil goes up, so does the cost of PAN. Therefore, this initiative seeks to provide viable routes to manufacturing PAN based on chemical intermediates derived from biological feedstocks or to find substitutes for PAN from renewable resources that have the same or better properties in the manufacture of carbon fiber.

In FY 2014, $5.3 million will be used to expand the Biochemical Conversion R&D focus to include the study of organic fraction of municipal solid waste and biosolids for waste-to-energy applications. This effort will attempt to enable a near-term market entry point for waste to fuels, power, and products. Initial efforts will target enhanced understanding of the metagenomic composition of the anaerobic microbial consortia, as well as investigate techno-economic and life-cycle benefits associated with anaerobic digestion of biomass to fuels, products, and power. Of this investment, $3.6 million is intended for an initial FOA targeting for productivity enhancements and cost reductions in the process unit

operations associated with anaerobic digestion technology applications, including methane upgrading, effluent refining, and process control and optimization.

The Incubator Program is intended to be a separate funding opportunity for small and large companies, universities, and national laboratories that explicitly focus on pathways/technologies/approaches that are not supported in a meaningful way on the program's current Multi-Year Program Plan/Roadmap. Therefore, the program is proposing its Incubator Program to identify novel biochemical conversion technologies/approaches applied to existing or new pathways in its portfolio. Based upon a highly successful model piloted by EERE's Solar Energy Technologies Office, the program plans to invest in the creation of a biochemical conversion Incubator program in FY 2014.

These Incubator activities are an expansion of an already proven innovative program that EERE's Solar Energy Technologies Office piloted with a specific focus on partnering with businesses and researchers to bring "off-roadmap" impactful new technologies into the EERE portfolio. These early prototypes were developed into manufacturing and commercially relevant prototypes designed around pilot-stage process development. Based upon this highly successful model, the program plans to invest in the creation of the Incubator programs in FY 2014 ($20.0 million)

Explanation of Funding Changes

(dollars in thousands)

	FY 2012 Current	FY 2014 Request	FY 2014 Request vs. FY 2012 Current
Thermochemical – Funds are requested to conduct R&D on bio-oil intermediate pathways that use pyrolysis or direct liquefaction based technologies followed by catalytic upgrading for producing gasoline, diesel (including heating oil), and jet fuels. The request includes increased funding to refocus gasification R&D on syngas intermediate pathways followed by catalytic upgrading to finished fuels. Funds would also support an incubator program with the intent to assists applicants, large or small, in prototype and pilot-stage process development for next-generation technologies.	51,685	64,000	+12,315
Biochemical – The funds requested will allow for ongoing core R&D and allow for a FOA to further develop advanced conversion technologies to increase biochemical conversion efficiency. Additionally, the increased funds will fund conversion technologies that enable the production of renewable chemicals and intermediates for low-cost carbon fibers in support of EERE's Clean Energy Manufacturing Initiative. Additionally, a portion of the funds will support initiation of an advanced waste to energy program. Funds would also support an incubator program with the intent to assists applicants, large or small, in prototype and pilot-stage process development for next-generation technologies.	50,733	77,000	+26,267
Total, Conversion Technologies	102,418	141,000	+38,582

Funding Schedule

Fiscal Year	Activity	Funding (dollars in thousands)
FY 2012	• FY 2012 funding was used to demonstrate the production of cellulosic ethanol through gasification of woody biomass followed by mixed alcohols synthesis, achieving the 5-year cost projection for a total fuel production cost of $2.05/gallon. • Continued competitive and core R&D projects focused on addressing the key technical barriers to converting biomass to bio-oil through pyrolysis and other direct liquefaction processes, followed by catalytic upgrading to produce finished fuels or a petroleum refinery feedstock. Based on modeled results, the R&D investments achieved the FY 2012 state of technology conversion contribution cost of $3.95/gge for a combined fuel (gasoline/diesel). • $11.2 million in FY 2012 was directed at a FOA called "Bio-Oil Stabilization and Commoditization" and aimed at producing an acceptable bio-oil intermediate suitable for use in a petroleum refinery, thus leveraging existing infrastructure for fuel finishing. • $3.5 million in FY 2012 was used to select a project from the USDA-DOE joint solicitation using an innovative solvent liquefaction technology to finished fuels, which was not in the program's R&D portfolio. • FY 2012 funding was used to demonstrate and validate integrated technical achievements necessary for the cost-competitive conversion of biomass to cellulosic ethanol through biological and chemical processing—achieving the 10-year cost projection for a total fuel production cost of $2.15/gallon. • Approximately $10 million in FY 2012 funding was directed at a FOA called "Innovative Biosynthetic Pathways to Advanced Biofuels" (synthetic biology awards) to transition into production of hydrocarbon fuels. • Continued core laboratory and industry R&D projects in pretreatment and enzymatic hydrolysis, conversion fundamentals, process integration, and fermentation organism development • Continuation of FY 2011 Process Integration awards.	102,418
FY 2013	Planned activities in the Fiscal Year 2013 Budget (final allocations have not yet been determined): • Continued competitive and core R&D projects focused on addressing the key technical barriers to converting biomass to bio-oil through pyrolysis and other direct liquefaction processes, followed by catalytic upgrading to produce finished fuels or a petroleum refinery feedstock. Based on the current design case (Jones et al. 2009), R&D investments are projected to achieve the FY 2013 state of technology conversion contribution cost of $3.18/gge for a combined fuel. • In FY 2013, the subprogram is coordinating a computational modeling consortium of national laboratories and universities to develop tools to understand (on a fundamental level) the R&D challenges involved with converting biomass to bio-oil and subsequent catalytic upgrading. This is critical knowledge to inform the design and development of technology breakthroughs. The effort leverages work from the Office of Science, National Science Foundation, etc. • Approximately $12 million in FY 2013 funding will be placed on a new FOA called CHASE Bio-Oil Pathways, which focuses on moving fundamental knowledge (TRL 2) to applied innovations (TRL 3-4) that significantly improve carbon, hydrogen, and separations efficiencies in bio-oil pathways to produce gasoline, diesel, and jet fuels. • Continued development of techno-economic analysis and associated design cases that include cost projections and technical targets for other bio-oil or gaseous intermediate pathways to make gasoline, diesel, or jet fuels at less than or equal to $3/gge by 2022. • Continue to support the competitive and core R&D projects in pretreatment and hydrolysis, conversion fundamentals, process integration, catalyst optimization, and hydrocarbon organism development toward the anticipated cost goals to be set for hydrocarbon	

	fuels/products production through a biochemical route. • Techno-Economic Model and associated Design Case for a Novel Bioprocessing Route to Hydrocarbon Fuels. • Continuation of FY 2011 Process Integration awards. • Continuation of FY 2012 Synthetic Biology awards.	—
FY 2014	• Continued competitive and core R&D projects focused on addressing the key technical barriers to converting biomass to bio-oil through pyrolysis and other direct liquefaction processes, followed by catalytic upgrading to produce finished fuels or a petroleum refinery feedstock. Based on the current design case (Jones et al., 2009), R&D investments are projected to achieve the FY 2014 state of technology conversion contribution cost of $2.70/gge for a combined fuel. • A FOA for the integration of bio-oil intermediates into petroleum refineries will be conducted to enable a partnership between refiners, biofuel producers, and technology developers to address the challenges to integrating bio-oils into existing refineries, such as improving the chemical understanding of intermediates and fuels, along with their properties. • Increased R&D efforts for upgrading syngas intermediate from biomass through gasification to produce gasoline, distillate, and jet range hydrocarbons in support of the programmatic goal of less than or equal to $3/gge by 2022. • Continued development of techno-economic analysis and associated design cases that include cost projections and technical targets for other direct and indirect pathways to make gasoline, diesel, or jet fuels at less than or equal to $3/gge by 2022. • Core national laboratory competency R&D in pretreatment and hydrolysis, conversion fundamentals, process integration, lignin utilization, catalyst optimization, and hydrocarbon organism development directed toward the goals identified in FY 2013, on the path to cost-competitive hydrocarbon fuels by 2020–2022. • A FOA will be issued to develop indirect liquefaction catalysts and investigate process intensification (combining multiple process steps)—improving process yield and efficiency, molecular modeling to understand and improve catalyst performance, and analysis methods to perform in situ process stream characterization. • Continued management and funding of the awards competitively selected through the process integration FOA. • Continued development of Techno-Economic Model and associated Design Case for a Novel Chemical Catalytic Route to Hydrocarbon Fuels. • New Advancing Technologies for Bioconversion Efficiency FOA focused on reducing cost and increasing efficiency of hydrocarbon fuels production from lignocellulosic intermediates such as sugars or lignin (approximately $10.0 million). • New FOA, Biomass-Derived Low-Cost Carbon Fiber, focused on converting cellulosic sugars and lignin into renewable chemicals for low-cost carbon fiber manufacturing; (up to $19.0 million) • Initiate Waste-to-Energy activities to identify promising routes to fuels, chemicals, and power, including up to $3.6 million for a new FOA (up to $5.0 million). • Support an Incubator Program to assist small and start-up companies in prototype and pilot-stage process development for next-generation technologies.	141,000

Integrated Biorefineries
Funding Profile by Activity

(dollars in thousands)

	FY 2012 Current	FY 2013 Annualized CR*	FY 2014 Request
Integrated Biorefineries	42,897	—	33,000
Defense Production Act (DPA)	0	—	45,000
Total, Integrated Biorefineries	42,897	—	78,000

*FY 2013 amounts shown reflect the P.L. 112 175 continuing resolution level annualized to a full year. These amounts are shown only at the "congressional control" level and above; below that level, a dash (—) is shown.

The Integrated Biorefineries subprogram manages a diverse portfolio of integrated biorefinery projects focused on the scale up of biofuels production technologies from pilot to demonstration to commercial scale. The current portfolio includes 21 projects consisting of 12 biochemical technologies, 6 thermochemical technologies, and 3 algal technologies. The active portfolio includes 13 projects focused on cellulosic ethanol and 8 projects focused on renewable hydrocarbons.

In 2013, the program's first pioneer plant will begin the production and sale of cellulosic ethanol. The plant has an annual production capacity of 8 mmgy of cellulosic ethanol produced from MSW and green waste.

In FY 2014, two more commercial plants are scheduled for commissioning—adding another 40 mmgy of domestic cellulosic ethanol production capacity based on agricultural residues. In 2015, another two commercial-scale facilities are scheduled for completion, bringing the total program supported production capacity to more than 80 mmgy of cellulosic ethanol.

The program will focus on actively managing and paying down mortgages on its existing portfolio of 21 active integrated biorefinery projects. FY 2014 funds will complete mortgage obligations for demonstration-scale integrated biorefineries.

The increase in funds will be used to partially fulfill the DOE's obligation to the joint DOD-Navy, DOE, and USDA memorandum of agreement established to support the construction of commercial-scale biofuels production facilities that can produce drop-in, hydrocarbon biofuels. This $45 million request reflects part of DOE's $170 million commitment of total funding to this initiative with the DPA.

The significance of the DPA activity is demonstrated by the President's invoking Title III of the Defense Production Act. In so doing, the Administration has deemed that this activity is of strategic importance to the national security of the United States. In addition, use of the DPA to support the construction and operation of these vital facilities will serve to validate the biofuels production technologies, contribute to building the emerging market, and facilitate follow-on expansion of the industry by providing the confidence required by the private-sector financial community to finance additional projects to address the market mandated by the Renewable Fuels Standard.

Explanation of Funding Changes

	(dollars in thousands)		
	FY 2012 Current	FY 2014 Request	FY 2014 Request vs. FY 2012 Current
Integrated Biorefineries — The decrease in funds is due to completing the Federal commitment to pilot through commercial scale biorefinery demonstrations and completely pays down the remaining mortgages from these previous year projects.	42,897	33,000	-9,897
Defense Production Act (DPA) – Additional funding is requested to support the Memorandum of Agreement between the Department of the Navy, DOE and USDA to pursue production of biofuels for defense purposes.	0	45,000	+45,000
Total Integrated Biorefineries	42,897	78,000	+35,103

Funding Schedule

Fiscal Year	Activity	Funding (dollars in thousands)
FY 2012	• Fund mortgages associated with commercial- and demonstration-scale integrated biorefinery projects. • Innovative pilot-scale biorefinery solicitation.	42,897
FY 2013	Planned activities in the Fiscal Year 2013 Budget (final allocations have not yet been determined): • Draw down the mortgages associated with commercial- and demonstration-scale awards that originated in FY 2008 through EPAct 932. • Integrated pilot-scale biorefinery solicitation for drop-in hydrocarbon fuels. • Commercial demonstration through DPA.	—
FY 2014	• Provide funding committed by DOE in support of commercial production facilities through DPA authority. • Fulfill mortgage obligations for demonstration-scale integrated biorefineries. • Integrated pilot and demonstration-scale biorefinery solicitation for biofuel and bioproduct manufacturing.	78,000

Analysis and Sustainability
Funding Profile by Activity

(dollars in thousands)

	FY 2012 Current	FY 2013 Annualized CR*	FY 2014 Request
Systems Analysis	3,925	—	5,500
Cross-Cutting Sustainability	3,925	—	6,500
Systems Integration	1,963	—	1,500
Total, Analysis and Sustainability	9,813	—	13,500

*FY 2013 amounts shown reflect the P.L. 112 175 continuing resolution level annualized to a full year. These amounts are shown only at the "congressional control" level and above; below that level, a dash (—) is shown.

Analysis and Sustainability activities play a vital role in supporting decision making, demonstrating progress toward established goals, and directing research activities; they are instrumental in setting the entire biofuel value chain on an environmentally, socially, and economically viable course. Relationships with experts at the national laboratories, institutions of higher learning, and numerous external stakeholders are leveraged to obtain the best qualitative information and quantitative data possible. The program also coordinates with EERE's Office of Strategic Programs to ensure coordination of analyses within the transportation sector.

Through quantification, Systems Analysis activities give context and justification for decisions regarding the future direction and scope of the subprogram's RD&D work. This information is critical to the sound management of the program's RD&D portfolio and the establishment, adaptation, and fulfillment of its vision in a dynamic context of rapid technological progress and great economic and environmental uncertainty.

Cross-Cutting Sustainability activities focus on developing and evaluating best practices with regard to life-cycle GHG emissions, air quality, land use, water quality and quantity, soil quality, and biodiversity, as well as relevant social aspects of sustainability. The program works with research partners to conduct field trials, applied research, capacity building, and analyses to inform best practices that are integrated across the RD&D portfolio. These critical efforts result in publications and data made available through the Bioenergy Knowledge Discovery Framework to better inform researchers, policy makers, and private-sector stakeholders. Sustainability activities also enable the program to engage in critical international dialogues on bioenergy such as the Global Bioenergy Partnership.

Systems Integration provides tailored technical and programmatic support to the program by employing systems engineering processes and practices to calibrate internal management processes for enhanced internal efficiency and overall performance. A decision-making support framework, data management tools, and analytical resources are provided to the program to inform and facilitate strategic planning, performance evaluation, and portfolio management.

Systems Analysis: Systems Analysis supports each individual subprogram, and program as a whole, through the provision of critical quantitative measures of progress and future projections. Critical to strategic decisions at both the program and activity levels, programmatic analysis activities are focused on clearly identifying synergies and addressing potential barriers, while progress is concurrently monitored and accomplishments are validated in each of the program's technology areas.

Specific focus areas include technical and economic feasibility analysis, integrated biorefinery analysis, and technology deployment analysis. Rigorous quantitative analysis is applied wherever possible, and the results are subsequently interpreted in the context of a greater body of work and peer discourse to provide vital insight for RD&D prioritization, technology performance needs, and reasonable performance expectations.

FY 2014 Systems Analysis activities include techno-economic, feedstock resource, and life-cycle assessments to help the program focus its technology development priorities and identify key drivers and hurdles for bioenergy technology commercialization. Additional funds ($1 million) are requested to conduct materials testing and analysis of mid-level ethanol blends (E15-E85) in support of increasing markets for advanced

biofuels. Work will include material compatibility testing on representative materials in order to better understand the ability of the existing fueling infrastructure to accept increased levels of ethanol in the fuel. Modeling and analysis will explore the impact of mid-level ethanol blends on life-cycle emissions and air quality and will be done in coordination with Vehicles Technologies Office and the Environmental Protection Agency.

The analytical tools, models, methods, and datasets resulting from System Analysis efforts advance the understanding of bioenergy and its related impacts. Maintaining these capabilities at the cutting edge helps ensure that the most complete and reliable information is available to technology developers, Office management, Congress, and the general public.

Cross-Cutting Sustainability: Cross-Cutting Sustainability activities focus on increasing the long-term viability and scale-up potential of the bioenergy industry by developing and supporting the implementation of best practices with regard to GHG emissions, air quality, land use, water quality and quantity, soil quality, and biodiversity, as well as relevant social aspects of sustainability. The program works with research partners to conduct field trials, applied research, capacity building, and analysis to inform best practices that will be integrated across the RD&D portfolio. These activities are done in partnership with the program's technology research activities in order to consider the latest advances in feedstock production, supply-chain logistics, and conversion technologies.

A near-term objective is to establish a transparent methodology for evaluating and comparing technologies, practices, and inputs in terms of environmental sustainability. Particular focus is given to a systematic evaluation of data related to climate, water, and land use for agricultural residue utilization and energy crop production for conversion to advanced biofuels. Current activities are establishing metrics and targets for GHG reductions, air quality, water quantity and quality, and soil quality. FY 2014 and future activities will be focused on implementing RD&D plans for improving those metrics for multiple bioenergy pathways. Continuous improvement toward these targets will help drive innovation of efficient and economical biofuels technologies; assist in reducing non-market barriers, such as public acceptance and resource or regulatory constraints; and increase the long-term viability and scalability of the bioenergy industry. Additional funds ($2.5 million) in FY 2014 will support a collaborative effort with the Feedstocks subprogram to demonstrate the potential for increased biomass productivity and more efficient land use, while improving environmental performance. Increasing biomass availability through improved production and logistics systems is critical to supporting the growing biofuels industry, but this must be achieved in concert with reducing negative environmental impacts to ensure a sustainable industry in the long term.

Systems Integration: Systems Integration provides independent, strategic, systems-level expertise, and processes to enable data-driven decision-making, effective portfolio management, and program integration for the program and project managers.

Systems Integration provides tailored technical and programmatic support to the program by employing systems engineering processes and practices to calibrate internal management processes for enhanced internal efficiency and overall performance. A decision-making support framework, data management tools, and analytical resources are provided to the program to inform and facilitate strategic planning, performance evaluation, and portfolio management.

With the decision-making and data management tools and support framework provided, the program can better articulate its vision, identify and validate performance goals, measure progress toward these goals, plan for future work, prioritize its portfolio, conduct risk management, and plan for the successful fulfillment of its mission in support of national policies and priorities.

FY 2014 activities will focus on needed analytical studies, performance verification of program-funded projects, and enhancing tools and models for systems-level analyses, particularly the Biomass Scenario Model (BSM). The BSM enables the program to investigate which supply chain modifications have the greatest potential to accelerate deployment of biofuels. FY 2014 enhancements to the BSM will strengthen understanding of the impacts of biomass competition, policy changes, international trade, and technology learning curves.

Explanation of Funding Changes

	(dollars in thousands)		
	FY 2012 Current	FY 2014 Request	FY 2014 Request vs. FY 2012 Current
Systems Analysis – Funding increase will support development of an aviation biofuels roadmap and a bioenergy data and market report that tracks status, capacity, and progress of the advanced biofuels industry. In addition, material testing and analysis on mid-level ethanol blends is planned to facilitate the development of the infrastructure and market capacity to transport, store, and use large volumes of renewable fuel.	3,925	5,500	+1,575
Cross-Cutting Sustainability – Funding increase will support innovative feedstock production projects in collaboration with the Feedstocks subprogram. Funding contribution from Sustainability subprogram will focus on more efficient land use while improving environmental performance (reduced GHG and/or water impacts).	3,925	6,500	+2,575
Systems Integration – Slightly reduced scope of Systems Integration analyses to support Systems Analysis and Cross-Cutting Sustainability.	1,963	1,500	-463
Total, Analysis and Sustainability	9,813	13,500	+3,687

Funding Schedule

Fiscal Year	Activity	Funding (dollars in thousands)
FY 2012	• Techno-economic assessments of new hydrocarbon pathways to inform development of future design cases. • Updating and expanding life-cycle GHG modeling to include pyrolysis, aviation fuels, and additional algae pathways. • Enhancing land-use change modeling and data collection to better assess land-use impacts and GHG emissions. • Defining baselines and setting targets for climate, water, and land management for agricultural residues and energy crops pathways. • Developing an empirical biorefinery learning curves tool and estimating potential cost reductions for cellulosic biochemical ethanol and gasification pathways. • Coordinating a multi-lab study investigating biorefinery sizing and logistics • Enhancing the BSM and completing full supply-chain analysis for major biorefining pathways. • Supporting program's management of integrated biorefinery projects through supporting comprehensive project reviews and implementing tools to monitor technical progress.	9,813
FY 2013	Planned activities in the FY 2013 Budget (final allocations have not yet been determined): • Cross-cutting and systems-level analyses to inform program planning, decision-making, and R&D investments. • Initiate effort to develop techno-economic analyses and design cases for feedstock logistics systems and hydrocarbon pathways to supplement the existing design cases for cellulosic ethanol and pyrolysis. • Enhancing land-use change modeling and data collection to update life-cycle GHG assessments and contribute credible analyses on the land-use impacts of biofuels. • Integrate new hydrocarbon pathways into full range of models and analyses, including GHG life-cycle assessments, industry learning curve analysis, and others. • Identifying baselines and targets for soil quality and air quality for agricultural residues,	

	energy crops, and forest resources pathways to guide future RD&D. • Developing and testing best practices for nitrogen recovery, water quality, soil quality, and land productivity. • Updating biorefinery learning curves analysis for cellulosic biochemical ethanol and gasification pathways and expanding to include additional advanced biofuels pathways. • Enhancing and utilizing the BSM to conduct full-supply-chain analysis with additional emphasis on biomass-based aviation fuel, impacts of international trade, and effects of industrial learning. • Developing and implementing processes to gather, evaluate, verify, and analyze data and information regarding technical and project management performance and progress relative to the program's cost and performance goals. Supporting and participating in project and program peer review meetings and integrated biorefinery comprehensive project reviews.	—
FY 2014	• Cross-cutting and systems-level analyses to inform program planning, decision-making, and R&D investments. • Continue techno-economic analyses, life-cycle assessments, and design cases for new hydrocarbon pathways. • Continue updating biomass resource assessments and initiate a market assessment of advanced biofuels and bioproducts. • Collaborate with FAA, CAAFI and others to develop aviation biofuels strategy. • Conduct materials testing and analysis of mid-level ethanol blends in support of increasing markets for advanced biofuels. • Evaluate feedstock production, logistics, and conversion technologies on the basis of select sustainability metrics to identify best practices and opportunities for improvement. • Conduct core national lab analysis and R&D projects investigating approaches to meet sustainability targets for improving productivity, minimizing GHG emissions, and reducing water impacts of feedstock supply and conversion technologies. • Support projects in collaborate with Feedstocks sub-program that demonstrate the potential for more efficient land use while improving environmental performance (reduced GHG and/or water impacts). • Utilize the BSM to conduct full-supply-chain analysis and updating the model to reflect emerging biofuel pathways, biomass competition, technology advancements, and industry learning. • Develop and implement processes to gather, evaluate, verify, and analyze data and information regarding technical and project management performance and progress relative to the program's cost and performance goals. • Support and participate in integrated biorefinery comprehensive project reviews.	13,500

Biopower/Cookstove
Funding Profile by Subprogram

(dollars in thousands)

	FY 2012 Current	FY 2013 Annualized CR*	FY 2014 Request
Biopower	4,829	—	4,000
Total, Biopower	4,829	—	4,000

*FY 2013 amounts shown reflect the P.L. 112 175 continuing resolution level annualized to a full year. These amounts are shown only at the "congressional control" level and above; below that level, a dash (—) is shown.

The clean cookstoves effort will span applied research, development, and piloting in the field, integrated with laboratory and field testing, to develop science and engineering solutions to clean energy, climate change, and environmental challenges, while addressing indoor air quality and personal health. This research will address the problem of incomplete combustion in small-scale systems and thereby improve its efficiency. New cookstoves, while still burning biomass such as wood and crop waste can be designed to reduce fuel usage by 50% and reduce indoor air pollution by more than 80%. This research is important because cookstove emissions contribute to 4 million unnecessary premature deaths per year with women and young children the most affected and also contribute to black carbon buildup in the environment. In FY 2012, the program hosted a competitive solicitation that resulted in projects that focused on increasing combustion efficiency and heat transfer while using control systems to reduce the carbon monoxide and particulate emissions. A wide range of biomass fuels was considered, along with lower cost materials of construction and sensors, as well as controls. This effort will culminate in field demonstration and validation tests.

In FY 2014, the program will focus on actively managing the existing projects selected in FY 2012 and FY 2013. In addition, funds will be used for a new FOA on research into improved combustion kinetics technology for increased efficiency and decreased emissions, less costly and more durable materials of construction, improved compatibility between feedstock and stoves, and additional testing and demonstration of prior year design results.

Explanation of Funding Changes

(dollars in thousands)

	FY 2012 Current	FY 2014 Request	FY 2014 Request vs. FY 2012 Current
Biopower – The subprogram will continue to emphasize the development and validation of clean cookstoves. The funds will support additional meritorious combustion and heat transfer projects from the FY 2012 FOA.	4,829	4,000	-829
Total, Biopower	4,829	4,000	-829

Funding Schedule

Fiscal Year	Line Item	Funding (dollars in thousands)
FY 2012	Conducted a technical information workshop on cookstove R&D needs and issued a solicitation for next generation cookstove R&D.	4,829
FY 2013	Planned activities in the FY 2013 Budget (final allocations have not yet been determined): Selection of additional projects from FY 2012 FOA.	—
FY 2014	New funds are requested for FY 2014 to support a new FOA that continues the development and validation of natural and forced air convection stoves and improved understanding of the combustion and heat transfer processes in the lab and in the field.	4,000

NREL Site-Wide Facility Support
Funding Profile by Subprogram

(dollars in thousands)

	FY 2012 Current	FY 2013 Annualized CR*	FY 2014 Request
NREL Site Wide Facility Support	0	—	5,000
Total, NREL Site Wide Facility Support	0	—	5,000

*FY 2013 amounts shown reflect the P.L. 112 175 continuing resolution level annualized to a full year. These amounts are shown only at the "congressional control" level and above; below that level, a dash (—) is shown.

EERE will begin to directly fund NREL site-wide facility support costs that are not included in the Facilities and Infrastructure budget rather than continue to fund these costs in the laboratory overhead rate. This practice is consistent with other national laboratories. NREL's labor rate multiplier will be significantly reduced, thereby reducing the cost barrier to accessing unique NREL capabilities (facilities, staff expertise, etc.) by industry and academia to increase the impact on the clean energy market. This change in accounting practice will also make site operating costs more transparent, better facilitating cost control. With the proposed FY 2014 budget, NREL's labor rate multiplier is expected to be reduced between 15% and 20% by directly funding site-wide facility support. The site-wide facility support funds cover maintenance and engineering support; fire, emergency, and custodial services; general utilities; network infrastructure and licenses; environment, safety, and health support; and sustainability. By moving these costs from laboratory overhead to direct funding, EERE expects to gain a faster and greater impact to the renewable energy and energy efficiency market place.

Program funding has a significant presence at NREL, with major capabilities in the Integrated Biorefinery Research Facility, Alternative Fuels User Facility, and Field Test Laboratory Building, and is supported by general management and operations housed in buildings such as the Research Support Facility, Shipping and Receiving Facility, and related site assets. Starting in FY 2014, EERE offices will fund site-wide costs directly supporting EERE's commitment to enhance NREL's competitiveness by providing direct operating funding for all appropriate activities consistent with Generally Accepted Accounting Principles.

The Integrated Biorefinery Research Facility (IBRF) and Thermochemical Users Facility (TCUF) are critical capabilities that enable the program to validate the progress and success of the industry. In order to achieve commercial-scale production of renewable biofuels and chemicals at a cost that is competitive with petroleum, it is crucial to understand the entire integrated biorefining process and how one stage of the process can impact performance of the others. In FY 2014, the program's budget will support NREL facilities and infrastructure operating needs through direct funding; $5 million of that total funding will go to the IBRF and TCUF facilities to support capabilities critical to the program's strategies and goals. The IBRF is a state-of-the-art facility for developing and demonstrating biological and chemical processing with the biomass throughput capacity of 1 ton/day. The TCUF can accommodate the testing and development of various direct and indirect liquefaction reactors, filters, catalysts, and other unit operations with the biomass throughput capacity of approximately one-half ton/day. Access to these unique facilities at the NREL is critical to the program and industry (that may not have the facilities or resources to do it on their own) to validate the cost effectiveness of renewable biofuels and chemicals production processes, which ultimately accelerates the commercialization of these technologies.

The user facilities will be available for industry partners who wish to demonstrate their technology breakthroughs, but may not have the facilities or resources to do it on their own. The maintenance of the user facilities is critical to ensure the state-of-the-art capabilities to validating these industry innovations. These facilities also provide process data to showcase the results of DOE national laboratory core R&D that address industry wide challenges. The program utilizes the operational data from the core R&D to assess programmatic progress toward meeting the $3/gallon renewable gasoline, diesel, and jet fuel by 2017. These results are often publicly available through the program's state-of-technology updates.

The IBRF is utilized to evaluate the core R&D activities requested in the Biochemical Conversion section of this

budget document. The TCUF is utilized to evaluate the core R&D activities requested in the thermochemical conversion section of this budget document. An annual evaluation of the user facilities will be conducted to ensure that it is meeting its intended purpose and serving the industry and research community.

Explanation of Funding Changes

(dollars in thousands)

	FY 2012 Current	FY 2014 Request	FY 2014 Request vs. FY 2012 Current
NREL Site Wide Facility Support — The funding change results from this new subprogram to support the NREL facilities.	0	5,000	+5,000
Total, NREL Site Wide Facility Support	0	5,000	+5,000

Funding Schedule

Fiscal Year	Line Item	Funding (dollars in thousands)
FY 2012	N/A	0
FY 2013	N/A	—
FY 2014	In FY 2014, the program's budget will support NREL facilities and infrastructure operating needs for the IBRF and TCUF facilities to support capabilities critical to program strategies and goals.	5,000

Hydrogen and Fuel Cell Technologies
Funding Profile by Subprograms

(dollars in thousands)

	FY 2012 Current	FY 2013 Annualized CR*	FY 2014 Request
Hydrogen and Fuel Cell Technologies			
Fuel Cell R&D	43,634	—	37,500
Hydrogen Fuel R&D	33,824	—	38,500
Manufacturing R&D	1,944	—	4,000
Systems Analysis	3,000	—	3,000
Technology Validation	8,986	—	6,000
Safety Codes and Standards	6,938	—	7,000
Market Transformation	3,000	—	3,000
NREL Site-Wide Facility Support	0	—	1,000
Total, Hydrogen and Fuel Cell Technologies	101,326	104,258	100,000

*FY 2013 amounts shown reflect the P.L. 112 175 continuing resolution level annualized to a full year. These amounts are shown only at the "congressional control" level and above; below that level, a dash (—) is shown.

SBIR/STTR:
- FY 2012 Transferred: SBIR: $2,025,000; STTR: $273,000
- FY 2013 Annualized CR Transferred: SBIR: $150,000
- FY 2013 Annualized CR: SBIR: $1,925,000; STTR: $269,000
- FY 2014 Request: SBIR: $2,104,000; STTR: $300,000

FY 2014 Program Summary

- Increased funding for Hydrogen Fuel research and development (R&D) to focus on improving renewable hydrogen production technologies (e.g., improving electrolyzer stack efficiency and lowering the cost of longer-term technologies using solar resources, including wide bandgap semiconductors) and lowering the carbon fiber composite cost for hydrogen storage vessels (+$4.7 million).
- Increased funding for the Manufacturing R&D subprogram to improve domestic capabilities in hydrogen and fuel cell clean energy manufacturing (+$2.1 million).
- Reduced emphasis on the Fuel Cell R&D subprogram to allow for increased focus on Hydrogen Fuel R&D and Manufacturing R&D (-$6.1 million).
- Reduced Technology Validation funding to allow sustained efforts in Fuel Cell R&D and Hydrogen Fuel R&D, as well as an increase in funding for Manufacturing R&D; this will allow more technologies to ultimately move to a state when validation under real-world conditions is required (-$3.0 million).

Overview

The mission of the Hydrogen and Fuel Cell Technologies Program (program) is to enable the widespread commercialization of hydrogen and fuel cell technologies, which would reduce petroleum use, greenhouse gas (GHG) emissions, and criteria air pollutants. They also contribute to a more diverse energy supply and more efficient use of energy. Fuel cells can provide power from diverse domestic fuels, including hydrogen and other renewable sources—such as bio-methanol or biogas—as well as natural gas, and they offer numerous potential advantages that make them appealing for end users, including quiet operation, low maintenance needs, and high reliability.

The program pursues this mission through research, development, demonstration, and deployment (RDD&D) activities, with the goals of advancing these technologies to be competitive in terms of cost, reliability, and performance, and reducing the institutional and market barriers to their widespread commercialization. Key objectives include reducing the cost of fuel cells to $30/kilowatt (equivalent to the cost of a gasoline internal combustion engine) and improving fuel cell durability to 5,000 hours (equivalent to 150,000 miles of driving) for automotive systems by 2017. While the primary emphasis is on transportation technologies, the program

is also pursuing advances that will reduce the cost of fuel cells for other applications, including stationary power. Goals for other applications include reducing the cost of combined heat and power (CHP) fuel cell systems operating on natural gas or liquefied petroleum gas (LPG) to $1,500/kilowatt (kW) and enabling a more than 60,000-hour durability by 2020 to be competitive with other advanced technologies.

The increased widespread availability of low-cost natural gas has greatly improved the near-term viability of hydrogen and fuel cell technologies. However, while fuel cells are becoming competitive in several specialized markets, achieving major impact through widespread market deployment will require additional technological improvements that utilize renewable hydrogen.
To achieve its goals, the program employs a comprehensive strategy that addresses both technical and non-technical barriers to commercialization and aims to catalyze domestic growth in this emerging industry. The program supports pre-competitive R&D, demonstrates hydrogen and fuel cell systems under real-world conditions, and conducts activities to address key market barriers (see Figure 1). The program is investing in R&D to increase fuel cell durability; reduce fuel cell costs; reduce the costs of producing, delivering, and storing renewable hydrogen; and improve the capacity of hydrogen storage systems. These efforts are balanced to address a variety of technical approaches to fuel cells and to provide critical advances for a wide range of applications, including stationary, portable, and transportation applications, while maintaining a longer-term focus on vehicle transportation.

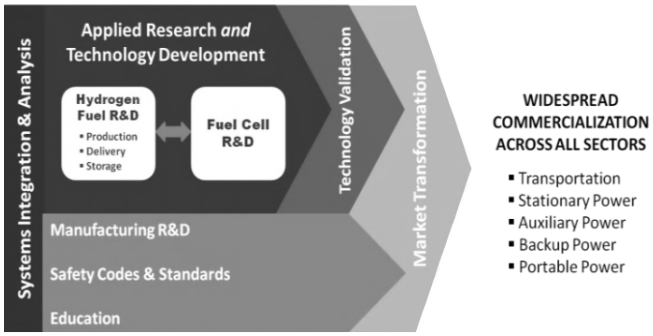


Figure 1. The program integrates activities to enable widespread commercialization of fuel cells and hydrogen technologies.

The program addresses technical barriers through pre-competitive applied research, technology development, and technology validation and demonstration. The program's R&D strategy maintains an inclusive, technology-neutral approach, while conducting focused efforts in specific technical areas and applications.

Emphasis on different applications is balanced to enable success in early markets and support the growth of a strong domestic industry, while maintaining progress in longer-term, higher-impact areas. Maintaining this balance is critical while fuel cell electric vehicles (FCEVs) and related technologies, which will have a large material impact, are still in the pre-commercial phase. Through this approach, the program provides near-term advances that can accelerate the growth of existing early markets (such as backup power and material handling equipment), while maintaining progress along near, mid, and longer-term developmental roadmaps, such as those for CHP fuel cell systems, FCEVs, and technologies for the large-scale production and delivery of renewable hydrogen.

The program's efforts are highly integrated, with the necessary cost reductions and improvements in performance and durability coming from advances in several different areas. For example, the program's R&D efforts in fuel cell stacks and hydrogen fuel seek to reduce the overall levelized cost per mile (LCM) of FCEVs by as much as $0.15/mile (depending on impact of platinum cost), over the life cycle of the car (see Figure 2; Figure 3 shows a more detailed breakdown of the cost reductions that could be achieved through Fuel Cell R&D). The program's efforts to improve manufacturing technologies and spur early commercial markets (to achieve economies of scale) will contribute to an additional $0.14-per-mile reduction (assuming high-volume manufacturing—e.g., 500,000 vehicles per year). Together, these efforts will enable reductions in the LCM of the hydrogen and fuel cell portions of the vehicle from $0.416 per mile to $0.125 per mile. The LCM includes the per-mile cost of fuel (a function of the fuel economy and fuel price) and annualized capital cost (manufactured vehicle cost) over the expected ownership period of the vehicle (assumed at 5 years and 14,000 miles per year).[a]

[a] For this estimate, markups on the vehicle beyond the manufacturing plant were not considered—e.g., distribution, dealer's markups, taxes, etc. Also not included were insurance and maintenance costs incurred by the vehicle owner.

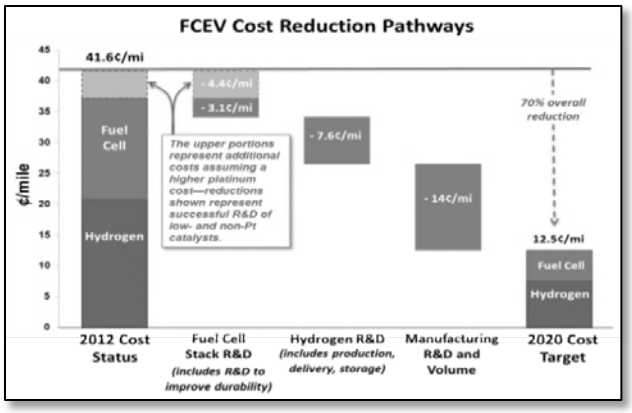


Figure 2. Cost-reduction pathways for fuel cell electric vehicles (only hydrogen and fuel cell-related costs shown)

The program's highly integrated and leveraged approach will result in substantial cost reductions in hydrogen and fuel cell systems, which will enable the program to meet key targets, including an interim electricity cost target of less than $0.09/kilowatt hour (kWh) in stationary power (with a long-term goal of $0.05–$0.06/kWh, see Figure 4); the hydrogen fuel threshold cost of $2–$4/gallon gasoline equivalent (gge); and a vehicle LCM of about $0.42 (including costs associated with the fuel cell, hydrogen, and the rest of the vehicle) to be competitive with other advanced automotive technologies.

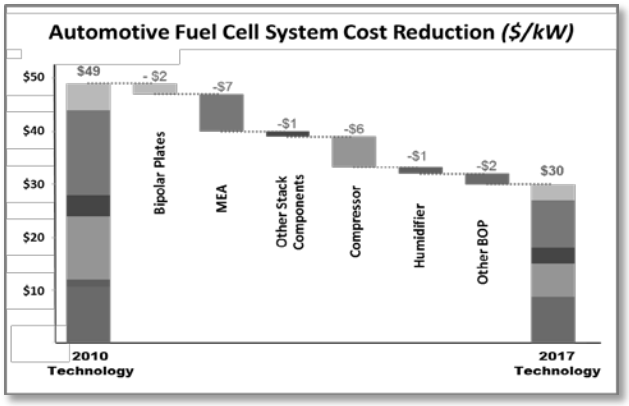


Figure 3. Detailed breakdown of cost reduction pathways for automotive fuel cell systems

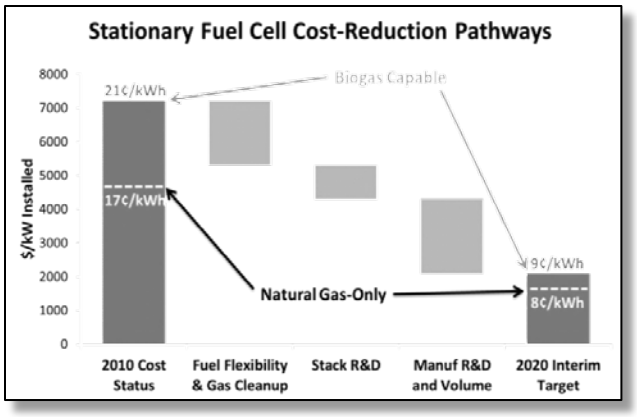


Figure 4. Cost reduction pathways for stationary fuel cells

The subprograms reflect key areas of research, development, and demonstration (RD&D), which include:

- Fuel Cell R&D, which seeks to improve the durability, reduce the cost, and improve the performance of fuel cell systems
- Hydrogen Fuel R&D, which focuses on enabling the production of low-cost hydrogen fuel from diverse renewable pathways and addressing key challenges to hydrogen delivery and storage
- Manufacturing R&D, which works to develop and demonstrate advanced manufacturing technologies and processes that will reduce the cost of fuel cell systems and hydrogen technologies
- Systems Analysis, which provides systems-level support to the program on resource and infrastructure issues and estimates the potential impact of the R&D efforts
- Technology Validation, which demonstrates and validates pre-commercial technologies before the deployment phase.

Market Transformation activities provide financial and technical assistance for the use of hydrogen and fuel cell systems in early market applications, with the goals of achieving sales volumes that will enable cost reductions through economies of scale, supporting the development of a domestic industry, and providing feedback to testing programs, manufacturers, and potential technology users. The program also conducts efforts in Safety, Codes and Standards to develop information resources and best practices to address safety issues and provide critical information needed for the development of technically sound codes and standards. These efforts in codes and standards are critical to enabling commercial deployments, and they will be ongoing as new technologies emerge and mature.

Analysis by Brookhaven National Laboratory[a] indicates that by 2050, FCEV penetration could range from 40%–45% of the light-duty vehicle stock (not just sales) and benefits of the program could include reductions in oil consumption of 2–3 million barrels per day and reductions in GHG emissions of 350–400 million metric tons per year (assuming the program meets its cost targets). These predictions are in line with National Research Council (NRC) estimates.[b] In addition, analysis by Argonne National Laboratory shows that fuel cells could reduce nitrogen oxide (NOx) emissions from light-duty vehicles by up to 70% on a "well-to-wheels" basis.[c]

Fuel cells also provide an opportunity for substantial long-term employment growth. The emerging fuel cell industry is poised to realize this potential—investing heavily in new product development and leading the clean-energy sector in patents, with nearly 1,000 patents issued in 2011.[d] The United States currently leads the world in fuel cell patents, with 46% of the patents issued from 2002–2011; however, other countries are accelerating their efforts, with Japan now claiming 31 percent of the total number of patents issued, and other countries such as Germany and South Korea ramping up efforts as well. Leading holders of fuel cell patents include General Motors (U.S), Honda (Japan), Samsung (South Korea), Toyota (Japan), UTC Power/ClearEdge Power (U.S.), Nissan (Japan), Ballard (Canada), Plug Power (U.S.), Panasonic (Japan), and Delphi Technologies (U.S.).

International investment in hydrogen and fuel cell technologies is strong and growing. Major government-industry partnerships in Germany, Japan, the United Kingdom, and Scandinavia have been announced to support hydrogen infrastructure development for FCEVs. Continued interest and support by major industrial players and governments of other countries—including Germany, Japan, and South Korea—underscore the global market potential for these technologies and the need for continued Federal investment for domestic industry to remain competitive. Sustained support of the program and continued progress toward its goals will enable the United States to maintain leadership in innovation and manufacturing of fuel cell and hydrogen technologies.

Achieving the program's major longer-term outcomes will depend on meeting key out-year targets, but will also depend on other external factors. For example, reducing the cost of automotive fuel cells to less than $30/kW will play a key role in enabling widespread commercialization of FCEVs. However, external factors, including the price of platinum and the price of natural gas could affect the pace and extent of the market penetration of FCEVs today. In addition, reducing the cost of renewably produced hydrogen to meet the threshold cost of $2–$4/gge will be essential for FCEVs to achieve major reductions in GHG emissions. This threshold cost would enable FCEVs to compete with other vehicles on a cost-per-mile basis, and the range in this cost threshold accounts for potential variation in future gasoline prices and a range of potential fuel economies for competing vehicles.

Incubator Programs: The great majority of EERE investments are currently, and must going forward, be primarily driven by detailed short, medium, and long-term RDD&D roadmaps. EERE proposes Incubator activities in the FY 2014 budget, and designed them to use a small fraction of EERE's technology office's annual R&D budget to regularly introduce potentially high-impact "off-roadmap" new technologies. These Incubator activities will enable the "rapid on-ramping" of potentially transformational new energy technologies into the EERE portfolio, dramatically increasing the rate of technology innovation.

Technology Status, Program Accomplishments, and Near-Term Milestones[e]

Currently, hydrogen and fuel cell technologies are becoming competitive in a number of markets, with substantial growth in commercial shipments in the last few years. Approximately 20,000 fuel cell systems were shipped worldwide in 2011, which demonstrates more than 200% growth since 2008, and more than 80 megawatts of fuel cells were shipped worldwide in 2011—with that number expected to nearly double in

[a] Internal analysis conducted for DOE, using the MARKAL model

[b] *Transitions to Alternative Transportation Technologies—A Focus on Hydrogen*, National Research Council of the National Academies, 2008, www.nap.edu/catalog.php?record_id=12222.

[c] Internal analysis conducted for DOE, using the GREET model, version 1_2012.

[d] Source: Clean Energy Patent Growth Index, which tracks patents issued in the U.S. annually.

[e] For a list of milestones please see "*Strategic Performance Management by Program*" section.

2012.[a] Key early markets include backup power installations and material-handling applications (e.g., forklifts), with growing opportunities seen in auxiliary power units, airport ground support equipment, and portable fuel cells. There are currently more than 70 commercially available hydrogen and fuel cell products on the market today;[b] and in the United States, there are approximately 1,200 miles of hydrogen pipelines, and more than 9 million tons of hydrogen are produced each year.[c]

The program's RD&D efforts are building on this commercial progress to enable further expansion of the technologies into new markets, with potential for greater environmental, economic, and energy-security benefits. Substantial progress has already been made in a range of key areas, including the following:

- Reduced the cost of automotive fuel cell systems (projected at high volumes) to $47/kW in 2012—a more than 35% reduction since 2008 and more than 80% percent reduction in cost since 2002—and well on the way to achieving the 2017 target of $30/kW, which would enable cost-parity with internal combustion engines, when produced at high volumes.
- More than doubled the durability of automotive fuel cell systems operating under real-world conditions, with a durability of more than 2,500 hours (about 75,000 miles), which has been demonstrated on the road with less than 10% degradation in performance (a substantial improvement over the maximum demonstrated durability of 950 hours in 2006).
- Improved the catalyst specific power of fuel cells to 5.8 kW per gram (g) of platinum group metal in 2012, which is more than double the 2008 baseline of 2.8 kW/g and approaching the 2017 target of 8.0 kW/g. This reflects a more than 80% reduction in total platinum content in fuel cells since 2005. This has been achieved through breakthrough developments such as nanostructured thin film catalysts and core-shell catalysts (in which platinum coats the outside of a non-platinum-containing core).
- Reduced the capital cost of electrolyzer stacks by 80% since 2002, which will help to achieve the 2020 threshold cost of $2.00–$4.00/gge for renewable hydrogen.
- Validated vehicles with a more than 250-mile driving range (and one vehicle capable of up to 430 miles on a single fill of hydrogen) and a refueling time of less than 5 minutes for about 4 kilograms of hydrogen, which is enough fuel for about 250 miles of driving.
- Demonstrated the world's first tri-generation (combined heat, hydrogen, and power) fuel cell station, which has shown a combined efficiency of 54% for co-producing hydrogen and power from a stationary fuel cell.
- Achieved substantial impact on the marketplace through strategic deployments of early market fuel cells; DOE-supported deployment of about 1,400 fuel cells has directly led to more than 5,000 additional industry orders of fuel-cell-powered forklifts and backup power fuel cells—with no additional DOE funding.

Status and Targets for Key Program Metrics

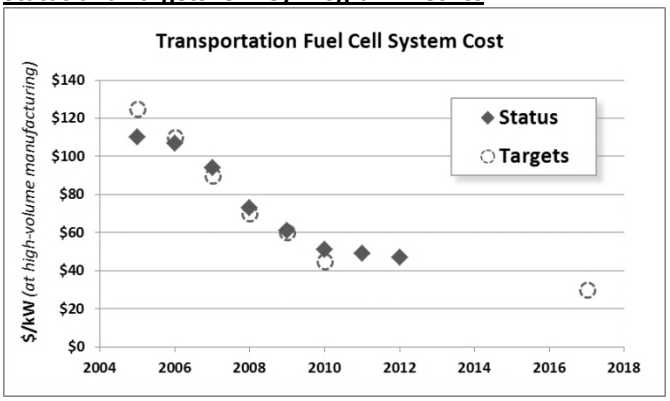


Figure 5. Status and targets for transportation fuel cell system cost (assuming high-volume manufacturing)[d]

[a] *2011 Fuel Cell Technologies Market Report*, DOE, July 2012, http://www1.eere.energy.gov/hydrogenandfuelcells/pdfs/2011_market_report.pdf; and *The Fuel Cell Industry Review*, Fuel Cell Today, September, 2012, http://www.fuelcelltoday.com/media/1713685/fct_review_2012.pdf

[b] *2011 Fuel Cell Technologies Market Report*, DOE, July 2012, http://www1.eere.energy.gov/hydrogenandfuelcells/pdfs/2011_market_report.pdf;

[c] Alternative Fuels Data Center, DOE, http://www.afdc.energy.gov/fuels/hydrogen_basics.html ; and Hydrogen Analysis Resource Center, Pacific Northwest National Laboratory, http://hydrogen.pnl.gov/cocoon/morf/hydrogen/article/860.

[d] Sources: *DOE Hydrogen & Fuel Cells Program Records* #12020, #11012, #10004, #9012, #8019, #8002, #5005, http://hydrogen.energy.gov/program_records.html; pdf

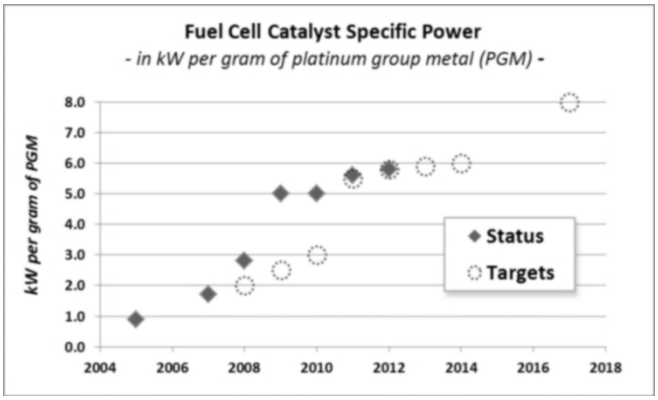


Figure 6. Status and targets for fuel cell catalyst specific power, showing reduced need for platinum group metals[a]

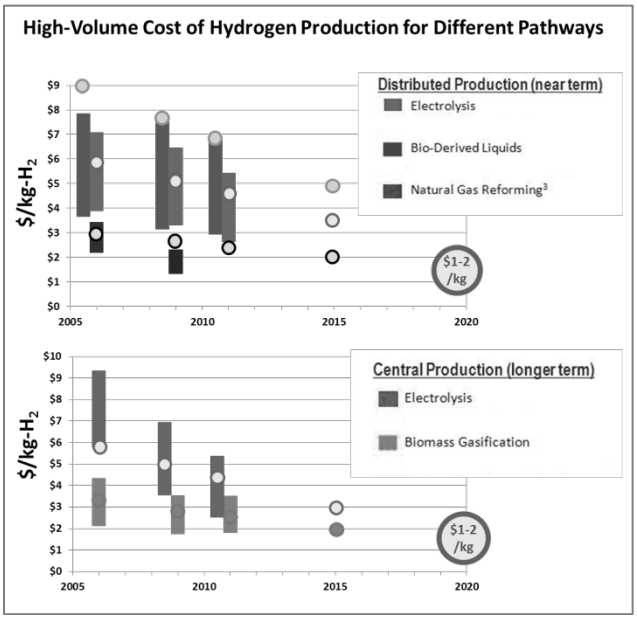


Figure 7. Status and targets for hydrogen production cost (assuming high production volumes)[b]

[a] Sources: *DOE Hydrogen & Fuel Cells Program Record* #9018, http://hydrogen.energy.gov/program_records.html (NOTE: Program Record #9018 shows platinum group metal content in grams per kilowatt; while this chart and the Program's budget metrics track catalyst specific power in kilowatts per gram of platinum group metal; these metrics are merely the inverses of each other); M. Debe, "Advanced Cathode Catalysts and Supports for PEM Fuel Cells," *2011 Annual Merit Review Proceedings*, http://www.hydrogen.energy.gov/pdfs/review11/fc001_debe_2011_o.pdf; and M. Debe, "Advanced Cathode Catalysts and Supports for PEM Fuel Cells," *2012 Annual Merit Review Proceedings*, http://www.hydrogen.energy.gov/pdfs/review12/fc001_debe_2012_o.pdf.

Program Planning and Management

The Hydrogen and Fuel Cell Technologies Program prioritizes its RDD&D work according to EERE's "Five Core Questions":

1) High Impact: Is this a high-impact problem?
2) Additionality: Will the EERE funding make a large difference relative to what the private sector (and other funding entities) is already doing?
3) Openness: Have we made sure to focus on the broad problem we are trying to solve and be open to new ideas, new approaches, and new performers?
4) Enduring Economic Benefit: How will this EERE funding result in enduring economic benefit to the United States?
5) Proper Role of Government: Why is what you are doing a proper high-impact role of government versus something best left to the private sector to address on its own?

To guide R&D priorities, set program goals, and clarify where hydrogen and fuel cells can be most beneficial, the program also conducts a comprehensive systems analysis effort and engages in several key partnerships that provide valuable stakeholder input. These partnerships help to ensure that the RD&D efforts of government, academia, and industry are well coordinated; their diverse capabilities are well integrated; and their resources are effectively utilized. The program coordinates closely with the Vehicle Technologies Program to participate in a key strategic partnership—involving automobile manufacturers, energy companies, and utilities—known as U.S. DRIVE (Driving Research and Innovation for Vehicle Efficiency and Energy sustainability). The program engages continually with stakeholders through involvement with various other organizations and participates in working groups that coordinate activities in specific technology areas. In addition to input received through these groups, the program regularly solicits input and feedback from stakeholders in the planning of its activities, through various channels, including requests for information and workshops to establish high-level program direction and update technology-specific RD&D

[b] Source: *DOE Hydrogen & Fuel Cells Program Record* #12002, http://www.hydrogen.energy.gov/pdfs/12002_h2_prod_status_cost_plots.pdf (For consistency in cost basis and techno-economic assumptions, the targets indicated in the plots for years prior to 2015 are consistent projections back along the trajectories established by the 2015 and 2020 targets (which incorporate updated H2A analysis and cost bases).

plans.

The program also maintains close collaboration with hydrogen and fuel cell activities in the Office of Science's Basic Energy Sciences Program and Energy Frontier Research Centers, the Advanced Research Projects Agency–Energy (ARPA-E), and other agencies to advance work on hydrogen and fuel cell technologies.

The program's key activities also involve a number of efforts that are essential for ensuring that funds are spent effectively and in areas with the highest potential impact—including peer reviews; data collection and dissemination; and technical, market, economic, and other analyses. Some program funding is also used to address specific statutory requirements (e.g., reporting requirements in the Energy Policy Act of 2005).

Strategic Performance Management by Program

Performance Measure	**Hydrogen & Fuel Cells -** Improve the catalyst specific power of fuel cells, as measured in kW/g of platinum group metal		
Fiscal Year	**2012**	**2013***	**2014**
Target	5.8	5.9	6.0
Result	5.8		
Endpoint Target	Impact: 8.0 kW/g in 2017 to approach $30/kW fuel cell system cost target		
Performance Measure	**Hydrogen & Fuel Cells - Cost** – Reduce the cost of hydrogen ($/gge) 2013: Relative to the 2011 baseline, reduce the cost of delivering hydrogen from the point of production to the point of use. 2012: Relative to the 2010 baseline, decrease the capital cost for hydrogen production and delivery using renewable resources.		
Fiscal Year	**2012**	**2013***	**2014**
Target	20% decrease	10% decrease	$7.2
Result	**Met** – 20		
Endpoint Target	$2–$4/gge by 2020		

*2013 targets represent DOE's FY 2013 Budget Request to Congress. FY 2013 target updates can be found in the upcoming FY 2012-2014 Annual Performance Plan & Report.

Fuel Cell R&D
Funding Profile by Subprogram

(dollars in thousands)

	FY 2012 Current	FY 2013 Annualized CR*	FY 2014 Request
Fuel Cell R&D	43,634	—	37,500
Total, Fuel Cell R&D	43,634	—	37,500

*FY 2013 amounts shown reflect the P.L. 112 175 continuing resolution level annualized to a full year. These amounts are shown only at the "congressional control" level and above; below that level, a dash (—) is shown.

The program's efforts in the Fuel Cell R&D subprogram seek to advance fuel cell technologies that can be used in diverse applications and provide the maximum benefits compared with incumbent or other advanced technologies.

To this end, the program plans to continue R&D to address challenges facing fuel cells for near - and longer-term applications. Near-term applications—which will help drive volume—include distributed power (primary and backup), portable power, auxiliary power units (APUs), material handling equipment, and specialty vehicles. Longer-term applications include light-duty vehicles, which will have the greatest impact on national energy goals and associated metrics, as well as APUs that could be applicable for marine or aircraft applications. The portfolio is "technology neutral" in the sense that it covers a range of fuel cell technologies, including polymer electrolyte membrane (PEM) fuel cells, alkaline fuel cells, direct methanol fuel cells, and high-temperature fuel cells such as solid oxide fuel cells. The primary objectives of Fuel Cell R&D activities are to improve the durability, reduce the cost, and improve the performance (e.g., power, start-up time, and transient response) of fuel cell systems.

Advances in fuel cell technologies can provide a range of benefits for multiple applications, including the following.

Transportation Applications: In transportation applications, FCEVs can substantially reduce the nation's dependence on petroleum and reduce emissions of carbon dioxide and criteria pollutants. In the future, when hydrogen from low-carbon sources (e.g., wind electrolysis, direct solar conversion, nuclear thermal processes, or biomass) is widely available, FCEVs will produce 90% less GHG emissions than today's gasoline internal combustion engine vehicles; about 70% less than plug-in hybrid electric vehicles (PHEVs) fueled with gasoline and low-carbon electricity; and about 35% less than PHEVs fueled with cellulosic biofuel and low-carbon electricity.[a]

Distributed Stationary Power (including CHP): Key applications in distributed stationary power include primary power for critical load facilities and remote power applications and CHP for residential and commercial buildings. Fuel cells are an attractive option for grid integration and resiliency, in both grid-dependent and grid-independent operation—offering high efficiency and reliability, and low emissions.

Backup Power: Fuel cells can be an economically viable option for providing backup power, particularly for telecommunications towers, data centers, hospitals, and communications facilities for emergency services. Compared with batteries, fuel cell systems offer higher energy density and greater durability in harsh outdoor environments under a wide range of temperature conditions. Compared with generators, fuel cells are quieter and have low-to-zero emissions (depending on the fuel). In addition, they require less maintenance than both generators and batteries.

Specialty Vehicles: Fuel cells powered by hydrogen have become a cost-competitive option for powering specialty vehicles such as forklifts, especially in indoor facilities and locations where air quality is important. Forklifts powered by fuel cells can provide significant savings in life-cycle costs and increases in productivity over battery-powered forklifts, when used continuously in operations consisting of two to three shifts per day. They can be rapidly refueled—eliminating the time, labor, and space devoted to charging and changing batteries. Also, battery

[a] DOE Hydrogen and Fuel Cells Program Record #10001, http://hydrogen.energy.gov/pdfs/10001_well_to_wheels_gge_petroleum_use.pdf

power diminishes as it is drained, resulting in loss of productivity toward the end of a charge cycle, while fuel cell power remains constant as long as fuel is supplied.

Auxiliary Power Units (APUs): Fuel cells can provide auxiliary power for tractor trailers, refrigerated trucks, recreational vehicles, yachts, commercial ships, locomotives, aircraft, and similar applications. In many of these applications, the propulsion engines are often used to provide auxiliary power while the vehicle or vessel is not moving, which is a very inefficient practice. Fuel cells can provide a much cleaner and more efficient source of auxiliary power.

Portable Power: Manufacturers are developing portable fuel cells for use in cell phones, cameras, PDAs, MP3 players, laptop computers, and as portable generators and battery chargers. Benefits over current technologies include smaller packaging, less weight, elimination of recharge time, and longer run time. The military also has a strong interest in portable power for field electronics. Successful commercialization of portable power applications will help to develop a domestic knowledge and supply-chain base.

The Fuel Cell R&D ($37.5 million) subprogram will continue R&D for fuel cell stack and system balance of plant (BOP) components. The subprogram plans to allocate more than half of its funds to fuel cell stack component R&D (including catalysts, membranes, and membrane electrode assembly [MEA] integration), about a quarter of its funds to stack and component operation and performance (including durability, impurities, and mass transport), and the remainder to work on balance of plant components, testing, and technical analysis. Exact amounts will be determined based on R&D progress in each area and the relative merit and applicability of projects competitively selected through planned funding opportunity announcements (FOAs).

In FY 2014, the subprogram will increase the power density to 6.0 kW per gram of platinum group metal (PGM), in support of the FCEV life-cycle cost of $0.48 per mile. These efforts target cost reduction and an increase in fuel cell stack and system durability. As recommended in the 2008 NRC report, the program has reallocated funding over the past several years to prioritize and emphasize R&D that addresses the most critical barriers, such as catalysts (low- and non-platinum-group-metal catalysts), electrodes, membranes, MEAs, and modes of operation addressing stack and component durability and performance. There are different technology needs for different types of fuel cells, and the subprogram implements a portfolio approach to ensure specific R&D needs are addressed based on the status of the technology compared to application-driven targets.

In FY 2014, the subprogram will continue to emphasize R&D at the materials and component level, as well as component integration into MEAs and stacks. The subprogram will continue system BOP component R&D (e.g., for air management) that can lead to lower cost and lower parasitic losses. The subprogram will also pursue the development of longer-term technologies (e.g., anion-exchange (alkaline) membrane fuel cells), which will provide high-performance and durable, PGM-free technology. R&D of medium- and high-temperature fuel cell technologies (polybenzimidazole *[PBI]* type, phosphoric acid, molten carbonate, and solid oxide fuel cells) will create a viable pathway for cost-effective systems for a range of non-motive applications and will accelerate our ability to take advantage of abundant, low-cost natural gas for highly efficient production of power and heat. In addition, fuel processors integrated with the fuel cell will enable the conversion of fuels—such as methanol, ethanol, biomass-derived liquids, natural gas, propane, diesel, or waste gas—into hydrogen for use in automotive fuel cells, and other applications that require hydrogen.

Fuel cell system modeling will serve to guide component R&D, help to benchmark complete systems before they are built, and explore alternate system components and configurations. The modeling activity will include cost analysis for multiple applications and evaluation of operation strategies—with the aim of enhancing performance and reducing degradation. Optimizing system controls will improve performance and durability, while lowering cost. Analytical tools and partnerships continue to expand research capabilities. In addition, R&D efforts will leverage activities outside of the program, through coordination with other activities in the Office of Science's Basic Energy Sciences program, ARPA-E, the National Science Foundation (NSF), and others.

Fuel Cell R&D Incubator Activities: These Incubator activities are an expansion of an already proven innovative program that EERE's Solar Energy Technologies Office piloted with a specific focus on partnering with businesses and researchers to bring "off-roadmap" impactful new technologies into the EERE portfolio. These early prototypes were developed into manufacturing and commercially relevant prototypes designed around pilot-stage process development. Based upon this highly successful model, the Hydrogen

and Fuel Cell Technologies Program plans to invest in the creation of Incubator Programs in FY 2014($3.7 million).

Explanation of Funding Changes

(dollars in thousands)

	FY 2012 Current	FY 2014 Request	FY 2014 Request vs. FY 2012 Current
Fuel Cell R&D — This $6.1 million decrease allows for an increased focus on Hydrogen Fuel R&D particularly for hydrogen produced from renewable resources and an increased focus on Manufacturing R&D. This reflects a redirection in resources to support higher priority activities within the program and EERE.	43,634	37,500	-6,134
Total, Fuel Cell R&D	43,634	37,500	-6,134

Funding Schedule

Fiscal Year	Line Item	Funding (Dollars in Thousands)
FY 2012	• Improve performance, reduce cost, and increase durability of PEM fuel cell stack components, including catalysts and membranes to achieve 5.8 kW/g PGM catalyst. • Begin integration of state-of-the-art membranes and catalysts into advanced MEAs. • Expand BOP component development for fuel cell systems.	43,634
FY 2013	Planned activities in the FY 2013 Budget (final allocations have not yet been determined): • Continue R&D to advance catalyst and membrane development—reducing the PGM content of PEM fuel cells and improving their ability to operate under hotter, drier conditions; expand R&D to include catalysts and membranes for PGM-free and alkaline membrane fuel cells. • Optimize integration of state-of-the-art membranes and catalysts into advanced MEAs to achieve 5.9 kW/g PGM catalysts. • Develop system BOP components, including low-cost, durable air management systems.	—
FY 2014	• Further develop catalysts and membranes and integrate state-of-the-art components in advanced MEAs to achieve 6.0 kW/g PGM catalysts. • Validate performance, cost, and durability improvements of advanced, optimized MEAs containing previously developed catalysts and membranes. • Develop high-temperature fuel cell stack components, as well as BOP system and subsystem components. • Conduct activities on novel catalysts and membranes.	37,500

Hydrogen Fuel R&D
Funding Profile by Subprogram

(Dollars in thousands)

	FY 2012 Current	FY 2013 Annualized CR*	FY 2014 Request
Hydrogen Fuel R&D	33,824	—	38,500
Total, Hydrogen Fuel R&D	33,824	—	38,500

*FY 2013 amounts shown reflect the P.L. 112 175 continuing resolution level annualized to a full year. These amounts are shown only at the "congressional control" level and above; below that level, a dash (—) is shown.

Hydrogen Fuel R&D subprogram supports the program's mission through materials research and technology development to enable the production of low-cost, low-carbon hydrogen from diverse renewable pathways and address key challenges to hydrogen delivery and storage.

The program is developing methods for producing and delivering renewable hydrogen at reduced cost. The overarching goal is to enable several different domestic production approaches—at a variety of scales ranging from large, centralized production to small, local (distributed) production—that will achieve a hydrogen cost of $2–$4/gge, dispensed and untaxed, in 2020. This cost range represents the threshold at which hydrogen for FCEVs will be competitive on a cent-per-mile basis with competing advanced vehicles and fuels, based on current analysis. To enable the use of hydrogen produced from highly efficient centralized facilities, technologies will have to be developed to lower the cost of delivery to the station. There are also costs associated with compression, storage, and dispensing (CSD) at the station that will affect the final cost of hydrogen produced at both central and distributed sites. The program is pursuing advances in existing technologies for hydrogen delivery and station CSD and developing new technologies to reduce costs, with the ultimate goal of reducing the delivery portion of the total hydrogen cost to less than $2/gge by 2020.

The program is also developing technologies to enable efficient and cost-effective hydrogen storage systems. The overarching goal of the program's hydrogen storage efforts is to enable a driving range of more than 300 miles (~500 km), while meeting the packaging, cost, safety, and performance requirements of current and future vehicle markets. While some automakers have demonstrated progress with prototype and concept vehicles that can travel more than 300 miles on a single fill—including one vehicle that was independently validated at 430 miles—this driving range must be achievable across many vehicle platforms without compromising passenger cargo space or performance and at a competitive cost. The subprogram has established onboard automotive storage density goals for 2017 of 1.8 kWh/kg (5.5% by weight) and 1.3kWh/liter (0.04 kg H_2/liter) and "ultimate" light-duty vehicle targets of 2.5 kWh/kg (7% by weight) and 2.3 kWh/liter (0.07 kg H_2/liter), with a storage system cost target of $8/kWh. While some storage materials have been identified that meet or exceed either the 2017 gravimetric or volumetric targets, no single material meets both of these targets simultaneously. Furthermore, any hydrogen storage material will have to be able to be integrated into a system that meets the cost, safety, and performance requirements of current and future vehicle markets.

The Hydrogen Fuel R&D subprogram ($38.5 million) will continue to provide grants, cooperative agreements, and national laboratory funding to develop technologies and materials to achieve increased electrolyzer efficiency and reduced hydrogen compression and storage cost to support the hydrogen threshold cost of $2–$4/gge by 2020. The sub-program plans to allocate more than half of its funding to renewable hydrogen production and delivery (one third of which will be allocated to hydrogen delivery), with the remainder to hydrogen storage. Exact amounts will be determined based on R&D progress in each area and the relative merit and applicability of projects competitively selected through FOAs.

The hydrogen production component of this subprogram will address materials and process development to enable hydrogen production from diverse renewable resources. In FY 2014, this effort will focus on hydrogen from direct solar water splitting through advanced technology pathways such as photoelectrochemical, photolytic biological, and solar thermochemical production. R&D of wind- and solar-powered electrolysis will include developing advanced power electronics

interfaces and other BOP components for the direct coupling of electrolyzers to renewable sources; testing of electrolyzer performance and durability in response to direct coupling will also be included. In addition, the subprogram will develop fermentative and microbial-aided electrolysis technologies that produce hydrogen from organic matter. In solar high-temperature water splitting, the program will continue to develop three chemical cycles in the laboratory and then select at least one cycle for small-scale, on-sun testing by 2015. The program will coordinate closely with EERE's Solar Energy Technologies Program on this effort.

In photoelectrochemical hydrogen production, the program will continue to coordinate with and leverage R&D efforts funded through DOE's Office of Science, the "Fuels from Sunlight Innovation Hub," and other agencies (e.g., NSF) to develop and evaluate wide bandgap semiconductor materials and systems for integration into solar water-splitting device configurations that are projected to achieve 2015 and 2020 program targets for cost and efficiency. Also in coordination with the Office of Science and other agencies, research will continue on the design and development of biological micro-organism systems to achieve breakthroughs in hydrogen production efficiency using photolytic, photosynthetic, fermentation, and microbial electrolysis pathways.

The subprogram's hydrogen delivery component includes technologies for hydrogen transportation and distribution to the end user, as well as for the fueling-station operations of compression, storage, and dispensing. These efforts will aim to reduce the capital costs and increase the energy efficiency of hydrogen delivery systems. In FY 2014, these efforts will focus on developing and testing technologies that will enable lower-cost station design or upgrades and on technologies that will improve delivery system reliability and integrity—through development and testing of advanced materials (such as fiber reinforced polymer and high temperature polymer) and key station components such as storage vessels, compressors, and dispensers. Testing and assessing materials and station technologies will be coordinated with industry and will incorporate early market experience.

The hydrogen storage component of this subprogram will support R&D of technologies to lower the cost of near-term physical storage options and longer-term material-based hydrogen storage approaches that can enable the widespread commercialization of fuel cell systems for diverse applications across the stationary, portable, and transportation sectors. The program conducts R&D on low-pressure, materials-based technologies and innovative approaches to increase storage potential and broaden the range of commercial applications. Hydrogen storage efforts will also explore low-cost carbon fiber composites for high-pressure physical storage and advanced conformable and cryogenic-capable tank technologies.

The hydrogen storage materials activities will continue to focus on materials discovery R&D of novel materials with the potential to store hydrogen near room temperature at low-to-moderate pressures and at energy densities greater than either liquid or compressed hydrogen. Key activities will include improving the energetics, temperature, and rates of hydrogen release. Advanced concepts include high-capacity metal hydrides, chemical hydrogen storage materials, and hydrogen sorbent materials, as well as novel material synthesis processes. R&D will focus on the most promising material technologies down-selected from the overall portfolio, which have the potential to meet DOE's 2017 system targets. Applied R&D will be closely coordinated with the Office of Science's basic research efforts, as well as NSF and other relevant agencies.

The subprogram will conduct R&D on the integration of novel hydrogen storage materials into complete, engineered storage systems, focusing on developing innovative solutions to thermal management, material packaging, and control strategies to provide complete, compact, efficient, and cost-effective storage systems. While materials-based technologies offer the potential for low-pressure and high-density hydrogen storage, control of the hydrogen charge and release (within specified ranges of temperature and pressure from the system) requires a total system engineering approach. Engineering research focuses on designing and integrating innovative components into complete hydrogen storage systems with the potential to meet DOE performance and cost targets. Research activities will be carried out on integrated heat exchangers, low-cost pressure vessels, hydrogen purification and conditioning systems, and low-cost and low-weight BOP components. The subprogram will also continue to develop and validate complete system models that address both subsystems and fuel cycles.

For high-pressure physical storage applications, the subprogram will conduct R&D to enable weight and cost reductions of the composite tanks and increase the dormancy of cryogenic-capable tanks. For near-term market applications, the subprogram will initiate R&D to

address hydrogen storage technology gaps at a system level to enable broad commercialization of fuel cell technologies.

Hydrogen Fuel R&D Incubator Activities: These Incubator activities are an expansion of an already-proven innovative program that EERE's Solar Energy Technologies Office piloted with a specific focus on partnering with businesses and researchers to bring "off-roadmap" impactful new technologies into the EERE portfolio. These early prototypes were developed into manufacturing and commercially relevant prototypes designed around pilot-stage process development. Based upon this highly successful model, the subprogram plans to invest in the creation of Incubator Programs in FY 2014 ($3.8 million).

Explanation of Funding Changes

(Dollars in thousands)

	FY 2012 Current	FY 2014 Request	FY 2014 Request vs. FY 2012 Current
Hydrogen Fuel R&D — The $4.6 million increase allows for an increased focus on renewable hydrogen, such as R&D to meet interim targets of 75% electrolyzer stack efficiency and longer-term technologies using solar resources.	33,824	38,500	+4,676
Total, Hydrogen Fuel R&D	33,824	38,500	+4,676

Funding Schedule

Fiscal Year	Line Item	Funding (Dollars in thousands)
FY 2012	• Address key materials needs in membranes and catalysts for PEM-based water electrolyzers to enable a hydrogen cost of $2–$4/gge. • Demonstrate electrochemical compression. • Focus on lowering carbon fiber precursor costs to meet $6/lb by 2017. • Develop complete hydrogen storage system models.	33,824
FY 2013	Planned activities in the FY 2013 Budget (final allocations have not yet been determined): • Address key materials in photolytic devices and reactors to achieve $2–$4/gge. • Test designs for cost-efficient pipeline compressors. • Continue efforts to lower carbon fiber precursor costs. • Design low-cost, materials-based storage options to meet $12/kWh. • Design and build complete prototype hydrogen storage systems.	—
FY 2014	• Incorporate new organisms and nanostructured materials in photolytic hydrogen production. • Reduce cycle time and increase solar to hydrogen efficiency for solar-thermochemical hydrogen production. • Verify that energy-efficient forecourt compressors can meet 73% isentropic efficiency by 2015 from a baseline of 65% in 2011. • Further reduce carbon fiber composite costs. • Develop hydrogen storage materials guided by system engineering analysis. • Initiate validation of hydrogen storage system models through prototype testing.	38,500

Manufacturing R&D
Funding Profile by Subprogram

(Dollars in thousands)

	FY 2012 Current	FY 2013 Annualized CR*	FY 2014 Request
Manufacturing R&D	1,944	—	4,000
Total, Manufacturing R&D	1,944	—	4,000

*FY 2013 amounts shown reflect the P.L. 112 175 continuing resolution level annualized to a full year. These amounts are shown only at the "congressional control" level and above; below that level, a dash (—) is shown.

Manufacturing R&D supports the program's mission through grants, cooperative agreements, and national laboratory funding for the development of advanced fabrication technologies and processes to meet the cost targets of critical hydrogen and fuel cell technologies. These activities will help reduce fuel cell and hydrogen system costs to be competitive with those of current technologies. Benefits include growing the domestic supplier base, which will provide jobs in the United States.

The program will identify specific manufacturing R&D projects as technology roadmaps are updated to reflect the needs of near-term applications. The subprogram coordinates extensively with other organizations within the Advanced Manufacturing Partnership—a national effort the Administration launched in 2011 to support the domestic advanced manufacturing sector, create high-quality jobs, and encourage companies to invest in the United States.

The Manufacturing R&D subprogram ($4.0 million) will continue its development of fabrication processes that lead to low-cost, high-volume manufacturing and help to develop a domestic supply base. In FY 2014, the subprogram will demonstrate methods to inspect full MEAs and cells prior to assembly into stacks, which will help achieve the FCEV life-cycle cost of $0.48 per mile by 2017. The subprogram will pursue methodologies to identify defects generated during the manufacture of fuel cells, and determine what effect the defects have on fuel cell performance— which will be of great value to manufacturers that lack these capabilities.

The subprogram is also pursuing reductions in the costs of manufacturing fuel cells and hydrogen technologies by eliminating intermediate backing materials and reducing process steps. Near-term activities include new and ongoing R&D of technologies critical to accelerated introduction of high-volume commercialized products such as catalyst-coated membranes and gas diffusion electrodes for fuel cells and vessels for hydrogen storage. The subprogram will coordinate with DOE's Advanced Manufacturing Office, the Department of Defense (DOD) (e.g., the Defense Production Act efforts), and the Department of Commerce (National Institute of Standards and Technology) to leverage other activities.

Explanation of Funding Changes

(dollars in thousands)

	FY 2012 Current	FY 2014 Request	FY 2014 Request vs. FY 2012 Current
Manufacturing R&D — The $2 million increase allows for additional investment in hydrogen and fuel cell manufacturing R&D, such as that to develop in-line quality control tools and develop materials and methods for hydrogen storage vessels.	1,944	4,000	+2,056
Total, Manufacturing R&D	1,944	4,000	+2,056

Funding Schedule

Fiscal Year	Line Item	Funding (dollars in thousands)
FY 2012	• Develop in-line quality control technologies for roll goods.	1,944
FY 2013	Planned activities in the FY 2013 Budget (final allocations have not yet been determined): • Demonstrate a non-woven platform, reducing total cost of materials and labor by an additional 30% over best woven scenario.	—
FY 2014	• Develop processes for direct coating of electrodes on membranes or gas diffusion media. • Develop processes for highly uniform continuous lamination of MEA components.	4,000

Systems Analysis
Funding Profile by Subprogram

(dollars in thousands)

	FY 2012 Current	FY 2013 Annualized CR*	FY 2014 Request
Systems Analysis	3,000	—	3,000
Total, Systems Analysis	3,000	—	3,000

*FY 2013 amounts shown reflect the P.L. 112 175 continuing resolution level annualized to a full year. These amounts are shown only at the "congressional control" level and above; below that level, a dash (—) is shown.

The Systems Analysis subprogram provides the analytical and technical basis for informed decision making for the program's R&D direction and prioritization. Systems Analysis is an essential component of the program that contributes to understanding and assessing market growth and job creation, technology needs and progress, potential environmental impacts, and energy-related economic benefits of fuel cells across applications and for multiple fuel pathways. These efforts assess R&D gaps, planning, and budgeting, as well as synergies and interactions with other energy sectors. The subprogram assesses the requirements of potential end users to determine metrics for multiple components, subsystems, and systems. Results also support annual updates to key program planning documents that provide the current direction and planned milestones for the program. The Systems Analysis subprogram provides the analytical and technical basis for informed decision-making for the office's R&D direction and prioritization.

The Systems Analysis subprogram ($3.0 million) will continue to utilize analytical models and tools. In FY 2014, the subprogram will:

- Update the analyses of the economic and environmental benefits of FCEVs—including reductions in GHG emissions, criteria pollutants, and petroleum use, on a life-cycle basis
- Identify research and technology gaps in order to guide program investments and enable targeted R&D that will help achieve the FCEV life-cycle cost of $0.48 per mile by 2017; these gaps will also be assessed for other applications, including material handling, stationary, and portable power, as well as CHP systems
- Assess life-cycle GHG emissions and cost for on-board storage, resource and technology limitations, options and opportunities for stationary power production from fuel cells, renewable fuel supply evolution, infrastructure issues and limitations, and the potential environmental impacts of widespread commercialization
- Assess the use of hydrogen produced from renewable resources (such as wind and solar) for energy storage and as an energy carrier to understand opportunities to alleviate electrical grid congestion and enable the distribution of energy from the point of generation to end users through multiple transport modes such as electrical transmission and natural gas delivery systems
- Assess the use of various fuels for stationary fuel cells—including landfill gas, other biogases (e.g., from dairy farms), and unused sources of gaseous hydrogen—to determine their potential environmental benefits.

In FY 2014, the Macro System Model (MSM), which provides overarching analysis for the program, will be used to analyze near- and mid-term impacts and benefits of integrating stationary fuel cells with other renewable technologies, as well as the life-cycle cost of on-board storage options. The Systems Analysis subprogram will also work with other subprograms to update other models as needed.

The subprogram will provide system analysis support and input for all the program elements—such as:

- Go/no-go decisions
- Assessments of market penetration, commercial market stimulus, job creation, and opportunities for fuel cell applications in the near term (e.g., materials handling, backup power, and residential CHP markets)
- Updates and maintenance of the Analysis Portfolio, prioritized analysis list, and Analysis Resource Center database—to ensure analysis consistency and transparency
- Modeling and analysis of synergies between hydrogen and fuel cells with other emerging technologies, fuels, and energy systems to identify and understand potential opportunities, assess the benefits of achieving economies of scale, and identify ways to

reduce infrastructure cost

In addition to analyses of the environmental benefits of fuel cells mentioned above, the subprogram will also estimate the program's return on investment by determining the number of commercial technologies developed through program funding. The subprogram will also update the Systems Analysis Plan and assist in updating the program's Technical Requirements document and Multi-Year Research, Development, and Demonstration Plan.[a]

[a] *Fuel Cell Technologies Office Multi-Year Research, Development and Demonstration Plan,* http://www1.eere.energy.gov/hydrogenandfuelcells/mypp/index.html.

Explanation of Funding Changes

(dollars in thousands)

	FY 2012 Current	FY 2014 Request	FY 2014 Request vs. FY 2012 Current
Systems Analysis — No funding change	3,000	3,000	0
Total, Systems Analysis	3,000	3,000	0

Funding Schedule

Fiscal Year	Line Item	Funding (dollars in thousands)
FY 2012	• Perform wells-to-wheels analysis FCEVs and other advanced transportation fuels and technologies.	3,000
FY 2013	Planned activities in the FY 2013 Budget (final allocations have not yet been determined): • Complete GHG emission life-cycle assessment of 3 FCEV on-board storage options.	—
FY 2014	• Using the Macro System Model, analyze near- and mid-term market impacts and the benefits of integrating stationary fuel cells into the electricity supply system and the life-cycle cost of on-board storage options. • Calculate return on investment by determining the number of commercial technologies that were developed using program funding.	3,000

Technology Validation
Funding Profile by Subprogram

(dollars in thousands)

	FY 2012 Current	FY 2013 Annualized CR*	FY 2014 Request
Technology Validation	8,986	—	6,000
Total, Technology Validation	8,986	—	6,000

*FY 2013 amounts shown reflect the P.L. 112 175 continuing resolution level annualized to a full year. These amounts are shown only at the "congressional control" level and above; below that level, a dash (—) is shown.

The Technology Validation subprogram provides accurate assessments of the state of the technologies—providing valuable feedback to R&D efforts, along with information to enable an informed assessment of the risks facing continued government and industry investment. To enable the automotive, energy, and utility industries to determine whether technology readiness has been achieved, integrated vehicle and infrastructure systems need to be validated and individual component targets need to be met under real-world operating conditions. This subprogram has supported the program's mission by providing critical data to predict whether FCEVs can meet the 2017 targets of 60% peak efficiency, 5,000-hour fuel cell durability, a range greater than 300 miles, 5-minute fill time, and hydrogen fuel costs of $2–$4 per gge. Specifically, the subprogram will validate the performance and vehicle interfaces of FCEVs to demonstrate an increase in durability from 2,521 hours in 2012 to 5,000 hours by 2019 in a vehicle fleet (5,000 hours is equal to approximately 150,000 vehicle miles). Technology Validation also provides information in support of codes and standards development, as well as for the development of best practices regarding safety.

The Technology Validation subprogram ($6.0 million) will continue to collect and analyze real-world operational data, and in FY 2014, it will assess current technology and provide feedback to hydrogen and fuel cell R&D activities to help achieve an FCEV life-cycle cost of $0.48 per mile by 2017. The subprogram will collect data from advanced light-duty FCEVs, hydrogen refueling stations, and other vehicles such as fuel cell–powered transit buses (in collaboration with the U.S. Department of Transportation (DOT)). These ongoing data collection efforts allow for tracking advancements in performance, reliability, and durability of technologies in real-world operational systems. Assessing durability is critical for assessing the viability of technologies, but requires significant time, warranting an ongoing effort to capture the performance, reliability, maintenance, and repairs over the life cycle of a technology and as the technology advances. These efforts identify needs and provide direct feedback to R&D efforts.

Stationary Fuel Cells: In FY 2014, projects validating advanced stationary fuel cell systems will begin. These systems may span a range of fuel cell sizes and types and may use various conventional or alternative fuel sources, including waste-gas from wastewater treatment facilities, landfills, or industrial processes; anaerobic digester gas from agricultural or other biological waste; or hydrogen produced from renewable sources. Stationary fuel cells can be used in a wide range of buildings—with varying sizes, needs, equipment, and thermal characteristics, and in diverse locations with various climates, policies, costs, and resource constraints.

Hydrogen, Electricity, and Heat Tri-generation: Data will also be collected from systems that coproduce hydrogen, electricity, and heat; these systems offer the ability to upgrade low-grade, low-value fuels to high-grade, high-value energy products—electricity and hydrogen. These systems can also operate in a tri-generation mode to utilize byproduct heat, further increasing the value of output energy and improving system economics.

The subprogram will increase its emphasis on production and delivery of hydrogen (including central and distributed production), and it will also address the use of hydrogen for grid energy storage to enhance and facilitate the use of variable renewable energy resources. The subprogram will coordinate these efforts with DOE's Grid Integration Initiative to avoid duplication. In FY 2014, the subprogram's efforts in hydrogen production will focus on distributed hydrogen production using electrolysis or bio-derived liquids. Data collection efforts will also include systems for hydrogen refueling for early fuel cell markets, such as material handling equipment and backup power (e.g., for cell towers).

In FY 2014, Technology Validation will conclude its data collection efforts on early market applications such as material handling equipment, backup power systems, and ground support equipment.

Explanation of Funding Changes

(dollars in thousands)

	FY 2012 Current	FY 2014 Request	FY 2014 Request vs. FY 2012 Current
Technology Validation — The $3 million decrease allows for an increased focus on preparing technologies for validation such as those to be supported in the Manufacturing R&D and Hydrogen Fuel R&D subprograms.	8,986	6,000	-2,986
Total, Technology Validation	8,986	6,000	-2,986

Funding Schedule

Fiscal Year	Line Item	Funding (dollars in thousands)
FY 2012	• Begin collection and analysis of data from hydrogen fueling station operation. • Validate advanced, innovative components in operating hydrogen fueling stations.	8,986
FY 2013	Planned activities in the FY 2013 Budget (final allocations have not yet been determined): • Begin data gathering and analysis of advanced FCEV operation. • Validate SAE J2601 fueling protocols.	—
FY 2014	• Collect and analyze data from fuel cells used in transit buses and light-duty vehicles. • Collect and analyze data for hydrogen refueling stations and renewable hydrogen production. • Begin validation of advanced stationary fuel cell systems, such as tri-generation systems capable of producing hydrogen, heat, and power.	6,000

Safety Codes and Standards
Funding Profile by Subprogram

(dollars in thousands)

	FY 2012 Current	FY 2013 Annualized CR*	FY 2014 Request
Safety Codes and Standards	6,938	—	7,000
Total, Safety Codes and Standards	6,938	—	7,000

*FY 2013 amounts shown reflect the P.L. 112 175 continuing resolution level annualized to a full year. These amounts are shown only at the "congressional control" level and above; below that level, a dash (—) is shown.

The Safety, Codes and Standards subprogram supports R&D that provides critical data required for the development of technically sound codes and standards, which will be needed for the widespread commercialization and safe deployment of hydrogen and fuel cell technologies. The subprogram also promotes collaborative efforts among government, industry, standards development organizations, universities, and national laboratories in an effort to harmonize regulations, codes, and standards (RCSs) both domestically and internationally.

The subprogram also conducts safety activities focused on developing information resources and best practices. The subprogram utilizes extensive external stakeholder input from automobile manufacturers and the energy, insurance, and aerospace sectors, as well as the fire protection community and academia, to enhance and create safety knowledge tools for emergency responders and authorities having jurisdiction. Continual availability of safety knowledge tools, distributed via an array of media outlets to reach the largest number of safety personnel possible, is a subprogram priority. The subprogram also supports the development and implementation of best practices and procedures to ensure safety in the operation, handling, and use of hydrogen and fuel cell technologies in all program-funded projects.

The Safety, Codes and Standards subprogram ($7.0 million) will continue efforts in fuel quality and metering, and in FY 2014, it will quantify the impact of fast fueling (SAE standard J2601). The impact of fuel contaminants on fuel cell system components will be quantified to support the revision of fuel quality standards, to validate the impact of fuel impurity in PEM stacks, and to define additional analytical methods that will allow cost-effective verification of fuel purity to help achieve the FCEV life-cycle cost of $0.48 per mile by 2017. Metering technologies and fuel dispensing requirements will be developed to allow accurate measurement of delivered commercial fuel. The subprogram will collaborate with DOT, EPA, NIST, and other government agencies, as well as the International Partnership for the Hydrogen Economy and the International Energy Agency to ensure that fuel, fuel storage, and dispensing standards development proceeds in agreement with existing regulatory authorities. The cooperating agencies will maximize available resources and expertise in areas such as hydrogen dispensing and measurement (NIST), vehicle safety (DOT National Highway Traffic Safety Administration), and the development of a Global Technical Regulation (DOT, EPA). The subprogram will also conduct comprehensive R&D to characterize the behavior of materials such as polymers in hydrogen environments and provide data to optimize the design engineering of components and systems.

In the area of safety research, the subprogram will continue analysis of creditable accident scenarios to identify potential system weaknesses, with complementary R&D efforts focusing on mitigating the identified weaknesses to improve system safety. FY 2014 funding will also support risk assessment activities, which will provide information to guide the codes and standards development process, and these risk assessments will be made available to key industry stakeholders, such as fuel providers and insurers. Risk assessment activities will include: supporting the development of numerical experiments and models, such as computational fluid dynamics, and characterizing the release of gas and liquid hydrogen to help determine technical requirements for the hydrogen infrastructure, such as separation distances.

In addition to R&D activities, the subprogram will continue to develop and enhance safety information tools and monitor the safety of DOE hydrogen projects through the Safety Panel. The panel will conduct site visits, interviews, and safety plan reviews of all program-

funded hydrogen projects. The subprogram will also conduct training for firefighters and fire department training coordinators, law enforcement personnel, and emergency medical technicians, as well as code officials, fire marshals, city planners, state government representatives, and other fuel cell users. Training for first responders and code officials facilitates the approval and implementation of fuel cell projects using hydrogen. Building on prior-year efforts, the subprogram will also expand the implementation and deployment of an introductory course designed specifically for code officials.

Explanation of Funding Changes

(dollars in thousands)

	FY 2012 Current	FY 2014 Request	FY 2014 Request vs. FY 2012 Current
Safety, Codes and Standards — No significant funding change.	6,938	7,000	+62
Total, Safety, Codes and Standards	6,938	7,000	+62

Funding Schedule

Fiscal Year	Line Item	Funding (dollars in thousands)
FY 2012	• Determine the impact of hydrogen impurities on fuel cell performance. • Submitted, to the United Nations, the Global Technical Regulation on hydrogen fueled vehicles, which will serve as the technical basis for the U.S. safety standard.	6,938
FY 2013	Planned activities in the FY 2013 Budget (final allocations have not yet been determined): • Quantify the effects of fuel contaminants on fuel cell system components to develop and publish an ISO International Standard for hydrogen fuel specification and the SAE J2719 standard.	—
FY 2014	• Publish results from H_2 cycle tests and materials studies conducted in a high pressure hydrogen environment; • Conduct a quantitative risk assessment study to address indoor refueling requirements to be adopted by code development organizations; • Validate the impact of fuel impurity in PEM stacks and other fuel cell system components; and • Support the development and validation of metering technologies and fuel dispensing requirements, such as SAE J2601.	7,000

Market Transformation
Funding Profile by Subprogram

(dollars in thousands)

	FY 2012 Current	FY 2013 Annualized CR*	FY 2014 Request
Market Transformation	3,000	—	3,000
Total, Market Transformation	3,000	—	3,000

*FY 2013 amounts shown reflect the P.L. 112 175 continuing resolution level annualized to a full year. These amounts are shown only at the "congressional control" level and above; below that level, a dash (—) is shown.

The primary goal of the Market Transformation subprogram is to increase penetration of hydrogen and fuel cell technologies in key early markets where a modest number of new orders will have a significant impact on reducing costs through economies of scale. Enabling economies of scale will reduce total life-cycle costs (not just the costs of hardware components) and will help fuel cells to achieve life-cycle cost parity with incumbent technologies such as diesel engines and batteries. Market Transformation activities make up a key final phase in the program's comprehensive strategic timeline for moving technologies from the laboratory to self-sustaining commercialization in the marketplace. The subprogram's approach is aligned with national laboratory and market research studies that outline necessary deployment measures to reach the program's goals.

Early market sales will also stimulate further market activity by supporting the growth of the domestic fuel cell manufacturing industry—overcoming some of the logistical and other deployment challenges associated with adoption of new technologies, and establishing key elements of the infrastructure that will be essential for later market growth. In addition to their direct positive impact on the market, these deployments will provide valuable data on the performance of the technologies in real-world operation, lessons learned from early adopters, and information that will be used to validate the benefits of the technologies.

The program's early market deployment efforts are primarily focused on identifying opportunities for purchases of fuel cells by government agencies and facilitating those purchases through technical and financial support. The subprogram actively collaborates with other Federal agencies to facilitate the deployment of hydrogen and fuel cells in key early markets, including specialty vehicles, backup/remote power, auxiliary and portable power, primary power for critical applications, and renewable hydrogen production (including the use of hydrogen for energy storage). The subprogram also coordinates with regional, state, and local initiatives involving hydrogen and fuel cells. The subprogram strives to achieve a "critical mass" of activity that will lead to a self-sustaining market for the technologies.

The Market Transformation subprogram ($3.0 million) will continue to fund cost-shared deployments and provide technical support to deployment efforts, which will address deployment costs and market barriers that industry does not currently address. In FY 2014, the subprogram will complete assessment of early market fuel cell systems and provide feedback to program R&D areas to help achieve the FCEV life-cycle cost of $0.48 per mile by 2017. The subprogram will continue efforts to provide technical and financial assistance for government and other technology adopters. It will also provide training and workshops targeting niche market opportunities that include distributed power, renewable grid management, and auxiliary power for Federal fleets such as DOD non-tactical motive power. Other focus areas include

- Waste-to-energy stationary power
- Auxiliary power for on- and off-road vehicles
- Specialty vehicles such as airport ground support trucks
- Expanded use of energy storage using hydrogen produced from renewables
- Related models, tools, and templates for accelerating the hydrogen and fuel cell user base and expanding commercialization.

Working in conjunction with technology experts, activities include outreach, training, and technical assistance for early market adopters. Critical tools and information will be provided via the Internet, publications, and direct interaction with experts.

The subprogram will continue to build national and regional alliances to support further expansion of fuel cell technology use in both motive and non-motive power applications. Public awareness of these technology applications will be enhanced by high visibility demonstration projects at national parks and other public locations whenever possible. For example, the program is working with the National Park Service, the U.S. Army Corps of Engineers, and the South Carolina Research Authority to install a backup power fuel cell system and a renewable hydrogen generation system at Fort Sumter National Monument.

In the key area of permitting and standards (and in conjunction with the Safety, Codes and Standards subprogram), FY 2014 funds will support work to identify, develop, and disseminate best practices and convene key stakeholders to work through these complex issues. For example, the subprogram will engage with Federal agencies, including the Department of the Interior and DOD, to accelerate hydrogen and fuel cell system permitting on Federal lands and support development of open information platforms to consolidate and standardize permitting.

In FY 2014, the subprogram will conduct and coordinate the development of inter-governmental deployment tools that support cost-effective siting of stationary fuel cells, specialty vehicles, and APU or other early market deployments. It will also support activities to reduce costs associated with the installation process, and it will coordinate the development of strategies for projects involving utility-scale renewable energy storage using hydrogen. In FY 2014, to facilitate Federal early adoption, the subprogram will develop a Fuel Cell Instructor Training Network, which will create a nationwide foundation for scaling up training and certification programs to promote dissemination of high-quality training and best practices. The subprogram will also develop a national interagency deployment data resource to assist individual project economic assessments and technical design evaluations.

Explanation of Funding Changes

(dollars in thousands)

	FY 2012 Current	FY 2014 Request	FY 2014 Request vs. FY 2012 Current
Market Transformation — No funding change	3,000	3,000	0
Total, Market Transformation	3,000	3,000	0

Funding Schedule

Fiscal Year	Line Item	Funding (dollars in thousands)
FY 2012	• Collect and analyze data from micro-CHP systems. • Begin support of ground-support equipment (GSE) early market application.	3,000
FY 2013	Planned activities in the FY 2013 Budget (final allocations have not yet been determined): • Defer activities until data are available from Recovery Act and FY 2012 deployments.	—
FY 2014	• Collect and analyze data for early market applications such as backup power, forklifts, CHP, and GSE. • Coordinate efforts to reduce costs associated with hydrogen fuel cell system siting and installation. • Provide technical and financial assistance for technology in critical early market niches such as auxiliary power applications.	3,000

NREL Site-Wide Facility Support
Funding Profile by Subprogram

(dollars in thousands)

	FY 2012 Current	FY 2013 Annualized CR*	FY 2014 Request
NREL Site-Wide Facility Support	0	—	1,000
Total, NREL Site-Wide Facility Support	0	—	1,000

*FY 2013 amounts shown reflect the P.L. 112 175 continuing resolution level annualized to a full year. These amounts are shown only at the "congressional control" level and above; below that level, a dash (—) is shown.

EERE will begin to directly fund NREL site wide facility support costs that are not included in the Facilities and Infrastructure budget rather than continue to fund these costs in the laboratory overhead rate. This practice is consistent with other national laboratories. NREL's labor rate multiplier will be significantly reduced, thereby reducing the cost barrier to accessing unique NREL capabilities (facilities, staff expertise, etc.) by industry and academia to increase the impact on the clean energy market. This change in accounting practice will also make site operating costs more transparent, better facilitating cost control. With the proposed FY 2014 budget, NREL's labor rate multiplier is expected to be reduced from 15% and 20% by directly funding site-wide facility support. The site-wide facility support funds cover maintenance and engineering support; fire, emergency, and custodial services; general utilities; network infrastructure and licenses; environment, safety, and health support; and sustainability. By moving these costs from laboratory overhead to direct funding, EERE expects to gain a faster and greater impact to the renewable energy and energy efficiency market place.

Hydrogen and Fuel Cell Technologies R&D is a significant program at NREL, with capabilities across a number of research buildings, and is supported by general management and operations housed in a number of buildings—such as the Research Support Facility—and related site assets. Starting in FY 2014, EERE programs will fund site-wide costs directly in support of EERE's commitment to enhance NREL's competitiveness by providing direct operating funding for all appropriate activities consistent with generally accepted accounting principles. This new activity focuses on developing, testing, validating, and demonstrating new energy system technologies at NREL. The direct provision of NREL site-wide facility support will allow energy system developers to optimize system configurations and thereby reduce the risk inherent with incorporating new technologies into the existing electrical grid system. The overall impact will be increased penetration of variable renewable energy resources into the electrical grid.

The Fuels Laboratories at NREL provide critical capabilities for meeting the Hydrogen and Fuel Cells Program strategies and goals. The Energy System Fabrication Laboratory is a state-of-the-art facility for fabricating fuel cell catalysts, thin-film and gas diffusion electrodes, and membrane electrode assembles. The Materials Characterization and Electrochemical Characterization laboratories use a suite of analytical techniques to characterize the physical, photo-electrochemical, and electrochemical properties of novel materials as well as developing new characterization techniques. The Fuel Cell Development and Test Laboratory provides testing capabilities for Fuel Cells ranging from small single cell tests up to full fuel cell stack testing. The Manufacturing Laboratory is focused on the development of methods and technologies that will assist manufacturers of hydrogen, fuel cell, and other renewable energy technologies to scale up their capabilities to meet DOE and industry targets. Specifically, the focus is on the development and validation of quality-control techniques to assist manufacturers of fuel cells in the transition from low- to high-volume production. A unique asset of this laboratory is a roll process web-line, giving the program the capability to test new quality-control techniques in a realistic manufacturing setting. The Energy System Sensor and High-Pressure Testing Laboratories provide critical capabilities for meeting and demonstrating hydrogen safety goals. The Sensor Laboratory evaluates the performance of new hydrogen sensors technologies. The high pressure test laboratory is designed to validate high-pressure components needed for deployment of a hydrogen and compressed natural gas fueling infrastructure. The electrical and thermal grid simulation capabilities are linked to hydrogen generation and storage equipment, giving the program the ability to investigate the potential role of hydrogen fuels in an integrated system of renewable energy sources.

Explanation of Funding Changes

(dollars in thousands)

	FY 2012 Current	FY 2014 Request	FY 2014 Request vs. FY 2012 Current
NREL Site-Wide Facility Support — The funding change results from this new subprogram to support the NREL facilities.	0	1,000	+1,000
Total, NREL Site-Wide Facility Support	0	1,000	+1,000

Funding Schedule

Fiscal Year	Line Item	Funding (dollars in thousands)
FY 2012	No funding requested.	0
FY 2013	No funding requested.	—
FY 2014	• Demonstrate capabilities of the test facilities. • Integrate water electrolyzers with renewable energy generation. • Model fuel cell system integration with the grid.	1,000

Solar Energy Technologies
Funding Profile by Subprogram

(dollars in thousands)

	FY 2012 Current	FY 2013 Annualized CR*	FY 2014 Request
Solar Energy Technologies			
Concentrating Solar Power	44,922	—	90,053
Photovoltaic R&D	75,563	—	79,061
Systems Integration	47,916	—	64,262
Balance of Systems Soft Cost Reduction	31,897	—	61,081
Innovations in Manufacturing Competitiveness	84,404	—	50,043
NREL Site-Wide Facility Support	0	—	12,000
Total, Solar Energy Technologies Program	284,702	290,719	356,500

*FY 2013 amounts shown reflect the P.L. 112 175 continuing resolution level annualized to a full year. These amounts are shown only at the "congressional control" level and above; below that level, a dash (—) is shown.

SBIR/STTR

- FY 2012 Transferred: SBIR $3,744,000; STTR: $505,000
- FY 2013 Annualized CR Transferred: SBIR: $793,796
- FY 2013 Annualized CR: SBIR: $2,653,204; STTR: $464,000
- FY 2014 Request: SBIR: $5,167,000; STTR: $738,000

FY 2014 Program Summary

- Concentrating Solar Power (CSP) subprogram: This funding increase will focus on thermal storage for solar systems to stabilize input into the grid and smooth out intermittencies and on development of advanced component technologies such as power plant subsystems that can operate reliably at the elevated temperatures necessary for CSP performance improvements. This increase is to enable front funding of projects including work on thermal storage for improved integration of renewables to the grid (+$45.1 million).
- Photovoltaic Research and Development (R&D): This funding primarily supports research in innovative PV technologies at our Nation's research institutions. The funding increase will enable expansion of the successful Incubator program which helps small businesses commercialize novel technologies (+$3.5 million).
- Systems Integration: This funding increase will help develop technologies to enable improved integration of solar power with the grid, including power electronics and systems level research on renewables integration, such as a collaboration with the Buildings and Vehicles Technologies programs (with $30.0 million from Solar) to coordinate a systems approach to grid integration (+$16.4 million).
- Balance of Systems Soft Cost Reduction: This funding increase will enable work with state and local governments to reduce permitting, interconnection, inspection, and other soft costs which now account for more than 50% of residential systems costs (+$29.2 million).
- Innovations in Manufacturing Competitiveness: SUNPATH, a program to support Scaling Up Nascent Photovoltaics (PV) At Home with projects fully funded and just underway in FY 2013, will not be run again in FY 2014, pending assessment of the impacts of the existing awards. In FY 2014, the subprogram will continue to fund high priority areas to ensure defensible competitive advantages for domestic manufacturing (-$34.4 million).
- National Renewable Energy Laboratory (NREL) Site-Wide Facility Support: Begin to directly fund the program's NREL site-wide facility support costs to reduce the cost barrier of accessing unique NREL capabilities by industry and academia to increase the impact on the clean energy market, and to make site operating costs more transparent to better facilitate cost control (+$12.0 million).

Overview

The program supports the DOE SunShot Initiative's mission to make solar energy technologies, including both PV and CSP technologies, cost-competitive with fossil fuel based sources of electricity, without subsidies,

by 2020. This will require cost reductions of 50% to 75% relative to 2010 baseline levels. This investment will help re-establish American technological and market leadership in solar energy, diversify the Nation's electricity supply, reduce environmental impacts of electricity generation, strengthen manufacturing competitiveness in the United States, and catalyze domestic economic growth. Through the SunShot Initiative, the program closely coordinates its activities with those in the Office of Science and the Advanced Research Projects Agency - Energy (ARPA-E) to prevent duplication of efforts while maximizing department-wide impact on solar energy. At the fundamental level, the program embraces two complementary approaches, namely converting solar photons to electricity through direct conversion in a semiconductor (PV) and through intermediate conversion to thermal energy (CSP).

Reducing the total installed system cost for utility-scale solar electricity to approximately $.05-$.06/kWh without subsidies will enable broad cost-competitiveness and rapid, large-scale adoption of solar electricity across the United States. A levelized cost of energy (LCOE) of $.05-$.06/kWh is roughly equivalent to the wholesale cost of electricity from fossil fuels, and it translates to an installed cost of approximately $1/Watt (W) of capacity for utility scale PV systems. Today's systems are being installed in the range of $2.00-$2.50/W, exclusive of subsidies. The explicit goals of the program are to achieve the following targets by 2020:

- Average utility-scale installed system price: $1.00/$W_{dc}$
- Average commercial-scale installed system price: $1.25/$W_{dc}$
- Average residential-scale installed system price: $1.50/$W_{ac}$

Achieving these goals will require significant technological innovations and reductions in cost in all PV system components. These components are broadly defined as modules, power electronics, and balance of systems (BOS), which includes all other components and costs required for a fully installed system, including permitting and inspection costs. For the PV utility scale system, a breakdown of the targeted $1/W installed cost includes $.50/W for the module, $.10/W for the power electronics, and $.40/W for the BOS elements.

Deployment of PV across the United States has been growing at a rapid rate, with a record 3.3GW deployed in 2012, a 350% increase from 2010 of 0.9GW.[a] This has resulted in significant job growth. By the end of 2012, there were approximately 119,000 people in the United States employed in the solar sector according to the National Solar Jobs Census, representing a 13% job growth rate over the prior year.[b] This rapid market and job growth has been made possible by rapid declines in systems costs. For example, by the end of 2012, utility systems prices in the United States fell to about $2.27/$W_{dc}$ making significant progress towards the SunShot goal of $1/W.[c] This improvement was primarily enabled by over 50% reductions in module prices but also improvements in the rest of the system.

- Average module price: $0.68/$W_{dc}$
- Average utility-scale inverter price: $0.16/$W_{ac}$
- BOS price for utility scale systems: $1.43/$W_{dc}$

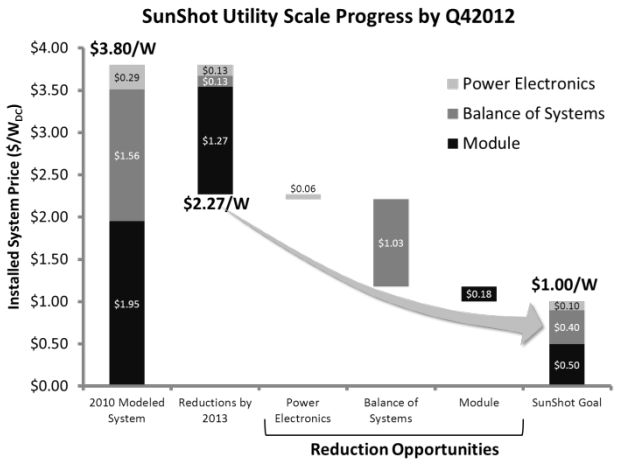


Figure 1. The SunShot Initiative is more than halfway towards the goal of $1/W for utility scale solar by 2020.

These price points represent a very significant and rapid decline from 2010 baseline figures. This progress increases the likelihood that the 2020 goals will be met. Innovations such as those supported by the program over the past 30 years have enabled a dramatic decline in PV module prices of more than 95%, and more than half of the world record solar cell efficiencies over the past 30 years were achieved through program investments. Despite U.S. technological leadership, intense

a "U.S. Solar Market Insight Report: 2012 Year in Review," GTM Research and SEIA, March 2013. Includes solar energy firms working in installation, manufacturing, sales and distribution, project development, R&D, et cetera.
b "National Solar Jobs Census 2012," SEIA, Nov. 2012.
c "U.S. Solar Market Insight Report: 2012 Year in Review," GTM Research and SEIA, March 2013.

international competition and support from foreign governments has created adverse conditions for U.S.-based manufacturers as evidenced by America's decline in PV cell and module manufacturing share. Module manufacturing market share has fallen from 43% in 1997 to about 2% in 2012. In order for manufacturers in the United States to compete globally, innovation in technology as well as innovation in manufacturing will be required. To that end, the program is focused on efforts to ensure that U.S.-developed technologies can compete in the global marketplace and capture a larger portion of the global value add in solar manufacturing, which is estimated at about $100 billion worldwide today. The United States continues to have strength in different parts of the value chain including high-technology materials manufacturing such as polysilicon and polymers, as well as manufacturing equipment.

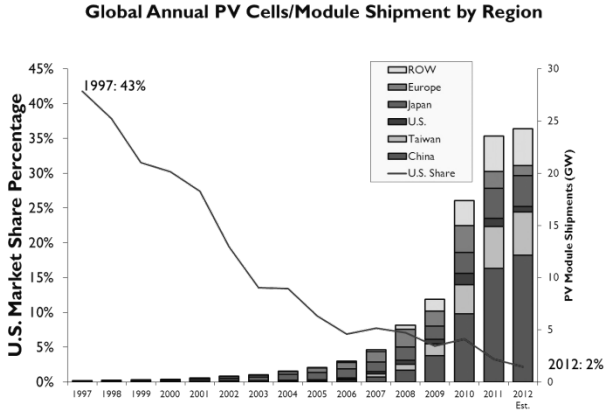


Figure 2. United States share of worldwide PV module manufacturing has declined since 1997 and fell to about 2% in 2012.

The success of the program will assist the United States in regaining competitive advantage in worldwide PV manufacturing and the associated value chain. While the United States will unlikely recapture the entire value chain for solar manufacturing, focus on areas that leverage indigenous strengths such as low cost and reliable electricity and abundant natural gas (ethylene-vinyl acetate (EVA) is made from hydrocarbon feed stocks) as well as the domestic industry's capacity for innovation will allow domestic enterprises to capture increased value add in the final system. Investment in innovative technologies, in parallel with reduction of BOS costs and market barriers, coupled with technology validation activities to help boost private sector project financing ("bankability"), will further help to stimulate the manufacturing base in the United States.

The program will continue to develop CSP technologies with thermal storage to reach the goal of base-load grid parity by 2020. The subprogram invests in thermal storage and supporting systems research and optimization to provide baseload power on demand, even at night. Improved, cost-effective thermal storage would enable more widespread deployment of CSP and help achieve economies of scale to further reduce CSP system cost, improve grid balancing to enable higher levels of renewable generation integration, and enhance the ability of CSP systems to manage short-term and diurnal disruptions in solar output.

Development of novel and cost effective thermal storage becomes more paramount as the level of renewables deployment increases.[a] Key factors in increasing the penetration of solar energy into the grid include the ability to better match the supply of renewable resources with demand via increased spatial diversity, shiftable load, or energy storage. The use of thermal energy storage in concentrating solar power plants potentially provides an excellent cost effective solution that could result in greater use of non-dispatchable solar PV and wind, meaning CSP and PV may actually be complementary technologies, especially at higher penetrations.

Going forward, the CSP subprogram will advance its RD&D activities through a strong push towards grid parity, an LCOE of $.06/kWh cost structure, and the innovations in the sub-system level required to achieve this. Technical and economic costs analysis has been performed on modeled systems to extract technical performance and cost targets for each of the critical subsystems.

For CSP, explicit goals are to achieve the following targets by 2020 that add up to $.06/kWh from a 2012 baseline of $.185/kWh:

- Average solar field costs: $.02/kWh (2012 baseline: $.08/kWh)
- Average power plant costs: $.02/kWh (2012 baseline: $.04/kWh)
- Average receiver costs: $.01/kWh (2012 baseline: $.03/kWh)
- Average storage costs: $.01/kWh (2012 baseline: $.035/kWh).

a P. Denholm et. al. "Enabling Greater Penetration of Solar Power via the Use of CSP with Thermal Energy Storage," NREL, Nov. 2011.

Analysis from NREL indicates that achieving $1/W$_{dc}$ could result in approximately 375 GW of PV capacity supplying approximately 13% of electricity generated in the United States by 2030. By 2050, approximately 600 GW of solar PV capacity could be installed, providing 18% of generation. Implementation of the CSP component of SunShot could lead to 3% of the total electricity by 2030 and 9% by 2050.[a]

The benefits to be obtained for industry and the public sector include:

- Increased efficiency (and lower costs) for PV and CSP systems through fundamental scientific advances in materials technologies
- Catalyzing industry wide collaborations by linking academia, national laboratories, and businesses to address common technology problems
- Reduction in risk associated with the use of new technologies (i.e., improved bankability)
- Establishment of streamlined processes for integrating high-penetrations of solar technologies into the grid in a safe, reliable, and cost-effective manner while providing value to the system owner and the utility grid
- Reduction of costs and streamlining outdated and patchwork regulations associated with permitting, interconnection, and inspection
- Increased professional installation workforce trained for jobs in the solar industry that meets the increasing demand.

Technology Status, Program Accomplishments and Near-Term Milestones[b]

- Funded three new world records for solar cell efficiency: single junction, multi-junction, and thin-silicon – in partnership with three start-up companies
- Supported construction of a new CPV module manufacturing facility in San Diego that increased overall PV manufacturing capacity in the United States by 10% and demonstrated the capability of American manufacturing to compete globally
- Continued the Solar Instructor Training Network (SITN). Its network of 493 instructors at 261 community colleges developed workforce development programs to train/retrain workers to be skilled professionals in the solar industry and led to 9,780 people enrolling and seeking to enter the solar job space to support our Nation's increased solar demand
- Supported state and local governments to innovatively reduce permitting, interconnection, inspection and other non-hardware costs of deploying solar. Successes include the Solarize Mass-Boston program, a group buying program that reduced costs by 25%, and the Broward County, Florida online permitting process, which previously took many months and was reduced to 30 minutes
- Through the SunShot Incubator program, supported innovation and leveraged $90 million in competitively awarded government funds into more than $1.7 billion in private-sector follow-on funding. Successes include start-up companies that are revolutionizing the ways in which small scale solar projects are financed.

Program Planning and Management

The Solar Energy Technologies program prioritizes its RDD&D work according to EERE's "5 Core Questions":

1) High Impact: Is this a high-impact problem?
2) Additionality: Will the EERE funding make a large difference relative to what the private sector (and other funding entities) is already doing?
3) Openness: Have we made sure to focus on the broad problem we are trying to solve and be open to new ideas, new approaches, and new performers?
4) Enduring Economic Benefit: How will this EERE funding result in enduring economic benefit to the United States?
5) Proper Role of Government: Why is what you are doing a proper high-impact role of government versus something best left to the private sector to address on its own?

The program is structured as a technology pipeline. Each segment of the technology pipeline is designed to address the cost reduction and performance improvement necessary to reach the overall program objective of deployed systems at $1/W$_{dc}$ by 2020.

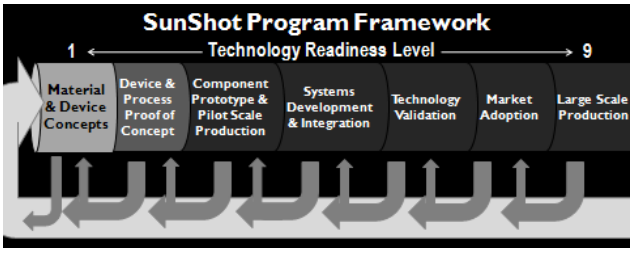


Figure 3. EERE's Solar program activities span the

a R. Margolis et. al. "SunShot Vision Study," DOE report published February 2012.

b For a list of milestones please see "Strategic Performance Management by Program" section and DOE's Annual Performance Plan/Report (APPR).

technology space from laboratory R&D to systems development and all the way to assisting local and state governments with streamlining and improving regulations associated with solar deployment.

To achieve the goal of grid-parity, the PV technology program invests in transformative research, development, and demonstration (RD&D) activities focusing on achieving radical improvements through manufacturing cost and efficiency improvements as well as new discoveries. The program funds such activities in a synergistic fashion across industry, national laboratories and universities, and in close collaboration with the Office of Science on fundamental research and ARPA-E to advance work on power electronics. DOE funding activities span the entire technology readiness level (TRL) scale, from basic science (TRL-1, through work in the Office of Basic Energy Sciences) to reducing market barriers (TRL-9). All of the research funding is merit reviewed by scientific and technical experts from academia, laboratories, and industry.

The program will continue to focus on innovative technology and manufacturing process concepts as applied to PV and CSP and will help stimulate and spur the domestic PV and CSP manufacturing base and supply chain. The program also supports systems integration by developing radically new approaches to reduce the cost and improve the reliability and functionality of power electronics by supporting industry development through test and evaluation standards and by developing tools for understanding grid integration issues. Increased emphasis will also be placed on reducing BOS soft costs, including streamlined permitting, inspection, and interconnection, as well as performing key analyses of policy options and their impact on the rapid deployment of solar technologies.

Strategic Performance Management by Program

(CSP targets have changed and, like the PV targets, now do not include any subsidies such as the energy Investment Tax Credit.)

Performance Measure	**Solar - Photovoltaic (PV) -** Reduce the levelized cost of solar PV energy at utility scale (cents/kWh)		
Fiscal Year	**2012**	**2013***	**2014**
Target	17 cents/kWh (range 14 – 18)[a]	15 cents/kWh (range 13 – 17)	13 cents/kWh
Result	16 cents/kWh		
Endpoint Target	6 cents /kWh by 2020, cost competitive with traditional electricity sources		

Performance Measure	**Solar – Concentrated Solar Power (CSP)** – Reduce the levelized cost of CSP solar power energy at utility scale (cents / kWh)		
Fiscal Year	**2012**	**2013***	**2014**
Target	19 cents/kWh (range 18-20)	18 cents/kWh (range 17-19)	17 cents/kWh
Result	**Met** – 18.5		
Endpoint Target	6 cents /kWh by 2020, cost competitive with traditional electricity sources		

*2013 targets represent DOE's FY 2013 Budget Request to Congress. FY 2013 target updates can be found in the upcoming FY 2012-2014 Annual Performance Plan & Report.

a The range in the targets corresponds to different geographic regions in the United States.

Concentrating Solar Power
Funding Profile by Subprogram

(dollars in thousands)

	FY 2012 Current	FY 2013 Annualized CR*	FY 2014 Request
Concentrating Solar Power	44,922	—	90,053
Total, Concentrating Solar Power	44,922	—	90,053

*FY 2013 amounts shown reflect the P.L. 112 175 continuing resolution level annualized to a full year. These amounts are shown only at the "congressional control" level and above; below that level, a dash (—) is shown.

The near-term goal of the Concentrating Solar Power subprogram is to reduce the levelized cost of CSP energy at utility scale (cents/kWh) to $0.17/kWh without subsidies by the end of FY 2014 from a baseline of $0.185/kWh in 2012. The goal endpoint is $0.06/kWh by 2020, cost competitive with traditional electricity sources.

Key additional subprogram details include:

- Cost target is unsubsidized
- Because costs vary across geographic regions, the target is averaged across the United States
- 2012 baseline: $0.185/kWh without subsidies
- Includes the value of storing energy into the evening hours as CSP thermal storage technologies improve
- Long-Term subprogram goal: $3.50/W including 16 hours storage (equivalent to $0.06/kWh) - thermal storage allows a much higher capacity factor, enabling $0.06/kWh to be met with $3.50/W installed capacity. NREL runs this LCOE analysis annually based on best known industry data.

DOE supports research and development of CSP technologies as a unique path to achieve SunShot Initiative cost targets with systems that can supply solar power on demand through the use of thermal storage. CSP technologies use mirrors (the solar field) to reflect and concentrate sunlight onto receivers that collect solar energy and convert it to heat carried by a heat transfer fluid. This thermal energy can then be used to produce electricity via the power block – a steam turbine or heat engine driving a generator. Thermal energy can also be stored between collection and power generation using a thermal storage system – for example, to enable power generation in the evening.

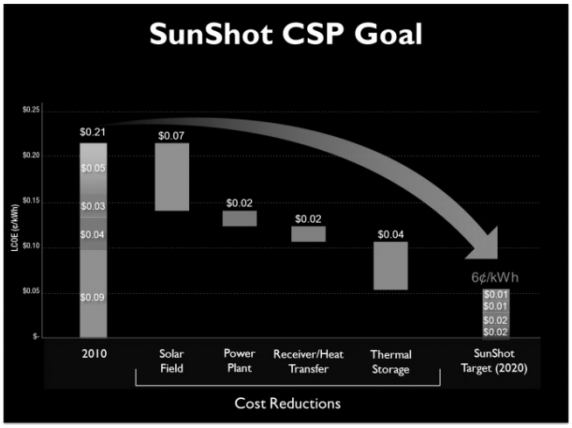


Figure 4. The subprogram has identified critical areas for cost reductions to achieve 2020 objectives. As shown, improvements in the solar field and in thermal storage are particularly critical.

To achieve the SunShot goals by 2020, subprogram activities are focused on the following key areas with cost and performance targets shown in Figure 5:

- Solar field: cost less than $75/m2, lifetime greater than 30 years
- Components including receiver and power block: cost less than $1,200/kWe at efficiency greater than 50%
- Heat transfer fluids: cost less than $1/kg; thermal stability greater than 800 C
- Thermal storage: cost less than $15/kWh thermal.

The CSP subprogram seeks to accomplish these technical objectives through competitive funding research programs at academia, national laboratories, and businesses. The following are the portfolio of activities supported by the CSP subprogram.

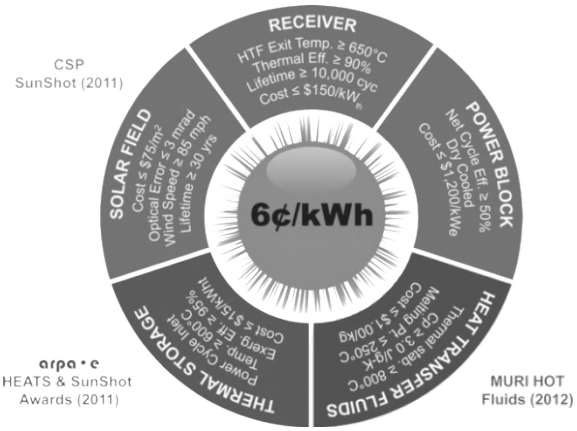


Figure 5. Aggressive technical and cost targets have been identified in all major subsystems.

CSP Advanced Research: In order to meet the 2020 SunShot goals, CSP systems will need to operate at higher temperatures, and solar field costs will have to be reduced by 50% to 75%. Higher temperature operation results in higher power block and overall system efficiency and enables thermal storage systems to be less costly. The R&D goals in this area are to: lower costs and improve performance and reliability of solar mirrors, characterize and test materials developed in cooperation with industry, and broaden and unify test methods to standardize qualification requirements of CSP materials, components, and systems. Additionally, the national laboratories will continue work on optical tool development and performance and economic modeling software that assists the industry in focusing research on critical cost/performance improvements. This funding buys down prior year mortgages and supports research at the national laboratories ($33.8 million).

CSP Component & Systems Development: A new completely forward funded solicitation in FY 2014 will focus on developing novel collection systems through use of new materials, new system configurations, and/or new rapid field installation methods; new solar receivers capable of operation in excess of 650°C with new solar selective coatings that have an absorptivity >0.9 and emissivity <0.4 at this temperature; adapting or continuing the R&D of turbines capable of thermal to electric conversion efficiencies of >50% at a temperature of 650°C or below; and supporting hardware for these systems, such as heat exchangers and pumps, capable of operating at >650°C and with the heat transfer fluids that are capable of reaching that temperature ($23.2 million).

Thermal Storage R&D: A new completely forward funded solicitation is planned for 2014. This critical activity area enables power from CSP plants to be dispatched into the utility grid when it is most needed and most valuable ($33.0 million). The work leverages early results from research in this area in FY 2013. The key goals for this activity are to:

- Develop and demonstrate advanced heat-transfer fluids (HTF) and thermal storage systems
- Characterize and improve advanced HTF and thermal storage systems to reduce storage costs
- Integrate thermal storage cost and performance models into CSP system models.

Explanation of Funding Changes

(dollars in thousands)

	FY 2012 Current	FY 2014 Request	FY 2014 Request vs. FY 2012 Current
Concentrating Solar Power: This funding increase is significantly higher than prior levels, but this does not represent a significant change in focus of program priorities, but rather is an artifact in FY 2014 alone of the EERE-wide move to front-funding of its awards. All multi-year program activities will be fully funded upfront in the fiscal year of awards. There are large solicitations planned for FY 2014 for multi-year projects that will require upfront funding. First, storage for solar systems to stabilize the grid and smooth out intermittencies ($33.0 million in thermal storage R&D), and second, CSP component and systems development will develop advanced component technologies such as power plant subsystems that can operate reliably at the elevated temperatures necessary for CSP performance improvements ($23.0 million).	44,922	90,053	+45,131
Total, Concentrating Solar Power	44,922	90,053	+45,131

Funding Schedule

Fiscal Year	Line Item	Funding (dollars in thousands)
FY 2012	• Multi University Research Initiative (MURI) awards focused on long term thermal storage challenges. • CSP SunShot awards focused on specific techno-economic objectives for the solar field, receiver, and power block. • Core national laboratories research on advanced system designs for efficiency gains.	44,922
FY 2013	Planned activities in the FY 2013 Budget (final allocations have not yet been determined): • Thermal storage R&D focused on high temperature fluids and thermal chemical processes - phase 1. Demonstrate insulated stainless steel storage tanks that can withstand 700 C salts, reducing costs from nickel alloy tanks by up to 25%. • CSP hybrids overcome technology barriers to integration of CSP with conventional fossil fuel power plants, leveraging existing power generation equipment to demonstrate and validate CSP technologies and to develop CSP component technologies and supply chain - phase 1. • Core national laboratory research on advanced system designs for efficiency gains.	—
FY 2014	• New Thermal storage R&D focused on high temperature fluids and thermal chemical processes - Phase 2. Increase salt temperature up to 800 C for higher systems efficiency. • CSP Component & Systems Development is focused on developing novel collection systems through use of new materials, new system configurations, and/or new rapid field installation methods; new solar receivers capable of operation in excess of 650°C with new solar selective coatings that have an absorptivity >0.9 and emissivity <0.4 at this temperature. • CSP hybrids overcome technology barriers to integration of CSP with conventional fossil fuel power plants, leveraging existing power generation equipment to demonstrate and validate CSP technologies and to develop CSP component technologies and supply chain - phase 2. (Fully funded with prior-year funds) • Core national laboratory research on advanced system designs for efficiency gains.	90,053

Photovoltaic R&D
Funding Profile by Subprogram

(dollars in thousands)

	FY 2012 Current	FY 2013 Annualized CR*	FY 2014 Request
Photovoltaic R&D	75,563	—	79,061
Total, Photovoltaic R&D	75,563	—	79,061

*FY 2013 amounts shown reflect the P.L. 112 175 continuing resolution level annualized to a full year. These amounts are shown only at the "congressional control" level and above; below that level, a dash (—) is shown.

The near-term goal of the Photovoltaic R&D subprogram is to reduce the levelized cost of Solar PV energy at utility scale (cents/kWh) to $0.13/kWh without subsidies by the end of FY 2014. The goal endpoint is $0.06 /kWh by 2020, cost competitive with traditional electricity sources. Key additional Photovoltaic R&D subprogram details include:

- Cost target is unsubsidized
- Because costs vary across geographic areas, this target is averaged across the United States
- 2011 baseline: $0.15/kWh without subsidies
- Module cost goal of $0.50 per watt by 2020
- Power electronics and balance of system cost goals to be pursued by other subprograms.[a]

DOE aggressively supports development of low-cost, high-efficiency photovoltaic (PV) technologies through the SunShot Initiative, which seeks to make solar electricity cost-competitive with other sources of energy by 2020.

The DOE SunShot program advances the state-of-the-art in PV by taking a technology-agnostic approach to funding R&D across the technology type and readiness spectrum with industry, academic and national laboratory partners through a competitive process. Specifically, the program does the following:

- Seeds funding for new types of materials and device approaches that enable higher PV performance, greater reliability and reduced cost
- Funds translational research and development to bridge gaps in applied research accomplishments with those in device and materials development and manufacturing environment
- Funds transition of novel PV devices to pilot production and as well as the development of innovative manufacturing equipment and processes that serve the whole solar industry and supply chain; these all serve to distinguish and strengthen the United States-based PV industry.

In addition to supporting R&D to significantly advance existing photovoltaic technologies, such as crystalline silicon, thin-film, and multi-junction (III-V) PV, SunShot supports research into emerging PV concepts that are still in the proof-of-concept phase. These projects, which are still being developed in a laboratory, have the potential to revolutionize the photovoltaic industry. This work is primarily supported by the transformational science and technology focus area.

Transformational Science and Technology: A core activity is the next generation PV R&D work, the goal of which is to develop revolutionary and highly disruptive next-generation PV technologies, leading to prototype PV cells and/or processes, directly impacting the $1/Watt (W) paradigm. Examples of the types of concepts and devices considered in this activity are: nanowires, metal-organic frameworks, photon up-conversion, intermediate bandgap cells, and hybrid technologies. Development work on emerging PV technologies is essential to ensuring innovation and supporting the development and expansion of advanced PV options that will enable PV systems that are even cheaper than $1/W. FY 2014 will be the third round of funding for this activity, the first two rounds of which were released in 2007 and 2011 ($33.6 million).

SunShot Postdoctoral Research Awards: The SunShot postdoctoral research program funds the next generation of research leaders in the field that will pursue breakthrough solar energy technologies. These 2-year awards provide doctoral degree recipients the opportunity to conduct applied research at universities,

a Solar Industry Financial Issues and Opportunities," Chapter 8. SunShot Vision Study. (February 2012). http://www1.eere.energy.gov/solar/SunShot/vision_study.html

national laboratories, and other research facilities ($4.0 million).

National Center for Photovoltaics (NCPV): This funding supports merit reviewed research activities at the national laboratories. NCPV work covers foundational research applicable to applied problems (such as model systems for known materials), materials and device optimization and study to advance existing and emerging photovoltaic technologies, and the development of new measurement and characterization techniques. NREL also works in collaboration with industry through unique capabilities, such as specialized equipment that simultaneously allows the creation and analysis of PV devices. In FY 2014, the budget for the NCPV is separated out into R&D tasks – described here – as well as a line item for NREL site-wide facility support. This change does not represent a change in funding support to the lab ($20 million).

SunShot Incubator: The SunShot Incubator program provides early-stage assistance to help industries – including new start-up businesses and/or new business units within an existing commercial entity – to cross technological barriers to commercialization with potentially high-impact "off-roadmap" new technologies. These incubator activities will enable the "rapid on-ramping" of potentially transformational new energy technologies into the EERE portfolio, dramatically increasing the rate of technology innovation. Since this program was launched in 2007, $90 million in competitively awarded government funds have resulted in more than $1.7 billion in follow-on funding from venture capital and private equity investment. The SunShot Incubator program shortens the time between laboratory-scale proof of concept and prototype development and supports the development of new American businesses with a technological competitive advantage. The demonstrated success of the SunShot Incubator provides the foundation and framework for new incubator activities in other EERE programs that similarly target off-roadmap innovation ($21.4 million).

Explanation of Funding Changes

(dollars in thousands)

	FY 2012 Current	FY 2014 Request	FY 2014 Request vs. FY 2012 Current
Photovoltaic R&D: The subprogram plan for FY 2014 includes the continuation of two successful activities, including next generation PV and the SunShot Incubator. Next generation PV III is the third round of funding for university and national laboratory research into transformational PV materials and devices ($20.0 million). SunShot Incubator IX is the 9th round of the highly successful program that supports small businesses in transitioning innovative and potentially disruptive products into the marketplace.	75,563	79,061	+3,498
Total, Photovoltaic R&D	75,563	79,061	+3,498

Funding Schedule

Fiscal Year	Line Item	Funding (dollars in thousands)
FY 2012	• Incubator VI and VII: help small businesses rapidly transition new technologies to the marketplace. • Bridging Research Interactions through collaborative Development Grants in Energy (BRIDGE): connects applied solar energy researchers to Scientific User Facilities managed by the Office of Science. • Postdoctoral research awards: develop research leaders to enhance innovation in the United States. • Core national laboratory research in PV cells and modules.	75,563
FY 2013	Planned activities in the FY 2013 Budget (final allocations have not yet been determined):	

Fiscal Year	Line Item	Funding (dollars in thousands)
	• Foundational Program to Advance Cell Efficiency II (F-PACE II): One of the targeted outcomes of this effort is to break new efficiency records through fundamental understanding of the limits on efficiency, with the goal of breaking at least 2 new world records per year, continuing the trend of American PV R&D leadership. • Physics of Reliability: Evaluating Design Insights for Component Technologies in Solar (PREDICTS): is a cross-program effort to understand fundamental processes of reliability of solar components including those that limit reliability for PV cells. • Optical path optimization to reduce optical losses in concentrating photovoltaic (CPV) systems. • Incubator Round 8: early-stage assistance to help small businesses commercialize innovative technologies. Increase leverage of federal funds by at least 1500% with follow on private financing. • Postdoctoral research awards: develop research leaders to enhance innovation in the United States. • Core national laboratory research in PV cells and modules.	—
FY 2014	• Next Generation III: investigate new concepts for PV materials and cells that approach and exceed the practical efficiency limits for conventional solar cells of about 30%. • Postdoctoral research awards: develop research leaders to enhance innovation in the United States. • Incubator Round 9: early-stage assistance to help small businesses commercialize innovative technologies. • Core national laboratory research in PV cells and modules.	79,061

Systems Integration
Funding Profile by Subprogram

(dollars in thousands)

	FY 2012 Current	FY 2013 Annualized CR*	FY 2014 Request
Systems Integration	47,916	—	64,262
Total, Systems Integration	47,916	—	64,262

*FY 2013 amounts shown reflect the P.L. 112 175 continuing resolution level annualized to a full year. These amounts are shown only at the "congressional control" level and above; below that level, a dash (—) is shown.

The Systems Integration subprogram works closely with industry, universities, and the national laboratories to overcome technical barriers to the large-scale deployment of solar technologies by:

- Reducing the costs of power electronics and balance-of-system (BOS) hardware
- Reducing the technical risk associated with the use of new technologies (bankability)
- Working with stakeholders to improve timely processes for integrating high-penetrations of solar technologies into the grid in a safe and reliable manner such as within the context of Small Generator Interconnection Procedures (SGIP).

DOE supports the development of innovative, cost-effective solutions that allow increasing amounts of solar energy to integrate seamlessly into the electricity grid while mitigating associated risks. Such solutions can improve system reliability and encourage widespread deployment of solar technologies, such as PV and CSP.

As the cost associated with PV modules continues to fall, reducing power electronics and balance-of-system costs is increasingly important. This includes developing new approaches to installing PV systems such as building-integrated photovoltaics. In addition, the SunShot Initiative continues to develop new technologies through solicitations like the Incubator program. In the course of bringing new technologies to scale, manufacturers must demonstrate “bankability” by validating their new technology to potential investors, potential customers, or insurance companies. The Systems Integration subprogram supports the national laboratories and Regional Test and Evaluation Partnerships to test the reliability of new products and demonstrate their bankability in an unbiased manner. Finally, to enable the high penetration of solar technologies on the grid, the subprogram also focuses on technical areas such as variability, voltage regulation, power quality, protection, and unintentional islanding where systems continue to energize local electric loads after unplanned disconnection from the utility source. The approaches include developing advanced grid-friendly PV interconnection technologies, validating inverter and system models, proactively engaging with external stakeholders, and updating codes.

As the deployments of photovoltaic systems in electric distribution systems have aggressively accelerated over the past few years, utilities, regulatory agencies, and developers have been faced with a significant number of integration challenges. Utilities are concerned with variability from solar and wind, voltage regulation, unintentional islanding, protection coordination (planning for fault currents with distributed generation), and reverse power flows. Multi-systems integration into the grid is critical to ensure that utilities can continue to operate the grid in a safe and reliable manner, while capturing the benefits of clean energy.

Grid Integration Initiative ($30.0 million): Customer owned electric vehicles, distributed renewable generation, and building equipment can be integrated to optimize their overall performance as well as interact with the utility grid to reduce the costs of greater concentrations of grid connected renewable energy. To enable customer options that address these grid integration issues in a comprehensive manner, EERE, in coordination with the Office of Electricity, will implement a joint $80 million funding opportunity announcement sponsored by the Solar Energy Technologies program ($30 million), Buildings Technologies program ($30 million), and Vehicles Technologies program ($20 million) to solicit participation from key market participants such as both investor and publically-owned utilities with a substantial deployment of photovoltaic systems, electric vehicles, and building energy technologies. These utilities will partner with national laboratories, industry, and other innovators to develop and further advance the platform of technologies necessary for renewable

energy, building, and electric vehicle systems to synergistically interact with each other and with a modernized and more flexible distribution system. In addition to the solicitation, DOE proposes to work directly with the national laboratories based on a merit-reviewed evaluation of how their expertise, capabilities, and research facilities can help solve this customer to grid integration challenge. For instance, the Energy Systems Integration Facility at NREL brings on-line new capabilities to develop the technologies, tools, and approaches to enable improved customer-side integration into distribution systems. Through this initiative, DOE will maximize the beneficial impact of its and other parties' R&D investments, increasing the value of customer-side equipment and enabling widespread deployment of clean energy technologies across the distribution system.

The path to achieve high penetrations of solar technologies on the grid in a safe and reliable manner requires addressing the following key areas for the Solar program:

- Voltage control: Develop techniques to integrate high penetrations of photovoltaic systems onto the grid with other distributed energy technologies while maintaining the voltage of the distribution system within acceptable limits.
- Protection and restoration: Develop protection schemes that can accommodate photovoltaic systems and two-way power flow with existing protection equipment (fuses, circuit breakers, reclosers, etc.) and develop management algorithms which improve restoration times or mitigate failures.
- Systems optimization: Develop controls and associated system architectures for photovoltaic systems needed to manage a diverse set of customer-side resources and grid assets, in order to improve their integration into the distribution system. This work on software controls systems will enable balanced optimization of electricity supply (grid and PV) with load (residential and commercial).
- Sensors and data: Collect higher resolution measurements on photovoltaic and associated distribution systems at strategic locations to determine real-time impacts on the feeder. For example, data from residential and commercial PV systems can be used in conjunction with load models to enable utilities to better plan for higher penetrations of PV on the distribution system.
- Value proposition: Develop methodologies to evaluate the value proposition of photovoltaic systems in terms of grid reliability, resiliency, ancillary services, etc., observed over the course of the project, and explore mechanisms to incentivize market participation to create grid-support business opportunities. Determining the value of solar energy in distribution networks at different levels of renewable penetration will help policy makers and regulators plan for tomorrow's more dynamic, flexible and resilient distribution system.

National Laboratories Research ($25.0 million): Peer and merit reviewed research activities at the national laboratories in systems and grid integration focus on a number of areas including:

- Reliability: In FY 2014, the subprogram will continue to conduct both outdoor testing as well as accelerated life-cycle testing in the laboratory, to identify failure modes and mechanisms in modules, inverters, and BOS components, in order to increase the reliability of new technologies and to reduce financial risk.
- Test and evaluation: In FY 2014, the subprogram will continue to conduct performance studies on fielded systems as well as on components at the national laboratories. Using this performance data, the subprogram will continue to develop, improve, and validate system performance models, testing and evaluation technology, and test procedures. This will reduce the risk to the financial community investing in both the installation and manufacture of these technologies.
- Regional Test and Evaluation Partnerships (RTEPs): Evaluation of components, as well as whole systems will continue to be conducted in the field via university and private test laboratory partnerships. These field studies will continue to provide region-specific data from various climates throughout the country. Findings at the RTEPs (both field and laboratories) will continue to be used to both validate and complement national laboratory and industry findings.
- Codes and standards: The subprogram will continue to fund national laboratory support and leadership on numerous code and standard making panels and committees including the National Electrical Code, Underwriters Laboratories standards review committees, International Electrotechnical Commission committees, and the Institute of Electrical and Electronic Engineers PV and PV systems related committees.
- System modeling and analysis: Activities will continue in benchmarking, modeling, and analysis for solar technology systems and their integration

into distribution and transmission systems (such as high penetration solar deployment). Validation of models for annual energy production will continue to include data collected from PV installations at select locations representative of the range of solar irradiation environments and weather conditions in the United States. The inclusion of these representative datasets will further validate the modeling of performance of PV systems operating across the United States.

- Solar resource assessment: In FY 2014, the subprogram will continue to improve resource maps for both PV and CSP focus areas with an emphasis on providing data to assist industry in site selection and better assurance to utilities and financial institutions on system performance. Support in FY 2014 will be at a reduced level compared to prior years, as these activities have begun to shift to other participants in the industry including businesses, and the subprogram has assisted this transition through a competitive solicitation for solar forecasting with awards starting in 2013.

The remainder of the funds ($9.0 million) in the subprogram will completely buy down out-year mortgages from several solicitations run in FY 2011 and FY 2012. This includes the BOS-Hardware activity, which tackles the technology barriers to lower BOS costs through transformational R&D in technologies that enable faster and more efficient system installation, as well as building integrated photovoltaics (BIPV) which can allow the PV system materials to replace a functional outer surface of commercial and residential buildings. The Solar Energy Grid Integration System - Advanced Concepts activity develops advanced power electronics that enable integration of PV systems to the electrical distribution network. FY 2014 will be the last full year of this program begun in FY 2011. This activity develops technologies in power electronics systems that reduce overall PV system costs, allow high penetrations of solar technologies onto the grid (e.g., through reactive power, energy storage, advanced functionalities), and enhance the performance, reliability, and safety of the PV system.

We note that all our activities in the power systems area are closely coordinated with on-going efforts in ARPA-E. For example, the materials and devices activity in ARPA-E under the Solar Agile Delivery of Electrical Power Technology (SOLAR-ADEPT) funding opportunity announcement is a key part of SunShot. The systems work funded here complements the work in SOLAR-ADEPT and focuses on the systems level of this technology in the development process.

Explanation of Funding Changes

(dollars in thousands)

	FY 2012 Current	FY 2014 Request	FY 2014 Request vs. FY 2012 Current
Systems Integration: This funding increase includes continued research at the national laboratories in the areas of solar energy grid integration, solar resource assessment, and technology validation. These are crucial areas of study at the national laboratories to evaluate and develop technologies that enable smooth integration of solar electricity on the Nation's electricity grid. Furthermore, research technology validation helps establish long term systems performance for solar energy systems with decades of expected operating life. A cross-cutting EERE effort to address grid integration challenges from an overall systems view will be run in conjunction with the Building Technologies and Vehicles Technologies programs (with $30.0 million in Solar program funding). The balance of 2014 funds in the subprogram will be used to buy down the out-year mortgages.	47,916	64,262	+16,346
Total, Systems Integration	47,916	64,262	+16,346

Funding Schedule

Fiscal Year	Line Item	Funding (dollars in thousands)
FY 2012	• Regional test and evaluation partnerships: validate performance of PV systems in different climatic conditions across the U.S. • Solar forecasting: Improve predictability of solar resource to enable better planning for grid integration and intermittency mitigation. • Core national laboratory research in reliability and systems integration. • Buy down out-year mortgages of programs started in FY 2011.	47,916
FY 2013	Planned activities in the FY 2013 Budget (final allocations have not yet been determined): • PREDICTS, a cross-program effort to understand fundamental processes of reliability of solar components including those that limit reliability for microinverters. • Advanced balance of systems hardware to reduce installation costs and labor. • Core national laboratory research in reliability and systems integration. • Buy down out-year mortgages of programs started in FY 2011 and FY 2012.	—
FY 2014	• Initiate new EERE cross-cutting clean energy Grid Integration Initiative. • Core national laboratory research in reliability and systems integration. • Complete buy down out-year mortgages of programs started in FY 2011 and FY 2012.	64,262

Balance of Systems Soft Cost Reduction
Funding Profile by Subprogram

(dollars in thousands)

	FY 2012 Current	FY 2013 Annualized CR*	FY 2014 Request
Balance of Systems Soft Cost Reduction	31,897	—	61,081
Total, Balance of Systems Soft Cost Reduction	31,897	—	61,081

*FY 2013 amounts shown reflect the P.L. 112 175 continuing resolution level annualized to a full year. These amounts are shown only at the "congressional control" level and above; below that level, a dash (—) is shown.

The goal of the Balance of Systems Soft Cost Reduction subprogram is to reduce the non-hardware barriers associated with the deployment of solar energy. The near term goals for this subprogram are to:

- Demonstrate a 50% reduction (from 2010 baseline) in non-hardware "soft costs" associated with residential and commercial PV systems. Balance of systems costs can still account for about $3/W-$4/W in many regions of the country, a long way from the SunShot goal of $0.60/W for residential systems.
- Achieve balance of system cost goal of $0.40/W for utility scale systems by 2020 compared to 2012 benchmark of $1.02/W.
- Reach goal endpoint with solar power at $0.06 /kWh by 2020, cost competitive with traditional electricity sources.

Non-hardware costs or "soft costs" account for a growing proportion of the installed cost of solar energy, especially in the context of rapid declines in the cost of PV modules. These costs can amount to approximately half of the total installed cost of a residential installation. DOE's SunShot Initiative partners with manufacturers, communities, universities, utilities, and other stakeholders to address these costs in order to meet the SunShot cost targets. The specific costs in this area include:

- Customer acquisition
- Financing and contracting
- System design and engineering
- Permitting, interconnection, and inspection
- Installation and performance
- Operations and maintenance.

Utility Solar Challenge: FY 2014 funds will support a new competitive solicitation, through which DOE will work with electricity providers to develop viable business models that encourage greater penetration of solar on the grid. This work will complement the R&D activities of the combined EERE grid integration focus by informing the development of business models where both utilities and customers are able to capture the true value and costs of distributed generation and energy efficiency deployment ($20.4 million).

Permitting, Interconnection and Inspection: In FY 2014, the subprogram will engage with federal agencies, including the U.S. Departments of the Interior and Defense, to provide technical advice for accelerated solar permitting on federal lands and support development of technology solutions to permitting challenges. Additionally, the subprogram will increase support to state and local governments to standardize and streamline permitting processes across the country to drive down costs through competitively awarded solicitations. Support of this effort at the state and local level has already yielded significant reductions in cost and time but now harmonization more widely across the country is required ($28.5 million).

Installation: In FY 2014, funding will focus on creating technical and professional standards for solar installers that would support an ecosystem in which small-scale solar installations do not require inspection by multiple entities. Additionally, funds will continue to support a competitively selected award to the national administrator of the Solar Instructor Training Network, which provides a nationwide train-the-trainer approach that is delivered throughout community colleges and other local educational institutions across the country ($4.0 million).

Research and Analysis at the National Laboratories: In FY 2014, research and analysis on key areas in reducing the balance of systems costs will be conducted at the national laboratories, including financing costs as well as other non-hardware costs for solar installations. For example, there will be comparative research between residential solar costs in the United States and other countries to understand the differences in costs to the

consumer that could be as high as twice that in Germany for systems that are similar in hardware. It also includes research in collaboration with Federal Aviation Administration in glint and glare and ways to mitigate glint and glare that can be especially sensitive when solar installations are sited near airports ($8.1 million).

Explanation of Funding Changes

(dollars in thousands)

	FY 2012 Current	FY 2014 Request	FY 2014 Request vs. FY 2012 Current
Balance of Systems Soft Cost Reduction: This funding increase is to launch the Utility Solar Challenge to identify and implement best practices and new business models that support large amounts of distributed generation with buy-in from utilities ($20.0 million), and work with state and local governments to reduce costs and timelines associated with permitting, interconnection and inspection ($28.0 million). Non-hardware costs, or "soft costs," account for a growing proportion of the installed cost of solar energy, especially in the context of rapid declines in the costs of PV modules.	31,897	61,081	+29,184
Total, Balance of Systems Soft Cost Reduction	31,897	61,081	+29,184

Funding Schedule

Fiscal Year	Line Item	Funding (dollars in thousands)
FY 2012	• Rooftop Solar Challenge (Phase 1) to standardize and streamline permitting in different regions around the country. • Solar Energy Evolution and Diffusion Studies (SEEDS) supports research on solar energy innovation dynamics and technology adoption patterns as well as tests approaches to accelerate market adoption. • America's Most Affordable Solar Prize to drastically reduce non-hardware costs for residential PV and to prove the model for the rest of the country. • Solar Instructor Training Network to develop curricula for instructors at community colleges who train and retrain workers for jobs in the solar industry including returning veterans.	31,897
FY 2013	Planned activities in the FY 2013 Budget (final allocations have not yet been determined): • Demonstrate the performance and cost competitiveness of distributed solar generation for small to medium sized utilities. • Rooftop Solar Challenge (Phase 2) to standardize and streamline permitting in different regions around the country.	—
FY 2014	• Utility Solar Challenge to develop viable business models that encourage greater penetration of solar on the grid. • Engage with state and local governments to reduce costs and timelines associated with permitting, interconnection, and inspection. • Create technical and professional standards for solar installers that would support an ecosystem in which small-scale solar installations do not require inspection by multiple entities.	61,081

Innovations in Manufacturing Competitiveness
Funding Profile by Subprogram

(dollars in thousands)

	FY 2012 Current	FY 2013 Annualized CR*	FY 2014 Request
Innovations in Manufacturing Competitiveness	84,404	—	50,043
Total, Innovations in Manufacturing Competitiveness	84,404	—	50,043

*FY 2013 amounts shown reflect the P.L. 112 175 continuing resolution level annualized to a full year. These amounts are shown only at the "congressional control" level and above; below that level, a dash (—) is shown.

The Innovations in Manufacturing Competitiveness subprogram supports EERE's Clean Energy Manufacturing Initiative. The overall goal of this subprogram is to reverse the trend of offshoring of PV cell and module manufacturing through innovations and automation that can enable American companies to manufacture competitively. It also seeks to strengthen the Nation's competitive advantage in the solar energy manufacturing value chain. Reaching $0.50/W for PV modules (or equivalent) erases some of the advantages of low cost manufacturing in other regions of the world because shipping becomes a more significant cost factor. The goal for the subprogram is to increase America's market share for manufacturing value added commensurate with domestic market demand.

For the past 35 years, the average selling price of PV modules has declined on a trend line often referred to as a learning curve shown in the figure below. In part, through committed EERE investments in RD&D, the cost of solar PV modules has been reduced by 95% over the past 35 years, and by 75% over just the last 4 years.

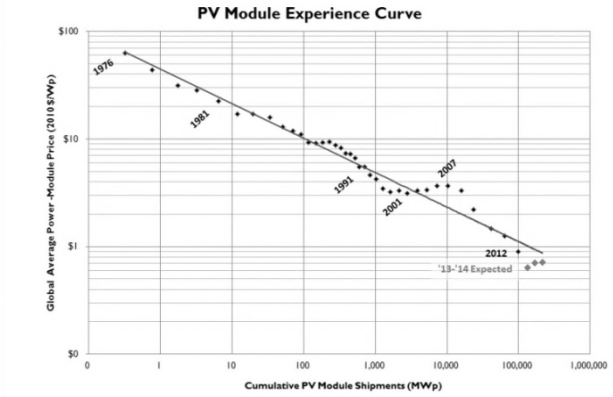


Figure 6: The PV module learning curve shows that for every doubling of manufacturing volume, the price of PV modules has fallen by about 95% over the past 35 years.

Innovations developed by the DOE have helped enable the decline in PV module prices. More than half of the world record solar cell efficiencies over the past 35 years were achieved through DOE investments. Despite U.S. technological leadership, intense international competition and support from foreign governments has created adverse conditions for manufacturers based in the United States as evidenced by the decline in PV cell and module manufacturing share. In order for American manufacturers to compete globally, innovation in technology as well as innovation in manufacturing will be required. To that end, the subprogram is focused on efforts to ensure that technologies developed in the United States can compete in the global marketplace, including focusing on segments of the value chain where America has defensible competitive advantages. The United States is unlikely to regain the entire value chain for solar manufacturing, but by focusing specifically on those areas where indigenous factors (such as innovation, low cost and reliable electricity, and abundant natural gas) as well as a focus on quality can provide domestic manufacturers a defensible competitive advantage, they can capture more value add in the final product. Analysis by NREL, shown in the figure below, has identified different segments of the value chain where the United States has unique manufacturing opportunities.[a]

a A. Goodrich and T. James, NREL internal analysis (unpublished), March 2013.

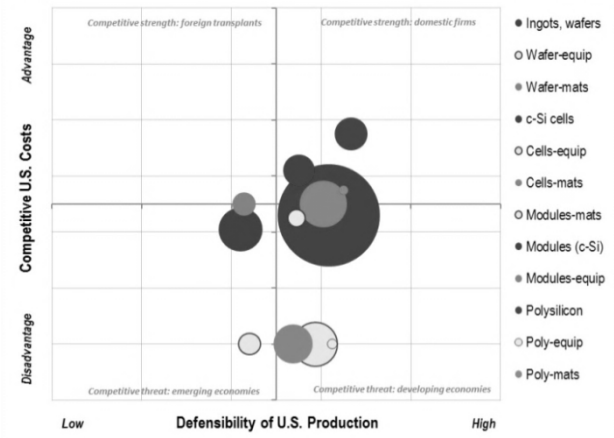


Figure 7: Competitive analysis by NREL has identified areas where the United States can have defensible long term advantages such as automated manufacturing equipment and advanced materials.

SolarMat II: SolarMat, a competitive solicitation, intends to fund the development and demonstration of innovative, but commercially and technically viable, manufacturing technology that can achieve a significant market or manufacturing impact in 1 to 4 years at businesses. This activity is motivated by the need for manufacturing advances in both photovoltaic and concentrating solar power technologies to significantly reduce costs of solar-generated electricity in the United States and to provide U.S.-based manufacturers a manufacturing edge in a very competitive global marketplace. The focus is on developing manufacturing technology to drive down the cost of manufacturing and/or the cost of implementing efficiency-increasing technology in manufacturing. This could include research in enhanced automation of manufacturing processes that would reduce capital and labor requirements at factories in the United States, thereby enhancing the ability for U.S.-based cost-effective manufacturing ($21.6 million).

PV Manufacturing Initiative: FY 2014 will represent the fourth full year of funding (out of 5) dedicated to the PV manufacturing initiative (PVMI). PVMI helps the solar power industry overcome technical barriers in PV manufacturing, to help the United States regain the lead in the global market for solar technologies. The competitively selected awardees engage with multiple companies across the PV supply chain to enable substantial cost reductions in PV module production and the associated equipment and materials. These collaborative organizations are demonstrating new technologies for manufacturing scale-up and assisting with the transition to commercial production. This initiative accelerates the commercialization and cost reduction of PV technologies by coordinating solutions across industry that will facilitate PV manufacturing in the United States. The anticipated result of this initiative is the creation of a more robust PV manufacturing base and the development of a workforce with the critical skills required to meet these goals. The initiative involves consortia of industry and university partners and multi-user manufacturing development facilities to speed the implementation of new cutting-edge technologies into production in the United States ($28.4 million).

Explanation of Funding Changes

(dollars in thousands)

	FY 2012 Current	FY 2014 Request	FY 2014 Request vs. FY 2012 Current
Innovations in Manufacturing Competitiveness: These funding decreases are because FY 2014 marks the planned ramp down of the 5-year PVMI funding from FY 2011, FY 2012 and FY 2013 as awardees initiate the transition to financial self-sufficiency. SUNPATH (Scaling Up Nascent PV at Home), an effort designed to support pilot-scale or first-demonstration PV factories in the United State, will not be run in FY 2014 in order to fund higher priority manufacturing R&D activities. In FY 2012 and FY 2013 SUNPATH awards were fully funded and require no additional resources in FY 2014; assessment of the impacts of these awards is pending. Instead, a SolarMat solicitation will be run to support research and development of manufacturing technologies that will assist industry in the United States to be competitive globally.	84,404	50,043	-34,361
Total, Innovations in Manufacturing Competitiveness	84,404	50,043	-34,361

Funding Schedule

Fiscal Year	Line Item	Funding (dollars in thousands)
FY 2012	• PV Manufacturing Initiative: consortia of industry and university partners and multi-user manufacturing development facilities to speed the implementation of new cutting edge technologies in industry manufacturing processes. • SUNPATH supported the development and pilot scale demonstration of innovative new manufacturing processes in the United States.	84,404
FY 2013	Planned activities in the FY 2013 Budget (final allocations have not yet been determined): • PV Manufacturing Initiative: consortia of industry and university partners and multi-user manufacturing development facilities to speed the implementation of new cutting edge technologies in industry manufacturing processes • SolarMat I: develop defensible manufacturing technologies for U.S. leadership by reducing manufacturing costs through innovations in manufacturing technology.	—
FY 2014	• PV Manufacturing Initiative: consortia of industry and university partners and multi-user manufacturing development facilities to speed the implementation of new cutting edge technologies in industry manufacturing processes. • SolarMat II: develop defensible manufacturing technologies for U.S. leadership by reducing manufacturing costs through innovations in manufacturing technology.	50,043

NREL Site-Wide Facility Support
Funding Profile by Subprogram

(dollars in thousands)

	FY 2012 Current	FY 2013 Annualized CR*	FY 2014 Request
NREL Site-Wide Facility Support	0	—	12,000
Total, NREL Site-Wide Facility Support	0	—	12,000

*FY 2013 amounts shown reflect the P.L. 112 175 continuing resolution level annualized to a full year. These amounts are shown only at the "congressional control" level and above; below that level, a dash (—) is shown.

EERE will begin to directly fund NREL site-wide facility support costs that are not included in the Facilities and Infrastructure budget rather than continue to fund these costs in the laboratory overhead rate. This practice is consistent with other national laboratories. NREL's labor rate multiplier will be reduced thereby reducing the cost barrier to accessing unique NREL capabilities (facilities, staff expertise, etc.) by industry and academia to amplify the impact on the clean energy market. This change in accounting practice will also make site operating costs more transparent, better facilitating cost control. With the proposed FY 2014 budget, NREL's labor rate multiplier is expected to be reduced between 15% and 20% by directly funding site-wide facility support. The site-wide facility support funds cover maintenance and engineering support; fire, emergency, and custodial services; general utilities; network infrastructure and licenses; environment, safety, and health support; and sustainability. By moving these costs from laboratory overhead to direct funding, EERE expects to gain a faster and greater impact to the renewable energy and energy efficiency market place.

The NREL site-wide facility support funding will be used to support major research and development capabilities critical to the advancement of solar energy technologies. Increasing outside users of these facilities at the National Renewable Energy Laboratory (NREL) will leverage significant long term capital equipment and human capital investments and create far reaching impact to the solar research community and businesses. The goal of this direct funding line is to reduce the effective cost for outside users of the facility by lowering the overhead rate at NREL. There is no net change in funding for research at NREL with this accounting change. The change will lower overhead rates to enable increased use of facilities at NREL by the external community.

NREL's solar R&D facilities provide critical capabilities to the American PV and CSP industries and serve as a cornerstone in meeting the DOE Solar Energy Technologies program's objectives. These facilities include the Outdoor Test Facility (OTF) and the Process Development Integration Laboratory (PDIL). At the OTF, researchers study and evaluate advanced or emerging PV technologies under simulated, accelerated indoor and outdoor, and prevailing outdoor conditions to support module reliability science and standards. The PDIL is a 10,000-square-foot laboratory space dedicated to a new class of tools for deposition, processing, and characterization for a wide range of PV materials that reduces the experimental cycle time and the subsequent time from scientific discovery to commercialization. Numerous capabilities also exist for fundamental PV materials and device research utilizing materials growth and characterization equipment at the Solar Energy Research Facility (SERF) and the Science and Technology Facility (S&TF). To support CSP subprogram and industry objectives, NREL houses numerous laboratories including the Advanced Thermal Storage Materials Laboratory for fundamental research on advanced high-temperature heat transfer fluids, the Optical Testing Laboratory and Beam Characterization System for characterization and testing of the optical surface quality and optical performance of various CSP technologies including parabolic troughs, linear Fresnel, dishes, and heliostats, and the Advanced Optical Materials Laboratory, which provides substantial analytical and measurement capabilities for developing and testing absorptive and reflective optical materials used in CSP systems. Taken together, these and other solar R&D facilities at NREL provide a critical and comprehensive tool set to support DOE and American industry in meeting the Nation's solar energy objectives.

Explanation of Funding Changes

(dollars in thousands)

	FY 2012 Current	FY 2014 Request	FY 2014 Request vs. FY 2012 Current
NREL Site-Wide Facility Support: This direct funding line is to reduce the effective cost for outside users of the NREL solar facilities by lowering the overhead rate at NREL through direct funding. There is no net change in funding for research at NREL with this accounting change. The change will lower overhead rates to enable increased use of unique NREL solar facilities by the external community and will make site operating costs more transparent, better facilitating cost control.	0	12,000	+12,000
Total, NREL Site-Wide Facility Support	0	12,000	+12,000

Funding Schedule

Fiscal Year	Line Item	Funding (dollars in thousands)
FY 2012	No funding requested in FY 2012.	0
FY 2013	No funding requested in FY 2013.	—
FY 2014	NREL Site-Wide Facility Support: core facilities support at the national laboratories to better enable shared usage by academia and industry.	12,000

Wind Energy
Funding Profile by Subprograms

(dollars in thousands)

	FY 2012 Current	FY 2013 Annualized CR*	FY 2014 Request
Wind Energy			
Technology Development and Testing	73,054	—	99,000
Technology Application	18,759	—	36,000
NREL Site-Wide Facility Support	0	—	9,000
Total, Wind Energy	91,813	93,825	144,000

*FY 2013 amounts shown reflect the P.L. 112 175 continuing resolution level annualized to a full year. These amounts are shown only at the "congressional control" level and above; below that level, a dash (-) is shown.

SBIR/STTR:

- FY 2012 Transferred: SBIR: $1,268,080; STTR: $172,920
- FY 2013 Annualized CR Transferred: SBIR: $264,706
- FY 2013 Annualized CR: SBIR: $1,887,870; STTR: $245,316
- FY 2014 Request: SBIR: $4,032,000; STTR: $576,000

FY 2014 Program Summary

Wind power has tremendous potential as a domestic U.S. energy resource that can contribute to a diverse, clean, inexhaustible U.S. energy portfolio. There are 90 quads of U.S. land-based wind potential and 50 quads of U.S. offshore wind potential, which, combined, are more than 10 times the total current U.S. delivered electricity consumption.

Although the wind industry has had great success in deploying land-based technology over the last five years, continued DOE investment is critical. Incremental industry cost reductions through continued or new learning-curve improvements can be significantly accelerated with DOE investments. DOE invests in high-risk, transformative technology innovations that industry does not address. DOE provides a national testing platform, drives improvements in permitting, and generates methodologies and data to address market barriers and grid integration. The FY 2014 Wind Energy Program (program) proposed budget includes three principal components (subprograms): Technology Development and Testing, Technology Application, and NREL Site-Wide Facility Support.

The Technology Development and Testing subprogram includes activities to support wind power plant optimization, innovative technology development (land-based and offshore), offshore demonstrations, distributed wind technologies innovations and certifications, advanced U.S. manufacturing, wind energy technology incubator, testing infrastructure, and analysis and modeling. To drive transformative technology innovations, the program is not focused on incremental improvements of individual components, as industry is conducting these activities. Instead, the program focuses on investing in whole wind power plant performance, as well as analyzing complex aerodynamic, terrains, and machine interactions. The program focuses on all forms of wind—land-based wind, offshore wind, and distributed wind. Land-based wind has the ability to continue to contribute immediate, substantial growth if costs targets can be achieved and market barriers reduced. Offshore wind is currently without any U.S. installations, but the program proposes investing to leapfrog global competition with a focus on deep-water technologies and innovative designs that address U.S.-specific challenges, along with demonstrations at scale of state-of-the-art technologies. Distributed wind is structured to enable new approaches to empower wind deployment on the distributed demand side of the transmission network. All three types of wind deployment provide significant opportunities for U.S. manufacturing. A strong demand for wind power should continue to yield a robust U.S. manufacturing presence.

The Technology Application subprogram includes activities to support grid integration planning and reliability, resource characterization, and addressing market barriers to avoid or mitigate impacts (environmental, wildlife, and radar). For wind energy to compete in the open energy markets, costs beyond just wind turbine costs must be considered, including cost of grid integration and grid management and balancing. The program supports the Grid Integration Initiative through projects that help ensure that wind generation

can be reliably and cost effectively integrated into the transmission network. The program supports resource characterization activities in order to further understand the spatial and temporal complexity and scales affecting the overall performance of wind power plants. Through this effort, the program seeks to provide the required information to better site and optimize the architecture of wind farms. The program also supports reductions of wind market barriers, where permitting; environmental, wildlife, and radar considerations; and limited access to network transmission capacity all impact wind deployment.

The National Renewable Energy Laboratory (NREL) Site-Wide Facility Support includes support for NREL for facilities and operations. NREL provides a state-of-the-art research facilities and this breakout provides transparency to this cost component.

Below is a summary of proposed budget changes relative to FY 2012 levels.

- Technology Development and Testing (+$26.0 million net funding change from FY 2012)
  Increased Funding
  - Wind plant optimization (+$23.5 million)
  - Offshore wind (+$11.6 million)
  - Distributed wind technology (+$5.6 million)
  - Advanced manufacturing (+$4.6 million)
  - The Wind Technology Incubator (+$4.5 million)

  Reduced Funding
  - Wind technology components R&D (-$13.0 million)
  - NREL Site-Wide Facilities Support reclassification (-$9.0 million)
  - Testing infrastructure (-$1.8 million)
- Technology Application (+$17.2 million funding change from FY 2012)
  - Resource characterization (+$5.7 million)
  - Grid optimization (+$5.6 million)
  - Addressing market barriers (+$5.9 million)
- NREL Site-Wide Facilities Support (+$9.0 million funding change from FY 2012)
  - Reclassification of NREL testing facilities to directly fund instead of indirectly fund through laboratory overhead rates paid by the wind technology development and testing subprogram. The reclassification will provide transparency for funding of the NREL facility. No change in level of support for this NREL facility.

Overview

The mission of the Wind Energy Program (program) is to accelerate widespread U.S. deployment of clean, affordable, reliable, and domestic wind energy. The program invests in wind energy research, development, demonstration, and deployment (RDD&D) of cutting-edge U.S. wind energy technologies with the goal of making wind energy directly cost-competitive with other sources of electricity without subsidies. Increased wind energy deployment can make significant contributions to economic vitality and environmental quality by providing domestic energy production, creating and maintaining domestic manufacturing and jobs, strengthening U.S. competitiveness in the global wind market, and reducing greenhouse gas emissions.

Through U.S. Department of Energy (DOE) investments and support, progress in U.S. wind energy technology and deployment has been substantial. The unsubsidized cost of U.S. wind energy has decreased by 85%—from more than $0.55 /kilowatt hour (kWh) ($2011) in 1980 to $0.08 /kWh ($2011) in 2012—and has decreased by 35% over just the last 4 years. Wind deployment has grown substantially in the last decade, from 6.6 GW in 2003 to 60 GW in 2012, doubling in the last 4 years and currently providing 3.5% of total U.S. electricity generation. However, continued cost reductions are required to enable wind energy to compete with natural gas and other fossil sources without subsidization.

DOE has a critical role investing in high-risk, high-impact technology innovation, as well as R&D and informational activities to improve grid integration and to reduce market barriers to wind implementation. Through innovation, supporting policies, and stable demand, U.S. manufacturing captured 73% of the domestic wind energy market in 2012, which is up from around 35% in 2005, with over 400 manufacturing plants in the wind energy supply chain across 40 states.

The program's RDD&D activities are applicable to utility-scale, land-based and offshore wind markets, as well as small-to-mid-sized wind turbines targeted at distributed wind markets, which are typically interconnected on the distribution grid at or near the point of end-use. The majority of the program's RDD&D activities have cross-cutting benefits for all wind market areas.

The program plays a unique role in supporting wind energy systems RDD&D that is not being undertaken by the U.S. wind industry due to real or perceived cost, risk, or their need to focus on near-term investment returns. The program conducts research and development (R&D) that addresses high-risk, high-impact technological innovations that are essential for the advancement of next generation U.S. wind energy systems. The program's portfolio is also structured to address the

different spatial and temporal characterization and modeling scales needed to fully capture the dynamics of wind power plants and engage comprehensive testing capabilities and competencies that industry cannot develop and sustain on its own—such as NREL's National Wind Technology Center. The program also addresses inter- and intra-governmental agency issues related to wind energy and leads the development of solutions that also engage agencies such as the Department of Defense (DOD), Department of Homeland Security (DHS), and Department of Transportation (DOT) concerning radar and turbine height limitations, as well as the Department of Health and Human Services (HHS) and Department of the Interior (DOI) concerning environmental, wildlife, and offshore permitting.

The Wind Energy Program directly contributes to the President's goal for the United States to achieve 80% of its electricity from clean energy sources by 2035, as well as to double generation from wind, solar, and geothermal sources by 2020 (relative to 2012 levels) through its support of wind energy RDD&D. The program is also aligned with DOE's Strategic Plan to transform U.S. energy systems by reducing the costs of renewable energy technologies and accelerating large-scale use of carbon-free electricity sources.

To support the President's clean energy goals, the program plans to lower the cost of energy for utility-scale, land-based and offshore wind power plants so that wind energy can compete (without subsidies) with electricity from conventional energy sources, including natural gas. Additionally, the program's objective in the distributed wind market is to increase the number of certified small wind energy systems and reduce the cost of energy of small and midsize wind turbines used in community and distributed electricity systems so that they can compete with retail electricity rates.

Significant improvements in cost and performance for utility-scale land-based and offshore wind power plant systems will be required to achieve levelized cost of energy (LCOE) parity with conventional fossil-fuel-derived energy generation. An integrated systems approach in technology development encompassing the entire wind power plant is necessary, as no single component or subsystem improvement will achieve the required LCOE goal. The relative contributions of (1) capital cost reduction through innovation in components and subsystems; (2) improved energy capture through technology innovation and siting at higher wind speed locations; (3) improved turbine and plant efficiency; (4) addressing market barriers to improve access to better wind resource areas; and (5) reduced financing risk premiums through testing and validation and improved informational resources, must all be addressed to significantly reduce LCOE for wind power plants and achieve program goals.

Reductions in LCOE are achieved by improving the cost, performance, and reliability of wind energy technology at both the turbine and plant level. Deployment barriers affecting LCOE are addressed by component and system validation programs aimed at creating investor confidence in new innovative wind energy technologies, as well as thereby reducing financing costs. The program's deployment goals of 300 gigawatts (GW) of U.S. wind by 2030 (including 54 GW of offshore wind) will only be met by both reducing LCOE and addressing key market barriers that block large-scale market adoption of wind energy technologies. These market barriers include individual environmental or radar challenges that if not thoroughly studied and addressed could prevent wind farms from being built. The program addresses the challenge of wind energy integration through grid system planning activities, including integration studies, modeling and grid integration support, and wind power plant technologies and grid system operations analysis to enable wind power's contribution to meet grid reliability requirements without additional grid storage. The program also participates in cross-cutting EERE Grid Integration Initiative activities to enable continued rapid growth in renewable power deployment, while maintaining a high level of grid reliability and resilience.

The program's portfolio includes a significant strategic focus on offshore wind. The U.S. offshore wind industry is in its very early stages, with no offshore wind turbines in the nation's waters today. There is a tremendous U.S. offshore wind resource, exceeding 50 quads (4,000 GW), which is more than three times larger than the total U.S. delivered electricity use. The proximity of this resource to many major U.S. cities and load centers has the potential to significantly address issues related to transmission cost and siting to access wind energy resources. However, numerous challenges currently exist, including technology development, infrastructure, permitting, financing, and other market barriers.

The program's investments in offshore wind energy innovation—as detailed in the National Offshore Wind Strategy (DOE, February 2011)—are designed to stimulate the domestic offshore wind industry directly by reducing costs through innovative deep-water resource area designs, innovative technologies that address key local issues (e.g., marine mammal protection and electro-magnetic interference (EMI)), and by tackling large-scale market and permitting barriers.

The program has very clear aggressive goals that are described below.

Cost goals are as follows:

- Reduce the unsubsidized market LCOE for utility-scale land-based wind energy systems from a reference cost of $0.08 per kilowatt hour (kWh) in 2010 to $0.057/kWh by 2020 and $0.042/kWh by 2030. These targets would compete with the predicted LCOE of electricity generation from the lowest-cost fossil generation, including wind grid integration and variability costs (grid integration and variability costs are estimated between $0.03/kWh and $0.018/kWh dependent on region of the country).
- Reduce the unsubsidized market LCOE for offshore wind energy systems from a reference cost of $0.21/kWh in 2010 (estimated from non-U.S. offshore deployment locations) to $0.167/kWh by 2020 and $0.136/kWh by 2030 for fixed-bottom systems (FY 2014 activity: Determine baseline/target LCOE for offshore floating systems). [Note: For programmatic purposes, all costs are reported at a 7% discount rate.]

Achieving these LCOE goals will help the program meet its aggressive wind energy deployment goals, which includes growth from 60 GW of total cumulative U.S. wind installed capacity in 2012 to 125 GW of total capacity by 2020 and 300 GW of total capacity by 2030. This total wind energy installed capacity is estimated to be able to meet 20% of projected U.S. electricity demand in 2030 compared to 3.5% today. As detailed in the 2008 DOE report "20 Percent Wind Energy by 2030," one scenario for meeting the 20% vision would require annual installations averaging 13 GW per year for every year from 2012 to 2030.

Major barriers and challenges to meeting wind LCOE and deployment goals are as follows:

- Unsubsidized wind energy LCOE is not currently "market competitive" with natural gas ($0.06/kWh). The program target for unsubsidized land-based utility-scale wind LCOE is $0.057/kWh (2020) to $0.042/kWh (2030), the latter of which is lower to account for additional regional transmission and grid integration costs under high penetration scenarios. The 2020 target will be pursued by the Wind Energy Program through R&D in components and systems that improve reliability and increase energy production—both at the turbine and through integrated wind power plant design.
- Current proposed offshore wind energy is not currently "market competitive" with regional U.S. coastal electricity pricing. The interim program 2020 target for the unsubsidized offshore wind energy (fixed bottom) LCOE is less than $0.167/kWh to enable regional competitive pricing for proposed East Coast locations.
- Access to transmission—from both new and existing lines—is a major barrier to further wind energy cost reductions and increased deployment. Transmission barriers impact access to higher wind classes (affecting LCOE) and constrain siting locations (affecting both LCOE and GW deployment). These and other deployment barriers drive wind energy siting into lower wind resource areas that are less productive, with the impact of constrained siting from Class V (wind speed 7.5–8.0 m/s) to Class III (wind speed 6.4–7.0 m/s) locations estimated at $0.017/kWh. Deployment barriers are reflected in the significant number of wind projects currently held up in the interconnection queue.
- Interconnection issues will be addressed through intra- and inter-agency coordination with the DOE's Office of Electricity Delivery and Energy Reliability (OE) and the Federal Energy Regulatory Commission (FERC). Specific program activities to help address interconnection issues include wind transmission and integration studies and grid tool development for the analysis and optimization of wind power plants for connection into the transmission grid.
- Market barriers, including radar, environmental, and permitting issues, can also impact access to higher wind classes (affecting LCOE) and constrain siting locations. These issues will be addressed through producing and analyzing new data to evaluate radar and technology solutions and identifying key cost and time drivers for regulatory and permitting processes. Specific activities include radar and environmental mitigation technology R&D.

To address these opportunities, requirements, and strategies, in FY 2014, key program investments are organized around four major thematic areas:

- Enable a competitive U.S. offshore wind industry
- Optimize "wind power plant level" cost of energy reduction
- Optimize grid integration
- Eliminate and reduce market barriers.

Ongoing program major activities include the following: developing advanced wind energy designs and technologies to increase energy capture, reliability, and survivability for reduced life-cycle costs; and continued cooperation and execution of industry-led offshore wind energy demonstration program initiated in FY 2012 and

aimed for completion in FY 2017.

A new set of program activities will focus on the following:

- Plant optimization, as an important new R&D thrust that moves the program from a focus on single turbine R&D to one that emphasizes integrated, interconnected multi-turbine wind power plants. While the efficiency of an individual turbine (as measured by its capacity factor) may be optimized, turbines in wind farm arrays interact with each other and with the transmission system, through turbine-to-turbine wake effects and system level curtailments—reducing overall wind power plant efficiency by as much as 20% to 30%. The opportunity to reduce LCOE will come from substantial gains in understanding complex wind power plant aerodynamics to improve overall plant capacity factors and interaction at a plant level with the transmission grid system. By applying existing key program assets, such as large-scale testing facilities, integrated field and sensor capabilities, the use of High-Performance Computing (HPC) capabilities at the National Laboratories, and integrating data and capabilities from other governmental agencies (such as NOAA), a high-impact new "wind power plant optimization" R&D effort will be launched.
- A next-generation advanced rotor R&D activity, which is aimed at enabling higher tip speeds and lower acoustic emission for current size rotors.
- A new offshore wind activity targeted at analysis and development of next-generation offshore wind substructure elements, such as foundations and innovative anchoring, mooring, and cabling solutions.
- Grid integration efforts that are focused on meso-scale data analysis, grid integration active power controls, and cross-cutting EERE technology analysis.

In addition, program activities support the following EERE-wide initiatives:

Clean Energy Manufacturing Initiative: Manufacturing R&D investments targeting very-large-scale wind blades (100+meters), including new composites applications, resins, new manufacturer's assembly automation techniques, and analysis of regional U.S. economic supply clusters, which will enable U.S. manufacturers to improve labor productivity and take better advantage of domestic demand and lower regional transportation costs.

Incubator Programs: The great majority of EERE investments are currently, and must going forward, be primarily driven by detailed short, medium, and long-term RDD&D roadmaps. EERE proposes Incubator activities in the FY 2014 budget, and designed them to use a small fraction of EERE's technology office's annual R&D budget to regularly introduce potentially high-impact "off-roadmap" new technologies. These Incubator activities will enable the "rapid on-ramping" of potentially transformational new energy technologies into the EERE portfolio, dramatically increasing the rate of technology innovation.

Technology Status, Program Accomplishments and Near-Term Milestones[a]

The program has led the nation's efforts to improve performance, lower costs, and accelerate the deployment of wind technologies on land and offshore. Through committed EERE investments in RDD&D and focused efforts of DOE and industry, the unsubsidized cost of U.S. wind energy has decreased by 85% from 1980 to 2012.

In 2012, the wind energy industry added 13.1 GW, which was nearly half of all new power capacity in America—even more than new natural gas power capacity.

The program's investments have driven improvements in wind components and continue to showcase technology innovation to increase viability and reliability of wind. Through research, development, and demonstration, EERE and its partners have achieved significant improvements in key wind turbine components, particularly composite-related structures.

EERE's wind projects have supported 112 patent families, ranking first among leading research organizations in the field of wind energy patents from 1978–2008. Of 695 other patent families in the wind energy field, 174 (25%) are linked to EERE-attributed patents, more than any other organization that pursues or supports wind energy R&D. High impact DOE-attributed patents include variable speed wind turbines, airfoils for blades, rotor control systems, active pitch controls and doubly fed generator control systems.

The reduction of the cost of wind reflects the cumulative impact of focused Wind Energy Program RDD&D efforts. The program is focusing on the following near-term milestones:

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a For a list of milestones please see "Strategic Performance Management by Program" section.

- The Offshore Wind Demonstration Funding Opportunity, a 6-year, $168 million initiative, with multiple recipients competitively awarded in FY 2013, has begun the engineering phase of the demonstration, and the program anticipates funding a sub-set of these projects to their actual deployment phase by 2017. These offshore wind energy demonstration projects will represent some of the very first at-scale deployments in the United States.
- The Clemson University Restoration Institute (CURI) Drive Train Test Facility is nearing completion and will house 15-megawatt (MW) and 7.5-MW dynamometers with the capability to apply loads to the main shaft of the specimen drivetrain, replicating forces and moments along three axes thereby simulating actual blade forces experienced in the field. This facility is currently the largest in the world for testing large-scale wind components.
- Installation has started on the Scaled Wind Farm Technology (SWIFT) facility, a joint project between Sandia National Laboratories and Texas Tech University, which will enable the program to begin to validate the performance of turbine-to-turbine complex flow aerodynamic modeling tools.
- The National Wind Technology Center (NWTC) Drive Train Testing Facility is being upgraded at NREL, housing 2.5 MW and 5 MW dynamometers with controllable grid interfaces to enable voltage fault tests, frequency response tests, continuous operation under unbalanced voltage conditions, and simulated strong and weak grid conditions. NWTC is targeted at research and sizes that support today's machines up to 5MW. CURI is targeted at the larger machines of the future and providing certification services to the industry.
- In partnership with DOD, DHS, and DOT, in FY 2013, the program completed the three "Interagency Field Test and Evaluation of Wind-Radar Mitigation Technologies" activities to identify potential mitigation options to eliminate radar interferences caused by physical and operational effects of wind turbines. Improved radar detection and changes to turbine systems and operation (such as stealth rotor blades) will increase our nation's opportunity to deploy more wind turbines in sites where abundant wind resources interact with air traffic control and other radar systems that are part of the nation's critical radar infrastructure.
- The first phase of the Next-Generation Drivetrain Funding Opportunity projects, awarded in FY 2012, was completed, and two projects were selected for further development, superconducting and medium speed technologies for next-generation turbine designs to reduce the cost of energy and improve reliability of wind turbine produced power.

The impact of program investments are validated through monitoring the trends in deployment across the United States, where innovation has enabled average nameplate capacity, hub height, and rotor diameter of installed U.S. wind turbines to continue to increase. Over the past decade, average wind turbine size has increased from 1.2 MW to 2.0 MW, average hub heights have increased from 66 meters to 81 meters, and average rotor diameters have increased from 64 meters to 89 meters in 2002–2003 to 2011, respectively, contributing to decreased cost of energy.

Program Planning and Management

The Wind Energy Program prioritizes its RDD&D work according to EERE's "5 Core Questions" by utilizing a balanced portfolio approach to its investments.

1) High Impact: Is this a high-impact problem?
2) Additionality: Will the EERE funding make a large difference relative to what the private sector (and other funding entities) is already doing?
3) Openness: Have we made sure to focus on the broad problem we are trying to solve and be open to new ideas, new approaches, and new performers?
4) Enduring Economic Benefit: How will this EERE funding result in enduring economic benefit to the United States?
5) Proper Role of Government: Why is what you are doing a proper high-impact role of government versus something best left to the private sector to address on its own?

High Impact: The program targets the high-impact goal of supplying 20% of the nation's electrical energy needs from wind energy technologies by 2030. This increase from today's level of 3.5% of generation (140 terawatt-hours in 2012) would avoid billions of cumulative tons of CO_2 emissions by 2030 as compared to current electricity generation. Significant sustainable U.S. wind resource potential exists on land (90 quads) and offshore (50 quads)—greater than 10 times current total U.S. delivered electricity consumption of 13 quads per year. In 2012, wind energy added 13.1 GW, which was nearly half (42%) of all new power capacity in America and more than new natural gas power capacity.

Additionality: The program provides the funding needed to go beyond industry efforts to solve performance and cost issues associated with wind energy systems installed today—transitioning from single turbine optimization to wind power plant scales. Program-led interagency

projects will collect needed high fidelity inflow and turbine data. The program will rely on HPC capabilities to properly model and improve the efficiency of wind power plants. The program is investing in the multi-year demonstration projects needed to evaluate multiple offshore wind design configurations, including towers, foundations, and installation vessels and techniques. Finally, as wind turbines are forecast to continue getting larger, the program will fund development of system designs for large offshore turbines because they are significantly beyond current industry R&D efforts.

Openness: The program's strategy is to continue to engage new actors and key stakeholders moving forward and to provide comprehensive and integrated solutions to wind energy advancements, the wind energy aspects of grid balancing, and permitting issues. The program expands component and system technology solutions from traditional gear drivetrains to magnetic direct and superconducting drivetrains; from current steel towers to self-erecting towers and onsite tower assembly and welding techniques; and from current composite rotors to advanced lightweight composite rotors and segmented blades.

Enduring Economic Benefit: Meeting the target of deploying 300 GW of U.S. wind energy by 2030 would provide up to 20% of generation and result in hundreds of billions of dollars in U.S. investment, with corresponding U.S. economic benefits from U.S. jobs in wind manufacturing, installation, and operations. Domestic U.S. wind manufacturing has increased from 52% domestic wind turbine content in 2008 ($6.14 billion) to 73% in 2012 ($14.9 billion), relying today on a robust U.S. wind manufacturing sector.

Proper Role of Government: The program plays a unique high-impact governmental role by conducting R&D addressing high-risk, transformational technological innovations that are essential for the advancement of U.S. wind energy systems. A key example is the pivotal role DOE played in supporting the development of a commercial 1.5 MW turbine, today's most-installed wind turbine. In order to achieve the 20% by 2030 deployment goals, key technology investment is needed to develop longer rotors and taller towers, as well as new innovation for fixed and floating offshore wind energy systems. Finally, the program, through interagency collaboration, is addressing key market challenges, such as meeting radar, environmental, and permitting and siting needs, in order to mobilize wind deployment across the nation.

The program's vision is to accelerate technology innovation and reduce market barriers to enable wind power to compete (without subsidies) with the unsubsidized cost of the lowest cost fossil alternatives. The program's utility-scale, land-based and offshore wind energy LCOE goals are based on an estimate of the magnitude of cost reductions necessary for wind energy to be able to compete with other generating sources. Figures 1 and 2 provide a pathway to achieving the program's targeted cost reductions for land-based wind by 2020 and for fixed-bottom offshore wind by 2030. Wind LCOE reductions will be achieved through reduced capital costs, improved energy production, reduced operating expenses, and optimized lending rates as follows:

- Higher hub heights will be achieved through innovative tower architecture, new materials, and control technologies. Increased rotor swept area and performance, with constrained growth in mass and aerodynamic loads, will be achieved through R&D in blade architecture, aerodynamics, and controls. These improvements will enable higher energy production at an effective lower capital cost, improving the overall cost of energy.
- Improving key component cost effectiveness and reliability, such as rotors, towers, drivetrains, and foundations will be achieved through targeted R&D investments in materials, manufacturing, system modeling and simulation, power electronics, and control systems.
- Balance of plant cost reductions will be achieved through decreased land-based system losses and reduced offshore system installation and logistical costs.
- Plant performance will be optimized through high fidelity modeling activities leveraging key DOE HPC assets, data collection, and resource characterization; understanding turbine-to-turbine wind wake interactions; and improving real-time control and feedback systems. These improvements will enable higher energy production at an effective lower capital cost, improving the overall cost of energy.
- Project contingency fees will be reduced through testing and validation and through the development and dissemination of standardized, transparent information—lowering overall capital costs.
- The program will reduce maintenance costs through reliability innovations in all wind power plant components and optimized operations and maintenance (O&M) strategies, condition monitoring, and prognostic health management.
- The program will also invest in understanding and reducing costs associated with integrating variable wind energy into the power system for both utility

and distributed applications. Outside the cost equation, the program is conducting substantial research and technology development, which is aimed toward reducing deployment market barriers, including radar interference and wildlife interactions.

The program's plan for achieving these cost reduction goals is focused on both the design of wind energy technology (Technology Development and Testing subprogram) and wind deployment (Technology Application subprogram).

Strategic Performance Management by Program

Performance Measure	**Wind - Offshore** - Modeled cost of fixed-bottom offshore wind energy (cents/kWh). 2014 and endpoint target calculated using a 7% normalized discount rate. 2012 and 2013 calculated using a market discount rate of 8.1%. The 2012 offshore wind target changed from 23.5 cents/kWh to 22.5 cents/kWh (20.9 cents/kWh at a 7% discount rate) due to improved information on projected capital cost and expected discount rates for future U.S. offshore wind deployment.		
Fiscal Year	**2012**	**2013***	**2014**
Target	22.5 cents/kWh	21.7 cents/kWh	20.0 cents/kWh
Result	22.5 cents/kWh		
Endpoint Target	16.7 cents/kWh by 2020. (Using a 7% discount rate.)		

Performance Measure	**Wind – Land-based** - Cost of land-based wind energy (cents/kWh)		
Fiscal Year	**2012**	**2013***	**2014**
Target	8.0 cents/kWh	7.7 cents/kWh	7.5 cents/kWh
Result	8.0 cents/kWh		
Endpoint Target	5.7 cents/kWh by 2020 (For programmatic purposes, all cost targets are reported at a 7% discount rate.)		

*2013 targets represent DOE's FY 2013 Budget Request to Congress. FY 2013 target updates can be found in the upcoming FY 2012-2014 Annual Performance Plan & Report.

Figure 1: Fixed-Bottom Offshore Wind Cost Reduction Targets

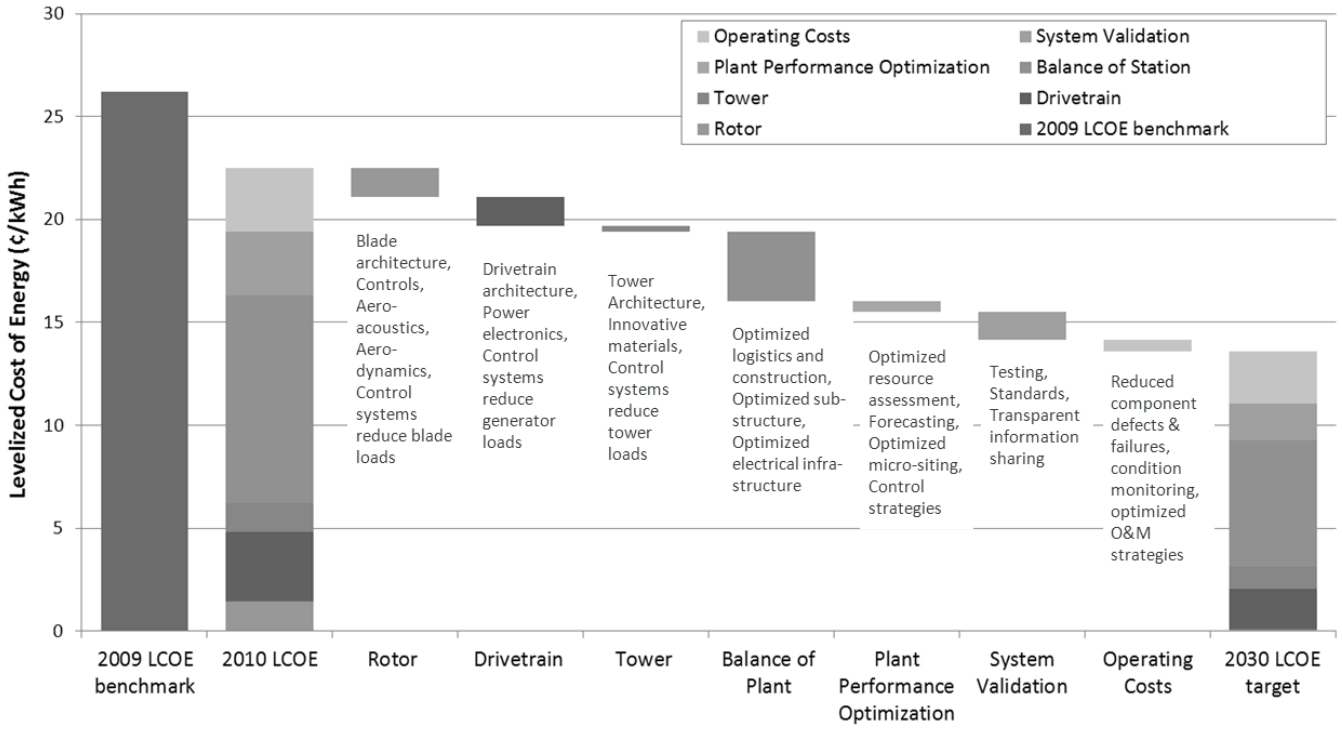
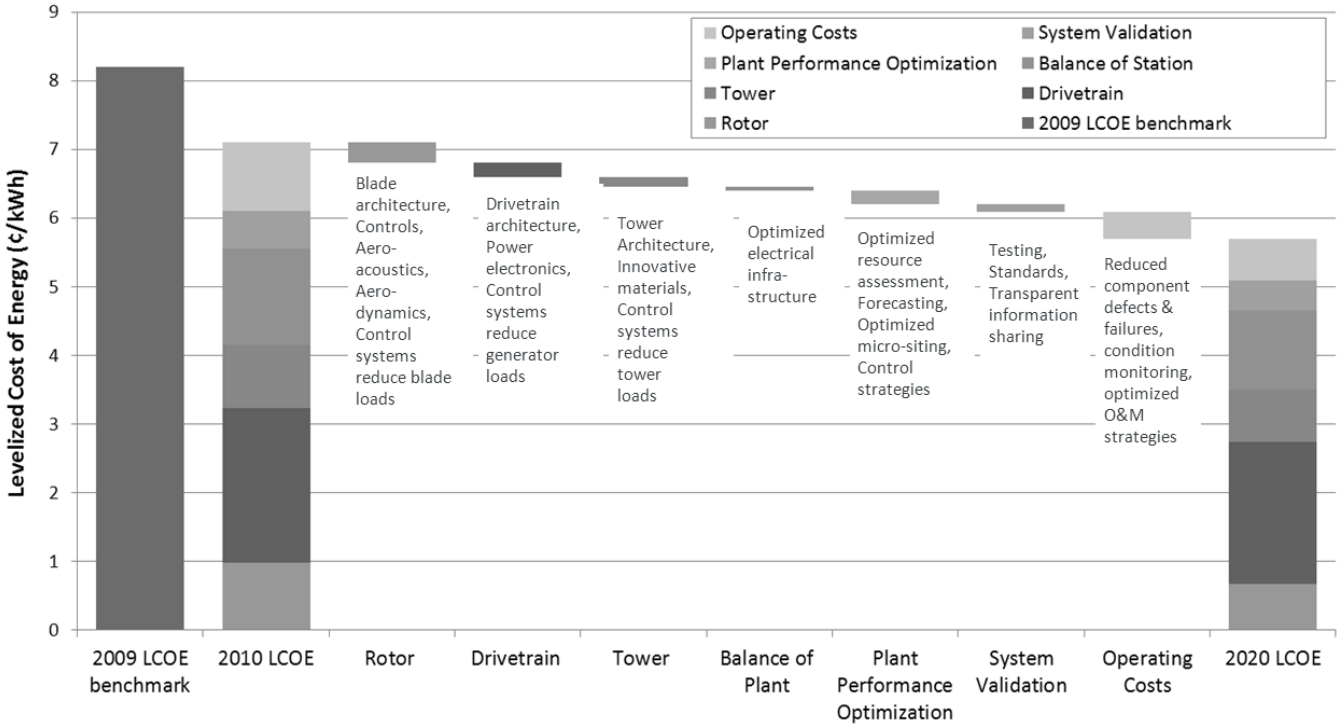


Figure 2: Land-Based Wind Cost Reduction Costs



Technology Development and Testing
Funding Profile by Subprogram

(dollars in thousands)

	FY 2012 Current	FY 2013 Annualized CR*	FY 2014 Request
Technology Development and Testing	73,054	—	99,000
Total, Technology Development and Testing	73,054	—	99,000

*FY 2013 amounts shown reflect the P.L. 112 175 continuing resolution level annualized to a full year. These amounts are shown only at the "congressional control" level and above; below that level, a dash (—) is shown.

The Wind Energy Program Technology Development and Testing subprogram consists of all program activities—from conceptual design to manufacturing and testing at scale – that are directed to improve wind component, system and plant technologies for land-based, offshore and distributed wind technologies. To achieve the program's LCOE goals, which are for both land-based and offshore wind power to be cost-competitive with fossil-fuel-based electricity generation without subsidies, the subprogram's efforts must extend beyond individual wind turbine component improvements into optimizing overall wind power plant performance and operations. Overall wind power plant performance improvements require a new suite of advanced modeling (requiring HPC) for both boundary layer meteorological interactions, as well as turbine-to-turbine interactions. The subprogram plans to address this multifaceted optimization challenge by developing new technology solutions currently unavailable to industry and academia alone. Interagency data sharing, such as with NOAA, is essential to this effort as well. New wind turbine design models and controls approaches will need to take advantage of advancing insights into improving plant performance efficiency, which is one of the key drivers to reducing LCOE. Fully integrated systems engineering models, which empower full-system alternative analysis reviews and prioritizations, are critical to the next generation of high-performance wind power plants.

In FY 2014, Technology Development and Testing subprogram activities ($99 million) will continue to focus on the following key RDD&D topics

- Offshore Wind: Consistent with the National Offshore Wind Strategy, subprogram funding will support research that is expected to simultaneously improve offshore wind power plant performance parameters and accuracy of energy projections—directly contributing to the program goal of lowering the cost of energy in areas such as plant performance optimization. Specifically, the subprogram will do the following ($46.0 million):
  - Further develop and provide system validation of next-generation offshore wind system designs, including innovative substructure concepts, through the improvement of design codes, validation of model and demonstration-scale testing data, conceptual design optimization, and the development of an offshore meteorology reference facility to drive instrumentation validation and model improvement.
  - Select three of seven projects to move to final design, construction, and installation activities based on project progress in 2012 and 2013 on the engineering and design phase of the Advanced Technology Offshore Wind Demonstration Project initiative. These three projects are anticipated to have completed construction and be in operation by the end of 2017.
- Technology Components R&D: Research on advanced materials and components will develop new architectures for larger, light-weight turbines that reduce overall mass (reducing costs) and provide access to better wind resources (larger rotors, taller towers), and improved systems performance (capacity factor). Additionally, improvements in turbine cost, strength, weight, and fatigue aim to reduce O&M costs and reduce the failure rate for large components, such as blades, gearboxes, and generators ($6.5 million).
  - Through Technology Components R&D, the subprogram provides a unique coordination role to help develop codes and standards for new turbine designs that enter the market. The distributed wind industry, for example, has added hundreds of new manufacturers to the marketplace, with limited or no safety or performance standards.

- Plant Optimization: Plant performance optimization activities will seek to understand the complex flow of the resource encountered by a wind turbine and the wake effect that a wind turbine has on surrounding turbines in order to more effectively operate the plant and improve the energy output. The program will support the development of detailed product design tools, which will be used by industry, government, and universities to model the physics behind aerodynamic inflows and the wind turbine dynamic structural response for specific implementations. Stakeholders will use these tools to integrate new designs into a modeled, operational wind turbine in order to predict the impact of these innovations on performance. Wind plant performance optimization will also include analysis of existing best practices currently deployed ($23.5 million).
  - As part of Plant Optimization activities, the subprogram will release a funding opportunity for R&D on cutting-edge technology development for the "Next-Generation Rotor" beyond current architectures and designs that will help enable the development of faster and quieter rotors as integrated in overall plant design. Faster rotors would increase tip speed, which would improve aerodynamic efficiency, and reduce structural weight throughout the entire system. The increase in tip speed will also necessitate advances in noise reduction through new airfoil designs and passive aerodynamic devices applied to rotor blades. The noise mitigation technology could also be used to further reduce noise on turbines in sensitive areas without an increase in the tip speed (i.e., existing turbines).
- Manufacturing Competitiveness: Wind-specific manufacturing R&D funding, complementary to EERE's new Clean Energy Manufacturing Initiative, will enable much larger turbines for both land-based and offshore wind markets. This will include the designs, materials, and manufacturing processes to overcome existing transportation barriers and fabricate very large modular or onsite blades, towers, and generators. Specific R&D avenues include new composites applications, resins, automation, and onsite assembly techniques ($6.0 million).
- Testing Infrastructure: Continued operation of testing infrastructure will provide a wide breadth of testing for all market segments. Laboratory and field testing of critical wind turbine components, such as generators, gearboxes and blades at the CURI Drive Train Test Facility, the SWIFT facility, and others, will lead to a better understanding of static, dynamic, and fatigue failures for emerging wind turbine technologies ($5.0 million).
- Distributed Wind Technology: An increased focus in distributed wind systems will support progress in innovative components, improved manufacturing processes and U.S. distributed wind certification. A national strategy for distributed wind will be developed which leverages and promotes continued U.S. manufacturing ($7.5 million).
- Technology Development and Testing Incubator Activities: EERE's Incubator activities are an expansion of an already-proven innovative program that EERE's Solar Energy Technologies Office piloted with a specific focus on partnering with businesses and researchers to bring "off-roadmap" impactful new technologies into the EERE portfolio. These early prototypes were developed into manufacturing and commercially relevant prototypes designed around pilot-stage process development. Based upon this highly successful model, the Wind Energy Program plans to invest in the creation of incubator programs in FY 2014 ($4.5 million).

Explanation of Funding Changes

	(dollars in thousands)		
	FY 2012 Current	FY 2014 Request	FY 2014 Request vs. FY 2012 Current
Technology Development and Testing — Increased focus on wind power plant optimization modeling (+$23.5 million), including complex flow analysis, component and system design impacts, and test campaigns, as well as a new initiative on next-generation advanced rotors that includes advanced concepts, such as active aerodynamics for current rotor sizes and very-large-scale wind rotors. Advanced manufacturing (+$4.6 million) includes a new R&D initiative on next-generation components that enable much larger land-based and offshore turbines, including new designs that solve key transportation and logistics barriers, as well as new manufacturing processes to enable modular shipping or onsite assembly. Distributed wind technologies (+$5.6 million) includes a new R&D initiative addressing resource characterization, built environment, grid integration, mid-sized turbine design testing, and small wind system testing and certification. The technology incubator (+$4.5 million) is a new initiative to fund institutions capable of performing fundamental analysis for, development of, and/or demonstrations on potentially high-impact "off-roadmap" new technologies for wind energy applications. Offshore wind (+$11.6 million) includes a new initiative targeted at analysis and development of next-generation offshore wind substructure elements, such as foundations and innovative anchoring, mooring, and cabling solutions. There are reductions in wind technology components R&D (-$13.0 million), testing infrastructure (-$1.8 million) and the reclassification of NREL site-wide facility support to its own subprogram (-$9.0 million).	73,054	99,000	+25,946
Total, Technology Development and Testing	73,054	99,000	+25,946

Funding Schedule

Fiscal Year	Line Item	Funding (dollars in thousands)
FY 2012	Utility-Scale Wind (applicable to both land-based and offshore wind): • Detailed reliability and performance testing on advanced drivetrains and blades • The Gearbox Reliability Collaborative and Blade Reliability Collaborative continued to address gearbox design and reliability issues through laboratory and field testing activities and development of innovative inspection methods • Advanced components research, development, and testing. Offshore Wind: • Launched the Offshore Wind Advanced Technology Demonstration Project, a set of first-of-a-kind offshore wind energy projects with the goal of developing and proving out innovative, integrated turbine, structure, and balance of system designs for various marine operating conditions • Technology development, including improvements to models, design tools, components, materials, turbines, and balance of plant configurations. Distributed Wind: • Independent laboratory field testing of small and medium turbines and support for the development and adoption of national standards for small wind energy systems • Collaboration with U.S. turbine manufacturers to deploy a mid-size turbine.	73,054
FY 2013	Planned Activities in the FY 2013 Budget (final allocations have not yet been determined):	—

Fiscal Year	Line Item	Funding (dollars in thousands)
	Utility-Scale Wind (applicable to both land-based and offshore wind): • Next-generation turbine architecture development R&D • Wind turbine detailed designs R&D • Wind plant aerodynamic flow model development and validation R&D • Wind plant complex flow performance optimization R&D • Wind plant and component reliability R&D • Root cause wind plant reliability R&D. Offshore Wind: • Continued investment in the offshore wind demonstration project • Floating platform offshore wind energy technology R&D for U.S. deep water • Technology development, including improvements to models, design tools, components, materials, turbines and balance of plant configurations. Distributed Wind: • Independent laboratory field testing of small and medium turbines • Transfer of technical knowledge to Regional Test Centers for the testing and certification of small wind energy systems, to complete their transition to financial self-sufficiency • Support for the development and adoption of national standards for small wind energy systems.	
FY 2014	Testing Infrastructure ($5.0 million): • The program's testing infrastructure sustains the world-class wind testing facilities at universities and national laboratories to support mission-critical activities, such as plant optimization. Distributed Wind Technology ($7.5 million): • New mid-sized turbine design testing and small wind system testing and certification. Plant Optimization ($23.5 million): • Complex aerodynamics R&D to focus on understanding complex flow for plant efficiency improvements and atmospheric boundary layer modeling • Next-generation advanced rotor program, including very-large-scale wind rotors (100+ meters) • Wind plant reliability improvement. Technology Components R&D ($6.5 million): • Advanced component development focused on plant optimization • Improvements in turbine cost, strength, weight, and fatigue aimed at reducing O&M costs and reducing the failure rate for large components such as blades, gearboxes, and generators. Offshore Wind ($46.0 million): • Offshore wind system development and validation • Multi-year program to perform pioneering U.S. offshore wind demonstration projects. Based on project progress in 2012 and 2013 on the engineering and design phase of the Advanced Technology Offshore Wind Demonstration Project initiative, in 2014, the subprogram will select three of seven projects to move to final design, construction, and installation activities. These three projects are anticipated to have completed construction and be in operation by the end of 2017. • New initiative targeted at analysis and development of next-generation offshore wind substructure elements. Manufacturing Competitiveness ($6.0 million): • Manufacturing initiative focused on technical challenges and components conducive to U.S. manufacturing. Supports EERE's Clean Energy Manufacturing Initiative.	

Fiscal Year	Line Item	Funding (dollars in thousands)
	Wind Technology Incubator ($4.5 million): • New initiative to fund institutions capable of performing fundamental analysis for, development of, and/or demonstrations on potentially high-impact "off-roadmap" technologies for wind energy applications.	99,000

Technology Application
Funding Profile by Subprogram

(dollars in thousands)

	FY 2012 Current	FY 2013 Annualized CR*	FY 2014 Request
Technology Application	18,759	—	36,000
Total, Technology Application	18,759	—	36,000

*FY 2013 amounts shown reflect the P.L. 112 175 continuing resolution level annualized to a full year. These amounts are shown only at the "congressional control" level and above; below that level, a dash (—) is shown.

The Technology Application subprogram consists of all program activities to reduce the costs and timing of market barriers, including wildlife, environmental, radar, and transmission integration barriers. One of the primary objectives of this subprogram is to improve the permitting and mitigation procedures needed to address wildlife, environmental, and radar concerns. The subprogram activities decrease permitting time and costs and enable realistic capital and operating cost estimates for financing purposes.

In FY 2014, subprogram activities will continue to focus on (1) environmental research to understand the effects of wind turbine deployment on sensitive species to better inform regulatory and permitting officials; (2) resource characterization that will significantly extend our knowledge of the detailed, multifaceted variables of wind patterns across various terrains and unstable weather patterns, which assist in the forecasting and integration of large quantities of wind energy into the electrical grid; (3) expansion of prior work to complete a detailed analysis of the effects of manufacturing defects and impacts on the manufacturing supply chain; (4) grid system planning and grid operations analysis for improved integration of wind into the transmission network; and (5) market trends reporting and analysis, modeling, and wind cost (LCOE) analysis ($36 million).

- Resource Characterization: Wind resource characterization activities aim to reduce direct additional costs to wind farm owners, operators, electric system operators, and the consumer, as wind penetration levels grow by better understanding and predicting wind resources levels, forecasts, and turbulence, as well as other complex phenomena due to uncertainty in these areas ($12.5 million).
- Grid Optimization: Grid integration activities, such as the development of active power controls, advanced grid integration studies, and expanded understanding of power system flexibility, seek to develop, validate, and/or support the adoption of advanced power system operations to aid in accommodating wind energy's added variability through R&D and collaboration with industry, national laboratories, other Federal agencies and universities ($10.5 million).
- Addressing Market Barriers: Market barrier activities will focus on mitigating environmental and siting barriers (e.g., radar), developing an adequate workforce, and accelerating the development of wind energy markets by helping stakeholders and officials understand wind energy technologies and how wind can be integrated into their local, state, and regional energy system. Specific activities include the following ($13.0 million):
  - Developing wind turbine-radar interaction solutions, which seek to mitigate electromagnetic interference and enable industry to identify and employ mitigation technology and/or techniques. The objective of this work is to reduce the cost of energy from wind energy by increasing the access to high-quality wind resources in previously constrained/restricted areas.
  - Creating a new, focused multi-year effort to support the research necessary to overcome permitting challenges associated with wildlife, specifically Golden and Bald Eagles. The funds will be used to evaluate risk factors to eagles from wind development, and develop new advanced conservation practices and mitigation measures. This work will be conducted collaboratively with the Fish & Wildlife Service, industry and environmental groups.
  - Starting a new interagency initiative assessing the environmental impacts of the first installed U.S. offshore wind projects as necessary to support NEPA and other environmental permitting of future commercial offshore wind energy facilities.

- Continuing to work with various state and local agencies to promote information and education on wind topics. However, the subprogram has terminated ongoing activities under the "Wind for Schools" program, as these activities will be more efficiently managed by the government wide science, technology, engineering, and mathematics (STEM) education consolidation strategy. In order to more fully leverage the annual Federal investment of almost $3 billion in STEM education and facilitate a cohesive national strategy, the Administration is proposing a comprehensive reorganization of STEM education programs to increase the impact of Federal investments in four areas: K–12 instruction; undergraduate education; graduate fellowships; and education activities that typically take place outside the classroom. As part of this strategy, Wind for Schools will be redirected for inclusion in a consolidated informal education program at the Smithsonian Institution. DOE will work with the Smithsonian to provide input into the development and implementation of this program, which will improve the reach of federally supported informal education activities.

Explanation of Funding Changes

(dollars in thousands)

	FY 2012 Current	FY 2014 Request	FY 2014 Request vs. FY 2012 Current
Technology Application — In the area of Resource Characterization (+$5.7 million), the subprogram will increase efforts on the wind power plant optimization program, including meso-scale data acquisition and power system flexibility assessment. These additional observations will be essential in providing the high-fidelity data needed for foundational understanding to better forecast the physical phenomena that drives the wind to and through wind power plants on time scales relevant to the wind industry. A deeper understanding of these elements is critical to improving overall wind plant capacity factor performance to achieve LCOE goals. In the area of Grid Optimization (+$5.6 million), the subprogram will launch a new R&D effort on the characterization of current power system flexibility and on how to improve the system's ability to integrate more wind energy. This activity is critical to informing the design of grid operations that can reliably manage variable energy sources such as wind. In the area of Addressing Market Barriers (+$5.9 million), the subprogram will develop utility-scale wind turbine-radar interaction solutions to mitigate electromagnetic interference. The subprogram will also launch a new multi-year initiative to support the research necessary to overcome market barriers and permitting challenges associated with Golden and Bald Eagles. Clear wildlife mitigation plans are essential to cost efficiently build utility-scale wind power plants. The subprogram will also create a new interagency initiative assessing the environmental impacts of the first installed U.S. offshore wind projects as necessary to support NEPA and other environmental permitting of future commercial offshore wind energy facilities.	18,759	36,000	+17,241
Total, Technology Application	18,759	36,000	+17,241

Funding Schedule

Fiscal Year	Line Item	Funding (dollars in thousands)
FY 2012	Utility-Scale Wind (applicable to both land-based and offshore wind): • Renewable systems interconnection • Wind resource characterization • Manufacturing competitiveness and supply chain • Technology acceptance. Offshore Wind • Offshore market barrier removal activities, including siting and permitting, manufacturing and supply chain, and transmission and interconnect planning. Distributed Wind: • Market barriers.	18,759
FY 2013	Planned Activities in the FY 2013 Budget: (final allocations have not yet been determined): Utility-Scale Wind (applicable to both land-based and offshore wind) • Transmission and infrastructure • Grid Disturbance Testing • Environmental and meteorological studies • Radar mitigation, manufacturing competitiveness, and supply chain • Technical analysis and distribution of results. Offshore Wind • Offshore market barrier removal activities, including siting and permitting, manufacturing competitiveness and supply chain, and transmission and interconnect planning. Distributed Wind • Transmission and infrastructure.	—
FY 2014	Resource Characterization ($12.5 million) • Improved atmospheric understanding of the planetary boundary layer to enable improved forecasting and optimized plant designs, which, as wind deployment continues to grow, will enable sub-hourly forecasting for significantly improved grid reliability associated with wind energy and alternate energy source ramp management. Grid Optimization ($10.5 million) • Grid integration and transmission optimization for wind energy systems • Integration studies and operational forecasting tool development • Analysis to support improved grid integration into the transmission power system, coordinated through the DOE Grid Technology Team. Addressing Market Barriers ($13.0 million) • Development of utility-scale wind turbine-radar interaction solutions to mitigate electromagnetic interference • Multi-year effort to support research necessary to overcome permitting challenges associated with wildlife, specifically Golden and Bald Eagles • Environmental impact assessments of the first installed U.S. offshore wind projects as necessary to support NEPA and other environmental permitting needs.	36,000

NREL Site-Wide Facility Support
Funding Profile by Subprogram

(dollars in thousands)

	FY 2012 Current	FY 2013 Annualized CR*	FY 2014 Request
NREL Site-Wide Facility Support	0	—	9,000
Total, NREL Site-Wide Facility Support	0	—	9,000

*FY 2013 amounts shown reflect the P.L. 112 175 continuing resolution level annualized to a full year. These amounts are shown only at the "congressional control" level and above; below that level, a dash (—) is shown.

EERE will begin to directly fund NREL site-wide facility support costs that are not included in the Facilities and Infrastructure budget rather than continue to fund these costs in the laboratory overhead rate. This practice is consistent with other national laboratories. NREL's labor rate multiplier will be reduced, thereby reducing the cost barrier to accessing unique NREL capabilities (facilities, staff expertise, etc.) by industry and academia to increase the impact on the clean energy market. This change in accounting practice will also make site operating costs more transparent—better facilitating cost control. With the proposed FY 2014 budget, NREL's labor rate multiplier is expected to be reduced between 15% and 20% by directly funding site-wide facility support. The site-wide facility support funds cover maintenance and engineering support; fire, emergency, and custodial services; general utilities; network infrastructure and licenses; environment, safety, and health support; and sustainability. By moving these costs from laboratory overhead to direct funding, EERE expects to gain a faster and greater impact to the renewable energy and energy efficiency market place.

The site-wide facility support funding is used to support major R&D capabilities that are critical to advancing wind technologies. The goal of this direct funding line is to reduce the effective cost for outside users of the facility by lowering the overhead rate at NREL. Lowering the cost will increase outside users of the NREL facilities, which leverages significant long-term capital equipment and human capital investments; plus, it creates far-reaching impacts to the wind research community and businesses. There is no net change in funding for research at NREL with this accounting change.

Several facilities at NREL's National Wind Technology Center (NWTC) provide capabilities that are essential for the Wind Energy Program's mission. The NWTC itself is an exceptionally valuable site for the field testing of modern wind turbines, ranging in size from 1 kW to 3 MW. The turbulent and energetic winds at the NWTC permit innovative new technologies to be developed and verified in a harsh, real-world environment. The Controls Advanced Research Turbines at the NWTC provide versatile test beds for developing advanced wind turbine control systems. Three dynamometers are located at the NWTC, ranging in size from 225 kW to 5.8 MW. These dynamometers are used to conduct fundamental research on the mechanical and electrical systems that convert wind or water power into electrical power, as well as to demonstrate innovative new technologies. These dynamometers work in conjunction with the new 40 MW peak-power Controllable Grid Interface (CGI). The CGI allows researchers to control the characteristics (frequency, voltage, and current) of the grid for the test articles in the dynamometers, and to subject these test articles to realistic grid anomalies, such as frequency droops and faults. The CGI will soon be available for the field test turbines—providing a grid integration testing capability that is unique in the world. The NWTC also includes structural testing laboratories that are used for ultimate load and fatigue testing of wind and water power blades and other structural components. All of these facilities are heavily used by U.S. industry for a wide variety of shared-resource R&D and funds in proprietary testing. The total complement of NWTC facilities provides an unmatched capability worldwide.

Explanation of Funding Changes

(dollars in thousands)

	FY 2012 Current	FY 2014 Request	FY 2014 Request vs. FY 2012 Current
NREL Site-Wide Facility Support — Reclassification of investments for wind-related facilities support costs, from laboratory overhead to direct funding, provides transparency, which is described in the Facilities and Infrastructure budget. These facilities support new and existing testing capabilities to improve wind power plant performance and structural testing.	0	9,000	+9,000
Total, NREL Site-Wide Facility Support	0	9,000	+9,000

Funding Schedule

Fiscal Year	Line Item	Funding (dollars in thousands)
FY 2012	No funding requested in FY 2012.	0
FY 2013	No funding requested in FY 2013.	—
FY 2014	NREL Site-Wide Facility Support	9,000

Water Power
Funding Profile by Subprograms

(dollars in thousands)

	FY 2012 Current	FY 2013 Annualized CR*	FY 2014 Request
Water Power			
Marine and Hydrokinetic Technologies	33,684	—	39,500
Hydropower Technologies	24,392	—	15,500
Total, Water Power	58,076	59,147	55,000

*FY 2013 amounts shown reflect the P.L. 112 175 continuing resolution level annualized to a full year. These amounts are shown only at the "congressional control" level and above; below that level, a dash (-) is shown.

SBIR/STTR:

- FY 2012 Transferred: SBIR: $627,000; STTR: $84,000
- FY 2013 Annualized CR: SBIR: $1,596,969; STTR: $207,015
- FY 2014 Request: SBIR: $1,540,000; STTR: $220,000

FY 2014 Program Summary

The U.S. hydropower industry is well established, and owner/operators invest significantly in maintaining and operating the existing hydropower fleet. The Water Power Program (program) supports the hydropower industry and complements the existing investments by identifying key opportunity areas through which hydropower generation can be cost effectively and responsibly enhanced, and supports new technology development and deployment.

The Marine and Hydrokinetics (MHK) industry is nascent, without a clear leader in technology archetype. The industry also lacks adequate facilities where developers can effectively and efficiently test critical design innovations in appropriate environments. Further, the investment and analytical capabilities required to research and develop these emerging MHK technologies is so significant that without Federal investments, these technologies may experience difficulties entering the market. Similar to the U.S. Department of Energy's (DOE's) role with other renewable energy technologies, the program—through foundational investments in technology innovation—will partner with the MHK industry to pursue the timely development and demonstration of a wide range of MHK technologies and support the underpinning research, development, testing, and evaluation (RDT&E) efforts necessary to showcase the promise of these emerging technologies.

The program's budget reflects the different roles it will play in these sectors. For hydropower, the program's investments will complement and leverage investments of the established hydropower industry, whereas the program will play a fundamental role in catalyzing the near-term realization of the MHK industry.

- Increased funding for the research, development, demonstration, and deployment (RDD&D) of full-scale MHK components and systems the development of world-class test and demonstration infrastructure, and activities supporting the Advanced Manufacturing for MHK Initiative, to include light-weighting of systems and components (+$5.8 million).
- Funding for hydropower technologies will focus on the development of technologies, tools, and sensors to co-optimize generation, flexibility, and environmental performance, and innovative technology development through the Advanced Hydropower funding opportunity announcement. DOE is de-emphasizing activities centered on technology upgrades for the existing hydropower fleet, the Basin Scale Opportunity Assessment, and the Hydropower Research Fellowship (-$8.9 million).

Overview

The mission of the Water Power Program is to conduct RDD&D efforts in new water power technologies capable of generating cost-effective renewable electricity in the United States, as well as to accelerate widespread U.S. deployment of clean, affordable, reliable, and domestically manufactured technologies that promote energy security, economic growth, and environmental quality. These resources include hydropower (domestic rivers, streams, and water conveyance systems) and marine and hydrokinetic resources (waves and ocean/tidal/river currents).

Pumped Storage Hydropower (PSH) is another important part of the program's portfolio. This utility-scale grid storage technology presents a renewable form of grid stabilization and is viewed as a critical enabler for high penetration of variable renewables. DOE can play an essential and catalytic role in demonstrating the benefits of PSH and its role in our nation's clean energy future.

Through a balanced portfolio approach, the program's investments in both the MHK and Hydropower subprograms span from transformational technological innovations that seek to enable new water power technologies to addressing key market deployment and environmental barriers. Additionally, through interagency and intra-agency partnerships, the program engages in activities structured toward streamlining the adoption of the various technologies. A key program partnership is with the U.S. Navy, where both entities are working together to expand research into wave energy conversion (WEC) technologies. The goals of this partnership are to advance the technical readiness of WECs, as well as to demonstrate and deploy innovative WECs at Navy facilities worldwide in support of the Navy's onshore energy goals and mandates.

For MHK technologies, the program has a unique role in the research, development, and demonstration (RD&D) of innovative water power systems. The program invests in high-risk, early-stage technologies that, due to market considerations, the private sector is unable to address on its own. DOE investments are targeted at developing technologies to lower the cost and improve the reliability of water power systems, as well as funding projects that advance the technical readiness of these devices. Additionally, DOE is developing the necessary critical test infrastructure to accelerate the technology development process and effectively compress the timeline to commercial competitiveness. With sustained R&D, the United States can seize global leadership in developing and manufacturing these types of technologies, as well as capture a substantial share of the growing export market.

Going forward, the program's investments in each resource technology type will be in relative proportion to its potential contribution to U.S. generation. WEC technologies extract energy directly from surface waves or from pressure fluctuations below the surface. Current energy technologies extract energy from unidirectional (ocean currents) or bidirectional (tidal) currents. DOE has recently completed studies that show that the recoverable wave resource in the United States is estimated to be 1,170 terawatt hours (TWh) per year along the outer continental shelf of the United States. DOE studies show a recoverable tidal resource of 250 TWh (ocean current resource assessments are not yet complete, but preliminary estimates show that it is less than the tidal resource). In alignment with the relative size of the resource potential, the program's near-term strategic investments will emphasize accelerating the development of WEC technologies. However, in order to maintain a comprehensive portfolio approach, and considering its advanced stage of technical readiness, the program will continue to invest in tidal technologies that show promise for near-term deployment.

In FY 2014, DOE will have completed a first-of-its-kind MHK techno-economic and resource analysis. The program will utilize the analysis' findings to strategically invest in resources and technologies that show the greatest potential to add clean energy to the U.S. grid.

In contrast to the nascent stage of the MHK industry, hydropower already provides approximately 7% of the nation's electricity today—and produces the largest share of renewable generation, with 78 gigawatts (GW) of installed capacity (62% of all U.S. renewable generation). Even after a century of proven experience with this reliable national resource, significant opportunities still exist to (a) exploit new hydropower opportunities, including non-powered dams and water conveyance systems, and (b) provide the grid with the additional flexibility and dispatchability required to integrate increasing levels wind and solar power (which are variable and intermittent). However, continued hydropower development faces significant challenges. The existing fleet is losing flexibility and generation capacity due to aging infrastructure and other performance limitations (technical, regulatory, and environmental). To address this deterioration, DOE funds R&D and collaborates with industry and other Federal agencies to accelerate the development and deployment of the next generation of sustainable hydropower technologies.

Marine and Hydrokinetic Technologies: The program will prioritize R&D and test the infrastructure development necessary to rapidly bring MHK technologies to commercial competitiveness. MHK developers need assistance to ensure that device prototypes can be deployed into real-world conditions; U.S. test infrastructure can dramatically reduce the cost and risk of prototype development and deployment, while speeding the timeline to commercial readiness.

Conducting advanced wave component R&D, developing high-performance design code, and continuing to invest in test infrastructure will provide the next-generation

technologies and test platforms from which the first U.S. commercial-scale wave device array can be deployed by FY 2016. Deploying a commercial array will clearly demonstrate the ability of next-generation wave devices to be efficiently permitted and deployed, as well as perform reliably at utility scale.

Ongoing MHK major activities include the following:
- Developing advanced MHK designs and technologies to increase energy capture, reliability, and survivability for reduced life-cycle cost
- Collaborating with the U.S. Navy to demonstrate technologies and demonstrate first-of-a-kind wave energy systems at Navy installations, which presents an early market entry point to support U.S. developers of these innovative technologies.

New MHK initiatives focus on the following:
- Supporting the construction of a controlled-conditions, deep-water wave tank test facility for mid-Technology Readiness Level (TRL) stage devices. This facility will be a world-leading test center that will enable U.S. developers to more rapidly optimize design performance and compress the timeline to WEC commercial competitiveness
- Creating advanced simulation tools to enable the rapid optimization of WEC devices in operational and extreme conditions—synergistically complementing the construction of controlled conditions deep-water wave tank test facility
- Initiating a "WEC Prize" competition aimed at accelerating the development of breakthrough wave energy technologies
- Developing low-cost, high-accuracy devices used for detecting and tracking marine mammals and other aquatic organisms of concern to facilitate commercial-scale and environmentally friendly deployments of MHK arrays.

Key barriers to MHK deployment include the following:
- The MHK industry is still nascent, and—as with all early stage technologies—it is not yet cost-competitive, and uncertainty in performance is a major barrier to attracting investment. DOE seeks to accelerate commercial competitiveness by investing in the full-scale demonstration and optimization of leading MHK systems and components that show the most promise for success.
- Currently, MHK designs are expensive and require frequent and costly maintenance interventions to operate in the harsh marine environment. DOE will invest in pioneering components that simplify device designs for manufacture, reliability, and maintainability, as well as systems optimization tools that will allow for reduced cost and increased performance.
- The high cost of testing MHK devices in marine environments is prohibitive for early stage companies with innovative designs. DOE intends to develop world-leading test infrastructure and then share non-proprietary test results and lessons learned that would facilitate rapid industry development with a substantial reduction in cost to the developer.
- The regulatory and permitting process is costly and expensive due to a lack of environmental data. DOE will address this barrier by targeting key environmental risks and ensuring that science-based, peer-reviewed studies are made publicly available to drive down the environmental uncertainty that leads to the costly permitting process.
- The industry lacks cost-effective mitigation options for known environmental barriers, such as technologies for deterring marine mammals from entering project areas during installation and maintenance. DOE will fund the development of innovative mitigation technology designs to reduce costs.

Hydropower: Funding is largely focused on reducing the cost of key components and systems for new hydropower development and reducing barriers to its deployment, including addressing component challenges across varying classes of hydropower.

Major ongoing Hydropower activities include the following:
- Developing advanced, cost-effective environmental and aquatic species monitoring sensors and optimization tools to co-optimize generation, flexibility, and environmental performance across entire hydropower systems
- Demonstrating, testing, and evaluating advanced turbine designs and other innovative technologies capable of co-optimizing electricity generation and environmental stewardship—such as advanced aerating turbine designs and the Alden "Fish Friendly Turbine"
- Facilitating stakeholder engagement in regulatory working groups that enables collaborative development of new hydropower through the development and sharing of best practices and scientific data.

New Hydropower initiatives focus on the following:
- Developing advanced hydropower component technologies at lower cost (e.g., standardized

generating units with improved energy and environmental performance), high-efficiency electrical components, and radically innovative, low-impact impoundment technologies to reduce the levelized cost of energy (LCOE) of new sustainable hydropower development
- Investigating modular designs of pumped storage units to facilitate flexible, phased deployment closely matched with variable renewables growth, which will significantly reduce market and financing risks.

Key Barriers to Hydropower Deployment:
- New hydropower can be developed with minimal environmental impacts, but doing so can be costly and requires new technologies. To reduce the high LCOE of new sustainable development, technology research to standardize generating units, increase efficiency through advanced generator design and the application of modular power electronics (Power Electronics Building Blocks (PEBBs)), and lower licensing risks and civil costs with low-impact impoundment structures is necessary.
- The hydropower licensing process is expensive and uncertain. New licensees face major costs and other barriers, while relicensing exposes the existing fleet to the risk of generation and flexibility reductions. DOE plans to develop mitigation technologies, such as next-generation fish passage systems, to reduce the risks of the licensing process associated with known environmental concerns.
- The dynamic flexibility of hydropower is an ancillary grid benefit that is not accounted for in the marketplace, thus promoting inefficient operation and inadequately rewarding carbon-free grid flexibility. DOE can demonstrate the portfolio benefits of hydropower and PSH through studies and newly developed models that consider high penetrations of variable renewables and investigate alternative market structures that value and compensate for these services.
- High capital cost and long payback periods inhibit the development of large PSH. DOE will investigate alternative design options, such as standardized, smaller PSH units, to reduce costs and market risks.

A Cross-Cutting Manufacturing Competitiveness Vision: In addition to generating renewable energy, deploying water power technologies will help support the revitalization of the industry's manufacturing sector in the United States. As a part of the DOE's Clean Energy Manufacturing Initiative (CEMI), the program will initiate a series of manufacturing initiatives focused on lowering LCOE and promoting technology pathways conducive to enabling a robust U.S. manufacturing presence for water power technologies.

Clean Energy Manufacturing Initiative activities include the following:
- Supporting and demonstrating the comprehensive reengineering of innovative MHK system designs along "design for manufacturability" principles to reduce LCOE and increase production volume through economies of scale
- Testing and applying high strength, light-weight materials, such as composites, to the design of MHK systems—reducing installation and operations and maintenance (O&M) costs through reduced weight and resistance to corrosion
- Researching advanced manufacturing processes that can be used to develop lightweight materials for hydropower turbines to drive down LCOE from reduced equipment and powerhouse costs.

Incubator Programs: The great majority of EERE investments are currently, and must going forward, be primarily driven by detailed short, medium, and long-term RDD&D roadmaps. EERE proposes Incubator activities in the FY 2014 budget, and designed them to use a small fraction of EERE's technology office's annual R&D budget to regularly introduce potentially high-impact "off-roadmap" new technologies. These Incubator activities will enable the "rapid on-ramping" of potentially transformational new energy technologies into the EERE portfolio, dramatically increasing the rate of technology innovation.

Technology Status, Program Accomplishments, and Near-Term Milestones[a]

In 2012, MHK technologies had a breakout year. DOE played a critical role in advancing technology readiness and facilitating the deployment of MHK technologies, as DOE-funded projects received the first U.S. Power Purchase Agreements (PPA) and licenses, and DOE technical leadership (with support from national laboratories) strongly supported the continuance of other industry projects.

- DOE supported significant full-scale, in-water tests of advanced MHK systems and components. In 2012, DOE provided critical project development assistance for the first commercial, grid-tied tidal energy project,

a For a list of milestones please see *"Strategic Performance Management by Program"* section.

which is an essential first step toward developing a robust U.S. industry.

- A comprehensive set of resource assessments demonstrated the potential for MHK technologies to provide a material contribution the nation's energy system. DOE completed assessments of U.S. wave, tidal, ocean-thermal, and river in-stream hydrokinetic energy resources in 2012. Based on quantitative estimates of resource and deployment potential, the program will place priority focus on technology development for wave energy devices, yet will also continue to support key tidal and current energy deployments, as well as the reduction of deployment barriers through market acceleration activities.
- The program also completed MHK "reference model" efforts to identify major cost and performance technology improvement opportunities for guiding R&D investments and technology design improvements. Baseline analytical efforts provide the real-world data and analytical guidance that have allowed DOE to identify the highest-leverage R&D and infrastructure development pathways. This will culminate in the program's Techno-Economic Report to Congress (to be released in 2013), describing cost-reduction potential in MHK technologies and the program's future R&D strategy.

Reaching an all-time high in 2012, hydropower capacity continues to grow by powering non-powered dams and conduits and upgrading existing plants. The program's efforts targeting the existing fleet, such as through American Recovery and Reinvestment Act of 2009 (ARRA) rehabilitations and tools for optimizing water use, will ensure that this infrastructure remains efficient and productive—maintaining and increasing hydropower contribution to U.S. electricity generation—in the face of aging equipment and changing water availability.

- DOE supported capacity and efficiency upgrades at seven U.S. hydropower facilities which are expected to be complete by 2014. The low-cost, high-impact retrofits added more than 131,000 megawatt hours (MWh) of sustainable annual generation of electricity. DOE also completed resource assessment efforts to identify opportunities at non-powered dams and in undeveloped streams.
- DOE developed a Water Use Optimization Toolset, which allows for the joint optimization of generation, ancillary service provision, and environmental objectives. This novel energy-environmental optimization approach will simultaneously increase energy and grid services from available water and enhance environmental benefits from improved hydropower operations and planning.
- In 2011, DOE released the first major solicitation for hydropower R&D in more than a decade. Hydropower R&D projects, scheduled for completion in FY 2014, are supporting the reduction of hydropower LCOE and are demonstrating the dynamic grid benefits of advanced hydropower and pumped storage technologies. In FY 2014, the program will build off of these accomplishments and the lessons learned from them by focusing R&D on key components of hydropower plants to bring down the LCOE of new hydropower systems.

Program Planning and Management

The Water Power Program prioritizes its RDD&D work according to EERE's "5 Core Questions":

1) High Impact: Is this a high-impact problem?
2) Additionality: Will the EERE funding make a large difference relative to what the private sector (and other funding entities) is already doing?
3) Openness: Have we made sure to focus on the broad problem we are trying to solve and be open to new ideas, new approaches, and new performers?
4) Enduring Economic Benefit: How will this EERE funding result in enduring economic benefit to the United States?
5) Proper Role of Government: Why is what you are doing a proper high-impact role of government versus something best left to the private sector to address on its own?

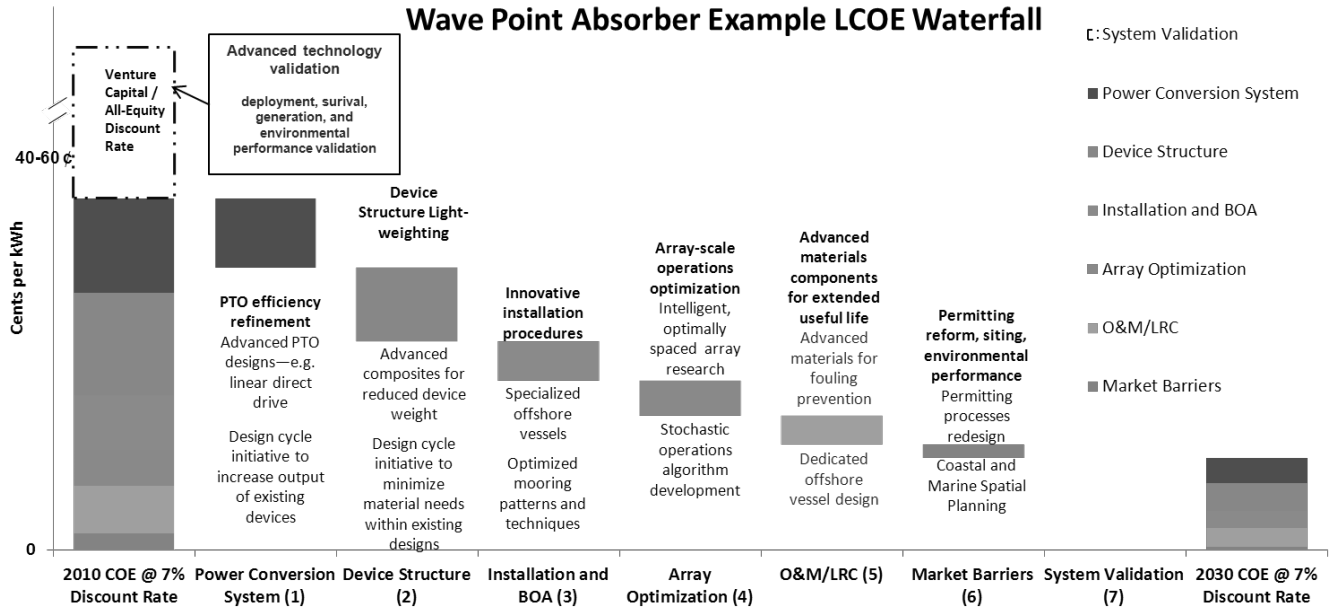
The program has established the high-impact goal of supplying 15% of the nation's electrical energy needs from water power technologies by 2030. By partnering with the MHK industry, DOE has rapidly evolved to a position of strong leadership within the MHK sector over a very short period of time. Through accelerated technology and test infrastructure development—utilizing best practices and lessons learned, and leveraging our nation's inherent maritime capabilities—the program aims to compress MHK technology development timelines to utility-scale deployments in approximately 10 years. DOE's openness to a wide range of nascent water power technologies is leading to dramatic and radical innovations with the potential to revolutionize marine energy production. With a deployment goal of 23 GW by 2030, MHK technologies will provide an enduring economic benefit to the nation by establishing a domestic manufacturing and technology sector, thus securing leadership in an emerging global market and charting a course toward even more significant deployments. DOE plays a critical role in MHK technologies because of their nascent stage of

development, which is similar to that of wind and solar technologies 20 years ago. Without strong DOE involvement and leadership, the domestic water power industry will not progress to its full potential as part of a diverse U.S. energy portfolio.

The global hydropower industry is currently focused on non-U.S., large-scale hydropower projects. Therefore, DOE involvement is needed to focus on solving unique hydropower challenges in the United States, which include smaller projects (less than 50 MW) with significant environmental concerns. Past efforts with U.S. private industry have been narrowly focused on incremental improvements; however, DOE's strategy is to provide pivotal leadership, engaging new actors and key stakeholders moving forward to achieve substantial innovation in all facets of hydropower development. This strategy supports a goal of doubling the contribution of hydropower, an additional 300 TWh, to the U.S. electricity system by 2030. To do so, DOE will provide comprehensive and integrated solutions to cost-effective, environmentally sustainable generation technology advancement, enhanced grid balancing and flexibility, and environmental and licensing barriers. With more than 2,500 U.S. companies supporting the hydropower industry in the nation, doubling generation from hydropower will create a large and enduring economic benefit here at home by revitalizing the domestic manufacturing and hydropower industry. DOE is driving down MHK technology costs to levels competitive with local hurdle rates through targeted technology R&D and market barriers research toward providing a market-competitive, renewable alternative in high-cost markets, such as Alaska and Hawaii, by 2020 and attaining full cost-parity in major coastal markets by 2030. From an estimated 2010 LCOE of $0.40–$0.60/kWh (wave), the technology will reach cost-competitiveness with local hurdle rates in major coastal load centers at between $0.12 and $0.15 per kWh. These cost reductions could enable up to 23 GW of deployment by 2030, powering approximately 5.5 million homes (see Figure 1). Reaching this aggressive cost goal will require significant reductions in capital and O&M costs, improvements in system and array performance, and the elimination of market barriers. MHK activities to achieve these LCOE goals include the following:

- Targeting component R&D to increase performance and drive down costs of key components—such as Advanced Power Take Off designs, eliminating inefficient, failure-prone hydraulics, increasing efficiency, and reducing O&M costs
- Achieving general system optimization through the development of advanced design codes that will allow for reduced safety margins and rapid design iteration, while reducing weight and cost
- Driving down the balance of plant and O&M costs through optimized mooring designs, on-water intervention strategies, and custom dedicated vessels
- Understanding array wake effects by leveraging DOE High-Performance Computing resources, which will enable the development of advanced control algorithms to optimize the operation of entire wave farms for increased energy capture
- Developing a controlled infrastructure to help allow for rapid design iteration, validation of performance modeling, and the inexpensive testing of devices in commercial operating conditions
- Eliminating environmental barriers associated with marine mammal detection and deterrence through the development of low-cost mitigation technologies
- Applying advanced materials and designs for manufacturing initiatives to enable utility-scale production, reduce manufacturing and life-cycle costs, and strengthen the U.S. manufacturing sector.

Figure 1: Example potential pathway for driving down MHK cost to levels competitive with local hurdle rates.



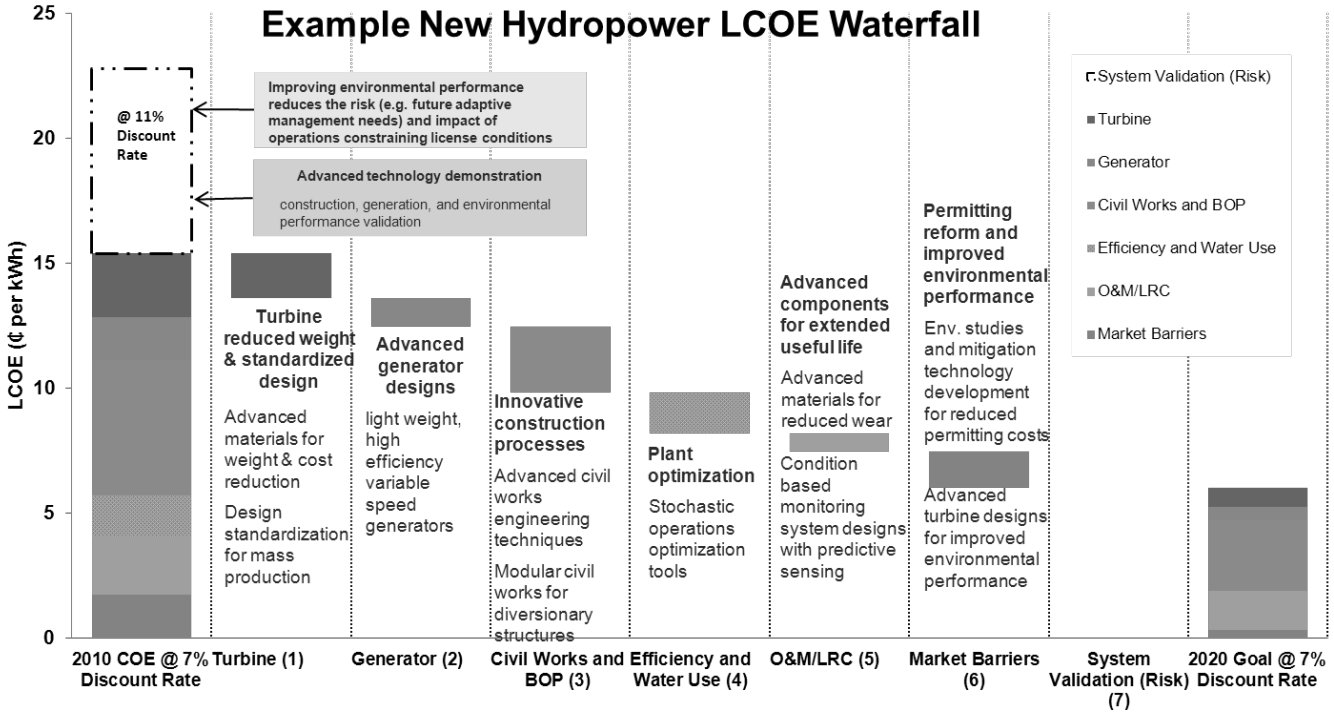
Based on resource assessment efforts, the program believes that the current contribution of hydropower to the nation's energy system can be doubled—adding up to an additional 70 GW, or 300 TWh/year by 2030, powering approximately 26.5 million homes (see Figure 2). Deployment target requires the reduction of the LCOE for new sustainable hydropower development to reach a cost-competitive LCOE of $0.06/kWh by 2020 to enable the largest remaining hydropower resources without the construction of new, large and expensive impoundments. Additional efforts must be made to prevent losses in generation and flexibility in the existing fleet and to eliminate the market barriers to utilizing pumped storage to integrate variable renewables.

A major expansion of hydropower will require the following:

- Light-weight, high-efficiency standardized generating units engineered to drive down turbine and generator costs through manufacturing economies of scale
- Intake and diversion structures that are optimized to reduce losses and eliminate expensive civil works
- Advanced optimization tools that allow for the maximization of energy, flexibility, and environmental health across entire rivers systems
- Quantifying the full value of hydropower grid services to demonstrate integration capabilities and grid value, which will reduce market barriers for the existing fleet and accelerate deployment of advanced pumped storage to integrate variable renewables
- Scientifically founded in-stream flow requirements to operate hydropower with maximum efficiency and environmental sustainability—reducing existing fleet and new deployment market barriers; and
- Regulatory working groups to disseminate best practices and scientific data to minimize the cost, risk, and time spent performing environmental studies and obtaining water quality certifications.

The program will need to assist industry and stakeholders in addressing major barriers in permitting and deployment to reduce the significant lead-time and risk of hydropower development, which both create significant difficulties in obtaining competitive financing and development capital. Research into science-based development of in-stream flow requirements, advanced environmental modeling and measurement technologies, and stakeholder engagement, as well as the modularization and standardization of hydropower units can lead to significant reductions in both permitting and construction timelines.

Figure 2: Example potential pathway for driving down the costs of sustainably developing new hydropower to fossil fuel competitive levels.



Strategic Performance Management by Program

Performance Measure	**Water - Marine & Hydrokinetic (MHK)** – Reduce the levelized cost of energy from MHK technologies 2012 – 2013: Test marine and hydrokinetic devices and components to determine baseline cost, performance, and reliability. (All targets are cumulative.)		
Fiscal Year	**2012**	**2013***	**2014**
Target	3 MHK devices tested	10 MHK devices tested	The Water Power Program will begin to track LCOE with baseline defined in 2013
Result	3 MHK devices tested		
Endpoint Target	15 cents/kWh by 2030		

Performance Measure	**Water - Demonstrations** - Demonstrations of advanced hydropower technologies at real-world sites to demonstrate energy and environmental performance—reducing financing and licensing risks (number of demonstrations).		
Fiscal Year	**2012**	**2013***	**2014**
Target	N/A	N/A	5
Result			
Endpoint Target	Deploy up to 70 GW of new hydropower to support the Water Program goal of providing 15% of U.S. electricity by 2030.		

*2013 targets represent DOE's FY 2013 Budget Request to Congress. FY 2013 target updates can be found in the upcoming FY 2012-2014 Annual Performance Plan & Report.

Marine and Hydrokinetic Technologies (MHK)
Funding Profile by Subprogram

(dollars in thousands)

	FY 2012 Current	FY 2013 Annualized CR*	FY 2014 Request
Marine and Hydrokinetic Technologies	33,684	—	39,500
Total, Marine and Hydrokinetic Technologies	33,684	—	39,500

*FY 2013 amounts shown reflect the P.L. 112 175 continuing resolution level annualized to a full year. These amounts are shown only at the "congressional control" level and above; below that level, a dash (-) is shown.

The MHK subprogram goal is to achieve cost-competitiveness at local coastal hurdle rates, which is approximately $0.12–$0.15/kWh by 2030. RD&D is a priority in FY 2014, as the subprogram invests $9.5 million toward activities that enable the development of innovative technologies and improve the reliability and technology readiness of MHK systems. This includes innovative components with cross-platform applicability that will comprise the next-generation of power take-off systems. Through simplified drivetrain designs, these systems will eliminate costly and unreliable components, such as gearboxes and hydraulics by utilizing permanent magnet and linear direct-drive generators. Research will also target the application of innovative corrosion resistant materials, such as composites, and the development of non-toxic coatings that will double intervals between major device rehabs, thus significantly reducing O&M costs and extending device lifetime.

The subprogram is focused on making strategic investments in transformative technologies, including systems and components demonstration for advanced MHK industry projects. Part of the subprogram's $10 million initiative for MHK systems and components advancement is the "WEC Prize" competition that is aimed at accelerating the development of next-generation WEC technologies. The competition's objective is to accelerate new wave energy conversion devices from TRL 3 to TRL 5/6, enabling the winner(s) with the most techno-economically promising innovation to attract investors, as well as to be ready for future subprogram solicitations to demonstrate their system at TRL 7/8.

Additional R&D, as part of EERE's Clean Energy Manufacturing Initiative, will leverage advanced manufacturing principals to lightweight MHK devices—reducing installation and manufacturing costs and increasing survivability. The subprogram will invest $5 million in activities that include the re-engineering of innovative MHK system designs along "design for manufacturability" principles to reduce LCOE and the increased production volume through economies of scale. Activities will also focus on the testing and application of high-strength, light-weight materials, such as composites, to the design of MHK systems—reducing installation and O&M costs through reduced weight and resistance to corrosion.

Validation of R&D Advances will require the development of world-class testing infrastructure. In FY 2014, the subprogram will invest $10 million toward developing a controlled-conditions, deep-water wave tank test facility to decrease the cost and time of mid-TRL (4/5/6) design iterations. This controlled test facility, which will be competitively selected, will allow for physical testing of critical parameters (e.g., device power performance and fatigue loads under a representative and repeatable spectrum of wave environments). Without this testing infrastructure, which is necessary to (1) validate numerical predictions of annual delivered energy and survivability and (2) identify and address component and system technology deficiencies early in the development cycle, the United States risks ceding global leadership in MHK technology development and manufacturing, as well as delaying the attainment of market competitiveness of these technologies until after 2030. In an effort to leverage industry expertise, innovation, and cost-share, the development of this facility will be competitively awarded. In addition to building this world-class, first-of-its-kind facility, the subprogram will also require the awardee to develop a business plan that ensure s that this facility is ultimately self-sustaining and that also provides a near-term off-ramp for DOE funding.

The subprogram will also pursue market acceleration and deployment activities that address key environmental and ecological uncertainties through a $5 million investment for the development of low-cost, high-accuracy devices used to detect and track marine mammals and other aquatic organisms of concern. The development of cost-effective mitigation technologies can both reduce LCOE and enable the testing and development of MHK technologies in prospective resource areas that would not otherwise be accessible without adequate environmental measures.

Marine and Hydrokinetic Technologies Incubator Activities: EERE's Incubator activities are an expansion of an already proven innovative program that EERE's Solar Energy Technologies Office piloted with a specific focus on partnering with businesses and researchers to bring "off-roadmap" impactful new technologies into the EERE portfolio. These early prototypes were developed into manufacturing and commercially relevant prototypes designed around pilot-stage process development. Based upon this highly successful model, the subprogram plans to invest in the creation of an Incubator Program in FY 2014. (up to $1.2 million).

Explanation of Funding Changes

(dollars in thousands)

	FY 2012 Current	FY 2014 Request	FY 2014 Request vs. FY 2012 Current
Marine and Hydrokinetic (MHK) Technologies: With prior year commitments from the Advanced Water Power Technologies FOA completed, the program will increase funding for a controlled-conditions, deep-water wave tank testing facility ($10.0 million) that is necessary for industry to rapidly evaluate advanced device designs. Additionally, the program will direct new funding to MHK related activities in EERE's Clean Energy Manufacturing Initiative ($5.0 million). R&D funds for the advancement of high-performance, cross-platform components (for example: wet-mate connectors, power electronics, and prognostic components e.g., health monitoring systems), as well as the development and application of innovative materials and coatings to improve system reliability, maintainability, and manufacturability remain flat from the previous year. The MHK subprogram budget reflects the critical role the program will play in catalyzing the near-term realization of the MHK industry.	33,684	39,500	+5,816
Total, Marine and Hydrokinetic Technologies	33,684	39,500	+5,816

Fiscal Year	Line Item	Funding (dollars in thousands)
FY 2012	• Per Congressional direction, established National Marine Renewable Energy Centers to serve as 'Centers of Excellence' for marine renewables research. • Demonstrated new technologies for wave and tidal technologies. The program's support of MHK technology demonstration projects is critical for accelerating the commercialization of technologies that have successfully completed systems development and limited testing. • Developed the "Tethys" online catalogue to systematically collect all available MHK environmental data (from U.S. and international sources) for centralized access; leveraged MHK environmental experience for the benefit of the industry as a whole. • Developed wave oscillating water column, wave surge device, and ocean current turbine reference models, identifying major cost and performance technology improvement opportunities for guiding R&D investments and next-generation design improvements. Developed and disseminated standards for the testing of open-ocean MHK devices, including standardized testing protocol and modular instrumentation package for MHK devices.	33,684
FY 2013	Planned activities in the Fiscal Year 2013 Budget (final allocations have not yet been determined): • Validate pioneering MHK system and component designs through in-water demonstrations resulting from the 2010 Advanced Water Power solicitation. These included WEC point absorbers and tidal energy machinery. • Continue cross-cutting activities with national laboratories, universities, and industry to improve and refine the physical science informing design and performance models. • Conduct environmental and siting research to measure and link key biological responses to MHK systems and extrapolate information from these studies to assess cumulative impacts of stressors. • Expand cooperation with the U.S. Navy on wave energy device demonstration through a device deployment at the Navy's Wave Energy Test Site in Hawaii; support further developments of this innovative test facility.	—
FY 2014	• Initiate the construction of controlled-conditions, deep-water wave tank testing facility ($10.0 million). • Test and validate the performance of wave point absorber and tidal current turbine devices through support systems and components demonstration for advanced MHK industry projects ($2.0 million). • Initiate the "WEC Prize" competition to develop breakthrough wave energy technology ($8 million). • Develop advanced marine monitoring technologies to lower the cost of licensing compliance and allow access to sensitive, but high-resource, sites ($5.0 million). • RD&D toward innovative technologies and improvement of the reliability and technology readiness of MHK systems ($9.5 million). • Start an advanced manufacturing competitiveness initiative, as part of EERE's Clean Energy Manufacturing Initiative, with initial projects focused on light-weight MHK devices to reduce LCOE ($5.0 million).	39,500

Hydropower Technologies
Funding Profile by Subprogram

(dollars in thousands)

	FY 2012 Current	FY 2013 Annualized CR*	FY 2014 Request
Hydropower Technologies	24,392	—	15,500
Total, Hydropower Technologies	24,392	—	15,500

*FY 2013 amounts shown reflect the P.L. 112 175 continuing resolution level annualized to a full year. These amounts are shown only at the "congressional control" level and above; below that level, a dash (-) is shown.

Hydropower currently provides approximately 7% of the nation's electricity today and produces the largest share of renewable generation, with 78 GW of installed capacity. The program estimates that water power technologies can supply 15% of the nation's electrical energy needs by 2030 (this equates to approximately 23 GW of installed MHK capacity and 70 GW of additional hydropower capacity). In addition to energy generation, the program also aims to improve the flexibility of the existing hydropower fleet, as well as facilitate the deployment of up to 30 GW of advanced pumped storage technologies, enabling greater penetrations of other variable renewables.

New hydropower technology development is the major focus area for the Hydropower Technologies subprogram in FY 2014. A substantial $7.5 million investment will be made in specific, high-leverage components including the following:

- Standardized, "off-the-shelf" generating unit designs (1 megawatt (MW), 2 MW, 5 MW and 10 MW) with high efficiencies to leverage economies of scale in the manufacture of new hydropower generating equipment
- Next-generation electrical-conversion equipment, such as variable speed generators and modular "power electronic building block," or PEBB technologies to decrease capital costs and increase ranges of high efficiency for power generation, while eliminating traditional mechanical generators and governors
- Optimized river diversion structures with or without small impoundments that minimize environmental impacts and licensing risks, while reducing capital costs.

The subprogram will make a new $5 million investment in EERE's CEMI to develop lightweight, advanced material turbines that reduce both manufacturing and structural costs. These innovations can dramatically reduce LCOE for a variety of sites around the country and enable hydropower generation to achieve cost competitiveness with fossil fuels for higher quality sites by 2020—lower quality sites are expected to become competitive by 2030 with additional phases of R&D prioritization. Through the commercialization and wide deployment of the $1 million investment in the program's Water Use Optimization Toolset's efforts in software refinement and outreach, improved generation and environmental performance will be enabled across entire hydropower systems.

DOE will explore the feasibility and economics of modular pumped storage designs. These "modular" designs (envisioned to be 100–250 MW in scale) will leverage manufacturing economies of scale and open new markets by avoiding many of the financing and permitting constraints associated with larger, GW-scale deployments. The program will invest $1 million for this effort.

Key activities addressing hydropower's market barriers will include the continued sharing of environmental best practices, environmental data, and science-based impacts. The subprogram is focusing its efforts on regulatory initiatives and developing advanced environmental modeling and measurement tools, such as "sensor fish" and biological design criteria for generating units. Targeted activities advancing water-quality modeling and measurement will enhance hydropower systems optimization and operation—increasing energy generation, system flexibility, and environmental benefits. The subprogram allocates $1 million for activities focused on improving the computational simulation of water-quality issues and associated measurement infrastructure.

No FY 2014 funding will be applied to new Hydro Research Fellowships. The Administration is proposing a comprehensive reorganization of STEM education programs to increase the impact of Federal investments. As part of this effort, the National Science Foundation

(NSF) will be consolidating and reforming graduate fellowship activities. DOE will work with NSF to provide input into the development and implementation of STEM activities, which will reach more students and address national workforce needs.

Hydropower Technology Incubator Activities**:** EERE's Incubator activities are an expansion of an already-proven innovative program that EERE's Solar Energy Technologies Office piloted with a specific focus on partnering with businesses and researchers to bring "off-roadmap," impactful new technologies into the EERE portfolio. These early prototypes were developed into manufacturing and commercially relevant prototypes designed around pilot-stage process development. Based upon this highly successful model, the program plans to invest in the creation of Incubator programs in FY 2014 (up to $462 thousand).

Explanation of Funding Changes

(dollars in thousands)

	FY 2012 Current	FY 2014 Request	FY 2014 Request vs. FY 2012 Current
Hydropower Technologies: Funding will be reduced as commitments from the Advanced Hydropower FOA, Basin Scale Opportunity Assessment, and the Hydropower Research Fellowship will be completed. Based on the new hydropower potential in the United States and the opportunity for DOE to play a strong role in its development, the subprogram will transition away from activities centered on technology upgrades for the existing hydropower fleet. The subprogram will allocate funding to advanced manufacturing R&D work in support of EERE's Clean Energy Manufacturing Initiative ($5.0 million). The subprogram will direct remaining funding toward increasing performance and reducing costs of new cross-cutting hydropower components, reducing the barriers to hydropower deployment, developing innovative pumped storage technologies, and validating the storage value and other ancillary benefits of hydro to the nation's power grid ($10.5 million). The subprogram's investments will complement and leverage investments of the established hydropower industry (requiring a smaller investment).	24,392	15,500	-8,892
Total, Hydropower	24,392	15,500	-8,892

Funding Schedule

Fiscal Year	Line Item	Funding (dollars in thousands)
FY 2012	• Developed advanced dynamic power systems models of new pumped storage technologies. • Initiated the RD&D of innovative small hydropower technologies, including modular turbine-generator designs and advanced variable generators. • Developed advanced sensor technology and modeling codes to predict environmental impacts of turbine operations. • Completed capacity and efficiency upgrades at three U.S. hydropower facilities through an American Recovery and Reinvestment Act investment.	24,392
FY 2013	Planned activities in the Fiscal Year 2013 Budget (final allocations have not yet been determined): • Demonstrate the combined energy and environmental benefits of using cutting-edge optimization techniques implemented in the "Optimization Toolset" to maximize the use of multipurpose hydropower systems. • Initiate a regulatory working group to share environmental data and best practices, as well as engage stakeholders to speed the licensing process.	—

Fiscal Year	Line Item	Funding (dollars in thousands)
FY 2014	• Standardize unit designs, develop advanced electrical conversion technologies for high efficiencies, and reduce the footprint and cost of new hydropower development through targeted civil structure R&D ($7.5 million). • Launch the advanced manufacturing competitiveness initiative, a hydropower effort in support of CEMI, for composite turbine development ($5.0 million). • Explore feasibility and economics of modular pumped storage designs ($1.0 million). • Evaluate the future impacts of water availability and water use changes on the existing hydropower fleet to provide essential information for long-term water and power infrastructure planning through coordination with the Army Corps of Engineers and Bureau of Reclamation ($1.0 million). • Improved generation and environmental performance across entire hydropower systems through the Water Use Optimization Toolset ($1.0 million).	15,500

Geothermal Technologies
Funding Profile by Subprograms

(dollars in thousands)

	FY 2012 Current	FY 2013 Annualized CR*	FY 2014 Request
Geothermal Technologies			
Enhanced Geothermal Systems	15,556	—	42,000
Low Temperature Co-produced Resources	4,940	—	2,000
Innovative Exploration Technologies	12,483	—	12,000
Systems Analysis	4,000	—	4,000
Total, Geothermal Technologies	36,979	38,094	60,000

*FY 2013 amounts shown reflect the P.L. 112 175 continuing resolution level annualized to a full year. These amounts are shown only at the "congressional control" level and above; below that level, a dash (—) is shown.

SBIR/STTR

- FY 2012 Transferred: SBIR: $778,000; STTR: $105,000
- FY 2013 Annualized CR: SBIR: $1,022,274; STTR: $132,517
- FY 2014 Request:: SBIR: $1,680,000; STTR: $240,000

FY 2014 Program Summary

- Increased funding to optimize and validate Enhanced Geothermal Systems (EGS) by initiating a government-managed EGS field lab in addition to strategic EGS research and development (R&D) (+$26.4 million).
- Decreased funding in Low Temperature Co-produced Resources due to relative maturity of the portfolio and relative de-emphasis on new power demonstration projects (-$2.9 million).

Overview

The mission of the Geothermal Technologies Program (program) is to accelerate the development and deployment of clean, domestic geothermal resources that will promote a stronger, more productive economy; provide valuable, stable, and secure energy to the electrical generation system; and support a cleaner environment. The goals of the program are to develop exploration tools to lower the upfront risk of hydrothermal geothermal resource exploration; reduce the levelized cost of electricity (LCOE) of hydrothermal geothermal power to $.06/kilowatt hour (kWh) by 2020; reduce the LCOE of newly developed geothermal systems to $.06/kWh by 2030; and develop improved methods for developing geological heat reservoirs, which will allow geothermal energy to compete equally with conventional electricity sources in the marketplace. The program will achieve these goals by investing in research, development, and demonstration (RD&D) and analysis efforts that will increase performance, as well as decrease project risks and costs.

In FY 2014, the program will address technical challenges that affect the development of undiscovered hydrothermal resources and EGS through targeted research, development, demonstration, and deployment (RDD&D). It will also engage in a concerted effort to fully establish and demonstrate low-temperature and co-production technologies that are ready to deploy in the private sector. Major focus areas in FY 2014 include:

- RD&D to further refine geophysical and geochemical technologies and methodologies—including "play fairway" mapping—to identify undiscovered hydrothermal resources.
- RD&D to address key challenges to EGS development, including more robust fracture characterization technologies and effective and sustainable stimulation technologies.
- The scoping and preparation of an EGS field laboratory—a dedicated, government-run, industry/stakeholder operated site devoted to creating a commercial pathway to EGS. This initiative will promote transformative and high-risk/high-reward science and engineering that the private sector is not financially or operationally equipped to undertake, which will ultimately facilitate the design testing and pathway for a reliable methodology for creating large-scale, economically sustainable EGS.
- R&D to lower the LCOE of low-temperature hydrothermal systems.
- Data collection and analysis to support the increased adoption of commercially ready co-production technologies.

- The assessment of strategic minerals dissolved in geothermal brines and development of an extraction strategy to recover these materials.

The program operates in a challenging subsurface environment with unique technical and operational challenges. Foremost among those challenges is the fact that the resource is "out of sight" at a depth of approximately 2 to 5 kilometers, with elevated temperatures and pressures well beyond those typically encountered in oil and gas operations. In addition, geothermal resources are typically hosted in hard, abrasive rock formations. The sum of these challenges necessitates cutting-edge and innovative sensing and measurement technologies coupled with new drilling and development technologies specifically designed to access and secure the geothermal resource. Therefore, two major objectives of the program are to increase the probability of success of finding geothermal resources and to lower the attendant cost of geothermal exploration and development.

The potential benefits of geothermal energy are immense—once found, domestic geothermal resources have the value of serving as a reliable and nearly inexhaustible baseload energy source, with greatly reduced greenhouse gas and criteria emissions. Further, EGS technology has the potential to act as a reservoir management tool on the margins of existing hydrothermal fields, and in the longer-term, EGS can be broadly deployed across the United States as a new baseload energy source. Breakthroughs in this area will create domestic jobs, reduce the environmental impacts of energy production, and enhance U.S. economic competiveness. The U.S. Department of Energy (DOE) funded early research and technology development for shale gas development and related horizontal drilling, fracturing, and multistage stimulation in the late 1970s through early 1990s, which supported the oil and gas industry's development and deployment activities that led to today's shale gas revolution.

The program sees a similar opportunity today, to add to and further leverage that valuable government investment into technology for accessing new subsurface environments and dramatically advance geothermal energy as a broad-based renewable energy source. Once remaining technical barriers are addressed, EGS can be deployed using an efficient, repeatable methodology analogous to that utilized widely in shale gas operations today, but designed for the challenges of the EGS subsurface environment. To facilitate this breakthrough, the program and its partners have assembled a team with deep knowledge of that subsurface environment, required operational techniques and technologies, and related oil and gas practices.

To help realize these benefits, the program's technology portfolio is focusing on two closely related areas that balance a near-term and long-term investment strategy: hydrothermal[a] and EGS, respectively. This two-pronged strategy will help the current geothermal industry continue to grow by making exploration more cost competitive, while also advancing EGS to unlock this vast geothermal resource potential. New exploration technologies and tools can help reduce risk associated with both near-term hydrothermal systems and long-term EGS. Additionally, the program's ongoing investments in systems analysis can help identify ways to reduce non-technical costs (e.g., regulatory and permitting issues) associated with all geothermal development efforts, both long and short term. Figure 1 illustrates the interrelation of program investment areas and how investments in each area are mutually supportive and synergistic.

[a] Hydrothermal encompasses low-temperature resources, co-produced resources, and both identified and undiscovered hydrothermal resources.

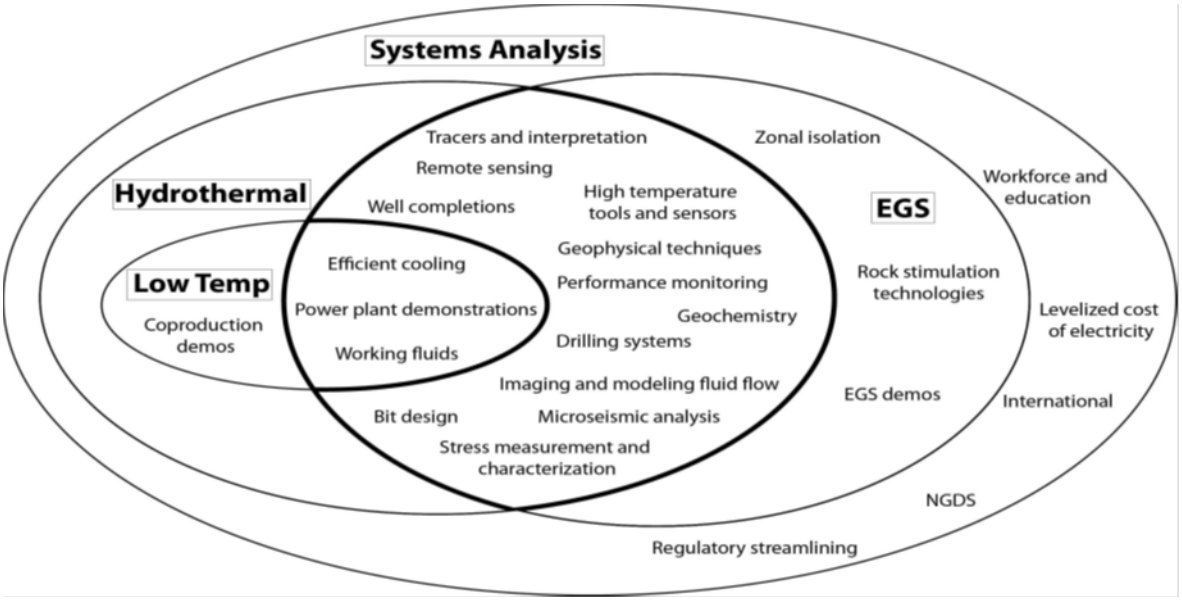


Figure 1: Interrelationship and synergies among Geothermal Technologies Program investment areas

To bring more renewable electricity online in the near term, detection and imaging of subsurface geothermal reservoirs needs to be significantly improved. Upfront technical and financial risks related to drilling unproductive exploration wells and the associated costs of failed exploration activities are major barriers to increased development of geothermal resources in the United States. To lower costs and expand the use of geothermal renewable electricity in the United States, targeted R&D of advanced, efficient, and low-cost geothermal power cycle components is needed as well. To address this, the program plans to invest $14 million in FY 2014 in hydrothermal RD&D activities to identify and develop innovative exploration technologies, as well as to conclude activities to demonstrate the viability of low-temperature (<300°F) resource development and co-production[a] opportunities to the private sector. The low-temperature portfolio ($2.0 million) also includes an initiative to assess the potential for extracting strategic minerals from geo-fluids—leveraging off of the program's highly successful RD&D to extract lithium from geothermal brines. The low-temperature funding request level reflects the current relative maturity of this portion of the portfolio; the program will de-emphasize new power demonstration projects in FY 2014 and shift its focus to targeted R&D and analysis to reduce the LCOE of hydrothermal systems.

A significant near- and long-term opportunity for widespread power production from new geothermal sources lies in EGS. Rather than relying on natural hydrothermal systems, EGS entails creating a man-made geothermal reservoir wherever there is accessible heat in the subsurface. This is accomplished by adding key elements found in natural hydrothermal systems: fluid and permeability. The program's strategy to accelerate the successful demonstration of EGS technology involves a progression of EGS trials from near-existing hydrothermal fields to undeveloped sites, known as "greenfields". The ability to develop EGS reservoirs on the margins or in unproductive portions of existing hydrothermal fields at a relatively low cost can facilitate the build out of additional capacity in the short term (see Figure 2). Successful EGS technology development and deployment in greenfield sites could facilitate access to a resource category estimated to be on the order of 100–500+ gigawatt electrical (GWe).

[a] Co-produced resources use hot fluid that is a byproduct of oil, gas, and other mineral extraction efforts to generate electricity.

Figure 1: Rig at The Geysers geothermal field in in Middletown, California. This EGS demonstration project, funded by DOE and cost-shared with industry, has shown the potential to produce 5 megawatts from an engineered reservoir in a deep, impermeable, and unproductive rock body, with far greater additional potential at this site. (Photo credit: Calpine; Geothermal Technologies Program 2012 Peer Review)

Extensive permitting processes also play a role in limiting development by increasing costs and overall project timelines. To address externalities such as this, the program will also invest $4 million in robust techno-economic modeling, data gathering and dissemination efforts, as well as permitting and policy analysis.

The priorities of the program are designed to support the administration's goals to have 80% of U.S. electricity generated from clean sources by 2035 and to double generation from wind, solar, and geothermal sources by 2020 (relative to 2012 levels). They are also designed to support DOE's strategic goal to catalyze the timely, material, and efficient transformation of the nation's energy system and secure U.S. leadership in clean energy technologies.[a]

Technology Status, Program Accomplishments and Near-Term Milestones[b]

The United States currently has approximately 3,386 megawatts (MW) of installed geothermal capacity—more than any other country in the world. Of this total, in 2012, the nation added 147 MW of geothermal installed capacity. New geothermal projects are also in various stages of development in many states.

According to a U.S. Geological Survey estimate, the United States has an estimated 9,057 MWe of power generation potential from domestic, conventional, identified geothermal systems; 30,033 MWe of power generation potential from conventional, undiscovered geothermal resources; and 517,800 MWe of power generation potential from unconventional (high-temperature, low permeability) EGS resources.

Examples of recent accomplishments include the following:

- In FY 2011 and FY 2012, the program's EGS demonstration project at the Geysers in California, proved that a man-made reservoir can be created in impermeable rock via injection of fluid into an unproductive portion of a natural reservoir (see Figure 2). This project—the first-ever sustained EGS demonstration at commercial scale in the nation—has the potential to produce 5 MW from the newly created reservoir. It represents a significant first step toward reaching the program goal of demonstrating technical and more broadly applicable feasibility of EGS systems.
- In FY 2010, DOE commissioned a group of experts to develop an Induced Seismicity Protocol, an effort that engaged the United States and international scientific and industry communities to assess the impacts of induced seismic events. Induced seismic events are small-magnitude earthquakes, rarely felt at the surface, that can be attributed to human activities. While IS data allow the industry to better characterize the subsurface, DOE has taken the global lead in establishing procedures that ensure safety at injection sites. DOE released the Protocol in 2012 and adopted its safety guidelines for all DOE-funded EGS demonstration projects. The Protocol was well received by the National Research Council (NRC) and recommended as a "best practice" document for use by all other subsurface technologies.
- In FY 2012 and FY 2013, the program will have successfully advanced drilling technology—including by identifying, transferring, and adapting technology from oil and gas and mining—in geothermal environments and shown increased rates of penetration in hard, crystalline rocksc from 10–15 feet per hour (ft/hr) to the target goal of 30 ft/hr. Drilling improvements of this magnitude will play an integral role in decreasing high development costs associated with geothermal energy and are vital to facilitating widespread deployment.

[a] *U.S. Department of Energy Strategic Plan*, DOE/CF-0067, May 2011: page v.

[b] For a list of milestones please see "Strategic Performance Management by Program" section.

- In FY 2011, for the first time, the Beowawe low-temperature demonstration project in Nevada showed that production from bottoming-cycle, low-temperature resources (at 205° F) is economically feasible and can be a viable contributor to the geothermal and renewable energy mix.
- In FY 2013, the Newberry Volcano EGS demonstration project completed reservoir stimulation, and preliminary results suggest that the project successfully created three separate zones of fluid flow from a single well where none existed before—a first-of-its-kind achievement.
- In FY 2013, the Desert Peak project completed an 8-month, multi-stage stimulation of an existing sub-commercial well, and it and successfully demonstrated fluid injection and stimulation to levels within the magnitude of a commercial well, as well as dramatically increasing flow rate. As of April 2013, this project is now connected to the grid, making it the first EGS project in America to generate commercial electricity, by providing an additional 1.7 MW at the existing wellfield.
- In late FY 2013 or early FY 2014, a project based in the Salton Sea area of California will break ground on its production-scale lithium co-production facility. Based on extraction technology originally developed at Lawrence Livermore National Laboratory, this project is the first demonstration facility to co-produce lithium, manganese, and zinc from geothermal brines during the power production process. The estimated lithium production alone could produce enough batteries to power 300,000 to 600,000 electric vehicles per year and make the United States a major lithium producer.

Program Planning and Management

The program prioritizes its RDD&D work according to EERE's "5 Core Questions:"

1) High Impact: Is this a high-impact problem?
2) Additionality: Will the EERE funding make a large difference relative to what the private sector (and other funding entities) is already doing?
3) Openness: Have we made sure to focus on the broad problem we are trying to solve and be open to new ideas, new approaches, and new performers?
4) Enduring Economic Benefit: How will this EERE funding result in enduring economic benefit to the United States?
5) Proper Role of Government: Why is what you are doing a proper high-impact role of government versus something best left to the private sector to address on its own?

The geothermal industry is relatively small, and there is a lack of readily available, low-cost financing. Consequently, DOE involvement in applied research provides the geothermal community with critical access to research in cutting-edge technologies that help reduce LCOE and expand potential for domestic geothermal energy production in new regimes, which they would otherwise not do. Equally, the sector is an eager recipient of new technologies that can have an immediate impact, lower risks and costs, and lead to the development of new geothermal resources. Lowered risks and costs and greater certainty of outcomes have a profound impact on the sector's ability to secure attractive financing and backing for geothermal energy projects. The payback period on investment in geothermal development can be longer than that in the Oil and Gas (O&G) industry, while development costs are often similarly high. This is balanced by the potential for unique, stable, multi-decade production and cash flow from a geothermal reservoir. Furthermore, EGS technology testing and validation at a government-managed EGS field lab that is performed in parallel with applied R&D would provide a low-risk opportunity to develop a reproducible EGS methodology that can eventually be transferred to industry to fully deploy.

As shown in Figure 3, program planning is additionally built around five broad elements: (1) characterization of resource and development of well field, (2) power plant, (3) operation and maintenance, (4) deployment barriers, and (5) system validation. In each of these areas, our goal is to spur technological innovations and identify opportunities for reducing their costs. To do so, the program will focus on the following key activities:

- Demonstrating the feasibility of imaging geothermal fluid-filled fractures in the subsurface
- Increasing geothermal heat exchange surface area per unit volume of reservoir via unique and replicable stimulation and creation technologies
- Reducing the cost of geothermal well field development, which includes these reservoir stimulation activities and also leverages the value of technology improvements in EGS characterization and creation
- Reducing the number of geothermal wells required per MW produced through the stimulation of existing unproductive wells and better targeting of well sites
- Increasing geothermal production by stimulating multiple zones per well.

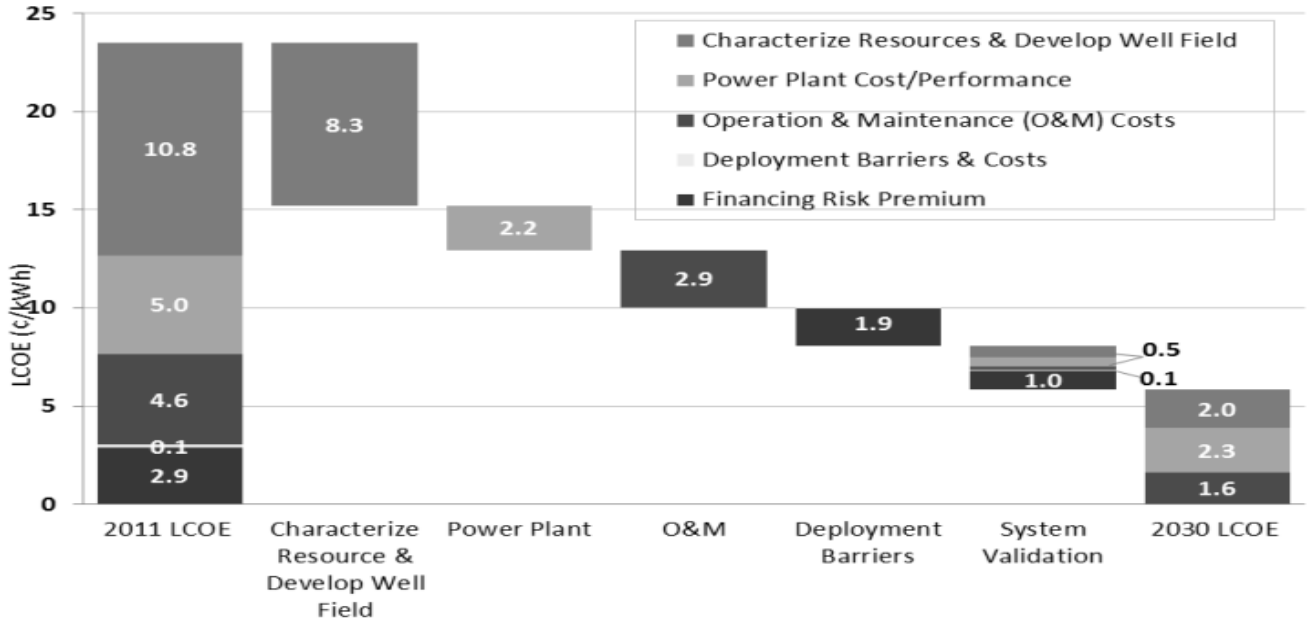


Figure 3: Levelized cost of electricity for newly developed geothermal systems

The program measures its performance through its ability to drive reductions in the cost of geothermal electricity—primarily through technological advancements (e.g., flow per well) and tracking LCOE. The program uses detailed roadmaps to track progress toward its LCOE goal of $.06/kWh by 2030 for newly developed geothermal systems and includes key interim goals to ensure that progress is consistent and measureable against R&D investment. This also helps ensure the ability to rebalance R&D investments, such as when key technology areas achieve significant breakthroughs or when research avenues produce results indicating that other avenues are likely to be more fruitful.

Strategic Performance Management by Program

Performance Measure	**Geothermal - Systems** - Reduce the Levelized Cost of Electricity (LCOE) from newly developed geothermal systems (cents/kWh)[a] 2013: Reduce the LCOE for development of Enhanced Geothermal Systems: assuming non-uniform discount rate.		
Fiscal Year	**2012**	**2013***	**2014**
Target	18 cents/KWh for 24-hour electricity production	22.5 cents/KWh	22.4 cents/KWh
Result	18 cents/KWh		
Endpoint Target	$0.06/kWh by 2030		

[a] The Geothermal Technologies Program previously reported measures in 2012 and prior years on LCOE reduction targets related to near-field EGS development. This measure has been updated for 2013 and 2014 to include all newly developed geothermal system.

*2013 targets represent DOE's FY 2013 Budget Request to Congress. FY 2013 target updates can be found in the upcoming FY 2012-2014 Annual Performance Plan & Report.

Enhanced Geothermal Systems
Funding Profile by Subprogram

(dollars in thousands)

	FY 2012 Current	FY 2013 Annualized CR*	FY 2014 Request
Enhanced Geothermal Systems	15,556	—	42,000
Total, Enhanced Geothermal Technologies	15,556	—	42,000

*FY 2013 amounts shown reflect the P.L. 112 175 continuing resolution level annualized to a full year. These amounts are shown only at the "congressional control" level and above; below that level, a dash (—) is shown.

Enhanced Geothermal Systems (EGS) are engineered reservoirs that are created where there is hot rock but little to no natural permeability or fluid saturation. In an EGS, fluid is injected into the subsurface at low pressures using a safe and well-engineered stimulation process, which causes pre-existing fractures to re-open. These open conduits increase permeability and allow fluid to circulate throughout the rock. This fluid transports heat to the surface where electricity can be generated with current technologies. In the long term, EGS will potentially enable the utilization of an enormous, geographically diverse energy resource on the order of 100–500+ GWe. While there have been a number of EGS projects throughout the world, surmounting the remaining technical barriers to achieve cost-competitive EGS success requires a new approach. Therefore, the subprogram will pursue the development of innovative technology solutions via three complementary technical pathways—closely managed strategic R&D, industry-run EGS demonstration projects, and a government-led EGS field lab focused on EGS optimization and validation.

The EGS field lab is a critical step toward creating a commercial pathway to EGS because it will promote transformative and high-risk science and engineering that the private sector is not financially or operationally equipped to undertake. This represents an evolution from the subprogram's five existing private-sector-run EGS demonstration projects, and the EGS field lab approach will be more fiscally efficient than setting up multiple competing demonstrations sites.

Essential to informing the future direction of EGS are the consideration of higher-risk stimulation methods; the ability to accommodate rapid scope changes; and the comprehensive capture of high-fidelity data that ensures a deep understanding of created systems and reproducibility in a variety of geologic environments. The EGS field lab will enable these activities, which the geothermal private sector cannot pursue because of its small size and risk-adverse nature. A key distinction between existing private-sector-led demonstration projects and the EGS field lab is the ability to develop, test, and comprehensively monitor an engineered reservoir at a scale that has not yet been demonstrated and with minimal upfront risk. The program envisions the field lab as a collaborative and inclusive effort among all forms of geothermal stakeholders; participation from industry, national laboratories, and academia will be integral to the success of the initiative.

A dedicated site where new technologies and techniques can be tested and improved in an ideal EGS environment (as determined by the rigorous scoping analysis underway) will allow the geothermal community to gain a fundamental understanding of the key mechanisms controlling EGS success and how to initiate and sustain fracture networks in low permeability rock formations. This critical knowledge will be used to design and test a methodology for reproducing large-scale, economically sustainable heat exchange systems. An integral part of creating a repeatable development methodology involves testing various well configurations to determine which design most efficiently and effectively exploits in-situ stress directions manifested through fracture orientations (see Figure 4). The program envisions that the first-ever true horizontal well for geothermal purposes could more efficiently stimulate existing micro-fractures and permit access to a greater effective rock volume, which would in turn facilitate greater power production.

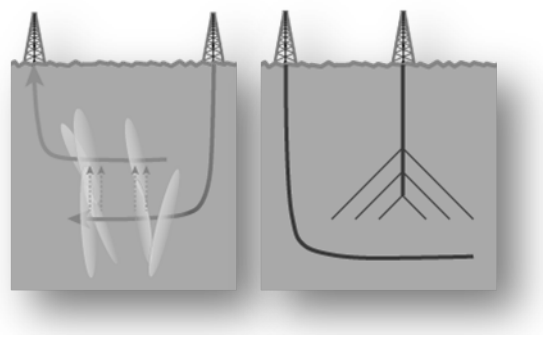


Figure 4: On left: Representation of horizontal well configuration; on right: Representation of combined horizontal and vertical well pair. Testing innovative well designs and orientations may play an integral role in increasing the efficiency of and production from EGS systems.

A comprehensive instrumentation and data collection effort that will capture a higher-fidelity picture of EGS creation and evolution processes than any prior demonstration in the world is essential to this critical technology and methodology development process. This will revolutionize our understanding of EGS conditions and will therefore pave the way for a rigorous and reproducible methodology that will reduce industry development risk. Finally, a dedicated, government-directed EGS field lab allows for the highly integrated comparison of technologies and tools in a controlled and well-characterized environment, as well as the immediate dissemination of technical data to all developers and other interested parties.

Both the site and operator of the EGS field lab will be selected via a competitive process that will weigh a number of technical, operational, regulatory, and cost-share factors. The priority will be to identify a candidate site that maximizes scientific and operational return on investment with the broadest applicability to future EGS activity by industry. The selected site will be managed by the program. The program will direct activities in collaboration and consultation with technology-specific advisory teams comprised of experts from industry, academia, and national laboratories, but the selected entity will solely execute these activities and maintain operational, safety, and regulatory responsibility.

The field lab is designed to be a finite, non-permanent operation. There will be minimal facilities at the site as the focus will be subsurface R&D with no permanent installations. At the end of the designed R&D and testing phase, which the program plans to complete within five years (after one year of set-up), control of the site will revert to the owner. If an EGS reservoir is successfully created, the site owner would then be responsible for any further investment, including surface installations and ultimately power generation. The field lab's success and exit strategy will include a robust and quantitative understanding of the mechanisms that control reservoir creation and sustainability; understanding of the optimal techniques, operating practices, and technologies to employ in the reservoir access and creation process; and ultimately developing, distributing, and publicizing a repeatable methodology for commercial EGS deployment.

In FY 2014, the EGS subprogram will focus on optimizing EGS technologies and building a commercial pathway to power generation via EGS. The subprogram seeks to accomplish this through EGS technology testing and validation at the EGS field lab and through targeted R&D performed in parallel with field lab activities.

EGS Field Laboratory ($30.0 million): In early FY 2014, the location of the field lab will be determined through a competitive process, basing the final selection on detailed site attribute and design analysis; the subprogram is conducting ongoing scoping and planning exercises to identify the physical and logistical characteristics of an optimal EGS field lab. Permitting and associated planning for the field lab will also initiate in FY 2014 after the site is selected. Background seismic monitoring, targeted geologic and geophysical site characterization, and detailed operations planning will begin in late FY 2014 (when permitting is complete) in preparation for the subsequent reworking and logging/drilling of the initial well.

Operations planning at the EGS field lab will be informed in large part by the results of the existing EGS demonstration projects currently underway—all of which will have completed the stimulation phase by the end of FY 2014. These five demonstration projects represent the cutting edge in EGS technology testing today and are already achieving groundbreaking success. Consequently, successes and lessons learned from stimulation methodologies, as well as other technologies employed over the life of these projects, will provide the basis for the detailed technical strategy and explicit goals set at the EGS field lab. For example, one of the program-funded EGS demonstration projects established injection rates necessary to sustain fluid acceptance from deep fractures in its target EGS reservoir. These findings will play an integral role in the formulation of the field lab's stimulation strategy.

Targeted EGS R&D ($12.0 million): Strategic R&D remains a key and fundamental part of the EGS subprogram and must run in parallel with the preparatory work at the EGS field lab. R&D performed in FY 2012 and FY 2013 is focused on addressing key barriers to EGS success, including reservoir access, reservoir creation, productivity, and sustainability, which will later define the breadth of technology deployed at the EGS field lab.

In FY 2014, the subprogram will continue to address these key issues through new and acutely targeted, competitively selected R&D focused on zonal isolation, novel stimulation methodologies, joint geophysical techniques for fracture and reservoir imaging, unique well designs and configurations, and advanced tracer technologies.

Explanation of Funding Changes

(dollars in thousands)

	FY 2012 Current	FY 2014 Request	FY 2014 Request vs. FY 2012 Current
Enhanced Geothermal Systems — The proposed funding increase will allow the subprogram to conduct selection and preparation of the EGS field lab ($30.0 million). This will include selection of the site and an independent operator responsible for field implementation of DOE management and R&D decisions, initiation of the permitting process and any additional required regulatory steps, and initial site instrumentation for baseline data collection. This major initiative is an integral part of the subprogram's strategy to facilitate near-term commercialization of EGS technology. Concurrent with the proposed field lab activities, the subprogram will conduct strategic R&D ($12.0 million) that is focused on lowering the risk and cost of development and characterizing the creation and evolution of EGS.	15,556	42,000	+26,444
Total, Enhanced Geothermal Systems	15,556	42,000	+26,444

Funding Schedule

Fiscal Year	Line Item	Funding (dollars in thousands)
FY 2012	• Pursued the development of EGS reservoir monitoring, innovative drilling, and fracture imaging technologies through continued funding of competitively awarded industry, academia, and national laboratory projects (FY 2011 FOA).	15,556
FY 2013	Planned activities in the FY 2013 Budget (final allocations have not yet been determined): • Continue competitively awarded industry, academia, and national laboratory (FY 2011 FOA) R&D projects using lessons learned to identify technology gaps. • Develop new technologies focused on reservoir creation, including novel stimulation methods, imaging technologies, and advanced zonal isolation techniques, as well as improved understanding of reservoir rock mechanics and fracture characterization. • Scope and plan for EGS field lab development (referred to as EGS test sites in the DOE 2013 Congressional Budget Request)	—
FY 2014	• Conduct targeted R&D focused on zonal isolation, novel stimulation methodologies, joint geophysical techniques for fracture and reservoir imaging, and advanced tracer technologies. • Initiate concerted R&D efforts on unique well designs and configurations, including first-of-its-kind horizontal well in a geothermal setting. • Advance field lab activities: ▪ Finalize the operating system, safety management system, governance structure, and legal/intellectual property (IP) requirements for potential operations awardees ▪ Complete preparation of competitive process for field lab and release FOA	42,000

Fiscal Year	Line Item	Funding (dollars in thousands)
	▪ Finalize future research objectives and cost estimates, based on potential site attributes ▪ Select field lab site and operator using identified criteria weighted by quantitative time and cost metrics ▪ Initiate EGS field lab permitting process ▪ Finalize scoping analysis, initial field design, and preliminary drilling plans ▪ Baseline data collection and monitoring ▪ Design and deploy high-resolution, multi-component data acquisition and seismic monitoring systems (via dedicated monitoring microholes) at the EGS field lab ▪ Incorporate results of EGS demonstration efforts into EGS field lab design and operations planning.	

Low-Temperature and Co-produced Resources
Funding Profile by Subprogram

(dollars in thousands)

	FY 2012 Current	FY 2013 Annualized CR*	FY 2014 Request
Low-Temperature Co-produced Resources	4,940	—	2,000
Total, Low Temperature Co-produced Resources	4,940	—	2,000

*FY 2013 amounts shown reflect the P.L. 112 175 continuing resolution level annualized to a full year. These amounts are shown only at the "congressional control" level and above; below that level, a dash (—) is shown.

The Low-Temperature and Co-produced Resources subprogram aims to provide the geothermal community with the means to achieve development and widespread deployment of economically viable, innovative, and scalable technologies applicable to this technical area. The goal of the subprogram is to provide sufficient testing and validation information for the private sector to increase the cost effectiveness of binary units and lower the LCOE of low-temperature and co-produced resources to $.06/kWh by 2020.

The Low-Temperature and Co-produced Resources subprogram is focused on targeted RD&D for geothermal resources below a temperature of 300°F, as well as geothermal resources that can be co-developed with O&G or combined with other energy technologies. These low-temperature resources, while widespread and highly accessible, have a lower efficiency of power conversion than other geothermal resources due to the lower temperature fluids.

It is estimated that roughly 15–30 billion barrels of hot water are produced annually from O&G wells within the United States.[a] Historically, this "co-produced" hot water has been viewed as an inconvenience and a disposal issue for operators; however, low-temperature power conversion units can now take this waste stream and use the thermal energy within it to generate power. The O&G industry is in possession of tens of thousands of established wells with known temperatures and flows that could be producing emissions-free distributed power.

However, the O&G industry has been reluctant to deploy relatively new or unproven technologies into industry fields due to the perceived risks to current operations and assumed liability issues. Additionally, the relatively low efficiency and cost effectiveness of existing systems brings cost competitiveness for both O&G operations (including onsite, low-cost natural gas production) and other low-temperature applications into question.

By validating the real-world deployment of these units into operating fields, the subprogram is completing the process of demonstrating to industry its economic value, while simultaneously alleviating operations, maintenance and reliability concerns. Additionally, ongoing R&D efforts related to advanced components and hybrid systems have improved efficiencies and lowered per unit costs, thus improving cost competitiveness.

Finally, a targeted initiative in FY 2014 focuses on strategic mineral extraction from geothermal brines, which would also improve the value proposition of low-to-moderate temperature resources. The objectives of this include improving industry's ability to develop, adapt, and validate extraction technologies, as well as ultimately transforming the materials extracted by these technologies into saleable products. Importantly, many of these materials have critical strategic value or application to advanced energy or manufacturing technologies.

Due to the relative maturity of the subprogram portfolio, the subprogram will de-emphasize new power demonstration projects in FY 2014 and shift its focus to targeted R&D and analysis to reduce the LCOE of low-temperature hydrothermal systems ($2.0 million). With these funds, the subprogram will leverage ongoing industry and national laboratory R&D to quicken the pace at which lower temperature hydrothermal and EGS applications become economically competitive. Strategic planning efforts for the subprogram indicate that R&D on

[a] The Future of Geothermal Technology," Jefferson Tester et al., Massachusetts Institute of Technology, 2006, http://geothermal.inel.gov/publications/future_of_geothermal_energy.pdf.

innovative energy conversion and further development of the traditional organic rankine cycle should be priority actions. In FY 2014, the subprogram will dedicate targeted R&D in this area, including hybrid cycles, advanced working fluids, and other power cycle components, with the goal of improving brine effectiveness[a] by 15%. To enable the validation of these technologies in commercial settings, researchers will perform data collection and analysis of prior year demonstration projects. These limited activities will be sufficient to increase power conversion efficiencies and allow for industry "buy in," creating a market for this widely available resource for base-load electricity generation without significant further Federal investment. Activities will build upon work conducted in cooperation with the Fossil Energy Program at DOE's Rocky Mountain Oilfield Testing Center (RMOTC) from 2009–2012. In 2013, the subprogram is demonstrating the applicability of existing binary technologies at commercial O&G fields through equipment deployment focused on comprehensive data collection. Data from these efforts, as well as data collected from completed ARRA and FY 2010 low-temperature demonstration projects, will be used to validate the technical and economic aspects of the technologies and to the establish boundary conditions for each application. These results will be clearly conveyed to industry to promote adoption of these technologies.

Through a competitive funding process, the program will also initiate the strategic mineral activity ($1.0 million). The goal is to develop processes to cost effectively extract valuable and strategically important materials from U.S. geothermal brines, thus creating an additional revenue stream from the geothermal resource, which will improve project economics. This will leverage the program's highly successful co-production project in the Salton Sea area in California, which is the first demonstration facility to co-produce battery materials like lithium, manganese, and zinc from geothermal brines during the geothermal power production process. This project is expected to commence production in late FY 2013 or early FY 2014. This technology is now deployable and applicable to additional project sites throughout the country. In FY 2014, the strategic mineral activity will focus on improving technologies for extracting lithium, developing technologies to extract other key minerals from geothermal brine, and identifying candidate areas and systems for these extraction technologies.

[a] Cycle efficiency is calculated as Power/Heat Input.

Explanation of Funding Changes

(dollars in thousands)

	FY 2012 Current	FY 2014 Request	FY 2014 Request vs. FY 2012 Current
Low Temperature and Co-produced Resources — Due to the relative maturity of the subprogram portfolio following the success of prior year activities, the subprogram will de-emphasize new power demonstration projects in FY 2014 and shift its focus to targeted R&D and analysis to reduce the LCOE of hydrothermal systems. Of this request, $1 million will be focused on the Strategic Mineral activity to cost-effectively extract valuable materials—such as lithium and zinc—from geothermal brines and to improve project economics.	4,940	2,000	-2,940
Total, Low-Temperature and Co-produced Resources	4,940	2,000	-2,940

Funding Schedule

Fiscal Year	Line Item	Funding (dollars in thousands)
FY 2012	• Completed RMOTC demonstration, data collection, and relocation to commercial field activities. • Conducted R&D on advanced working fluids. • Completed an update of the Low-Temperature Geothermal Resource Assessment in coordination with the U.S. Geological Survey.	4,940
FY 2013	Planned activities in the FY 2013 Budget (final allocations have not yet been determined): • Analyzed Hybrid Geothermal/Concentrating Solar Power (CSP) concept. • Commercial field demonstrations of binary units. • Disseminate the Low-Temperature Geothermal Resource Assessment digital data series in cooperation with the U.S. Geological Survey. • Update the Sedimentary Geothermal Resource Assessment in cooperation with the U.S. Geological Survey.	—
FY 2014	• Conduct R&D on hybrid cycles for binary power plants. • Begin the strategic mineral initiative. • Collect and analyze data on demonstration projects to validate the economics of binary units in commercial O&G applications. • Disseminate the Sedimentary Geothermal Resource Assessment digital data series in cooperation with the U.S. Geological Survey.	2,000

Innovative Exploration Technologies
Funding Profile by Subprogram

(dollars in thousands)

	FY 2012 Current	FY 2013 Annualized CR*	FY 2014 Request
Innovative Exploration Technologies	12,483	—	12,000
Total, Innovative Exploration Technologies	12,483	—	12,000

*FY 2013 amounts shown reflect the P.L. 112 175 continuing resolution level annualized to a full year. These amounts are shown only at the "congressional control" level and above; below that level, a dash (—) is shown.

The USGS estimated in 2008 that 30,000 MW[a] of undiscovered hydrothermal resources could still be found in the western United States alone, representing the potential to increase current U.S. geothermal energy production capacity by a multiple of 10.[b] These resources are defined by the presence of three key elements associated with geologically active areas: heat, fluid, and permeability (the ability for fluid to flow through rock). However, most of them are categorized as "blind" systems (i.e., they show little to no surface expression). The risks and costs associated with geothermal development in these poorly characterized areas are high, and the inability to consistently drill economically viable wells is a major barrier to near-term capacity expansion. The Innovative Exploration Technologies subprogram is addressing this challenge through critical research, development and technical analysis.

To find "blind" hydrothermal systems, scientists need to identify geochemical and geophysical signatures of hot fluid that are up to 10,000 feet underground. This is a challenge, especially given that hot water alone does not provide a unique signature; its presence has to be inferred by other detected features, for instance, sub-surface structures or physical properties (e.g., resistivity, magnetic, gravity, or seismic responses).

The core of the exploration technologies used in geothermal, originally developed to detect O&G, have been extended with varying success to the more challenging structural and temperature environment of geothermal. For instance, seismic surveys can frequently be used in O&G to determine not only sub-surface structures, but also porosity and fluid type of the reservoir. This is far more difficult in geothermal, and more work is needed on advanced seismic techniques before the technique becomes as useful in geothermal exploration as it is in O&G. Geochemical and isotope signals in surface or deep waters can also provide important clues to the presence of "blind" geothermal systems, but they currently do not provide consistently reliable results. Therefore, a step change evolution of the exploration tool suite is critical to provide a means to better and more cost effectively interpret the characteristics of the subsurface.

Another major barrier to increased geothermal development in the United States is geothermal well cost. Drilling in the typically high-temperature, hard-rock geothermal environments[c] presents challenges unique to this sector. Potential technical pathways to lower these costs include drilling systems, well completion technologies, and drill bits.

This subprogram is focused on supporting the development of the technologies necessary to effectively find and access "blind" resources at lower cost, after which, they can be developed and brought online by the private sector. The subprogram's goal is to lower the LCOE of "blind" resources to $.06/kWh by 2020 by decreasing geothermal exploration risk and lowering drilling costs in geothermal environments.

Results from ongoing projects, discussions with the private industry, and exploration technologies roadmapping have conclusively shown that industry

[a] Range was from a P95 of 7,900 MW_e to a P5 of 73,000 MW_e.

[b] "Assessment of Moderate- and High-Temperature Geothermal Resources of the U.S.," Williams, Colin F. et al., U.S. Geological Survey, 2008, http://pubs.usgs.gov/fs/2008/3082/pdf/fs2008-3082.pdf.

[c] Typical of all geothermal reservoirs, but atypical in terms of traditional oil and gas reservoir types.

needs better tools to image and predict heat and permeability in the subsurface.

In FY 2014, the subprogram will fund next-generation R&D focused on better detection of thermal and permeability signatures of hydrothermal systems, advanced subsurface imaging capabilities, and decreased drilling costs in the harsh environment encountered in geothermal wells. This will be done through fully funded competitive awards open to private industry, academia, and the national laboratories. Improved and new technologies will allow developers to more successfully target exploration wells, improve the probability of success and certainty of resource size, and develop resources economically.
This new funding will build upon successes and lessons learned from the subprogram's current RD&D portfolio.

Finally, the subprogram will complete a new prospect identification effort. This effort is based on the successful completion of a geothermal exploration data gap analysis for the western United States in 2012, and a subsequent effort in 2013 to collect data using innovative technologies in areas where high geothermal potential coincides with critical data gaps.

Explanation of Funding Changes

(dollars in thousands)

	FY 2012 Current	FY 2014 Request	FY 2014 Request vs. FY 2012 Current
Innovative Exploration Technologies — Subprogram activities will continue to focus on next-generation R&D for better detection of thermal and permeability signatures of hydrothermal systems, advanced sub-surface imaging capabilities, and decreased drilling costs in the harsh environment encountered in geothermal wells.	12,483	12,000	-483
Total, Innovative Exploration Technologies	12,483	12,000	-483

Funding Schedule

Fiscal Year	Line Item	Funding (dollars in thousands)
FY 2012	• Conducted R&D on advanced geophysical methods. • Conducted R&D on innovative geochemical techniques and tools. • Advanced drilling technologies for harsh geothermal environments. • Identified exploration data gaps, as well as evaluation and planning activities to maximize the impact of the subprogram. • Conducted geophysical, geological, and geochemical surveys for the evaluation of identified and undiscovered geothermal resources in coordination with the U.S. Geological Survey.	12,483
FY 2013	Planned activities in the FY 2013 Budget (final allocations have not yet been determined): • Conduct R&D on advanced geophysical methods. • Conduct R&D on innovative geochemical techniques and tools. • Advance drilling technologies for harsh geothermal environments. • Collect and analyze key resource information on regions where no hydrothermal development exists and where research has been limited in order to build a robust set of prospect areas and promote industry development. • Evaluate and plan activities to maximize the impact of the subprogram.	—

Fiscal Year	Line Item	Funding (dollars in thousands)
FY 2014	• Continue developing advanced drilling technology tailored to the geothermal subsurface environment. • Conduct R&D on innovative technologies to detect subsurface thermal signatures from the surface. • Conduct R&D on advanced techniques and tools to map subsurface permeability from the surface or nearby wells. • Evaluate and plan activities to maximize the impact of the subprogram. • Publish reports and a digital data series on the results of the FY 2012 update to national hydrothermal resource assessment and provide public access to all new or modified modeling software in coordination with the U.S. Geological Survey.	12,000

Systems Analysis
Funding Profile by Subprogram

(dollars in thousands)

	FY 2012 Current	FY 2013 Annualized CR*	FY 2014 Request
Systems Analysis	4,000	—	4,000
Total, Systems Analysis	4,000	—	4,000

*FY 2013 amounts shown reflect the P.L. 112 175 continuing resolution level annualized to a full year. These amounts are shown only at the "congressional control" level and above; below that level, a dash (—) is shown.

The Systems Analysis subprogram focuses on cross-cutting analysis and informational activities to support reducing cost, risk, and time of resource discovery, confirmation, and development. It cuts across the entire geothermal technology portfolio. Key activities include techno-economic modeling to evaluate system performance and cost; data collection, storage, and broad dissemination; sensitivity analysis of critical technologies; development of geothermal RD&D protocols and best practices; and analysis of geothermal life-cycle environmental performance. Each activity uses a systems approach to define technical targets and requirements, guide technology development, and validate technologies for deployment.

The goals of the Systems Analysis subprogram are to

- Continuously identify key technology pathways to commercial geothermal advancement, through a comprehensive techno-economic analysis
- Collect and disseminate demonstrated data from the field to reduce uncertainty and increase investor confidence
- Work with other Federal agencies to disseminate reliable resource data and to reduce technical, timeline, and financing uncertainties
- Develop financial scenarios for rapid deployment
- Identify and develop solutions to non-technical barriers to geothermal development
- Serve as a convener for a broad suite of stakeholders on integrated geothermal deployment barriers.

Specifically, FY 2014 will continue to focus on the followings tasks:

- Develop performance and cost targets for geothermal development in all suitable temperature, geological, and hydrological regimes;
- Capture, adapt, and develop best practices for horizontal drilling in geothermal settings from O&G
- Disseminate high-quality project data for broad use by industry, researchers, agencies, legislators, interested public, educators, and investors
- Benchmark and link domestic and international geothermal data sets
- Leverage program RD&D efforts with international partners through collaboration and information sharing
- Develop best practices for minimizing life-cycle water consumption for EGS plants and developments
- Address stakeholder concerns and expectations about geothermal energy.

Explanation of Funding Changes

(dollars in thousands)

	FY 2012 Current	FY 2014 Request	FY 2014 Request vs. FY 2012 Current
Systems Analysis — The subprogram will continue to focus on cross-cutting analyses, such as techno-economic modeling analysis, environmental analysis, and information-sharing activities, as well as planning and systems analysis to support the design and scoping of the EGS field lab initiative.	4,000	4,000	0
Total, Systems Analysis	4,000	4,000	0

Funding Schedule

Fiscal Year	Line Item	Funding (dollars in thousands)
FY 2012	• Developed baseline LCOEs for hydrothermal and EGS resources using a techno-economic model – the Geothermal Electricity Technology Evaluation Model (GETEM). • Developed "as-built" permitting flow charts for geothermal projects at the Federal, state, and local level for eight western states. • Estimated the life-cycle environmental merit (energy and emissions) of substituting supercritical carbon dioxide for water in a geothermal reservoir. • Estimated the range of life-cycle energy and emissions from geothermal field exploration. • Evaluated water availability for future geothermal growth within the context of regional water constraints, building upon previous work by quantifying the water demand of future geothermal growth to identify potential water availability barriers to geothermal development. • Expanded the examination of geothermal life-cycle water quality issues to include EGS and hydraulic stimulation activities in accordance with a review of past and existing EGS projects to identify potential water quality barriers to geothermal development. • Developed optimum geothermal performance criteria for exploration, drilling, and reservoir creation. • Developed a provisional geothermal resource classification in coordination with the U.S. Geological Survey.	4,000
FY 2013	Planned activities in the FY 2013 Budget(final allocations have not yet been determined): • Conduct a sensitivity analysis of critical research being funded for hydrothermal and EGS resources using the Geothermal Electricity Technology Evaluation Model (GETEM). • Complete "as-built" permitting flow charts for geothermal projects for all 13 western states. • Characterize geothermal technologies and publish best practices to help expedite the geothermal permitting process. • Estimate reservoir fluid volumes and establish fluid properties for life-cycle assessment. • Complete analysis of the CO_2 emissions (g/kWh) distribution of existing and potential geothermal power and coordinate with EERE efforts. • Complete the environmental life-cycle criteria pollutant assessment for program-funded power plants and compare and contrast with other power production technologies. • Expand the assessment of life-cycle water consumption to determine reservoir water loss from EGS activities. • Identify water management practices associated with EGS stimulation activities to address stakeholder concerns. • Study the interaction between reservoir temperature and pressure drawdown to identify R&D needs for sustaining geothermal reservoirs.	—
FY 2014	• Deploy the National Geothermal Data System—an interactive, open-source database that includes geothermal data from providers across the United States, including all 50 states' geological surveys, the nation's leading academic geothermal centers, the geothermal industry, and various Federal agencies. • Provide detailed analysis of LCOE breakdown by drilling, exploration, and reservoir creation using GETEM. • Conduct planning and systems analysis to support design and scoping of the EGS field lab initiative. • Disseminate, link, and benchmark geothermal data sets submitted to the DOE Geothermal Data Repository. • Continue developing a life-cycle emissions inventory of geothermal technologies by including additional technology stages and updating geothermal greenhouse gas emissions for well	

Fiscal Year	Line Item	Funding (dollars in thousands)
	field exploration data. • Conduct a return on Investment analysis of the program's R&D portfolio. • In cooperation with the U.S. Geological Survey, adopt key geological, socioeconomic, and project feasibility parameters of the United Nations Framework Convention Geothermal Resource Classification system.	4,000

Advanced Manufacturing[a]
Funding Profile by Subprograms

Non-Comparable Structure

(dollars in thousands)

	FY 2012 Current	FY 2013 Annualized CR*	FY 2014 Request
Next Generation Manufacturing R&D Projects			
Advanced Manufacturing R&D Projects	18,556	—	120,000
Materials R&D Projects	13,537	—	0[b]
Steel Manufacturing	4,066	—	0[b]
Combined Heat and Power R&D	24,175	—	0[b]
Total, Next Generation Manufacturing R&D Projects	60,334	—	120,000
Advanced Manufacturing R&D Facilities		—	
Critical Materials Hub	19,340	—	25,000
Clean Energy Manufacturing Innovation Institutes	15,288	—	192,500
Total, Advanced Manufacturing R&D Facilities	34,628	—	217,500
Industrial Technical Assistance	17,730	—	27,500
Total, Advanced Manufacturing	112,692	116,287	365,000

*FY 2013 amounts shown reflect the P.L. 112 175 continuing resolution level annualized to a full year. These amounts are shown only at the "congressional control" level and above; below that level, a dash (—) is shown.

Comparable Structure

(dollars in thousands)

	FY 2012 Current	FY 2013 Annualized CR*	FY 2014 Request
Next Generation Manufacturing Processes	62,085	—	220,000
Next Generation Materials	32,877	—	117,500
Industrial Technical Assistance	17,730	—	27,500
Total, Advanced Manufacturing	112,692	116,287	365,000

*FY 2013 amount shown reflect the P.L. 112 175 continuing resolution level annualized to a full year. These amounts are shown only at the "congressional control" level and above; below that level, a dash (—) is shown.

SBIR/STTR:

- FY 2012 Transferred: SBIR: $2,545,000; STTR: $343,000
- FY 2013 Annualized CR Transferred: SBIR: $661,765
- FY 2013 Annualized CR: SBIR $2,019,235; STTR: $347,000)
- FY 2014 Request: SBIR $9,113,000; STTR: $1,182,000

[a] Industrial Technologies, renamed Advanced Manufacturing in FY 2014.

[b] Materials R&D Projects, Steel Manufacturing, and Combined Heat and Power R&D will remain eligible for funding in FY 2014 through broader, competitive, merit-reviewed funding opportunities under Advanced Manufacturing R&D Projects.

FY 2014 Office Summary

- The funding increase for the Advanced Manufacturing R&D Facilities subprogram will support the creation of Clean Energy Manufacturing Innovation Institutes consistent with the President's vision for a larger multi-agency National Network for Manufacturing Innovation (NNMI). These are shared research facilities where industry and research institutions come together to develop and leverage cutting-edge cross-cutting advanced manufacturing capabilities to develop high-impact commercial manufacturing innovations. This funding increase also supports +$5.6 million for the Critical Materials Energy Innovation Hub relative to FY 2012 level to develop solutions across the lifecycle of critical materials (+$183.0 million).
- The funding increase for the Next Generation R&D Projects subprogram focuses on Advanced Manufacturing R&D projects in foundational cross-cutting manufacturing technologies to dramatically increase U.S. manufacturing energy productivity at the bench and prototype scale (+$60.0 million).
- The funding increase for Industrial Technical Assistance will help enable the increased deployment of energy efficient manufacturing technologies, including combined heat and power (CHP), across American industry through training programs, site assessments, and standards development (+$9.8 million).

Overview

Manufacturing converts a wide range of raw materials, components, and parts into finished goods that meet market expectations. The manufacturing sector provides about 12% of U.S. Gross Domestic Product (GDP) and employs nearly 12 million Americans today. It is an industry that is, and will continue to be, critical to future U.S. global economic competitiveness and job growth. As the National Science and Technology Council National Strategic Plan for Advanced Manufacturing notes, "Technology-based improvements to productivity made possible by the manufacturing sector consistently generate job growth over time across the economy" [a]. In addition, the manufacturing sector develops and produces many of the technologies that advance the competitiveness and growth of the entire economy, including the service sector; every dollar spent in manufacturing generates 1.35 dollars in additional economic activity.[b]

Despite the economic benefits of a thriving manufacturing sector, domestic producers are facing significant and increasing challenges in the global marketplace. To assist in regaining America's position as the world leader in advanced manufacturing competitiveness and bringing high tech manufacturing jobs back to the United States, public investments must bring together universities, research institutions, suppliers, and manufacturers to help ensure we are leading the race to develop and deploy advanced manufacturing technologies and processes. This approach will provide resources to develop critical foundational technologies sought by small, medium, and large manufacturers and to help address the innovation challenges and opportunities that will ensure cutting-edge clean energy products and high technology products that reduce life-cycle energy consumption are made in the United States. The program supports a targeted technology portfolio to accelerate research, development, demonstration, and deployment (RDD&D) of these technologies. Accelerating these technologies through cutting-edge R&D and deployment activities focused on increasing energy productivity in U.S. manufacturing industries will enable the creation of American leadership in the manufacturing of clean energy and energy efficiency products and boost American manufacturing competitiveness across the board.

The Clean Energy Manufacturing Initiative (CEMI) is a new cross-cutting activity that will incorporate the technical expertise of many of EERE's programs. CEMI will be anchored by the Advanced Manufacturing Office and, with strong involvement and dedicated funding through several EERE programs, will focus on the urgent economic opportunity in U.S. clean energy manufacturing. The goals of this effort are to dramatically improve U.S. competitiveness in the manufacturing of clean energy products (such as solar modules, LED's, batteries, and wind blades) and strengthen U.S. competitiveness across multiple manufacturing industries through increased energy productivity.

[a] National Science and Technology Council. "A National Strategic Plan for Advanced Manufacturing." Web. February 2012. http://www.whitehouse.gov/sites/default/files/microsites/ostp/iam_advancedmanufacturing_strategicplan_2012.pdf

[b] Bureau of Economic Analysis, Industry-by-Industry Total Requirements Table. www.bea.gov/iTable/index_industry.cfm

The program's main objectives are to:

- Catalyze public-private collaboration to transition scientific innovations into manufacturing capabilities for the United States economy.
- Support the development of cutting-edge foundational manufacturing technologies to a scale relevant to industry as a key part of national interagency manufacturing efforts like the Advanced Manufacturing Partnership.
- Drive a corporate culture of continuous improvement and wide-scale adoption of technologies to reduce energy use in the manufacturing sector.

The program strengthens American manufacturing competitiveness and energy productivity in three distinct ways, described directly in the new subprogram structure. In FY 2014, these subprograms seek to:

Next Generation Manufacturing R&D Projects: Invest in high impact Next Generation Manufacturing R&D projects focused on foundational manufacturing processes and materials at America's most innovative companies and research institutes. These projects will address core technical issues for foundational technologies that will enable U.S. manufacturers to realize significant gains in energy productivity and globally-competitive production and will focus on specific high-impact manufacturing technology and process challenges. The subprogram includes advanced manufacturing "next generation" R&D projects previously selected and managed from the Innovative Manufacturing Initiative funding opportunity announcement (FOA) that closed in FY 2012.

Advanced Manufacturing R&D Facilities: Support the creation of approximately three new Clean Energy Manufacturing Innovation Institutes in FY 2014, consistent with the President's vision for a larger multi-agency National Network for Manufacturing Innovation (NNMI). The Institutes will provide American companies – especially small and medium-sized enterprises (SMEs) – timely and affordable access to cutting-edge physical and virtual advanced manufacturing tools. They will help SMEs develop and transition to industry next-generation materials and process technologies to advance U.S. manufacturing competitiveness in clean energy and energy efficient manufacturing technologies. The Institutes will focus on foundational technologies that are broadly applicable and pervasive in multiple industries and markets with potentially transformational technical and manufacturing productivity impact. The program is planning to invest between approximately $70 million and $120 million into each of these Institutes, depending upon the magnitude of the opportunity, maturity, and capital intensity of the technology; scope of the focus area; and degree of non-Federal cost-sharing above a 1:1 ratio. These funds are to be expended over 5 to 7 years, and the program will front fund each Institute to the greatest extent practicable The existing Manufacturing Demonstration Facility (MDF), the Critical Materials Hub, and the program's partnership support with the Department of Defense (DOD) for the National Network for Manufacturing Innovation (NNMI) pilot institute on additive manufacturing will all be part of the subprogram's broader efforts. No new MDF's are expected be funded going forward. In their place, Clean Energy Manufacturing Innovation Institutes will be created instead.

Industrial Technical Assistance: Increase the program's efforts to work with industry to facilitate the adoption of energy cost-reducing technologies through technical assistance that provides U.S. industry with the education and tools to adopt these advanced energy efficiency technologies in their existing facilities. These efforts will include the following activities:

- Better Buildings, Better Plants Program
- ISO/ANSI Standards Certification
- Combined heat and power Technical Assistance Partnerships, formerly known as the Clean Energy Application Centers
- Industrial Assessment Centers (IAC).

The program is also partnering with other agencies, such as the Department of Defense, to identify opportunities to co-invest in critical manufacturing capacities of mutual interest. The program is currently a partner with the DOD to invest in the NNMI Pilot institute in additive manufacturing in Youngstown, Ohio, which was recently named as one of the top ten most innovative economic development initiatives in the United States by The Brookings Metropolitan Policy Program and The Rockefeller Foundation.[a] The program will continue to work with DOD and other agencies on synergistic projects through this and other co-investments aligned with both DOE and DOD priorities. To support co-investment opportunities with DOD and improve the effectiveness of Federal investments in critical cross-cutting manufacturing technologies of mutual interest, the program's budget request includes up to $50 million Defense Production Act transfer authority within the

[a] http://namii.org/namii-named-one-of-the-top-ten-most-innovative-economic-development-initiatives-by-the-brookings-institution-and-the-rockefeller-foundation

Next Generation Manufacturing R&D Projects subprogram.

The energy productivity of the U.S. manufacturing sector is critical to its global competitiveness, and the program's investments will support progress toward the President's goal of cutting in half the energy wasted by our homes and businesses, doubling our energy productivity over the next 20 years. The specific goal of the program is to help develop technologies to reduce the life-cycle energy consumption of affected manufactured goods by 50% within 10 years of the start of each development effort, compared to conventional manufacturing processes, and to encourage a culture of continuous improvement in manufacturing energy efficiency, including through the adoption of combined heat and power through industrial technical assistance partnerships.

Incubator Programs: The great majority of EERE investments are currently, and must going forward, be primarily driven by detailed short, medium, and long-term RDD&D roadmaps. EERE proposes Incubator activities in the FY 2014 budget, and designed them to use a small fraction of EERE's technology office's annual R&D budget to regularly introduce potentially high-impact "off-roadmap" new technologies. These Incubator activities will enable the "rapid on-ramping" of potentially transformational new energy technologies into the EERE portfolio, dramatically increasing the rate of technology innovation.

Technology Status, Program Accomplishments, and Near-Term Milestones[a]

Since 1979, the program cost-shared RD&D projects that have resulted in the cumulative commercialization of more than 220 new, energy efficient manufacturing technologies. These R&D projects have helped increase the competitiveness of U.S. industry and have led to 265 issued patents and 78 R&D 100 awards from 1999 to 2012. In 2009 alone, technologies developed through the program's R&D funding saved 53.1 trillion BTUs (British Thermal Units) that year.[b] The program expects even greater energy savings and contributions to U.S. manufacturing value added when its recent and continuing investments in R&D projects and facilities begin to have an impact across the economy.

The program's Manufacturing Demonstration Facility (MDF) at Oak Ridge National Laboratory, is focusing on developing cutting-edge additive manufacturing/3D printing processes and low cost carbon fiber. It has attracted interest from more than 200 potential partner organizations in its first year of operation. In 2012, 24 organizations engaged with the facility as active participants, leading to 25 Cooperative Research and Development Agreements (CRADAs), Work for Others, Material Transfer Agreements, and other types of industry partnership agreements. Partners have included manufacturers from industries such as solar energy, metals forging, robotics, glass, metals forming, composites, automotive, aeronautics, and several others. For example, one single partnership between a large U.S. chemical company and automobile maker has led to a $4.5 million private funding match on R&D for low-cost domestic production of carbon fiber with the potential to cut carbon dioxide emissions by 50%[c]. The MDF provides a collaborative, shared infrastructure that facilitates the development, integration, evaluation and commercialization of energy efficient, rapid, flexible manufacturing technologies. In addition to R&D successes like these, the MDF has also formed partnerships with two local community colleges to develop advanced manufacturing training programs in response to workforce challenges as identified by industry partners. The MDF is also engaged with a local economic development organization to accelerate the development of high-growth companies in the region through entrepreneurial and business support, including guidance on access to capital. The early success of this MDF provides strong support for the value of the President's proposed National Network for Manufacturing Innovation and the new Clean Energy Manufacturing Innovation Institutes proposed in the program's FY 2014 budget.

Through its Industrial Technical Assistance subprogram, the program has also delivered technical assistance to more than 33,000 industrial plants. Collectively, the program's activities have saved industry billions dollars and cut carbon emissions by millions of tons.
The program has also recently invested in a portfolio of technologies in combined heat and power through its current programs. Since 1970, as CHP use has increased by nearly a factor of six, EERE has also helped manufacturing facilities owners to nearly double the collective combined efficiency of their heat production

[a] For a list of milestones please see "Strategic Performance Management by Program" section.
[b] IMPACTS; Industrial Technologies Program: Summary of Program Results for CY 2009 http://www1.eere.energy.gov/manufacturing/about/pdfs/impacts2009_full_report.pdf. Accessed 2012.

[c] http://www1.eere.energy.gov/manufacturing/pdfs/imi_project_descriptions.pdf

and electricity generation through the installation of CHP. For example, EERE's network of Clean Energy Application Centers has supported more than 225 energy assessments, and provided over 700 technical support activities for CHP projects, supporting over 1.5 gigawatts (GW) of CHP capacity installed or under development in the United States.

Next generation manufacturing R&D projects selected in FY 2012 and FY 2013 from the Innovative Manufacturing Initiative FOA, which closed in FY 2012, have targeted advancements in manufacturing technologies and materials. The topic areas of these projects represent research areas that the program believes can have a strong impact on U.S. clean energy manufacturing and manufacturing energy productivity competitiveness.

Concerning manufacturing technologies, four of these competitively-selected projects are focused on reactions and separations in energy-intensive industries. Two of these projects are intended to reduce chemical manufacturing energy use, with potential savings approaching 0.25 quads; this energy-intensive sector consumes 5.0 quads annually, or 26% of manufacturing energy use.

Two projects propose to capture a portion of the large amount of underutilized waste heat available across various manufacturing industries; while another is looking at novel polymers for use in heat exchange applications. Of the four projects focused on sustainable manufacturing, one is developing a smart manufacturing platform which could provide savings of up to 30% in specific applications, with estimated potential savings of 1.3 quads across manufacturing.

Concerning materials, four projects are focused on providing cost or performance improvements that will yield substantial lifecycle energy benefits for manufactured products. For example, one project is focused on advanced GaN, a wide bandgap semiconductor for the next generation of power electronics, with energy-saving applications in motors, lighting, and transportation. The four materials projects could collectively save 0.6 quads annually in transportation applications as market penetration increases for these advanced materials. In total, seven of the 18 technologies under development would directly impact transportation energy use.

Since 2012, the program has continued to make significant investments in the advanced manufacturing processes related to the steel industry. Between 2012 and 2013, three R&D projects were competitively selected and/or awarded focused on advanced manufacturing processes applicable to the steel industry. To address current high temperature processes, a novel iron-making process and low-temperature stamping technology could potentially save over 65 trillion Btu (TBTUs) in the iron and steel industry. Another project is working to develop an advanced sheet metal forming tool which could reduce scrap metal generation by 70%, reduce energy consumption by 70%, and reduce costs for production by 90%. A third project is researching an alternative method to hot stamping of high strength, light weight steels. These projects are expected to save trillions of BTU of energy if successful.

Some examples of previously completed projects that have been successful include:

- A steelmaker that partnered with EERE to reduce four energy-intensive iron plant process steps—coke making, sintering, power plants, and blast furnaces—into a one-step breakthrough iron manufacturing process that saves time, eliminates the need for carbon-intensive coke, and consumes 30% less energy than a conventional blast furnace
- A company that used EERE support to take previously fragile and expensive super-insulation based upon extremely porous materials called aerogels and pioneered the commercial-scale production of flexible industrial insulation for piping, tanks, and other equipment that is twice as thin as, and up to five times more thermally efficient than, the current standard. The company has sold millions of square feet of this insulation, saving U.S. manufacturers money on energy costs while improving competitiveness.

Program Planning and Management

The program is strategically positioned to strengthen EERE's investment portfolio by addressing the critical cross-cutting materials and manufacturing challenges that are shared across multiple clean energy technologies and energy-intensive manufacturing industries. The program is adopting lifecycle-based performance metrics to accurately account for materials and process technologies with large impacts both within and outside of the industrial sector. For example, the development of manufacturing technologies to enable low-cost lightweight composite structures can have a significant impact on a variety of sectors including vehicles, wind power components, and aerospace. The program will continue to coordinate with other EERE programs, private industry, and academia to identify and co-invest in broadly-applicable technology domains that strengthen U.S. manufacturing capability. Competitive

FOAs under the Next Generation Manufacturing R&D Projects and the Advanced Manufacturing R&D Facilities subprograms are the mechanisms by which the program will target critical opportunities, including the EERE Wide Bandgap Semiconductors for Clean Energy Initiative. Finally, the program will also coordinate with other EERE programs through the EERE CEMI and other national initiatives like the proposed NNMI and the Materials Genome Initiative (MGI).

Program analysis and evaluation techniques are informed by historical accomplishments to guide the investment strategies of the program. The program is currently completing the development of a lifecycle systems and benefits analysis tool that aims to capture both the manufacturing sector energy consumption and product life-cycle energy consumption implications of manufacturing innovations. The result will be a transparent and uniform system of comparing production-phase and use-phase impacts of manufacturing technologies that will help the program to prioritize investment areas and select projects using projections for reduction in energy use, reduction in emissions, and/or increase in value-added through the supply chain.

The program relies on strategic planning, analyses, and stakeholder engagement to guide decisions according to EERE's "5 Core Questions" on where RD&D investments will result in the greatest benefit to the American economy. The program portfolio will invest in foundational technologies that ensure:

1) High Impact: Is this a high-impact problem?
2) Additionality: Will the EERE funding make a large difference relative to what the private sector (and other funding entities) is already doing?
3) Enduring Economic Benefit: How will this EERE funding result in enduring economic benefit to the United States?
4) Openness: Have we made sure to focus on the broad problem we are trying to solve and be open to new ideas, new approaches, and new performers?
5) Proper Role of Government: Why is what you are doing a proper high-impact role of government versus something best left to the private sector to address on its own?

Through an initial analysis, including recommendations from leading manufacturing experts across the country as captured in the PCAST report[a] as well as input from over 250 experts from industry and academia gathered from a series of workshops, the program has identified a number of candidate foundational manufacturing technology areas. Feedback from over 850 stakeholders in the manufacturing community obtained through four regional "Designing for Impact" workshops hosted by the Advanced Manufacturing National Program Office (AMNPO) and the 78 responses to the formal Request for Information released by the AMNPO in 2012 has further informed the program's analysis.[b] Candidate areas that are under consideration for support by the program for RD&D activities include:

- Additive manufacturing
- Wide band gap semiconductors such as silicon carbide (SiC) and gallium nitride (GaN) that will serve as the basis for a new generation of semiconductor devices for power conversion beyond silicon
- Low-cost carbon fiber composites
- Low-cost high-strength structural metals
- Membranes for more efficient industrial separations
- Catalysts to increase the efficiency of industrial processes
- In-situ metrology and process controls.
- Multi-material joining
- Advanced modeling and simulation and high performance computing technologies for manufacturing
- Combined heat and power systems
- Direct heating RF and microwave process technologies
- Other technology areas that will benefit multiple clean energy sectors and the entire economy by boosting manufacturing energy productivity and lowering manufacturing energy costs across multiple industries.

The program will invest in cutting-edge R&D in foundational manufacturing technologies like those listed above and those with significant potential to improve or replace energy-intensive manufacturing processes. These topics will form the basis for the program's competitive R&D funding opportunities in both the Next

[a] President's Council of Advisors on Science and Technology. "Report to the President on Capturing Domestic Competitive Advantage in Advanced Manufacturing." Web. July 2012. http://www.whitehouse.gov/sites/default/files/microsites/ostp/pcast_amp_steering_committee_report_final_july_17_2012.pdf

[b] http://www.manufacturing.gov/rfi_responses.html

Generation Manufacturing R&D Projects and the Advanced Manufacturing R&D Facilities subprograms.

One example of the potential impact of these foundational technology areas is the use of wide bandgap semiconductors, such as silicon carbide (SiC) and gallium nitride (GaN), for next generation power electronics which offer benefits across the EERE portfolio including renewable electricity (solar and wind), transportation (electric drive vehicles and fuel cells), and energy efficient data centers, power supplies for consumer based power electronics, and variable speed motors used in industry, appliances, and heating, ventilation and air conditioning (HVAC) applications. Estimated efficiency improvements from wide bandgap semiconductors include those from the lower switching frequency power losses compared to silicon. For example, recently commercialized silicon carbide transistor devices (MOSFETs) are reported to improve system efficiency up to 2%[a]. Scaling up the manufacture and reducing the cost of wide bandgap semiconductor-based power electronics components offers, for example, tremendous potential to reduce the cost and increase adoption of solar power and electric vehicles in the market. In fact, the SunShot Initiative and the Vehicle Technologies program have identified cost reductions in advanced components of solar inverters and integrated motor-inverter subsystems, respectively, as critical to their goals.

Another example can be found in the production of carbon fiber. Lower cost, lower energy processes to manufacture carbon fiber and carbon fiber composites could enable broader use of this promising high strength, light-weight material in clean energy systems, aerospace, and automotive U.S. manufacturing industries which combined contribute to over 3% of U.S. GDP.[b,c]

Light weighting is an important efficiency strategy. A 10% reduction in vehicle weight can improve fuel economy by 6% – 8%, or increase the range of a battery-electric vehicle by up to 10%.[d]

As a final example, separation processes account for roughly 60% of the energy use in the chemical and petroleum industries, and these industries account for approximately 34% of total U.S. manufacturing energy use. The development and demonstration of advanced separation technologies and improvements in manufacturing of membrane separation technologies could enable significant energy productivity gains in these and other important U.S. industries.

[a] S. Davis, 1200V SiC MOSFET Poised to Replace Si MOSFETs and IGBTs, Power Electronics Technology, February 2011

[b] "Contribution of the Automotive Industry to the Economies of All Fifty States and the United States." Center for Automotive Research, 2010.

[c] "U.S. Aerospace Manufacturing: Industry Overview and Prospects," Congressional Research Service, 2009.

[d] "Quadrennial Technology Review" Department of Energy, 2011 (p.39) http://energy.gov/sites/prod/files/QTR_report.pdf

Strategic Performance Management by Program

Performance Measure	**Advanced Manufacturing R&D Projects -** Demonstrate new manufacturing process technologies capable of reducing energy consumption by at least 25% compared to current industrial processes (annual number of new manufacturing processes).		
Fiscal Year	**2012**	**2013***	**2014**
Target	N/A	3 manufacturing processes	2 manufacturing processes
Result	N/A		
Endpoint Target	Demonstrate 10 manufacturing processes on an industrially-relevant scale by 2024, leading to energy savings and increased U.S. competitiveness.		

*2013 targets represent DOE's FY 2013 Budget Request to Congress. FY 2013 target updates can be found in the upcoming FY 2012-2014 Annual Performance Plan & Report

Next Generation Manufacturing R&D Projects
Funding Profile by Activity

(dollars in thousands)

	FY 2012 Current	FY 2013 Annualized CR*	FY 2014 Request
Advanced Manufacturing R&D Projects	18,556	—	120,000
Materials R&D Projects	13,537	—	0**
Steel Manufacturing	4,066	—	0**
Combined Heat and Power R&D	24,175	—	0**
Total, Next Generation Manufacturing R&D Projects	60,334	—	120,000

*FY 2013 amounts shown reflect the P.L. 112 175 continuing resolution level annualized to a full year. These amounts are shown only at the "congressional control" level and above; below that level, a dash (—) is shown.
**Materials R&D Projects, Steel Manufacturing, and Combined Heat and Power R&D will remain eligible for funding in FY 2014 through broader, competitive, merit-reviewed funding opportunities under Advanced Manufacturing R&D Projects.

The Next Generation Manufacturing R&D Projects subprogram will support projects at innovative American companies and research institutes that focus on specific high-impact manufacturing technology and process challenges in order to increase energy productivity and support EERE's Clean Energy Manufacturing Initiative (CEMI). These projects will target successful development and transition of high impact, mainly proprietary, next generation production technologies into industrial implementation in domestic production facilities.

The subprogram will focus on funding individual advanced manufacturing R&D projects in foundational manufacturing technology areas with the greatest potential impact on clean energy manufacturing competitiveness and manufacturing energy productivity-related competitiveness.

High-impact foundational technology area FOAs: In FY 2014, at least 3 new individual competitive funding opportunities of approximately $20 million to $40 million each will be released in specific manufacturing technology areas. These foundational technology areas will be selected from among the examples listed below as candidate areas under consideration and determined based on potential energy, environmental, and economic impacts. Projects will be evaluated through the competitive FOA process. The choices for topic areas have been based on the previously-identified high-impact technologies areas ($100.0 million):

- Additive manufacturing
- Wide band gap semiconductors such as silicon Carbide (SiC) and gallium nitride (GaN) that will serve as the basis for a new generation of semiconductor devices for power conversion beyond silicon
- Low-cost carbon fiber composites
- Low-cost high-strength structural metals
- Membranes for more efficient industrial separations
- Catalysts to increase the efficiency of industrial processes
- In-situ metrology and process controls
- Multimaterial joining
- Advanced modeling and simulation and high performance computing technologies for manufacturing
- Combined heat and power systems
- Direct heating RF and microwave process technologies
- Other technology areas that will benefit multiple clean energy sectors and the entire economy by boosting manufacturing energy productivity and lowering manufacturing energy costs across multiple industries.

Through these competitively-selected investments in foundational technologies, the program anticipates that it will increase the impact of its R&D investments on industrial energy efficiency, including in areas relevant to energy-intensive industries.

New Next Generation Manufacturing R&D projects funded in FY 2014 will also include additional awards from the Innovative Manufacturing Initiative FOA, which targeted advancements in manufacturing technologies and materials. The focus of these competitively selected projects will represent topic areas within which the program believes it can have a strong impact on U.S.

clean energy manufacturing and manufacturing energy productivity competitiveness.

AMO Incubator Activity: The AMO Incubator activity will make investments in a broad range of the technologies that can meet the goals of the Advanced Manufacturing Office with no pre-determination about specific technological pathways to allow the business community to propose ideas that may revolutionize the field and advanced manufacturing. These R&D projects will focus on the most fundamental of applied R&D projects that could have significant energy, environmental, and economic gains. This activity provides the incentive for small and medium size manufacturing companies needed to pursue high risk, high impact technology developments that they otherwise would not pursue ($20.0 million).

Explanation of Funding Changes

(dollars in thousands)

	FY 2012 Current	FY 2014 Request	FY 2014 Request vs. FY 2012 Current
Advanced Manufacturing R&D Projects: Focuses on foundational manufacturing processes and materials. The additional funding will provide strengthened support to address core technical issues for foundational technologies, as previously identified, that will enable U.S. manufacturers to realize significant gains in energy productivity, environmental performance, product yield, and economic growth. This will allow the program to increase the number of targeted Advanced Manufacturing Project funding opportunities to at least 3 in FY 2014. Each FOA will provide between $20 million and $40 million to support projects in different foundational technology areas, which includes a FOA to support the AMO Incubator Activity. This represents a strategy to focus on high priority foundational technologies through targeted investments based on analyses of impact and alignment with U.S. competitive advantages, versus the one broad FOA for Innovative Manufacturing Initiative projects which closed in FY 2012.	18,556	120,000	+101,444
Materials R&D Projects: Funding for Materials R&D projects will be implemented through the Advanced Manufacturing R&D Projects activity. R&D on Materials will target crosscutting foundational technologies, as previously identified, that will enable U.S. manufacturers to realize significant gains in energy productivity, environmental performance, product yield, and economic growth.	13,537	0	-13,537
Steel Manufacturing: No funding provided for steel manufacturing is requested for this specific industrial sector. Research and development activities on foundational technologies that crosscut several industries, including steel, will be supported through the Advanced Manufacturing R&D Projects activity.	4,066	0	-4,066
Combined Heat and Power: No funding provided for combined heat and power (CHP) is requested for this specific industrial sector. Research and development activities on foundational technologies that crosscut several industries, including CHP, will be supported through the Advanced Manufacturing R&D Projects activity. The deployment of CHP technologies will also be supported through the Industrial Technical Assistance sub-program through the Technical Assistance Partnerships for CHP.	24,175	0	-24,175
Total, Next Generation Manufacturing R&D projects	60,334	120,000	+59,666

Funding Schedule

Fiscal Year	Activity	Funding (dollars in thousands)
FY 2012	• Completed the Innovative Manufacturing Initiative (IMI) solicitation and launched projects to develop innovative technologies and materials for the industrial sector. The program invested 54 million into 13 IMI projects. • Examples of projects supported in FY 2012: ▪ Development of transformational ironmaking process for paired straight hearth furnace ▪ Developed 330 kWe CHP system that will achieve 85% efficiency ▪ Selected testing locations for advanced low temperature recovery absorption chiller/CHP module capable of 75% efficiency. • Supported Carbon Fiber Technology Facility startup.	60,344
FY 2013	Planned activities in the Fiscal Year 2013 Budget (final allocations have not yet been determined): • Invested $23.5 million into 5 research projects focused on foundational technologies related to applications for the steel industry, systems for combined heat and power, natural gas conversion to high-value chemicals, and using simulation to optimize process performance. • Assessment of R&D projects manufacturing process and technology improvements using the program's systems analysis tools to quantify product lifecycle energy reductions. • R&D projects partners meet milestones to achieve progress towards commercialization of new product or process technologies at industrially relevant scales, e.g.: demonstrate reproducible seeded film growth of the wide bandgap semiconductor, GaN; establish pilot line for protected lithium electrodes (PLE) for batteries; develop and demonstrate a process modeling design framework to improve manufacturing productivity and quality while lowering the cost of machined components; develop catalytic coatings capable of providing a 10-fold increase in operating run lengths; etc. • Examples of targeted project progress in FY 2013: ▪ Complete development of transformation iron making process for paired straight hearth furnace ▪ Demonstrate performance of a 65% kWe boiler burner/micro turbine CHPM system in a food processing plant ▪ Demonstrate that polymer sheets 1x5 cm^2 can be fabricated through the proposed nanochannel extrusion, and gel spinning process. • Integrate steel R&D activities into the broader advanced manufacturing R&D projects efforts and technical assistance efforts. • Integrate CHP R&D activities into the broader advanced manufacturing R&D projects efforts and technical assistance efforts.	—
FY 2014	• Invest $120 million dollars in approximately 30 manufacturing R&D projects focused on high priority foundational technologies that crosscut the industrial sectors. ▪ Issue up to 5 funding opportunity announcements, each of which will provide between $20 million and $40 million to support projects in different foundational technology areas ▪ Establish new R&D projects through a FOA focused on further innovations in wide bandgap semiconductors (such as SiC and GaN) for power conversion applications. ▪ Develop Annual Operating Plan for national labs which leverage capabilities in manufacturing to develop high impacts proof of concept technologies. • Complete development of manufacturing systems analysis tools in partnership with NREL and other national laboratories that will provide the program the ability to quantify lifecycle benefits of R&D investment decisions.	

Fiscal Year	Activity	Funding (dollars in thousands)
	• Continue projects selected for award under the Innovative Manufacturing Initiative FOA: ▪ R&D project (IMI) partners meet milestones to achieve progress towards commercialization of new product or process technologies at industrially relevant scales, e.g.: demonstrated Ti material with adequate mechanical properties demonstration of functional ESG (electrochemical solution growth) film of wide bandgap semiconductor GaN-based power electronic and optical devices; scale up pilot line for protected lithium electrodes (PLE) for batteries; demonstrate a 2-3 fold increase in standard operating run lengths under severe cracking conditions; etc. • Assessment of manufacturing process and technology improvements using the program's systems analysis tools to quantify product lifecycle energy reductions. • Assess technology improvements that have driven maturation of product and process technologies and quantified by annual IMPACTS assessment report.	120,000

Advanced Manufacturing R&D Facilities
Funding Profile by Activity

(dollars in thousands)

	FY 2012 Current	FY 2013 Annualized CR*	FY 2014 Request
Critical Materials Hub	19,340	—	25,000
Clean Energy Manufacturing Innovation Institutes	15,288	—	192,500
Total, Advanced Manufacturing R&D Facilities	34,628	—	217,500

*FY 2013 amounts shown reflect the P.L. 112 175 continuing resolution level annualized to a full year. These amounts are shown only at the "congressional control" level and above; below that level, a dash (—) is shown.

The Advanced Manufacturing R&D Facilities subprogram supports high-impact cross-cutting centralized facilities for foundational manufacturing research and development and transition of cutting-edge technology capabilities to American manufacturing firms. Despite the economic benefits of a thriving manufacturing sector, domestic producers are facing significant and increasing challenges in the global marketplace, including strong competition from producers in countries such as China and Germany. One important driver behind China's strong competitiveness is national policies that establish localized supply chains and innovation hubs that bring together universities, research institutions, suppliers, and manufacturers Germany invests heavily in innovation hubs through organizations like Frauhhofer-Gesellschaft which currently maintains 60 institutes at an annual operating research budget of approximately 1.9 billion euros[a]. Due to the scale of foreign investments in innovation hubs and clusters, the global competitiveness of individual domestic companies may suffer if the United States does not establish the appropriate manufacturing innovation and infrastructure to support them.

Consistent with the President's vision for a National Network for Manufacturing Innovation Institutes (NNMI), the program's facilities, including Clean Energy Manufacturing Innovation Institutes, the Critical Materials Hub, and existing MDF, are designed to address this discrepancy and help the United States regain its position as world leader in manufacturing competitiveness by bringing together universities, research institutions, suppliers, and manufacturers to focus on critical foundational technologies challenges faced by industry. The benefits from these Clean Energy Manufacturing Innovation Institutes and other advanced manufacturing R&D facilities will be spread broadly across industry and improve U.S. competitive advantage, especially for small and medium sized enterprises. The NNMI model[b] will induce collaboration and spread risk[c], complement university research, and focus national manufacturing policy.

The program's facilities focus on the development– through targeted and innovative shared facilities and capabilities – of new materials and associated production technologies that can reduce costs, reduce energy use, improve product quality, and enhance productivity for U.S. manufacturers. The first Institute for the program will target wide bandgap semiconductor power electronics devices, a foundational technology for power conversion-dependent clean energy technologies. This and future Institutes are expected to produce most of their impacts from long term R&D investments.

The program's experience with its MDF at Oak Ridge National Laboratory has illustrated that focused investments around nationally important technical focus areas can yield a great return on investment even in the short term. For example, in its first year of operation (FY12) the MDF attracted interest from more than 200 visiting potential partner organizations and engaged with 24 active participant organizations, leading to 25 Cooperative Research and Development Agreements (CRADA's), Work for Others, Material Transfer

[a] Fraunhofer-Gesellschaft. Web. Accessed March 2013. http://www.fraunhofer.de/en/about-fraunhofer.html

[b] Executive Office of the President National Science and Technology Council Advanced Manufacturing National Program Office, "National Network for Manufacturing Innovation: A Preliminary Design", March 2013

[c] Massachusetts Institute of Technology. "A Preview of the MIT Production in the Innovation Economy Report" February 2013.

Agreements, and other types of industry partnership agreements. Several key metrics for success - as generally identified through industry engagement during the National Network for Manufacturing Innovation Institutes Designing for Impact workshop series[a] - look promising for the MDF, including private sector cost share, strengthening workforce capabilities, and access to capital. Due to successes at the MDF, the program's existing investment of $21.4 million has been well validated as a model for future investments in other shared user facilities. The program will continue to fund the ORNL MDF with an additional $11 million in FY 2014 as part of its intended five-year funding profile. The program is in a unique position to leverage and apply experience with the ORNL MDF to ensure success in future centers in support of the President's vision for NNMI.

Clean Energy Manufacturing Innovation Institutes ($192.5 million): The FY 2014 funding will support the creation of at least three new Clean Energy Manufacturing Innovation Institutes in FY 2014, consistent with the President's vision for a larger multi-agency National Network for Manufacturing Innovation (NNMI). The Institutes are intended to provide American SMEs, in addition to large businesses, timely and affordable access to cutting-edge physical and virtual advanced manufacturing tools, and will develop and transition to industry next-generation materials and process technologies to advance the manufacturing competitiveness of the United States in clean energy manufacturing technologies and energy efficient manufacturing technologies. The Institutes will focus on foundational technologies that are broadly applicable and pervasive in multiple industries and markets with potentially transformational technical and manufacturing productivity impact. Institutes will be a partnership between government, industry, and academia, supported with cost-share funding from Federal and non-Federal sources. The program is planning to invest between approximately $70 million and $120 million into each of these Institutes, depending upon the magnitude of the opportunity, maturity, and capital intensity of the technology; scope of the focus area; and degree of non-Federal cost-sharing above a 1:1 ratio. These funds are to be expended over 5 to 7 years, and the program will seek to front fund each Institute to the greatest extent practicable, depending on the availability of funds. Institutes will be expected to be sustainable within seven years of launch.

Clean Energy Manufacturing Innovation Institutes will be competitively selected, through Funding Opportunities Announcements focused on foundational technology areas, such as those listed above as candidate areas under consideration. The program will track and assess the impact of all Clean Energy Manufacturing Innovation Institute awards, to ensure that supported facilities and activities contribute significantly to the program's clean energy, energy productivity, and manufacturing competitiveness goals.

The Program is currently a partner with the DOD investing in the NNMI pilot institute in additive manufacturing in Youngstown, OH which was recently named as one of the top ten most innovative economic development initiatives in the United States by The Brookings Metropolitan Policy Program and The Rockefeller Foundation.[b] The National Additive Manufacturing Innovation Institute (NAMII) is a public private partnership launched in FY 2012 to accelerate the development and adoption of additive manufacturing technologies in the U.S. manufacturing sector and to increase domestic manufacturing competitiveness. Additive manufacturing can lower energy intensity, reduce waste, increase speed to market, enable innovation in design, and create agile supply chains,[c] and has potential to impact a broad range of industries including clean energy, automotive, and aerospace. The Program is providing a total of $10 million to the pilot institute, with $4 million of the total being provided in FY 2014.

The Critical Materials Hub will focus on technologies that will enable American manufacturers to make better use of the critical materials we have access to as well as eliminate the need for materials that are subject to supply disruptions. These critical materials, including many rare earth elements, are essential for American competitiveness in the clean energy industry and other strategic industries like defense. Many materials deemed critical by the Department of Energy are used in modern clean energy technologies – such as wind turbines, solar panels, electric vehicles, and energy-efficient lighting. The initial focus of the Critical

[a] http://manufacturing.gov/rfi_responses.html

[b] http://namii.org/namii-named-one-of-the-top-ten-most-innovative-economic-development-initiatives-by-the-brookings-institution-and-the-rockefeller-foundation/

[c] http://www1.eere.energy.gov/manufacturing/pdfs/additive_manufacturing.pdf

Materials Hub will be five rare earth elements (dysprosium, neodymium, europium, terbium and yttrium) along with lithium and tellurium. The Critical Materials Hub was awarded to a team led by Ames Laboratory in Ames, Iowa. This award is a 5-year award, and FY 2014 will be the 3rd year of support for the Critical Materials Hub.

The Critical Materials Hub will establish a sustained multidisciplinary effort to develop solutions across the lifecycle of critical materials. It will bring together scientists and engineers from diverse disciplines to address challenges in critical materials, including mineral-related processing, manufacture, substitution, efficient use, and end-of-life recycling. The Hub will integrate scientific research, engineering innovation, and manufacturing and process improvements to provide a holistic solution to the materials challenges facing the nation.

Explanation of Funding Changes

(dollars in thousands)

	FY 2012 Current	FY 2014 Request	FY 2014 vs. FY 2012 Current
Critical Materials Hub: This funding will supports the $25 million investment in the FY 2014 Critical Materials Hub – a $5 million increase over its initial FY2012 and FY 2013 investment of $20 million each. Support for the Hub is committed through FY 2017 using funds provided through 2016. This funding increase reflects a DOE-wide emphasis and establishes a sustained, multi-year multidisciplinary effort to develop solutions across the lifecycle of critical materials.	19,340	25,000	+5,660
Clean Energy Manufacturing R&D Facilities: At the FY 2014 request level for the Advanced Manufacturing R&D Facilities subprogram, the additional funding will allow the program to provide $192.5 million to support the creation of at least three new Clean Energy Manufacturing Innovation Institutes, consistent with the President's vision for a larger, multi-agency National Network of Manufacturing Innovation (NNMI). These Institutes are intended to provide researchers, from small- and medium-sized enterprises (SMEs) and large businesses, timely, affordable access to cutting-edge physical and virtual manufacturing capabilities and to facilitate the transition of these technologies into the U.S. manufacturing sector to bolster its global competitiveness. DOE is planning to invest between $70 million and $120 million into each of these Institutes to be expended over the next 5 to 7 years. DOE plans to front fund each Institute to the greatest extent possible.	15,288	192,500	+177,212
Total, Advanced Manufacturing R&D Facilities	34,628	217,500	+182,872

Funding Schedule

Fiscal Year	Activity	Funding (dollars in thousands)
FY 2012	• Developed program concept, strategy and funding opportunity announcement (FOA) for the Critical Materials Hub, a consortium of industry/government/national laboratory/academic/non-profit partners which will enable domestic manufacturing capabilities related to critical materials, improving global industrial competitiveness and creating domestic jobs. • Launched the new manufacturing demonstration facility (MDF) at ORNL. Supported launch of NAMII to establish pilot institute in collaboration with DOD (as the lead) and other Federal agencies.	34,628
FY 2013	Planned activities in the FY 2013 Budget (final allocations have not yet been determined):	

Fiscal Year	Activity	Funding (dollars in thousands)
	• Issue targeted FOA to establish at least one new Institute on wide bandgap semiconductor (i.e. SiC and/or GaN) power electronic devices. • Continue support for ORNL MDF. Expected milestones include: ▪ Development of in-situ process monitoring showing defect evolution in the metal and polymer additive manufacturing systems ▪ Qualify the Carbon Fiber Technology Facility to produce high-quality PAN-based carbon fibers for composites R&D and as a pre-requisite for the testing of alternative carbon fiber feedstocks and conversion technologies. • Establish Critical Materials Hub infrastructure including appropriate laboratory space, instrumentation, meeting space to meet the "one-roof" collaborative objectives of the Energy Innovation Hubs, and milestones which balance DOE critical materials investments. • Establishment of collaborations with existing DOE projects and centers (e.g. EFRCs, other Hubs). • With DOD as the lead, initiate first round of RD&D projects and development of national additive manufacturing roadmap for NAMII pilot institute.	—
FY 2014	• Issue targeted FOAs for at least 3 topic-specific Clean Energy Manufacturing Innovation Institutes dedicated to supporting the deployment of high impact foundational technologies. • Continue support for ORNL MDF. Expected milestones include: ▪ Development of closed loop control system for Ti-6Al-4V ▪ Development of Ni superalloy process with 50% less development time ▪ Obtain low cost carbon fiber converted from polyolefin precursor or other low cost precursors (e.g. lignin based). • Continue support for the Critical Materials Hub. Expected milestone includes: Demonstrate at bench-scale technologies to reduce use of critical materials and/or more efficiently produce critical materials supplies.	217,500

Industrial Technical Assistance
Funding Profile by Subprogram

(dollars in thousands)

	FY 2012 Current	FY 2013 Annualized CR*	FY 2014 Request
Industrial Technical Assistance	17,730	—	27,500
Total, Industrial Technical Assistance	17,730	—	27,500

*FY 2013 amounts shown reflect the P.L. 112 175 continuing resolution level annualized to a full year. These amounts are shown only at the "congressional control" level and above; below that level, a dash (—) is shown.

The Industrial Technical Assistance subprogram is implemented through the Industrial Assessment Centers (IACs); Combined Heat and Power (CHP) Technical Assistance Partnerships (formerly known as Clean Energy Application Centers (CEACs); the Better Buildings, Better Plants (BBBP) activity; and the ISO/ANSI Standards Certification activity. Through these activities, the program's goal is to reduce manufacturing energy intensity by 25% over ten years and support the deployment of 40 GW of new, cost-effective combined heat and power (CHP) by 2020.

The program has delivered technical assistance to more than 33,000 industrial plants. Collectively, the program's activities have saved industry billions dollars and cut carbon emissions by millions of tons. The subprogram is critical to the deployment of existing and future advanced energy efficiency technologies.

The program has helped scale CHP by supporting manufacturers' R&D investments in reciprocating engines in CHP facilities. Since 1970, as deployment of CHP use has increased by nearly a factor of six, EERE has also helped manufacturing facilities owners to nearly double the collective combined efficiency of their heat production and electricity generation through the installation of CHP. For example, EERE's network of Clean Energy Application Centers (to be known as CHP Technical Assistance Partnerships (TAPs) going forward) has supported more than 225 energy assessments, and provided over 700 technical support activities on CHP projects, supporting over 1.5 GW of CHP capacity installed or under development in the United States since 2003.

The program will focus its industrial technical assistance efforts in FY 2014 in three areas:

- Energy Services Development – Support Industrial Assessment Centers (IACs) for universities' students and Combined Heat and Power (CHP) Technical Assistance Partnerships (TAPs), which promote and assist in transforming the market for CHP technologies and concepts. The IACs are a network of universities that provide extensive in-class and hands-on training for undergraduate and graduate engineering students in industrial processes, energy assessment procedures, and energy management principles. Led by faculty directors, students perform assessments at small and medium-sized manufacturers in their geographic region that result in energy savings, waste reduction, and sustainability and productivity improvements for the manufacturers and real-world experience for the students. The CHP TAPs provide essential support to continue to develop the market for CHP – this includes education and outreach and technical assistance to a variety of stakeholders including end-users (commercial, industrial, institutional and more), state decision makers, electric and gas utilities, trade associations and non-profit organizations. This assistance includes evaluating the economic, energy, reliability and environmental value of proposed systems. The CHP TAPs represent multi-state regions that will become CHP experts and provide fact-based, un-biased information on CHP, including with respect to technologies, project development, project financing, local electric and natural gas utilities interfaces, and related state best practice policies. In FY 2014, the program will continue to fund the CHP TAPs as part of their intended funding profile.
- Better Buildings Better Plants – DOE will provide technical assistance to industry to establish energy savings targets, identify and publish best practices, and encourage the use of energy management and assessment tools. Technical assistance is provided by national labs and other contractors primarily to help develop and track strong energy efficiency metrics, evaluate energy saving opportunities, and

implement on-site training events.

- ISO/ANSI Standards Certification – DOE will assist in developing standards that are compatible with internationally agreed upon platforms and tools for measuring, certifying, and recognizing energy savings. DOE supported the development of the ISO 50001 energy management system (EnMS) standard in partnership with the American National Standards Institute (ANSI) and in collaboration with over 40 countries through ISO Technical Committee 242. ISO 50001 was published in June 2011. Building upon the foundational ISO 50001 standard, DOE is currently supporting ISO standards development through Technical Committee 242 in the areas of: EnMS implementation guidance, auditing, energy baselines and energy performance indicators. It is projected that these standard development activities will be completed by FY2015. New Superior Energy Performance (SEP) activities are focused at integrating the facility-level SEP certification process with Better Plants corporate partner's efforts to drive continual energy management improvement. Also, a new workforce development professional training and credentialing, Certified Practitioner in EnMS, is being deployed through third party organizations to assist in the implementation of ISO 50001 throughout US manufacturing.

Explanation of Funding Changes

(dollars in thousands)

	FY 2012 Current	FY 2014 Request	FY 2014 Request vs. FY 2012 Current
Industrial Technical Assistance: The additional $9.77 million in funding for the Industrial and Technical Assistance subprogram versus FY 2012 levels will provide opportunities for the Combined Heat & Power Technical Assistance Partnerships to expand their role in promoting adoption of combined heat and power, waste heat to power, and district energy with CHP. This will include greater technical assistance and market development for critical infrastructure facilities (e.g. hospitals, military bases, wastewater treatment facilities), increased engagement of cities to consider CHP and district energy, increased technical assistance to state policymakers on combined heat and power policies. It will also allow additional targeted technical assistance through training under and expansion of the Better Plants program including greater engagement on supply chain opportunities, increased training on implementing strategic energy management across a company, additional program infrastructure to support significant new partners, and implementing critical training online.	17,730	27,500	+9,770
Total, Industrial Technical Assistance	17,730	27,500	+9,770

Funding Schedule

Fiscal Year	Line Item	Funding (dollars in thousands)
FY 2012	• Issue certificates of completion to at least 100 IAC students and conduct at least 300 assessments. • Promote and assist the development of 1 GW of new, cost-effective clean CHP. • 16 new companies joined the BBBP, resulting in a total of 126 companies and cumulative energy savings of approximately 100 TBTUs covering the time period 2010 through 2012. • Through 23 grants in support of the AMO technical assistance efforts, including Better Buildings, Better Plants and ISO 50001 / SEP, State energy offices conducted approximately 300 plant assessments, and 100 technical training sessions with over 2,000 total participants will be held. State awardees will participate in at least 3 of the	

Fiscal Year	Line Item	Funding (dollars in thousands)
	Better Buildings Better Plants in-plant-training sessions. Build local capacity to continue to provide this technical assistance when Federal funding is complete (end of FY 2013). • Certify 10 manufacturing facilities to Superior Energy Performance to save 0.75 TBTUs.	17,730
FY 2013	Planned activities in the Fiscal Year 2013 Budget (final allocations have not yet been determined): • Issue certificates of completion to at least 110 IAC students and conduct at least 330 assessments. • Promote and assist the development of 1.5 GW of new, cost-effective clean CHP. • 50 new companies join the BBBP, resulting in a total of 176 companies and cumulative energy savings of approximately 175 TBTUs. • Through 23 grants in support of the AMO technical assistance efforts, state energy offices will complete the plant energy management (SEP Pilot) demonstrations in at least 10 states and 10 companies. States will continue to identify local companies to participate in the Better Buildings Better Plants initiative. Build local capacity to continue to provide this technical assistance when Federal funding is complete (end of FY 2013). • Certify 18 manufacturing facilities to Superior Energy Performance to save 1.5 TBTUs in energy.	—
FY 2014	• Issue certificates of completion to at least 120 IAC students and conduct at least 350 assessments. • Promote and assist the development of 2.5 GW of new, cost-effective clean CHP. • 50 new companies join the BBBP, resulting in a total of 226 companies and cumulative energy savings of approximately 280 TBTUs. • 25 manufacturing facilities will be certified for Superior Energy Performance by a third party ANSI accredited verification body to save 3 TBTUs in energy.	27,500

Federal Energy Management Program
Funding Profile by Subprograms

(dollars in thousands)

	FY 2012 Current	FY 2013 Annualized CR*	FY 2014 Request
Federal Energy Management Program			
Project Financing	9,640	—	9,000
Technical Guidance and Assistance	9,640	—	9,000
Planning, Reporting and Evaluation	4,832	—	3,491
Federal Fleet	1,793	—	2,000
DOE Specific Investments	3,986	—	2,509
Federal Energy Efficiency Fund	0	—	10,000
Total, Federal Energy Management Program	29,891	30,074	36,000

*FY 2013 amounts shown reflect the P.L. 112 175 continuing resolution level annualized to a full year. These amounts are shown only at the "congressional control" level and above; below that level, a dash (-) is shown.

FY 2014 Program Summary

- The Office of Energy Efficiency and Renewable Energy (EERE) request for the Federal Energy Management Program's (program) Federal Energy Efficiency Fund (FEEF) subprogram is greater in FY 2014 than in FY 2012. Through FEEF, the program will provide direct funding to leverage cost-sharing at Federal agencies for capital improvement projects and other initiatives to increase energy efficiency and renewable energy investments at agency facilities. This high-impact program will dramatically increase the pipeline of these projects through direct financial incentives. In FY 2014, the program estimates that $10 million of FEEF funding will leverage $100 million of project investment and result in 13.6 trillion British thermal units (Btu) and $340 million in savings over the life of the projects (+$10.0 million).
- The decrease in funding for the Planning, Reporting, and Evaluation subprogram in FY 2014 is a result of the completion of a study in FY 2012 to assess the verifiable energy savings and carbon emission reductions from Federal energy management investments. The program obtained additional funding in FY 2012 to conduct this study (-$1.3 million).
- The decrease in funding for the U.S. Department of Energy (DOE) Specific Investments subprogram will reduce the technical assistance provided to DOE sites and national laboratories on implementation of Federal and departmental sustainability goals and requirements, in order to reallocate funds to higher priority activities (-$1.5 million).

Overview

The Federal Energy Management Program (program) works with Federal leaders to accomplish energy change within their organizations by bringing expertise from all levels of project and policy implementation to enable Federal agencies to meet energy- and sustainability-related goals and provide energy leadership to the country. By increasing its use of energy efficiency and renewable energy, the Federal sector leads by example, saves money, meets more of its energy requirements from clean technologies and secure sources, and spurs innovation and commercialization of clean energy technologies.

The program assists other agencies to achieve their goals by facilitating their use of directly appropriated funds and through increased use of performance contracting. Performance contracts available for use include energy saving performance contracts (ESPCs), utility energy service contracts (UESCs), and power purchase agreements as permitted.

The program facilitates the ESPC and UESC award process for multiple Federal agencies. From 1998 to December 2012, the program has assisted agencies to use its government-wide multiple award indefinite delivery, indefinite quantity (IDIQ) contract mechanism, which requires guaranteed savings, to achieve savings of more than 347 trillion Btu over the life of the agencies' projects. This savings is approximately equal to the energy consumption for all Federal facilities in FY 2012. A December 2011 Presidential Memorandum committing the Federal Government to enter into a combined $2 billion in performance-based contracts by the end of 2013 further supports these activities. The program also

provides technical guidance and assistance to all Federal agencies, and reports to Congress on Federal energy efficiency, Federal fleet performance, Federal use of renewable electric power, and agencies' compliance with relevant public law and Executive Order (E.O.) requirements.

The program's assistance helps agencies reach the goals set forth by the Energy Policy Act of 2005 (EPAct 2005), Executive Order (E.O.) 13423, the Energy Independence and Security Act of 2007 (EISA 2007), and E.O. 13514. Current government-wide goals include the following:

- Improve energy efficiency and reduce greenhouse gas (GHG) emissions of each agency, through the reduction of energy intensity by 3% annually, or 30% by the end of FY 2015, relative to the baseline of the agency's energy use in FY 2003 (EISA 2007)
- Ensure that at least 7.5% of Federal electricity consumption is generated from renewable sources in FY 2014 and each fiscal year thereafter (EPAct 2005)
- Ensure that at least half of the statutorily required renewable energy consumed by the agency in a fiscal year comes from new renewable sources (after 1999) and, to the extent feasible, the agency implements renewable energy generation projects on Federal or Indian property for agency use (E.O. 13423)
- Reduce water consumption intensity by 2% annually, or 26% by the end of FY 2020 as compared to the FY 2007 base year (E.O. 13514)
- For agencies operating a fleet of at least 20 motor vehicles, ensure that agencies reduce the fleet's total consumption of petroleum products by 2% annually through the end of FY 2015, relative to their respective baselines for FY 2005 (EISA 2007).

The program achieves its goals by enabling Federal agencies to use their funds more effectively to meet Federal and agency-specific energy management objectives. Working with our partners at the national laboratories, the program offers technical expertise that other Federal agencies do not typically have. Therefore, instead of each agency trying to determine effective energy management on its own, the program is in the position of being able to develop, analyze, and provide guidance on best practices in energy management that it disseminates to all agencies. The program's centralized role makes it uniquely capable of providing expertise on performance contracting, overcoming barriers to the use of alternative fuels in the Federal vehicle fleet, and providing centralized reporting, data collection, and strategic government-wide communication.

A substantial increase in the funding (+$10.0 million) for the FEEF will provide government-wide financial assistance to Federal agencies to increase their capital improvement investments in energy efficiency, water conservation, and renewable energy technologies, processes, and practices. The focus will be on cost-effective investments that are highly leveraged by the other agency's funds or non-Federal sources, such as ESPCs.

DOE Specific Investments subprogram activities assist DOE's compliance with Federal and departmental sustainability goals, including mandates from EPAct 2005, EISA 2007, and Executive Orders 13514 and 13423. Through this subprogram, the Sustainability Performance Office (SPO), housed in EERE, supports the integration and coordination of sustainability activities across DOE. SPO is DOE's lead organization for supporting the Senior Sustainability Officer; coordinates data collection, reporting, and analysis of DOE's energy, water, and resource data; helps manage and implement DOE's Strategic Sustainability Performance Plan; and provides oversight of energy, water, and resource assessments at DOE sites and national laboratories. These activities, coupled with the implementation of energy conservation measures and efficiency improvements, reduce DOE's operating expenses, overall energy use, and subsequent GHG emissions and costs.

The program is designed to overcome the following barriers:

- A lack of a broad knowledge base within agencies on acquisition and use of energy efficiency and renewable energy technologies
- Inconsistent interpretations of rules, processes, and procedures
- Inadequate infrastructure to support alternative fuel use for Federal vehicles.

Program Accomplishments and Near-Term Milestones[a]

Accomplishments for the program include the following:

- From FY 2005 to FY 2011, facilitated $3.1 billion of private-sector efficiency investments in Federal Government facilities from performance-based contracts, which will result in energy cost savings of approximately $8.5 billion over the life of the energy-saving measures, without any up-front investments from the American taxpayer. The savings on utility bills and operation and

[a] For a list of milestones please see "*Strategic Performance Management by Program"* section.

maintenance created through these facility upgrades are used to pay the private contractor for the project over the term of the contract, and in most cases, the agencies continue to save money and energy after the contract term ends.

- In FY 2012, provided Web-based training on the latest Federal energy requirements, best practices, and technologies to more than 10,000 registrants.
- Assisted other agencies to enable the Federal Government to achieve an overall reduction in scope 1 and 2 (direct) GHG emissions by 8% between FY 2008 and FY 2011
- In FY 2011, DOE reduced scope 1 and 2 (direct) GHG emissions by 13% relative to an FY 2008 baseline—placing DOE on track to meet the FY 2020 scope 1 and 2 GHG reduction goal (28% reduction).

Program Planning and Management

The program provides support to Federal agencies to measure, track, and meet the GHG reduction targets that E.O. 13514 established. The program also provides guidelines, web-based tracking tools, and one-on-one technical assistance. Because GHG emissions are primarily driven by energy use, reducing GHG emissions are primarily accomplished by reducing energy use, including petroleum, thereby lowering energy costs for the Federal Government. By promoting the use of alternative fuel in Federal agency fleets, the Federal Fleet subprogram helps to decrease our government's dependence on fossil fuels and to meet GHG targets.

DOE Specific Investment activities support implementation of Federal and Departmental sustainability goals throughout the DOE complex, to help ensure that DOE increases its energy productivity and energy diversity and reduces GHG emissions and energy use. DOE is committed to reducing Scope 1 and 2 GHG emissions by 28 percent and Scope 3 emissions by 13 percent by 2020, through efforts to meet Federal statutory and E.O. mandates as noted above and ensuring 15 percent of facilities meet the Guiding Principles (GP) for Federal Leadership in High Performance Sustainable Buildings (HPSB) by FY 2015.

Strategic Performance Management by Program

Performance Measure	**Federal Energy Management Program -** Reduce life-cycle energy consumption of Federal facilities via the year's technical assistance and associated activities for appropriated and alternative financing (trillion Btu, (TBtu))		
Fiscal Year	**2012**	**2013***	**2014**
Target	52 TBtus	47 TBtus	57 TBtus
Result	24.7[a]		
Endpoint Target	Federal Government is required to reduce annual energy use by an additional 64 TBtu by 2015, from the 2011 level of annual energy facility consumption. The program will help the government achieve 4 TBtu of those annual savings from its activities in FY 2014, which will cumulatively contribute 57 TBtu of life-cycle energy savings by 2030.		

*2013 targets represent DOE's FY 2013 Budget Request to Congress. FY 2013 target updates can be found in the upcoming FY 2012-2014 Annual Performance Plan & Report.

[a] In total, program activities in FY 2012 saved 24.7 trillion life-cycle Btu. As a result, the program did not meet its FY 2012 goal of life-cycle energy savings of 52 TBtu. For FY 2012, the program had 18 UESCs, 35 Renewable Energy Certificate projects, 9 ESPCs and 20 Technical Assistance Projects. The lag of expected ESPC & UESC projects in FY 2012 was due to a bottleneck in the pipeline. There has been progress in addressing some of those backlogs; however, a number of projects in the pipeline are still taking longer to award due to some internal agency issues. However, overall FY 2012 Q4 had a large amount of projects awarded and the program expects a high rate of awards to continue through the end FY 2013 in anticipation of meeting the Dec. 2011 Presidential Memorandum committing the Federal Government to enter into a combined $2 billion in performance-based contracts, including energy savings performance contracts (ESPCs) and utility energy savings contracts (UESCs), by the end of 2013.

Project Financing
Funding Profile by Subprogram

(dollars in thousands)

	FY 2012 Current	FY 2013 Annualized CR*	FY 2014 Request
Project Financing	9,640	—	9,000
Total, Project Financing	9,640	—	9,000

*FY 2013 amounts shown reflect the P.L. 112 175 continuing resolution level annualized to a full year. These amounts are shown only at the "congressional control" level and above; below that level, a dash (-) is shown.

The Project Financing subprogram will assist agencies to meet the goals set forth in the Presidential Memorandum on energy savings projects and performance-based contracts (December 2, 2011). The memorandum tasked Federal agencies to enter into a minimum of $2 billion in performance-based contracts in Federal building energy efficiency within 24 months. For this effort, the program has provided, and will continue to provide, Federal financing specialists to assist site staff and management with initial decision making on the scope of performance contracts, project facilitators to guide agencies through ESPC project development and implementation, beginning and advanced training for Federal personnel in project financing, and tracking of project implementation and performance.

Congress authorized Federal agency use of ESPCs to provide a supplement to direct appropriations for funding energy-efficient improvements in Federal facilities. By using ESPCs and UESCs, agencies can take advantage of private-sector expertise with little upfront cost to the government. The government pays back the third-party investment through energy and operations and maintenance cost savings achieved over the project's life. ESPC and UESC projects can include energy and water-efficiency improvements, renewable energy technologies, renewable alternative fuel (biomass/landfill), combined heat and power, advanced metering, and power management. These projects must improve site or system-wide energy efficiency and be life-cycle cost effective.

The program's assistance includes the management of the DOE IDIQ ESPC contract. The National Energy Conservation Policy Act (NECPA) first authorized Federal agencies to enter into shared-energy savings contracts with private-sector energy service companies. It was superseded by the Energy Policy Act of 1992; DOE promulgated regulations for its use in 1995, and ESPC authority was made permanent in 2007.

Explanation of Funding Changes

(dollars in thousands)

	FY 2012 Current	FY 2014 Request	FY 2014 Request vs. FY 2012 Current
Project Financing — Sustains activities in facilitating agency use of ESPCs, UESCs and power purchase agreements.	9,640	9,000	-640
Total, Project Financing	9,640	9,000	-640

Funding Schedule

Fiscal Year	Line Item	Funding (dollars in thousands)
FY 2012	• Facilitate Federal agencies' access to private-sector investment and financing to implement energy efficiency improvements through ESPCs. • Assist Federal agencies with UESCs. • Assist Federal agencies with onsite renewable Power Purchase Agreements. • Provide Federal agencies with information on Federal and state energy incentive programs.	9,640
FY 2013	Planned activities in the FY 2013 Budget (final allocations have not yet been determined): • Facilitate Federal agencies' access to private-sector investment and financing to implement energy efficiency improvements through ESPCs. • Assist Federal agencies with UESCs. • Assist Federal agencies with onsite renewable Power Purchase Agreements. • Provide Federal agencies with information on Federal and state energy incentive programs.	—
FY 2014	• Facilitate Federal agencies' access to private-sector investment and financing to implement energy efficiency improvements through ESPCs. • Assist Federal agencies with UESCs. • Assist Federal agencies with onsite renewable Power Purchase Agreements. • Provide Federal agencies with information on Federal and state energy incentive programs. • Continue to make improvements in ESPC project facilitation, outreach, technical assistance on investments and financing, training, reporting, measurement and verification, and competition processes through strategic sourcing initiative. • Continue to provide ESPC and UESC assistance through project facilitators, including identifying and screening projects and evaluating proposals. Facilitators will also provide technical and contracting expertise for issues, such as interest rates, competitive financing, and utility rates to support the negotiation process.	9,000

Technical Guidance and Assistance
Funding Profile by Subprogram

(dollars in thousands)

	FY 2012 Current	FY 2013 Annualized CR*	FY 2014 Request
Technical Guidance and Assistance	9,640	—	9,000
Total, Technical Guidance and Assistance	9,640	—	9,000

*FY 2013 amounts shown reflect the P.L. 112 175 continuing resolution level annualized to a full year. These amounts are shown only at the "congressional control" level and above; below that level, a dash (-) is shown.

The Technical Guidance and Assistance subprogram supports the program's mission by helping agencies implement projects and practices that reduce energy bills and promote the use of water conservation, energy efficiency, and renewable energy. The program's technical assistance on energy efficiency and renewable energy technologies results in accelerated Federal sector acceptance of these technologies.

The program's broad range of assistance includes the following:

- Analytical support from national laboratories
- Technical assistance on new technology deployment
- Direct technical assistance on capital projects
- Development of Federal agency efficiency standards
- Specification of energy-efficient products for agency procurement
- Energy assessments
- Other assistance to help other agencies develop comprehensive planning and internal processes to reduce their energy use and to achieve Federal water consumption goals.

Specifically, the program supports data center efficiency initiatives by encouraging Federal agencies to adopt best practices, construct energy-efficient data centers, and educate energy managers and information technology professionals. For energy-intensive Federal laboratories, the program develops tools designed to help Federal agencies optimize laboratory energy and environmental performance, provides detailed guides covering best practices in laboratory energy and environmental management, and conducts case studies on Federal laboratory energy and environmental projects exemplifying a whole-building guiding principle. For renewable energy, the program provides project assistance and expertise in project assessment and implementation areas to help Federal agencies identify and implement renewable energy technologies, provides a collection of resource maps and assessment tools to help Federal agencies screen for potential renewable energy projects, and consults with agencies on available options to purchase renewable power and renewable energy certificates (RECs) to meet energy regulatory requirements and goals.

EPAct 2005 and EISA 2007 establish the subprogram's responsibility to carry out a number of activities, including developing product specifications, as well as issuing guidance on metering, new construction, and other energy-related building topics. The subprogram's data center expertise enables services to other agencies, including technical project support, best practice guidelines, and case study reports on operational efficiency. In FY 2014, the subprogram will focus on increased agency interaction to facilitate accomplishing goals.

Explanation of Funding Changes

(dollars in thousands)

	FY 2012 Current	FY 2014 Request	FY 2014 Request vs. FY 2012 Current
Technical Guidance and Assistance — Sustains a broad range of technical assistance and analysis activities, with areas of focus in data center efficiency, energy-intensive Federal laboratories, and renewable energy.	9,640	9,000	-640
Total, Technical Guidance and Assistance	9,640	9,000	-640

Funding Schedule

Fiscal Year	Line Item	Funding (dollars in thousands)
FY 2012	• Provided technical assistance to Federal agencies in implementing sustainable design practices. • Assisted Federal agencies incorporate energy-efficiency, renewable energy, and water conservation in their facilities. • Assisted with developing renewable energy projects and improving operations and maintenance. • Promoted laboratory and data center best practices. • Implement and improve Federal product procurement specifications and procedures. • Advanced new technologies at Federal facilities.	9,640
FY 2013	Planned activities in the FY 2013 Budget (final allocations have not yet been determined): • Provide technical assistance to Federal agencies in implementing sustainable design practices. • Assist Federal agencies' corporate energy efficiency, renewable energy, and water conservation in their facilities. • Assist with developing renewable energy projects and improving operations and maintenance. • Promote laboratory and data center best practices. • Implement and improve Federal product procurement specifications and procedures. • Advance new technologies at Federal facilities.	—
FY 2014	• Provide technical assistance to Federal agencies in implementing sustainable design practices. • Assist Federal agencies incorporate energy efficiency, renewable energy and water conservation in their facilities. • Assist with developing renewable energy projects and improving operations and maintenance. • Promote laboratory and data center best practices. • Implement and improve Federal product procurement specifications and procedures. • Advance new technologies at Federal facilities.	9,000

Planning, Reporting and Evaluation
Funding Profile by Subprogram

(dollars in thousands)

	FY 2012 Current	FY 2013 Annualized CR*	FY 2014 Request
Planning, Reporting, and Evaluation	4,832	—	3,491
Total, Planning, Reporting, and Evaluation	4,832	—	3,491

*FY 2013 amounts shown reflect the P.L. 112 175 continuing resolution level annualized to a full year. These amounts are shown only at the "congressional control" level and above; below that level, a dash (-) is shown.

The Planning, Reporting, and Evaluation subprogram effectively tracks the government's record in energy achievement; ensures the program's capabilities are a known resource for energy management; and coordinates the program's strategic planning, budgeting, and evaluation. Specifically, the program compiles annual reports on energy consumption and management within Federal facilities, prepares an annual report to Congress and conducts interagency collaboration. In addition, this subprogram coordinates data collection to track Federal facility compliance with energy and water evaluations, project implementation measures, and benchmarking requirements per Section 432 of the EISA 2007. Furthermore, through communications and interagency coordination, this subprogram shares the program's technical resources with both the public and private sector. Finally, this subprogram also supports the program's strategic planning activities—ensuring that funding supports strategic goals.

NECPA (as amended by EISA 2007) requires DOE to collect, verify and report on Federal agencies' progress (including DOE) toward their goals to address energy efficiency in facilities. As it does every year, in FY 2014, the program will collect and publish data for the Section 432 Annual Report to Congress and respond to inquiries to help ensure accuracy in reporting and analysis of trends. In addition, through its awards program, the subprogram recognizes energy efficiency and renewable energy champions at Federal agencies.

Explanation of Funding Changes

(dollars in thousands)

	FY 2012 Current	FY 2014 Request	FY 2014 Request vs. FY 2012 Current
Planning, Reporting and Evaluation — This funding decrease is because the program received additional FY 2012 funds to complete a special study to assess the verifiable energy savings and carbon emission reductions from Federal energy management investments. Given that the study has been completed, this sub-program is now funded at a lower level, because it does not need funds to complete this special study.	4,832	3,491	-1,341
Total, Federal Energy Management Program	4,832	3,491	-1,341

Funding Schedule

Fiscal Year	Line Item	Funding (dollars in thousands)
FY 2012	• Collected and verified data from Federal agencies on energy and water consumption. • Reported and tracked Federal agencies' progress toward goals from law and executive order. • Trained Federal workforce in energy management and conducted interagency collaboration. • Conducted DOE and Federal annual awards program. • Delivered state-of-the-art communications and outreach activities on strategies, tools, training, technologies, and guidance that help Federal agency customers to meet energy mandates. • Conducted a study to assess the verifiable energy savings and carbon emission reductions from Federal energy management investments.	4,832
FY 2013	Planned activities in the FY 2013 Budget (final allocations have not yet been determined): • Collect and verify data from Federal agencies on energy and water consumption. • Report and track Federal agencies' progress toward goals from law and executive order. • Train Federal workforce in energy management and conduct interagency collaboration. • Conduct DOE and Federal annual awards program. • Deliver state-of-the-art communications and outreach activities on strategies, tools, training, technologies, and guidance that help Federal agency customers to meet energy mandates.	—
FY 2014	• Collect and verify data from Federal agencies on energy and water consumption. • Report and track Federal agencies' progress toward goals from law and executive order. • Train Federal workforce in energy management and conduct interagency collaboration. • Conduct DOE and Federal annual awards program. • Deliver state-of-the-art communications and outreach activities on strategies, tools, training, technologies, and guidance that Federal agency customers need to meet energy mandates.	3,491

Federal Fleet
Funding Profile by Subprogram

(dollars in thousands)

	FY 2012 Current	FY 2013 Annualized CR*	FY 2014 Request
Federal Fleet	1,793	—	2,000
Total, Federal Fleet	1,793	—	2,000

*FY 2013 amounts shown reflect the P.L. 112 175 continuing resolution level annualized to a full year. These amounts are shown only at the "congressional control" level and above; below that level, a dash (-) is shown.

The Federal Fleet subprogram assists agencies with meeting or exceeding requirements for reducing fleet petroleum consumption. The subprogram provides direct technical assistance and tools to agencies for achieving this goal, including the following:

- A fuel consumption dashboard
- A model that optimizes vehicle selection and location for maximum petroleum reduction
- Identification of areas where new alternative fuel infrastructure would displace the most petroleum consumption
- Training and communication on mandates and best practices
- Analysis of Federal fleet compliance with Federal mandates.

The program provides guidance and assistance to help implement Federal legislative and regulatory requirements that mandate reduced petroleum consumption and increased alternative fuel use for the Federal fleet. The program's efforts include assisting agencies with implementing and managing energy-efficient and alternative fuel vehicles and facilitating a coordinated effort to reduce petroleum consumption and increase alternative fuel use, as well as tracking and reporting Federal progress annually. The subprogram provides information and resources for Federal requirements, technology resources, technical assistance on infrastructure development, and data analysis and trends, as well as coordination of INTERFUEL (an interagency working group for vehicle fleets). The program also provides resources for Federal fleets, including publications, online tools, and related links on vehicles, alternative fuels, and fleet management deployment strategies. Federal agencies must report vehicle acquisitions and alternative fuel consumption annually; the program outlines reporting requirements and processes, including regulations, timelines, and tools to help Federal agencies meet annual requirements.

Explanation of Funding Changes

(dollars in thousands)

	FY 2012 Current	FY 2014 Request	FY 2014 Request vs. FY 2012 Current
Federal Fleet – This slight funding increase will advance FEMP's partnership with Clean Cities to increase agency utilization of alternative fuel in their dual fuel fleet vehicles.	1,793	2,000	+207
Total, Federal Energy Management Program	1,793	2,000	+207

Funding Schedule

Fiscal Year	Line Item	Funding (dollars in thousands)
FY 2012	• Collected data on fuel usage and maintain the Federal Automotive Statistical Tracking (FAST) database. • Provided reporting requirements and processes, including regulations, timelines, and tools to help Federal agencies meet annual requirements. • Coordinate INTERFUEL (an interagency working group for vehicle fleets). • Provide technical assistance on infrastructure development. • Provide assistance to increase the fuel efficiency of vehicle fleet. • Provide assistance to optimize location of vehicles with respect to fuel infrastructure. • Provide resources for Federal fleets, including publications, online tools, and related links on vehicles, alternative fuels, and fleet management deployment strategies.	1,793
FY 2013	Planned activities in the FY 2013 Budget (final allocations have not yet been determined): • Collect data on fuel usage and maintain the FAST database. • Provide reporting requirements and processes, including regulations, timelines, and tools to help Federal agencies meet annual requirements. • Coordinate INTERFUEL (an interagency working group for vehicle fleets). • Provide technical assistance on infrastructure development. • Provide assistance to increase the fuel efficiency of vehicle fleet. • Provide assistance to optimize location of vehicles with respect to fuel infrastructure. • Provide resources for Federal fleets, including publications, online tools, and related links on vehicles, alternative fuels, and fleet management deployment strategies.	—
FY 2014	• Collect data on fuel usage and maintain the FAST database. • Provide reporting requirements and processes, including regulations, timelines, and tools to help Federal agencies meet annual requirements. • Coordinate INTERFUEL (an interagency working group for vehicle fleets). • Provide technical assistance on infrastructure development. • Assistance to increase the fuel efficiency of vehicle fleet. • Assistance to optimize location of vehicles with respect to fuel infrastructure. • Provide resources for Federal fleets, including publications, online tools, and related links on vehicles, alternative fuels, and fleet management deployment strategies.	2,000

DOE Specific Investments
Funding Profile by Subprogram

(dollars in thousands)

	FY 2012 Current	FY 2013 Annualized CR*	FY 2014 Request
DOE Specific Investments	3,986	—	2,509
Total, DOE Specific Investments	3,986	—	2,509

*FY 2013 amounts shown reflect the P.L. 112 175 continuing resolution level annualized to a full year. These amounts are shown only at the "congressional control" level and above; below that level, a dash (-) is shown.

The DOE Specific Investments subprogram supports activities that help ensure implementation of Federal and departmental environmental, energy, and transportation management goals throughout DOE. These efforts are driven by mandates from EPAct 2005, EISA 2007, and E.O. 13514 and E.O. 13423.

DOE is committed to meeting its sustainability goals and requirements, which include reducing Scope 1 and 2 GHG emissions by 28% and Scope 3 emissions by 13% by 2020, through efforts such as reducing energy intensity by 30% from FY 2003 by FY 2015; reducing water use intensity by 16% from FY 2007 through FY 2015; using 7.5% of electricity from renewable sources by FY 2013; and ensuring 15% of facilities meet the Guiding Principles for Federal Leadership in High-Performance Sustainable Buildings by FY 2015 working toward 100% in the out years.

The DOE Specific Investments subprogram ensures departmental sustainability data is collected, analyzed, and reported. SPO, housed in EERE, manages this subprogram in collaboration with DOE corporate offices, the DOE Under Secretaries, Program Support Offices, national laboratories, and DOE sites. SPO collects sustainability data and performs detailed analysis to identify areas of strengths and weaknesses. In addition, SPO completes required DOE annual reporting and reports to Congress, including the Strategic Sustainability Performance Plan, the Annual Energy Report, the Greenhouse Gas Inventory, and the OMB sustainability/energy scorecard.

SPO will continue to assist DOE and the DOE Senior Sustainability Officer in the implementation of efficiency measures that ensure compliance with the sustainability goals. SPO will also continue to oversee and execute site-level energy, water, and resource assessments to determine where DOE should focus future improvements. SPO will leverage localized gains at DOE sites by sharing best practices and resources throughout the DOE community. SPO will assess all potential improvements based on practicability; assessments will include full life-cycle cost evaluations.

Building upon data gathered from site-level audits and assessments, the subprogram will fund additional activities that directly support DOE implementation of energy conservation measures. These activities include the following:

- Technical assistance for operations and maintenance, as well as retro commissioning
- Support for the use of performance-based contracting, such as ESPCs and UESCs, through training, project development, and implementation assistance
- Technical assistance for mission-critical energy intensive buildings and processes, such as supercomputers and scientific computing, data centers, accelerators, lasers, laboratories, and their supporting structures
- Support for policy guidance, technical assistance, reporting, and information on high-performance and sustainable building requirements and sites
- Identifying alternative energy opportunities, energy and water efficiency measures, and implementation assistance.

SPO will also promote continued long-term sustainability implementation by providing technical guidance, assistance, and outreach to DOE offices for the following:

- Meeting E.O. and statutory sustainability requirements and internal DOE policies and orders
- Establishing DOE recognition awards
- Assisting with the development and implementation of DOE energy, metering, water, and other sustainability plans
- Providing administrative and technical support for DOE workgroups and the DOE Chief Operating Officers, and representing DOE on interagency sustainability groups and matters.

Explanation of Funding Changes

(dollars in thousands)

	FY 2012 Current	FY 2014 Request	FY 2014 Request vs. FY 2012 Current
Decrease in funding for DOE Specific Investments will reduce the technical assistance provided to DOE sites and national laboratories for implementation of Federal and Departmental sustainability goals and requirements. This reduction is due to data reporting efficiencies resulting from enhanced collaboration with stakeholders (-$1.5 million).	3,986	2,509	-1,477
Total, Federal Energy Management Program	3,986	2,509	-1,477

Funding Schedule

Fiscal Year	Line Item	Funding (dollars in thousands)
FY 2012	• Conducted energy and water audits and assessments at DOE sites and national laboratories. • Provided technical assistance and training to DOE site managers and field personnel on sustainability reporting requirements. • Conducted data validation and analysis and prepared DOE annual reports, including the Strategic Sustainability Performance Plan, Greenhouse Gas Inventory, and OMB Sustainability/Energy Scorecard and reports to Congress.	3,986
FY 2013	Planned activities in the Fiscal Year 2013 Budget (final allocations have not yet been determined): • Conduct energy and water audits and assessments at DOE sites and national laboratories. • Provide technical assistance and training to DOE site managers and field personnel on sustainability reporting requirements. • Conduct data validation and analysis and prepare DOE annual reports, including the Strategic Sustainability Performance Plan, Greenhouse Gas Inventory, and OMB Sustainability/Energy Scorecard and reports to Congress.	—
FY 2014	• Conduct energy and water audits and assessments at DOE sites and national laboratories. • Provide technical assistance and training to DOE site managers and field personnel on sustainability reporting requirements. • Conduct data validation and analysis and prepare DOE annual reports, including the Strategic Sustainability Performance Plan, Greenhouse Gas Inventory, and OMB Sustainability/Energy Scorecard and reports to Congress.	2,509

Federal Energy Efficiency Fund
Funding Profile by Subprogram

(dollars in thousands)

	FY 2012 Current	FY 2013 Annualized CR*	FY 2014 Request
Federal Energy Efficiency Fund	0	—	10,000
Total, Federal Energy Efficiency Fund	0	—	10,000

*FY 2013 amounts shown reflect the P.L. 112 175 continuing resolution level annualized to a full year. These amounts are shown only at the "congressional control" level and above; below that level, a dash (-) is shown.

Through the Federal Energy Efficiency Fund subprogram, the program will provide direct funding to leverage cost sharing at Federal agencies for capital improvement projects and other initiatives to increase the energy efficiency, water conservation, and renewable energy investments at agency facilities. Although the subprogram is similar to the program's support of project investment in FY 2013 and prior years, it utilizes the authority provided in Public Law 102-486 to improve the program's strategy to promote new technology deployment in the Federal sector. It is part of the program's ongoing effort to employ best practices and promote significant cost sharing.

Grants from FEEF will be awarded after a competitive assessment of the technical and economic effectiveness of each agency proposal, which will consider the life cycle cost-effectiveness of the project, the amount of energy and cost savings anticipated to the Federal Government, the amount of funding committed to the project by the agency requesting financial assistance, and the extent that a proposal leverages financing from other non-Federal sources. Examples of the type of projects that will be encouraged include combined heat and power and onsite renewables.

This high-impact subprogram will dramatically increase the Federal pipeline of energy efficiency, water conservation, and renewable energy projects through direct financial incentives. In FY 2014, $10 million of the program's FEEF funding is estimated to leverage $100 million of project investment and result in 10.2 TBtu and $255 million in savings over the life of the projects.[a]

Through the application of active management, the subprogram will contribute financial support and incentives for awarded projects when they reach significant milestones. This incremental approach will provide significant incentives for agencies to progress through stages of a project in an efficient manner.

[a] A leveraged ratio of 10 to 1 was assumed because significant use of ESPCs is anticipated with FEEF. Key factors based on historical data include 6,000 Btu per dollar of investment, $25 average cost per MMBtu, and a 17-year lifetime of project equipment.

Explanation of Funding Changes

(dollars in thousands)

	FY 2012 Current	FY 2014 Request	FY 2014 Request vs. FY 2012 Current
Federal Energy Efficiency Fund – This subprogram will significantly increase the number, size, efficiency, and effectiveness of Federal clean energy projects government-wide through direct funding and incentives for Federal and non-Federal cost sharing.	0	10,000	+10,000
Total, Federal Energy Management Program	0	10,000	+10,000

Funding Schedule

Fiscal Year	Line Item	Funding (dollars in thousands)
FY 2012	Not funded.	0
FY 2013	Planned activities in the Fiscal Year 2013 Budget (final allocations have not yet been determined): • Issue call for projects for capital projects and technical assistance. • Evaluate projects on a competitive basis based on life-cycle cost effectiveness, the amount of energy and cost savings, and the leveraging of Federal and non-Federal funds. • Monitor and evaluate the success of each project. • Provide feedback and advice to agencies for projects not selected.	—
FY 2014	• Issue call for projects for capital projects and technical assistance. • Evaluate projects on a competitive basis based on life-cycle cost effectiveness, the amount of energy and cost savings, and the leveraging of Federal and non-Federal funds. • Monitor and evaluate the success of each project. • Provide feedback and advice to agencies for projects not selected.	10,000

Building Technologies
Funding Profile by Subprograms and Activities

Non-Comparable Structure

(dollars in thousands)

	FY 2012 Current	FY 2013 Annualized CR*	FY 2014 Request
Commercial Buildings Integration	31,913	—	36,570
Emerging Technologies			
Emerging Technologies R&D	61,182	—	101,740
Grid Integration Initiative	0	—	30,000
Total, Emerging Technologies	61,182	—	131,740
Energy Innovation Hub	23,583	—	24,300
Equipment and Buildings Standards	66,746	—	82,000
Residential Buildings Integration	31,282	—	24,390
NREL Site-Wide Facility Support	0	—	1,000
Total, Building Technologies	214,706	220,546	300,000

*FY 2013 amounts shown reflect the P.L. 112 175 continuing resolution level annualized to a full year. These amounts are shown only at the "congressional control" level and above; below that level, a dash (—) is shown.

Comparable Structure

(dollars in thousands)

	FY 2012 Current	FY 2013 Annualized CR*	FY 2014 Request
Commercial Buildings Integration	31,913	—	36,570
Emerging Technologies			
Lighting R&D	24,923	—	25,800
Space Conditioning and Refrigeration R&D	15,472	—	23,140
Building Envelope R&D	15,472	—	7,950
Analysis Tools	5,315	—	4,850
Grid Integration Initiative	0	—	30,000
High-Impact Technology R&D	0	—	40,000
Total, Emerging Technologies	61,182	—	131,740
Energy Innovation HUB	23,583	—	24,300
Equipment and Buildings Standards	66,746	—	82,000
Residential Buildings Integration	31,282	—	24,390
NREL Site-Wide Facility Support	0	—	1,000
Total, Building Technologies	214,706	220,546	300,000

*FY 2013 amounts shown reflect the P.L. 112 175 continuing resolution level annualized to a full year. These amounts are shown only at the "congressional control" level and above; below that level, a dash (—) is shown.

SBIR/STTR

- FY 2012 Transferred: SBIR: $3,964,000; STTR: $534,000
- FY 2013 Annualized CR Transferred: SBIR: $1,200,000
- FY 2013 Annualized CR: SBIR: $4,186,242; STTR: $542,661
- FY 2014 Request: SBIR: $6,104,000; STTR: $872,000

FY 2014 Program Summary

- Emerging Technologies. BTO will increase investment in RD&D related to:
- Grid Integration Initiative, specifically the role of buildings in grid integration, focusing on the interrelated barriers associated with variable, distributed renewable energy generators; building efficiency, demand response and electric vehicle charging; and controls (+$30.0 million).
- Sensors and Controls. A significant portion of the energy consumed in buildings is wasted because of the lack of building controls or the inability to use existing Building Automation Systems (BAS) properly (+$5.0 million).
- Other high-impact technologies and techniques associated with HVAC, lighting, plug loads, etc., which typically drive energy consumption in buildings (+$30.0 million).
- Equipment and Buildings Standards. BTO will make a first time investment to explore the potential benefits of commercial product labeling, which can provide purchasers with information on expected product energy performance, expected energy expenditures, and other related material (+$15.0 million).
- Residential and Commercial Buildings Integration. BTO will invest in the development of innovative new business models (incubator concept) designed to mitigate market barriers in both the commercial and residential building sectors (+$5.0 million).
- Cross-Cutting. BTO will increase funding to facilitate the establishment of a more holistic, strategic approach to energy performance data, including common structures or taxonomy, data collection and analysis to inform decision making, and analysis of energy efficiency projects, programs, and trends. BTO will be working across a range of activities to standardize and utilize building energy performance data to drive greater energy productivity and improve measurement and tracking of results (+$10.0 million).

Overview

In the United States, residential homes and commercial buildings consume 40% of the Nation's total energy with an annual energy bill of more than $400 billion.[a] This translates into more than 70% of the electrical energy consumed in the U.S. These energy bills can be cost-effectively reduced by 20-50% or more through various energy efficiency technologies and techniques.[b] The Building Technologies Office (BTO) directly supports DOE's goal to provide clean, secure energy by developing reliable, affordable, and environmentally sound energy efficiency technologies, which significantly reduce the energy consumption of both new and existing residential and commercial buildings.

The mission of BTO is to develop and promote efficient, environmentally friendly, and affordable technologies, systems, and practices for our Nation's residential and commercial buildings that will foster economic prosperity and lower GHG emissions while providing the energy-related services and performance expected from our buildings.

The long-term, overarching goal of BTO is to support the development and deployment of technologies and systems by reducing building-related energy use by 50% by 2030. To secure these savings, research, development, demonstration and deployment of next-generation building technologies are needed to advance cost competitive building systems and components in the market.

BTO will continue to develop and demonstrate advanced building efficiency technologies and practices to make buildings in the United States more efficient, affordable, and comfortable. BTO will utilize a three-pronged strategy: 1) High Impact: target the greatest energy efficiency products and solutions (i.e., the highest potential market and energy efficiency impact), 2) Technology-to-Market: validate and drive these technology products and solutions to market through improved information and partnerships with manufacturers and users, and 3) Lock in Savings: where a government role is appropriate, lock in the savings through regulatory efforts that provide clear public and net economic benefit (i.e., codes and standards).

- High Impact: support research, development, demonstration and deployment (RDD&D) of technologies that have the potential to achieve significant improvements in building efficiency that will help accomplish the program's goal. BTO will do

[a] *Buildings Energy Data Book*, U.S. Department of Energy. March 2012, http://buildingsdatabook.eren.doe.gov/TableView.aspx?table=1.2.3.

[b] See, for example, DOE/ASHRAE's *Advanced Energy Design Guides* for commercial buildings (http://www1.eere.energy.gov/buildings/commercial/aedg.html) and DOE's Building America Program (http://www1.eere.energy.gov/buildings/residential/ba_index.html)

so by improving both the performance of and the cost to manufacture/install building components (solid state lighting, windows, heating, ventilation and cooling, building envelope, sensors and controls) through ground-breaking research and development and integration of those technologies; and develop whole-building energy system solutions that engineers, architects, and researchers can use to model energy consumption/performance in buildings.

- Technology-to-Market: support market-priming measures to ensure that technologies overcome the market barriers to widespread adoption, such as first cost, building trades' limited acceptance and adoption of new technology and practices, and insufficient availability of consumer information. This will be accomplished by increasing market pull from building developers, owners, and tenants through cooperation with stakeholders to develop and share validated data and best practices, improvement of building design and audit tools, and the creation of reliable efficiency benchmarks and databases to facilitate energy efficiency financing and to define efficiency's value-add to consumers.
- Lock in the Savings: support the widespread adoption of building efficiency technologies through the development of national energy efficiency standards for products and technologies that are promulgated by BTO's Equipment Standards Program and ensure reductions in energy use and resulting in significant household cost savings. This will be accomplished by raising the standards for energy-consuming equipment and model building codes based on cost-effective, higher-performing technology that private-sector manufacturers have successfully proven and commercialized.

To achieve its energy savings goal, BTO supports work in four key areas or subprograms aligned with this three-pronged strategy to deliver results: Emerging Technologies, Commercial Buildings, Residential Buildings, and Standards and Codes.

- The Emerging Technologies subprogram accelerates the research, development, and commercialization of emerging, high-impact building technologies that are, generally, five years or less to market-ready. The Commercial and Residential Buildings subprograms (as well as OWIP and FEMP) are customers for BTO's Emerging Technologies subprogram and serve as enablers for subsequent regulatory measures developed in BTO's Codes & Standards subprogram;
- The Commercial Buildings Integration subprogram accelerates energy performance improvements in existing and new commercial buildings by developing, demonstrating, and deploying a suite of cost-effective technologies, tools, and solutions. This subprogram also promotes voluntary private-sector activities to prime and support improved energy efficiency in the commercial building sector, with an emphasis on high-potential products that are currently market-viable but underutilized;
- The Residential Buildings Integration subprogram seeks to achieve increased energy performance in new and existing homes to minimize energy use while ensuring affordability, safety, durability, and renewable energy readiness. This subprogram applies building science and innovative deployment-support tools and techniques to identify and promote whole-house solutions to cost-effectively reduce energy consumption beyond code required levels;
- The Equipment and Building Standards subprogram provides cost-effective energy savings through national appliance and equipment standards that are technically feasible and economically justified, and it develops cost-effective model building energy codes with adoption and compliance strategies. It works with the DOE Regulatory Policy Group (RPG) to identify a prioritized list of products annually and pursues standards to maximize cost-effective energy savings. It actively monitors and enforces all DOE energy and water conservation standards and works with EPA to update and/or create ENERGY STAR product test procedures. For building codes, it develops model approaches, supports adoption of, and increases compliance strategies for advanced residential and commercial codes.

BTO also supports the Energy Efficient Buildings Hub to accelerate the development and deployment of energy-saving solutions to reduce energy use in the commercial buildings sector in a way that is scalable and can be deployed throughout the nation.

BTO will continue to work with its program partners in industry, academia, National Laboratories, Office of Science, ARPA-E, and other relevant stakeholders to define, refine, and deliver program results. BTO's lead-by-example effort is critical to informing the development of effective energy efficiency-enabling state and local policies and the establishment of replicable and scalable energy efficiency products and approaches by market leaders.

Ultimately, BTO activities will enable the following benefits:

- Reduce the building-related energy used by 50% by 2030;
- Provide a relatively inexpensive energy resource – efficiency – that addresses national concerns and goals involving energy affordability, reliability and GHG emissions;
- Reduce energy bills for American families and businesses and increase energy availability; and
- Help position the United States as a world leader in advanced building technologies which would be manufactured here at home, create jobs, and enable the U.S. to continue to be a global innovator and exporter of high-tech clean energy technologies.

Barriers to meeting BTO goals include:

- Technology costs: The high initial cost of energy-efficient building components and systems can serve as a barrier to widespread implementation and adoption even with proven long-term cost and energy savings.
- Fragmented construction market: A highly diversified industry comprised of thousands of builders and manufacturers that lack the capacity to sustain R&D activities over multi-year periods can hinder the private sector from making key investments in the development of new energy-efficient building technologies.
- Lack of communication among professional groups: The compartmentalization of building professions hampers communication among professional groups. As a result, architects and designers, developers, construction companies, engineering firms, and energy services providers do not typically apply integrated strategies for improving building performance and value during siting, construction, operations and maintenance.
- Struggling housing and construction market: In challenging economic times, reduced activity in the housing and construction markets limits the number of new construction and retrofit projects.
- Information asymmetry: Building efficiency improvements entail unique market risks because they are relatively invisible, making them challenging to market, especially without independent verification of savings levels. The relatively small size of most building firms makes it very hard for them to absorb the costs and risks of verifying the efficiency, safety, and health characteristics of new building designs, techniques and technologies.
- Additional market challenges: There are a series of challenges to adoption of cost effective technologies and techniques, and the BTO program develops and deploys market relevant solutions needed by the impacted market sectors (e.g. landlord-tenant split incentive).

Technology Status, Program Accomplishments and Near-Term Milestones[a]

A 2001 National Academy of Sciences analysis found that in its first two decades of existence DOE generated approximately $40.4 billion (2008 dollars) in total benefits from energy efficiency R&D, based on $2.1 billion invested from 1978 to 2000.[b]

In 2012, DOE launched the Rooftop Unit (RTU) Challenge. The Challenge included 5 manufacturers - Daikin McQuay, Carrier, Lennox, 7AC Technologies, and Rheem - who agreed to develop and commercialize new, best in class RTU technologies as a result of a clear new product specification of demonstrated interest to commercial building owners. This specification for a 10-ton capacity commercial air conditioner, or rooftop unit, was developed by BTO in coordination with its industry partners from the Better Buildings Alliance; Wal-Mart, Target, Yum! Brands, and McDonalds, to name a few. Units that meet the Challenge specification can be expected to use 50% less energy than current units (i.e., AHSHRAE 90.1 compliant units).

Emerging Technologies

- Lighting: In 2012, BTO awarded the first L-Prize to Philips, who demonstrated a 60 W replacement bulb that uses only 9.7 W to produce 910 lumens (93.4 lm/W). In 2009 when Philips entered the contest, similar bulbs produced 55 lm/W and about one-half the light output. Relative to incandescent lamps, the L Prize lamp appeared the same, has an expected lifetime of about 25 times longer and an improvement in efficiency of about eightfold, albeit with a higher price (about 100x) when first developed. The manufacturing costs need to be further reduced, but similar LED-based lamps are now a multiple of 20x, and technological improvements continue to drive the price down.

[a] For a list of milestones please see "*Strategic Performance Management by Program*" section.
[b] Valued originally in inflation adjusted 1999 dollars, further inflation-adjusted to 2008 dollars; "Energy Research at DOE: Was It Worth It? Energy Efficiency and Fossil Energy Research 1978 to 2000," National Research Council, 2001

- HVAC: In 2012, BTO investments produced a technology breakthrough by a U.S. heat pump company resulting in an energy efficiency breakthrough (60% more efficient than conventional systems) with introduction of the first ground source integrated heat pump (GS-IHP) ever certified by the Air Conditioning, Heating, and Refrigeration Institute (AHRI). The results indicate that this new heat pump can save 57–62% of annual energy use and cost for space conditioning and water heating in residential applications versus new minimum efficiency conventional systems and 38–57% versus current state-of-the-art two-stage geothermal heat pumps
- Windows and Envelope: BTO investment in low emission (low-e) coatings for windows has played an important role in developing cost-effective windows that are three times more efficient than those from the 1970s. First introduced to the market in 1983, windows with low-e coatings now account for nearly 75% of home windows sold.
- Analysis Tools: BTO funded EnergyPlus v7.0 and OpenStudio v6.0, a best-in-class open source model for integrated, physics-based analysis of whole building energy performance that will be the foundation for a new generation of HVAC system selection and sizing software from an industry leader in the field.
- Incubator Programs: The great majority of EERE investments are currently, and must going forward, be primarily driven by detailed short, medium, and long-term RDD&D roadmaps. EERE proposes Incubator activities in the FY 2014 budget, and designed them to use a small fraction of EERE's technology office's annual R&D budget to regularly introduce potentially high-impact "off-roadmap" new technologies. These Incubator activities will enable the "rapid on-ramping" of potentially transformational new energy technologies into the EERE portfolio, dramatically increasing the rate of technology innovation.

Standards

- EERE appliance standards: These standards improve the energy efficiency of household appliances, saving households money on their utility bills, as these households replace their existing appliances with newer models that use less energy. As a result of the standards implemented from 1987 through 2011, energy users were estimated to have saved approximately $40 billion dollars on their utility bills in 2010.
- Since 2009, 16 new or updated standards covering more than 30 products have been issued, which will help increase annual savings even further over the coming years. Cumulative consumer utility bill savings associated with these recently enacted standards are projected to be $180 billion (undiscounted) through 2030.

Residential

- In collaboration with EPA through the Home Performance with ENERGY STAR Program, EERE has partnered with state governments, local governments, utilities, and non-profit organizations since 2002 to encourage homeowners to perform building science-based energy upgrades to their homes resulting in average energy savings of 20-30%. To date, more than 250,000 retrofits have been completed – saving owners 15-30% annually on their energy bills.
- The Better Buildings Neighborhood (BNNP) Program, which started in FY 2010, as a result of funding available through the ARRA is on target to enable the retrofitting of over 100,000 buildings by the end of FY 2013, and is yielding important information on how to more effectively implement a retrofit program.
- The Building America Research Program has been a primary driver in the development of new approaches to improve energy efficiency in residential housing by examining how to integrate new technologies into the construction of a new home or in a retrofit. Building America research has resulted in the development of over 100 innovative building systems, approaches, and tools. Thirty two of these innovations have had a significant impact on residential energy efficiency as follows: Twenty-two of these innovations have been adopted or encouraged as part of the ENERGY STAR New Homes and DOE Challenge Home Programs, with ENERGY STAR Homes achieving approximately 25% market penetration with an average of over 20% energy savings per home. Eight have been incorporated into codes.
- In 2012 the Public Relations Society of America (PRSA) awarded the DOE Solar Decathlon 2011 communications program a Silver Anvil Award for outstanding media, digital and social media programs.
- Launched the Home Energy Score (HES) in 2012. The HES is an easy-to-use software tool that quickly estimates the relative energy efficiency of a home. This tool substantially reduces the cost of energy audits, one of the barriers to improving the energy efficiency of homes.

Program Planning and Management

BTO prioritizes its RDD&D work according to EERE's "5 Core Questions":

1) High Impact: Is this a high-impact problem?
2) Additionality: Will the EERE funding make a large difference relative to what the private sector (and other funding entities) is already doing?
3) Openness: Have we made sure to focus on the broad problem we are trying to solve and be open to new ideas, new approaches, and new performers?
4) Enduring Economic Benefit: How will this EERE funding result in enduring economic benefit to the United States?
5) Proper Role of Government: Why is what you are doing a proper high-impact role of government versus something best left to the private sector to address on its own?

BTO invests in a balanced portfolio of activities in pursuit of its energy efficiency goals. This investment portfolio is established based on assessments of current markets, determination of the technologies that would contribute to national goals when adopted, and assessment of what technology development pathways are well suited to concurrently fulfill the demands of the market in both the near term and into the future. BTO uses analytically-based tools, field measurement and verification, and cost-effectiveness analysis to balance its portfolio. For example, the prioritization tool is used to assess and compare the potential impact of over 500 different building technologies and measures at various stages of development. Factors such as primary energy savings, costs of conserved energy, market size, lifetime and market penetration are considered.

BTO uses a rigorous project selection, management, and evaluation approach to assure that these strategies are effective and deliver the greatest value to the taxpayer. Project management improvements implemented in FY 2013 and greater emphasis on cost-effectiveness of projects outcomes will continue into FY 2014.

BTO will be a key player in DOE's holistic, strategic approach to energy performance data, including development of common structures or taxonomy, data collection and analysis to inform decision making, and analysis of energy efficiency projects, programs, and trends. BTO will be working across a range of activities to standardize and utilize building energy performance data to drive greater energy productivity and improve measurement and tracking of results. Ultimately, improvements in the collection and validity of energy performance data will enable builders, homeowners, investors and policy makers to better understand the benefits and cost of new energy efficient building technologies and measures, thereby reducing investment risk and informing decisions, resulting in increased private investment in cost-effective energy efficient technologies and techniques in the commercial and residential building sectors.

These data efforts will focus in four areas:

- BTO is working to develop and deploy the data formats and data exchange standards that will facilitate comparison and analysis across different facets of the building energy efficiency industry. BTO will work with industry, and Federal agencies and state governments to develop and adopt data standards and metrics, and initial tools to demonstrate and promote the value of this data;
- BTO will improve data collection on building energy performance and energy efficiency project performance across BTO-funded residential and commercial projects, and provide tools to support data collection on energy efficiency projects funded by state and local governments, utilities, and private building owners. These efforts will increase the depth and breadth of nationally available data while lowering costs of data collection for anyone using this standardized approach. The data will be publicly available, while protecting Personally Identifiable Information (PII). This data is needed to help all market participants, from manufacturers to building owners to utilities, make better decisions about how to allocate resources to achieve the most energy savings;
- BTO will support EERE to develop, demonstrate, and deploy improved methods of evaluation, measurement, and verification (EM&V) of energy efficiency impacts. This includes developing measurement and verification of performance for individual projects, whole programs run by utilities or governments, and aggregated across states or regions;
- BTO, working in coordination with the Energy Information Administration (EIA), will develop and demonstrate innovative ways to automatically collect data on energy use or performance of equipment and buildings while ensuring public and private sector privacy needs are addressed. This includes developing improved techniques, lower-cost options, and options providing more granular data in related activities, such as for consideration of use in EIA's Commercial Buildings Energy Consumption Surveys (CBECs) and Residential Energy Consumption Surveys (RECs). These currently resource-intensive surveys are the only nationwide source of data for current estimates of energy end uses in homes and commercial buildings. In addition we will work with industry to develop and deploy embedded sensors,

controls, and intelligence in equipment that allows self-knowledge, tracking, and communication of energy performance. BTO will develop standardized formats for building data to improve Federal and private sector alignment with the granular data becoming available from the nation's 40+ million smart meters to identify and implement energy efficiency measures more quickly and cheaply.

Strategic Performance Management by Program

Performance Measure	**Buildings - Standards** **Final Rules** - Annual number of products for which final rules for test procedures or standards will be issued **NOPRs** - Annual number of products for which Notices of Proposed Rulemaking (NOPRs) for test procedures or standards will be issued		
Fiscal Year	**2012**	**2013***	**2014**
Target	34 final rules; 34 NOPRs	TBD	13 final rules; 17 NOPRs
Result	29 final rules; 35 NOPRs		
Endpoint Target	57 products for which final rules issued for test procedures or standards by 2016 (cumulative) 73 products for which NOPR issued for test procedures or standards by 2016 (cumulative)		

*2013 targets represent DOE's FY 2013 Budget Request to Congress. FY 2013 target updates can be found in the upcoming FY 2012-2014 Annual Performance Plan & Report.

Commercial Buildings Integration
Funding Profile by Activity

(dollars in thousands)

	FY 2012 Current	FY 2013 Annualized CR	FY 2014 Request
Commercial Buildings Integration	31,913	—	36,570
Total, Commercial Buildings Integration	31,913	—	36,570

*FY 2013 amounts shown reflect the P.L. 112 175 continuing resolution level annualized to a full year. These amounts are shown only at the "congressional control" level and above; below that level, a dash (—) is shown.

The Commercial Building Integration (CBI) activity accelerates the uptake of significant energy performance improvements in existing and new commercial buildings throughout the United States by developing, demonstrating, and deploying a suite of cost-effective technologies, tools, solutions, best practices, and case studies. CBI catalyzes voluntary activities to prime the commercial building sector for increased efficiency, with an emphasis on high-potential products that are currently market-viable, but underutilized.

In addition, CBI executes activities that support several other legislative or Administration priority goals, including goals defined by EISA 2007 (develop and disseminate technologies, practices, and policies supporting all new commercial buildings designed to "zero net energy" by 2030 and all existing commercial buildings operating at zero net energy by 2050) and President Obama's Better Buildings Challenge (to support the goal of making America's commercial buildings 20% more efficient by 2020). In addition, CBI supports President Obama's recently announced goal to double energy productivity by 2030. The White House cites three key elements of the President's goal: (1) Energy Efficiency Race to the Top challenge; (2) building on the success of existing partnerships with the public and private sectors to promote energy efficiency; and (3) continuing investments in technologies that improve energy productivity and cut waste.[a] CBI supports 2 and 3 extensively via support of the Better Buildings public-private partnerships and efforts to demonstrate and deploy commercial technologies that improve energy productivity and cut waste.

Energy efficiency construction and upgrades performed in the commercial building market are currently impacted by a variety of barriers including lack of public data and information, lack of successful business models, lack of private sector investment, and lack of overall knowledge of proper specifications or resulting benefits. CBI addresses these barriers by deploying successful cost-effective implementation models and demonstrations of solutions that make energy performance and assessment more transparent and understandable, demonstrate high-impact new technologies and integrated building systems, and promote public and private sector commitments to energy efficiency investments. CBI develops successful models of public–private partnerships to increase investment in commercial building energy efficiency and to assist building owners and private sector investors in identifying cost-effective options for integrated energy upgrades. This requires investment in market infrastructure (e.g. developing clear workforce guidelines and standardized metrics for building energy performance) as well as investment in developing and demonstrating approaches that successfully save energy (energy upgrade case studies, efficient product specifications for manufacturers, business models for successful energy upgrades).

CBI performs its work in the following six focus areas:

- Building performance tools to drive efficiency by increasing access to and use of energy performance data, reduce investment risk to increase financing for energy efficiency and build the capacity of the building performance market. These database and software tools, such as the Standard Energy Efficiency Data (SEED) platform and the Technology Performance Exchange, provide standardized whole-building rating approaches that build upon and complement the existing ENERGY STAR Portfolio Manager software. In FY 2014, this work will include

[a] http://www.whitehouse.gov/the-press-office/2013/03/15/fact-sheet-president-obama-s-blueprint-clean-and-secure-energy-future

development of a building efficiency valuation portfolio, including building to grid interoperability, demonstrating non-energy value of efficiency for the commercial real estate market;

- Market partnerships to accelerate broad-scale uptake of advanced technology in new and existing buildings. Through the Better Buildings Alliance industry partners such as, Wal-Mart, Target, Yum! Brands and McDonalds, CBI convenes private sector building owners to develop and deploy solutions for the market, including advanced specifications that drive efficiency in a range of building technologies. These specifications can significantly increase energy efficiency in industries, such as the high-efficiency RTU air conditioner, or they can be for new system configurations that help to maximize the potential of existing technologies like those developed for parking structure lighting. CBI works with Alliance members to adopt those higher efficiency levels as procurement or design norms in their structures which, in turn, drives the specification's adoption in the commercial sector, resulting in more energy efficient outcomes. CBI will encourage whole-building energy performance improvement via market partnerships leading to portfolio-wide energy savings of 2% per year for participating organizations.
- Technology Demonstration and Integration of individual, newly or near-commercialized advanced technologies and methods to facilitate integrated low-energy building design and operation. This activity was referred to as Development, Demonstration, and Integration in FY 2012 and 2013.
- Expanding this activity for high-impact Commercial Buildings research projects through an external competitive process to whole building systems
- Extending the impact of CBI work in the small building, small portfolio space, which accounts for 95% of commercial buildings in the U.S.
- Expanding work on building performance assessment tools to include specific analysis of representative equipment and operations to help owners, operators, and tenants understand their energy performance and opportunities for improvement.

CBI coordinates each of these focus areas with the Energy Efficient Buildings (EEB) Hub, and provides technical assistance to the Hub by sharing project information and Advanced Energy Retrofit Guides for applicable buildings and climates. The EEB Hub, headquartered at the Navy Yard in Philadelphia, is providing a test bed for demonstrating in Greater Philadelphia scalable, market proven solutions to reduce energy use in commercial buildings. The Hub will support CBI by providing data and information collected from the implementation of Hub-developed energy audit and assessment tools, and by providing baseline building data for a representative distribution of building types in the Philadelphia region. Finally, the Hub will provide Energy Conservation Measurement data for use in the Building Component Library, a database of building component energy performance maintained by DOE.

Explanation of Funding Changes

(dollars in thousands)

	FY 2012 Current	FY 2014 Request	FY 2014 Request vs. FY 2012 Current
Commercial Buildings Integration — Expansion of Technology Demonstration and Integration efforts, including improved alignment and integration with other BTO efforts (emerging technologies, residential buildings, and codes), and with GSA and DoD efforts to improve energy efficiency in government buildings; Increased funding to support work in the small/medium building market segment; Increased funding to support development and demonstration of methods to reduce cost and increase credibility of measurement and verification of energy efficiency project savings; Enhanced focus on codes adoption and compliance in collaboration with codes efforts in BTO's Equipment and Buildings Standards program.	31,913	36,570	+4,657
Total, Commercial Buildings Integration	31,913	36,570	+4,657

Funding Schedule

Fiscal Year	Line Item	Funding (dollars in thousands)
FY 2012	• Building Performance Tools: Established common approaches for building data characterization, collection and reporting to provide consistent and credible information to building owners/operators and drive their investments in energy efficiency improvements. • Market Partnerships: To spur investments in technologies that increase energy productivity and cut waste, developed series of advanced Energy Design and Retrofit Guides, recruited 500 million sq. ft. of commercial building space into the Better Building Challenge, initiated high performance RTU challenge, and developed five performance specifications for high efficiency products for adoption by Commercial Building Energy Alliance. • Development, Demonstration and Integration: To enable building owners/operators to make informed decisions on energy efficiency upgrades, BTO developed 20 case studies to demonstrate technologies and approaches that reduce energy consumption by 20% with 5 year or less payback.	31,913
FY 2013	Planned activities in the FY 2013 Budget (final allocations have not yet been determined): • Building Performance Tools: Launching Building Performance Database, Commercial Building Asset Score to allow building owners and managers to more accurately assess building energy performance. • Market Partnerships: Concluding high performance RTU challenge demonstrating actual performance and savings for two challenge units; launch wireless sub-meter challenge to manufacturers to produce low-cost panel meters for commercial buildings, develop 5 new performance specifications, and 5 additional market solutions. An example is a case study documenting how an organization successfully overcame a landlord-tenant split-incentive barrier by adjusting clauses in the lease to allow both parties to reap rewards ($savings) from energy retrofits. • Developing program to enable adoption of energy efficient technologies in small commercial buildings. • Development, Demonstration and Integration: Demonstrating 10 technologies from the BTO portfolio including high efficiency washers, no touch audit software to provide data that validates technology performance and provides building owners/operators with the confidence to invest in energy efficient products.	—
FY 2014	• Building Performance Tools: Full launch of asset scoring tool with additional building types, pilot operational rating; develop building energy modeling tools. Full launch of Standard Energy Efficiency Data (SEED) platform and Technology Performance Exchange, a clearing house for energy performance information for building technologies. • Market Partnerships: Increase number of participating organizations from 200 to 300 and over 10 billion square feet of commercial floor space in key market sectors participating in the Better Buildings Alliance: commercial real estate/office, retail, hospitals, hospitality, higher education, supermarket and grocery, and food service. Conduct additional energy efficiency performance and challenge specifications as identified through new partnerships with Architecture and Engineering community, industry organizations and utility stakeholders. Support workforce certification scheme for key commercial building energy skills. Coordinate with WIPO and FEMP to deliver these solutions to public and Federal sector commercial buildings. • Technology Demonstration and Integration: In collaboration with Emerging Technologies and Grid Integration Initiative, demonstrate technologies from within and outside of the existing BTO portfolio of advanced energy efficiency technologies. Extend commercialization piloting to whole-building systems/solutions and technologies selected	

Fiscal Year	Line Item	Funding (dollars in thousands)
	through an external competitive process. • Valuation of Energy Efficiency: Address this critical barrier to uptake of energy efficiency through: full launch of Building Performance Database and open Application Programming Interface, development of building efficiency valuation portfolio including Demand Side Management and grid work and tools demonstrating non-energy value of efficiency for commercial real estate market. • Energy Performance Data: Apply the holistic, strategic approach to energy performance data, including development of common structures or taxonomy, data collection and analysis to inform investment and policy decisions and impacts analysis of energy efficiency projects and programs.	36,570

Emerging Technologies
Funding Profile by Activity

(dollars in thousands)

	FY 2012 Current	FY 2013 Annualized CR	FY 2014 Request
Emerging Technologies R&D	61,182	—	101,740
Grid Integration Initiative	0	—	30,000
Total, Emerging Technologies	61,182	—	131,740

*FY 2013 amounts shown reflect the P.L. 112 175 continuing resolution level annualized to a full year. These amounts are shown only at the "congressional control" level and above; below that level, a dash (—) is shown.

Emerging Technologies (ET) focuses on the research, development, and commercialization of advanced building technologies. Research and development of next generation building technologies lead to advances in building components and systems that ultimately decrease energy demands. The majority of ET investments focus on high impact technologies that generally have less than 5 years to market readiness.

All investments align with BTO's goals to achieve 50% building energy savings through 2030: 70% energy savings in lighting; 60% energy savings in water heating; 40% energy savings in HVAC/Building Envelope; 20% energy savings in appliances; and 20% energy savings in building controls.

Emerging Technologies will continue to use a "peer reviewed" prioritization tool to identify high-impact and cost-effective technologies ripe for innovation that has potential to be further explored within the ET portfolio. Specific competitive solicitations will be aimed at these gap areas in FY 2014.

ET will fund a competitive FOA solicitation in the topic area of cross-cutting Building Technology Manufacturing research and development that will be integrated with EERE's Clean Manufacturing Initiative.

To complement the FY 2013 FOA focused on motivating earlier stage building technologies, a FY 2014 FOA is also planned on accelerated commercialization of building technologies that are three years or less to market-ready with an emphasis on later stage R&D coupled with commercialization plan development. Additionally, in FY 2013, ET and CBI partnered with the Department of Defense Environmental Security Technology Certification Program (ESTCP) demonstration program to identify high-priority building technologies of mutual interest.

New FY 2014 competitive demonstration FOAs will involve a "match-making" partnership with building owners, including Federal agencies, to bring promising and high-impact technologies into the marketplace through targeted demonstration and assessment in residential and large commercial portfolios.

ET research and development is conducted in the following areas:

Lighting R&D: The objective of lighting R&D is to conduct the applied research needed to fill technology gaps, provide enabling knowledge or data to reduce manufacturing costs, and advance the technical knowledge base for Solid-State Lighting (SSL) to be used for general illumination applications. Specific emphasis will be given to achieving the performance and cost goals stated in the annual Solid-State Lighting Research and Development Multi-Year Program Plan (MYPP). In 2013, SSL made particular investments emphasizing manufacturing cost reductions for SSL (i.e., reducing $/klm), in light of renewed emphasis and opportunities in wide bandgap semiconductor material fabrication. Through analysis conducted with the Prioritization Tool there is approximately 60% primary energy savings that can be achieved through more efficient lighting, supporting continued investment in FY 2014. In FY 2014 SSL will increase focus on product development (i.e., reducing W/lm) ($25.8 million).

Space Conditioning and Refrigeration R&D: HVAC: The long-term goal for space conditioning and refrigeration R&D is to identify and support development of technologies that can provide a 20-40% overall reduction in energy consumption. This includes work in sensors and controls, low global warming potential (GWP) working fluids, alternative (i.e. non-vapor compression) heating/cooling cycles, integrated heat pumps, heat

exchangers, and sensors and controls technologies ($23.1 million).

- Integrated heat pumps (heat pumps that provide space heating and cooling, as well as water heating) and cold climate heat pumps are particular areas of emphasis. In 2014, project topic areas will focus on improving how HVAC systems treat separate sensible and latent cooling loads, which are of increasing interest due to the tightening of the building envelope and recent advances in membrane and other separation technologies. Both performance improvement and cost reduction through improved manufacturing will be emphasized.
- Support for sensors and controls is growing, due to their role as an enabling cross cut technology for grid integration and the substantial potential energy savings due to optimized building control. The estimated annual technical potential for optimized commercial building controls is greater than 1.5 quads in primary energy. In the sensors and controls area for FY 2014, project topics include the development of cost-effective, wireless, energy-harvesting sensors that will help enable widespread building automated control. This builds on current lab-directed research that has already generated a prototype sensor that measures temperature and relative humidity, and includes a small PV array for powering itself from ambient lighting and wireless capability.
- Building Envelope R&D: Windows and Envelope: With building envelope technologies, the long-term goal is to enable the development of high-performance attics and walls equivalent to greater than R-40 performance with no increase in 30-year life-cycle cost by 2020. Particular opportunities are present in the retrofit space, due to the large number of existing, relatively inefficient buildings in the United States. In FY 2014 project topic areas will combine technology research and development and early deployment, which would provide important feedback to the technology developers and help them overcome obstacles that hinder broad acceptance and adoption. The FY 2014 program will continue to fund activities that focus on high-impact areas such as cool roofs and advanced roofing systems, as well as novel high-performance and cost-effective thermal insulation solutions ($8.0 million).
- Near-term window technologies, such as R-5 windows that have recently become part of the Energy Star most efficient program, have largely moved out of the R&D space and into deployment. In FY 2014 funds will support further applied R&D and market transformation activities to overcome technical, manufacturing and market barriers, thereby making highly insulating windows more cost-competitive and enhance market penetration. Similarly, energy-efficient window attachments (blinds, shutters, awnings, etc.) do not in themselves require further research, but they do lack an energy efficiency rating system that would promote their widespread adoption. FY 2014 topics areas will be funded to facilitate establishment of a fenestration attachment energy efficiency rating and certification organization, with related support to finish the development of the needed software tools and measurement standards required for this rating and certification.
- Analysis Tools: Building Energy Modeling (BEM) tools support design of buildings, equipment and controls, along with energy-efficiency standards, policies, and rating scales. A planning effort currently underway that involves interaction with a wide variety of stakeholders will guide activities and identify: new partnerships that enable better tracking of model/tool use; the program's appropriate level of involvement in the modeling/tool sector; and projects that appropriately support a focus on enhanced usability and use, capabilities, and accuracy of the models/tools ($4.9 million).
- Building energy modeling is a tool that enables building designers to strive for integrated building design, that is, for designs that optimize whole-building energy efficiency. The BTO flagship building energy model, EnergyPlus, is the leading open source software tool for designing energy-efficient buildings. EnergyPlus is regularly updated by a cross-cutting team to incorporate new features. FY 2014 project topics areas will focus on modernizing of EnergyPlus to facilitate deployment of the tool.
- Cross-cut Technology: A cross-cutting technology that ET will pursue which could have substantial impact on efforts in improving building to electric grid interactions and building level energy storage. Relevant approaches could take the form of electrical or thermal energy storage. Recent DOE energy storage programs have focused on utility scale storage (ARPA-E; Office of Electricity), electric vehicle batteries (Vehicles Program; ARPA-E), and on high-temperature thermal storage for concentrating solar power (Solar program), but relatively little effort has been directed to building level energy storage. A particular goal is to enable buildings, which consume the majority of electricity generated in the USA, to manage their electrical demand by storing energy so that it can be used when the cost of electricity is high.

This benefits both the building owner, who saves on electricity costs, and the electrical utility, which is able to reduce their peak generation.

Grid Integration Initiative: In 2011, the National Energy Technology Laboratory (NETL) found that the potential nationwide value of demand dispatch (i.e. transactive control and energy within and to buildings) could be several billion dollars per year in reduced energy costs with 10% participation (NETL, Demand Dispatch – Intelligent Demand for a More Efficient Grid, Aug 2011). NETL also found that more than one-fourth of the 713 GW of U.S. electricity demand in 2010 could be dispatchable – if only buildings could respond to that dispatch. In FY 2014, BTO will work within EERE to ensure that seamless interactions and optimization of EERE technologies with the electrical grid will not present additional risks or jeopardize grid reliability. BTO will focus on how buildings and building related systems and technologies can transact with each other and with the grid more efficiently and effectively. This work is part of EERE's Grid Integration Initiative and will be coordinated with DOE's Office of Electricity, which is focused on grid operations, reliability and security ($30.0 million).

Presently, the energy-related components and systems within residential and commercial buildings are controlled with methodologies that deliver suboptimal energy operations. These systems are generally unaware of perturbations and potential opportunities both within and outside the building envelope. Control and dispatch of loads and on-site generation is often rudimentary with heavy human interaction and extensive customization, which is neither cost-effective nor scalable.

BTO's goal is to provide proven improvements to the building environment while integrating variable, distributed renewable generation assets and plug in electric vehicles into the grid. Even though this demand dispatch resource could cost-effectively reduce energy waste and facilitate more renewable penetration, existing buildings, building systems, and building components today cannot effectively respond. The primary building level issues that limit the scale and penetration of response is a deficiency in the ability to share performance information or transact load and energy services within the building and with other surrounding facilities or electric distribution systems. Building loads, similar to electric vehicles (EV) charging loads, can also serve as a resource to mitigate supply and demand imbalances in addition to other ancillary services. The following efforts are needed:

- Common definitions and data formats among building systems to facilitate scalable, lower-cost solutions that will enable building energy performance optimization
- Smart building solutions including automated controls to provide faster response and support greater penetration of end use solutions to U.S. energy, demand, and grid regulation needs (i.e. <50msec response to better enable ride-through capabilities)
- Further United States innovation and leadership focused on new innovations and solutions to support greater cost-effective energy efficiency and energy demand savings, renewable penetration, and grid support from the end use and building level.

As we move towards a truly integrated building-to-grid world, it is clear that systems and devices that can 'transact' their status, availability and identity would be optimal to facilitate better energy management at the grid, utility, and building level. However, despite the progress that has been made over the past thirty years in building automation, there remains considerable potential to fully deploy automation in buildings. And while it seems obvious that more and 'smarter' automation is needed, most buildings do not have basic controls systems installed. If we do not develop a holistic approach to integrate these technologies in building systems and connect with distribution systems, new clean energy technologies (including renewables) will face difficult barriers in adoption by utilities or the marketplace at relevant scale in the grid.

Customer-owned electric vehicles, distributed renewable generation, and building equipment can be integrated to optimize their overall performance as well as interact with the utility grid to increase system efficiency and energy utilization. EERE, in coordination with the Office of Electricity, will implement a joint $80.0 million funding opportunity announcement (FOA) sponsored by the Solar Energy Technologies Office ($30.0 million), Buildings Technologies Office ($30.0 million), and Vehicle Technologies Office ($20.0 million) to solicit participation from key market participants to integrate photovoltaic systems and electric vehicles into buildings. The optimized building complex, comprising building efficiencies, electric vehicles and renewable energy will interface with the distribution system. Building owners and operators will partner with utilities, national laboratories, industry, and other innovators to develop and further advance the platform of technologies, communications and controls necessary for customers to

interact with a modernized and more flexible distribution system.

In addition to the solicitation, DOE proposes to work directly with the national laboratories based on a merit-reviewed evaluation of how their expertise, capabilities, and research facilities can help solve this customer to grid integration challenge. For instance, the Energy Systems Integration Facility at the National Renewable Energy Laboratory brings on-line new capabilities to optimize building interface with the grid. Through this initiative, DOE will maximize the beneficial impact of its and other parties' R&D investments, increasing the value of customer side equipment, modernizing the interaction of behind-the-meter systems with the distribution grid, and enabling widespread deployment of clean energy technologies.

The path to achieve advanced automated buildings (that cost effectively transact within the building and with the grid) involves several key topics for utilities, industry, and building designers, contractors, managers and owners to resolve:

- Standardization of data: within the building complex, increasing levels of information are needed to optimize efficiency and behind the meter coordination of information prior to interactions with the grid. This work will explore common data interfaces within the building and provide an information basis for NIST to develop standards. This effort will be coordinated for handoff with NIST and OE. Once these markets mature, standards under development by NIST will replace them.
- High Resolution Data –Building -wide data will not be sufficient for a highly automated building. The metrics are too broad and vague. To optimize building performance and to transact with the grid, successful solutions require building data that is relevant to the product or service that is being provided with regard to the purpose the building serves. This work will develop higher resolution information from the buildings and validate what information is most useful for optimization within the building and with the grid (e.g., a refrigerated distribution center for foods vs a multi-family housing unit). These data will meet the grid-related data and interoperability standards developed and overseen by the National Institute of Standards and Technology (NIST), DOE's Office of Electricity, and other relevant organizations;
- Data Analytics/Tools – Data 'mining' to improve performance or forecast the value of transactions is necessary to support a fluid and vibrant building-to-grid (B2G) data sharing network. A critical component of any solution in building automation is predictive analytics that identifies trends in how the building is performing or being used, inferring relationships between variables and creating rules to predict how the building performs under different scenarios;
- Sensors - Highly automated buildings will need additional sensors and metering; some for energy systems (plug load, lighting, HVAC), others for air quality, building occupancy, external lighting conditions, water consumption, security, etc. A key issue that impedes broad scale deployment of even existing sensors is total cost (both device and installation). Scalable solutions that develop accurate, reliable, and low cost (<$1), wireless, and power harvesting sensors would be needed; and
- Open Architecture Building Energy Control Systems – A comprehensive, open architecture building energy control system solution would provide capabilities that enable properly implemented applications to run on a variety of platforms from multiple vendors, interoperate with other systems applications, and present a consistent style of interaction with the user and the grid.

Today, proprietary control systems lock building owners and operators in to one manufacturer, and often in to one contractor, in a geographic region for support. This prevents a scalable transaction-based environment that would enable a multitude of equipment and service providers, utilities, and third party investors to engage in practices that are economically beneficial. The development and deployment of a platform to support mobile and stationary software agents to perform both information sensing and control actions within a building would help deliver such an environment.

Truly open architecture building energy controls systems will enable reduced transaction costs, ensuring competitive pricing and competition for business. Properly developed, these systems will deliver true "plug and play" capability, similar to state of the art software operating systems.

BTO intends to award applicants that propose comprehensive end-use side solutions that address these topics at scale. Applicants with an effective project plan for higher penetrations of these technologies, and defined deliverables, will be given a higher priority in the selection criteria of the solicitation. No funding will be available for the purchase of distributed generation, EVs,

or charging stations. Awardees will be required to provide a minimum of 50% cost-share with higher priority given to those who exceed this requirement. Through this joint effort, DOE will maximize the beneficial impact of its R&D investments, enabling widespread deployment of clean energy technologies across the distribution system.

EERE's Incubator activities are an expansion of an already proven innovative program that EERE's Solar Energy Technologies Program piloted with a specific focus on partnering with businesses and researchers to bring "off-roadmap" impactful new technologies into the EERE portfolio. These early prototypes were developed into manufacturing and commercially relevant prototypes designed around pilot-stage process development. Based upon this highly successful model, the program plans to invest in the creation of Incubator Programs in FY 2014 ($5.0 million).

Explanation of Funding Changes

(dollars in thousands)

	FY 2012 Current	FY 2014 Request	FY 2014 Request vs. FY 2012 Current
Emerging Technologies – Identification of high-impact and cost-effective technologies ripe for innovation but not sufficiently represented within the ET portfolio. Specific competitive solicitations will be aimed at these gap areas, like next generation air conditioning technologies and advanced building controls. ET will also focus competitive FOAs in the area of innovations in manufacturing of high-impact building technologies to drive cost reductions; a specific topic in this FOA will be on cross-cutting building technologies (e.g., motors, heat exchangers) given their application to a broad industry space. To complement the FY 2013 project areas focused on motivating earlier stage building technologies, in FY 2014 project areas will be planned on accelerated commercialization of building technologies that are three years or less to market-ready with an emphasis on later stage R&D coupled with commercialization plan development. New FY 2014 competitive demonstration project areas will involve a "match-making" partnership with building owners, including Federal agencies, to bring promising and high-impact technologies into the marketplace through targeted demonstration and assessment in residential and large commercial portfolios.	61,182	101,740	+40,558
Grid Integration Initiative: Initiate RD&D to support the EERE-wide Grid Integration Initiative.	0	30,000	+30,000
Total, Emerging Technologies	84,765	156,040	+70,558

Funding Schedule

Fiscal Year	Activity	Funding (dollars in thousands)
FY 2012	• SSL R&D: LED lab prototype of 127 lumens/watt warm white light. • SSL Manufacturing R&D: Improvements in testing and inspection, and OLED disposition. • SSL: Initiated work on the 21st Century L Prize (24,923). • Advanced HVAC Technologies: Developed Ground Source –IHP (variable speed); Air Source (AS)-IHP (2-speed); Multifunction Natural Gas-driven HP; Next Generation Roof Top Unit (RTU); Next Generation Window AC; Cold Climate HP; HVAC Radial Air Bearing Heat Exchanger; Optimized Heat Exchangers design for condensers, zero cost improvement. Market introduction of Ground Source –IHP (variable speed). Work on drafting method of	

Fiscal Year	Activity	Funding (dollars in thousands)
	test for these advance technologies. Perform lab and field testing of these technologies in preparation of market introduction and provide engineering feedback to CRADA partners on results for further development of prototype units. • Advanced HVAC Technologies: Developed water heating and appliances; Electric Heat Pump Water Heater (HPWH) with low-GWP; Absorption HPWH; HP Coupled Washer/Dryer. • Advanced HVAC Technologies: Developed working fluids and nanolubricants; optimum thermodynamic parameters of potential working fluids and next generation alternatives. Estimated Global Warming Potential (GWP) for candidate working fluids, several thousand reduced to approximate 1234 candidates working fluids (15,472). • Windows: Developed low cost manufacturing of R5 windows; advanced day-lighting window coatings; technology to accelerate IGU production cycle time; affordable low-E storm window technology; cost effective low-emissivity film for windows. • Advanced Envelope Technologies: Developed roofs and attics for hot climate; cool roof aging protocol and new products (15,472). • BEM capabilities: Developed advanced system configurations, active component right-sizing, complex fenestration and shading, models for control development and optimization • BEM usability: Input model calibration for envelope characteristics (5,315).	61,182
FY 2013	Planned activities in the FY 2013 Budget (final allocations have not yet been determined): • SSL Manufacturing R&D: Improve testing and inspection, and OLED disposition. • Advanced HVAC Technologies: Complete research on integrated heat and high-efficiency low-emission supermarket refrigeration systems. This work includes the evaluation of alternative refrigerants in supermarket refrigeration system (R-404A, R-407F, R-1234yf blends). • Advanced HVAC Technologies: Multifunction Natural Gas-driven HP. Complete the design and development of alpha prototype. • Advanced HVAC Technologies: HVAC Radial Air Bearing Heat Exchanger develop samples for distribution to potential manufacture/users. Initial work on using this technology for water heating applications, small scale lab demonstration work, is started. Draft a commercialization report for this technology. • Advanced HVAC Technologies: Develop Water Heating and Appliances; field test CO2 HPWH (achieve 15% energy savings). Perform engineering analysis for the system to build and test a third generation prototype for cost and performance in FY 2014. Advanced HVAC Technologies: Develop working fluids and low GWP refrigerants. Reduced 1200 working fluid candidates passing the screening to less than hundred, 62 working fluids candidates. Compressor calorimeter evaluation of several R-410A alternatives. Heat Pump Water Heater and refrigerator tests with 1234yf resulting in more energy efficient HVAC technologies. • Advanced HVAC Technologies - Develop sensors and controls and Small Building Controls Platform resulting in more energy efficient technologies (23,200). • Windows: Research cost-effective highly insulating windows, including vacuum insulated glass (VIG) and high structural loading R5 windows; dynamic glazing technologies for windows and low-E storm windows; residential window attachments and retrofit solutions. • Advanced Envelope Technologies: Research integrated cool roofs for commercial buildings and advanced roofing systems for cold climate; develop cool roof aging protocol and new products; develop higher R per inch thermal insulation and very high R exterior insulation (9,500). • BEM capabilities: Right-sizing of thermal storage elements, enhanced modeling of ducted	

Fiscal Year	Activity	Funding (dollars in thousands)
	airflow, modeling of faulty execution, co-simulation with other engines to improve whole building analysis. • BEM accuracy: Validate selected envelope algorithms using measured data to ensure data is consistent and produce more accurate output analysis. • BEM usability: Input model calibration for HVAC components, support energy-efficiency code compliance (5,900).	—
FY 2014	• SSL Manufacturing R&D: Achieve a 15% reduction in manufacturing cost of a warm-white LED package. • SSL: Initiate work on the 21st Century L Prize. (20 -30% of the Emerging Technologies budget R&D budget) • Advanced HVAC Technologies: Complete research on advanced technologies such as radial air bearing heat exchanger and other advanced heat exchangers. This includes building a full scale heat pump unit using this technology in the 1 kW range using rotating heat exchangers. Future years will include higher capacity heat exchanger units, moving from water heating applications to HVAC applications. Evaluate not-in-kind technologies such as electrocaloric cooling. Using the commercialization report developed in FY 2013 explore the use of the axial version of this air bearing heat exchanger technology. • Advanced HVAC Technologies: Multifunction Natural Gas-driven HP. Perform design review with CRADA partner on prototype unit and initiate field test. • Advanced HVAC Technologies: Water Heating and Appliances; Absorption HPWH (achieve 45% energy savings compared to Energy Star Gas Storage). Develop third-generation prototype to cost target. • Advanced HVAC Technologies: Develop working fluids and low GWP refrigerants. Using the 62 working fluids candidates from FY 2013 further evaluate them and publish final list of candidates working fluids that are low GWP. • Advanced HVAC Technologies: Develop solar cooling and adsorption chillers. • Advanced HVAC Technologies: Develop next generation clothes dryer technologies using heat pump technology, complete design and testing of breadboard unit. • Advanced HVAC Technologies –Announce FOA to pursue advanced topics in building sensors and controls. • Announce FOA to develop cost-effective approaches for handling separate sensible and latent air conditioning loads (15-25% of Emerging Technologies budget). • Windows: Cost-effective highly insulating windows. • Advanced Envelope Technologies: Research cool roofs for residential retrofit and advanced roofing systems for all climates; thermal insulation optimized for wall retrofits (10-15% of the Emerging Technologies budget). • BEM capabilities: Improve modeling of airflow and advanced ventilation and air distribution, new equipment and system performance maps, general control strategies. • BEM accuracy: Validation of selected HVAC algorithms using measured data. • BEM usability: Input model calibration for operations and whole building, characterization of operational uncertainty, reduced-order models for dynamic control (10-15% of the Emerging Technologies budget). • Identification of high-impact and cost-effective technologies ripe for innovation that has the potential to be further explored within the ET portfolio. • Announce a competitive FOA in the area of innovations in manufacturing of high impact building technologies to drive cost reductions. • Grid Integration Initiative: RD&D support to EERE-wide Grid Integration Initiative. Activities will address grid integration barriers associated with variable, distributed renewable energy	131,740

Fiscal Year	Activity	Funding (dollars in thousands)
	generators, electric vehicle charging and building efficiency, demand response, and controls. Focus will include validation that grid integration barriers associated with EERE technologies can be overcome so that utilities, public utility commissions, and other stakeholders can have the confidence and risk tolerance necessary to adopt high penetration of clean energy technologies while maintaining grid reliability.	

Energy Innovation Hub: Energy Efficient Building Systems Design
Funding Profile by Activity

(dollars in thousands)

	FY 2012 Current	FY 2013 Annualized CR	FY 2014 Request
Energy Innovation Hub	23,583	—	24,300
Total, Energy Innovation Hub	23,583	—	24,300

*FY 2013 amounts shown reflect the P.L. 112 175 continuing resolution level annualized to a full year. These amounts are shown only at the "congressional control" level and above; below that level, a dash (—) is shown.

To accelerate the development and deployment of energy-saving solutions for commercial buildings, DOE established the Energy Efficient Buildings (EEB) Hub, a Regional Innovation Cluster headquartered at the Navy Yard in Philadelphia. A key feature of the Hub is the availability of a unique set of buildings as a test bed, including a 30,000-square-foot building that will be used to demonstrate advanced energy retrofits of commercial and multi-unit residential buildings. The tools developed, lessons learned and best practices from the Hub will ultimately help enable wide-scale deployment in similar climate zones and building types nationwide. The goal of the EEB Hub is to reduce energy use in the commercial buildings sector in Greater Philadelphia including multi-unit residential buildings by 20% by 2020.

To meet this goal, the EEB Hub has five objectives with supporting activities:

- Integrated Modeling and Design: The goal of this task is to deliver accessible, usable, affordable, calibrated and validated computer based tools to support integrated design of energy efficient retrofit projects by architects and engineers focused on average size commercial buildings. The tools must be adoptable at reasonable time and cost and available to small and mid-size Architectural and Engineering (A&E) design firms and suppliers in a cloud application environment.
- Integrated Technologies and Systems: The goal of this task is to identify and develop optimal configurations of integrated component and sub-system technologies as building system solutions for various classes of building retrofits. The system solutions are to be scalable, reliable and cost-effective for energy efficient retrofit of buildings and are expected to vary in content with commercial building functionality, size, and aspect ratio, as well as with multi-unit residential and mixed-use buildings.
- Policy, Markets, and Behavior (PMB): The goal of this task group is to create policy and market environments that support full-spectrum energy efficient retrofit of average size commercial, multi-unit residential, and mixed use buildings in Greater Philadelphia. To achieve this, the PMB team relies heavily on action-research methods, engaging policy and market actors as both research subjects and co-researchers to simultaneously "learn while doing".
- Education and Workforce Development: The goal of this task is to ensure a skilled workforce at all levels of the retrofit life-cycle process, including building energy auditors, designers, equipment and material suppliers, contractors, commissioning agents, operating engineers, and others. Particular emphasis is placed on establishing training and educational materials and career path opportunities for building operating engineers, commercial building energy efficiency and performance auditors, and building controls experts.
- Demonstration and Deployment: The goals of this task are to improve EEB Hub design and delivery methods, system design tools, integrated component and sub-system technologies, public policy approaches, customer value propositions, and business models, and to develop the Navy Yard as a job creation engine for Greater Philadelphia. This will be achieved through ongoing transfer of Hub outputs to the building industry with continuous feedback to the Hub from the industry by way of demonstration projects at the Navy Yard and other selected locations in the region.

Explanation of Funding Changes

(dollars in thousands)

	FY 2012 Current	FY 2014 Request	FY 2014 Request vs. FY 2012 Current
Energy Innovation HUB - No significant change	23,583	24,300	+717
Total, Energy Innovation HUB	23,583	24,300	+717

Funding Schedule

Fiscal Year	Activity	Funding (dollars in thousands)
FY 2012	• Modeling and design: Created an integrated building lifecycle process (IBLP) model to facilitate AER design; established a software framework and architecture that supports the IBLP. • Technologies and systems: Installed and commissioned Immersive Construction (I-CON) Laboratory in Building 101; installed energy monitoring system for model validation and technology test bedding in Building 101; technologies and systems: design an open access portal for access to Hub HQ building energy data; technology roadmap developed for commercial building market; design of a rapid and reliable building energy auditing and AER decision support tool; awarded seven Innovation Fund grants to support innovative energy efficient building applications. • Policy, markets and behavior: Implementation of policy strategy aimed at adoption of local building energy disclosure ordinances; launch Regional AER Model (RAM) for new policy and market incentives. • Education and workforce development: Launched the School District of Philadelphia Sustainability Workshop; developed competency-based career map created for pathways and credentials in AER marketplace. • Demonstration and deployment: AER demonstration project selection criteria and project execution strategies developed.	23,583
FY 2013	Planned activities in the FY 2013 Budget (final allocations have not yet been determined): • Modeling and design: Generation 1 of a new “bottom-up” simulator. • Technologies and systems: Beta test of building energy management system; beta test of control algorithms. • Policy, markets and behavior: Identification of emerging policy, market, and behavior issues critical to accelerating AERs in FY 2014. • Education and workforce development: Online guide for career map of pathways and credentials in AER marketplace; building operator training certificate program developed and tested; develop business plan for Building Energy Assessment Center. • Demonstration and deployment: Demonstration of building energy auditing and AER decision support tool; launch EEB Hub business incubator facility.	—

Fiscal Year	Activity	Funding (dollars in thousands)
FY 2014	• Modeling and design: Guidebook for AER combining qualitative and quantitative aspects of process. • Technologies and systems: control algorithms offering guaranteed performance and robustness deployed in buildings. • Policy, markets and behavior: Identification of emerging policy, market, and behavior issues critical to accelerating AERs in Year Five. • Education and workforce development: Building operator training certificate program for building operation and retuning replicated in region; launch of Building Energy Assessment Center. • Demonstration and deployment: New business ventures in AER sector located in Hub business incubator facility; demonstration of model based, distributed control to optimize the performance of building 101.	24,300

Equipment and Building Standards
Funding Profile by Activity

(dollars in thousands)

	FY 2012 Current	FY 2013 Annualized CR	FY 2014 Request
Equipment and Buildings Standards	66,746	—	82,000
Total, Equipment and Buildings Standards	66,746	—	82,000

*FY 2013 amounts shown reflect the P.L. 112 175 continuing resolution level annualized to a full year. These amounts are shown only at the "congressional control" level and above; below that level, a dash (—) is shown.

The Equipment and Buildings Standards subprogram supports market-priming measures to ensure that energy-efficient technologies overcome barriers to widespread adoption. The subprogram generates cost-effective energy savings through the development of national appliance and equipment standards. Since minimum standards effectively eliminate low-efficiency products from the marketplace, the program saves energy by ensuring that products purchased, installed, and operated are energy-efficient. Test procedures and energy conservation standards developed by this subprogram correlate directly to the Administration's energy policy objectives, such as increasing energy savings, energy productivity, and reducing carbon emissions.

DOE remains committed to meeting all of its legislatively mandated deadlines for covered appliances and equipment and actively enforcing its existing standards to the greatest extent practicable to provide a level playing field for all manufacturers. The subprogram addresses market challenges or barriers in the adoption of energy efficient technologies primarily through regulatory activities. The vast majority of the test procedure and standards rulemaking activities are legislatively mandated by the Energy Policy and Conservation Act. The rulemaking schedule, and thus the level of program activity (number of proposals and final rules) are largely determined by legislation.

DOE will build upon prior year activities by accelerating or initiating new energy conservation standards and test procedures for certain types of consumer products and commercial equipment. The program's goal in FY 2014 is to issue Notices of Proposed Rulemaking for standards or test procedures for 17 products, Final Rules for standards or test procedures for 13 products, and ENERGY STAR test procedure proposals for 8 products.
Building Codes regulate 75% of building energy and represent the baseline for building energy efficiency. They help deploy all of the technologies that were previously researched and are an existing solution that can provide between 20-30% whole building energy savings. The Building Energy Code Program is BTO's only legislatively mandated program that directly addresses all new construction and major renovations in residential and commercial buildings. As directed by law, the Building Energy Codes Program (BECP) activities include:

- Code Development - Supporting and participating in the codes and standards processes by developing and building consensus between stakeholders for technologically feasible and economically justifiable energy efficiency measures:
  - Current Goal - Cost-effectively achieve a 50% increase in efficiency in the IECC 2015 and ASHRAE 90.1-2013.
- Code Adoption and Compliance - Providing financial and technical assistance to states and territories to upgrade, implement, and increase compliance with their building energy codes:
  - Current Adoption Goal - Develop and implement programs to achieve adoption of more current code by 50% of the market by 2015, 70% of the market by 2020;
  - Current Compliance Goal - Develop tools to assist States and jurisdictions to obtain 70% compliance with their adopted code by 2020, 90% by 2030.

Increases in efficient building energy code development and an adoption by states and localities, paired with rigorous compliance verification will provide significant reductions in building energy use. DOE's current goals for more efficient code development, coupled with increased adoption and compliance rates would result in significant energy savings over current practices.
In FY 2014, increased funding will enable DOE will continue to take all necessary and feasible steps to

finalize legally required efficiency standards consistent with all applicable judicial and statutory deadlines. DOE will build upon prior-year acceleration and new product coverage activities by completing those rulemakings that deliver a high level of benefits beyond those for statutorily mandated rules. DOE will also maintain its activities in certification and enforcement to increase the effectiveness of existing energy conservation standards. The frequency and scope of product testing to verify compliance with DOE standards will reflect the compliance experience from previous years.

Energy Star: Work with EPA to update and/or create ENERGY STAR test procedures for products that have the potential to save the most energy. Key Projects:

- Develop test procedures for ENERGY STAR products
- Test products for ENERGY STAR compliance.

Standards and Test Procedures: Develop national appliance and equipment standards for all legislatively mandated covered products. Key Projects:

- Work with Regulatory Policy Group to identify prioritized product list annually and pursue standards to maximize energy savings
- Accelerate energy conservation standards and test procedures
- Add new products to DOE portfolio and initiate additional new coverage conservation standards and test procedure rulemakings.

Standards Compliance and Enforcement: Actively monitor and enforce all DOE energy conservation and water standards through testing of products and initiate investigations into any detected non-compliance. Key Projects:

- Acquire and test products to verify compliance with energy conservation standards
- Work with DOE General Counsel to initiate enforcement actions based on results of verification tests.

Building Codes: Develop advanced model residential and commercial code supported by sound building science and lifecycle cost analysis. Increase code adoption by providing assistance to states which includes language, cost analysis and state specific adoption strategy. Prioritize state adoption support to target areas of highest potential for energy savings, and increase code compliance. Key Projects:

- Focus will be on conducting analysis for IECC 2015 determinations (required by law)
- Support and participate in the codes and standards processes, by developing and building consensus among stakeholders for technologically feasible and economically justifiable energy efficiency measures
- Provide technical assistance to states through cost analysis and state-specific adoption strategies
- Funding will increase compliance activities by providing technical assistance, training, curriculum development, and guidance to states, builders, designers, and other stakeholders.

Explanation of Funding Changes

(dollars in thousands)

	FY 2012 Current	FY 2014 Request	FY 2014 Request vs. FY 2012 Current
Equipment and Buildings Standards and Codes — Increased funding will allow BTO to enhance Federal and ENERGY STAR test procedure development, including testing of products with new and innovative technologies, and expansion of its verification efforts to include testing a wider variety of commercial equipment at third-party laboratories. This work also supports enforcement of Federal minimum standards and the ENERGY STAR program. With increased funds, BTO will add additional products to its Federal test procedure and standards program and explore the potential benefits of commercial product labeling, which can provide purchasers with information on expected product energy performance, expected energy expenditures, and other related information.	66,746	82,000	+15,254
Total, Equipment and Buildings Standards and Codes	66,746	82,000	+15,254

Funding Schedule

Fiscal Year	Line Item	Funding (dollars in thousands)
FY 2012	• Issued NOPRs—29 products/12 NOPRS (totals), including 8 Final Rules for test procedures, 5 Final Rules for standards, E-Star test procedure Proposals—12 products/12 Proposals • Building Energy Codes: Publish Residential Cost Effectiveness (C/E) Methodology, National C/E Report for 2012 & 2009 IEECC, and State C/E Reports for 2012 & 2009 IECC for all 50 States.	66,746
FY 2013	Planned activities in the FY 2013 Budget (final allocations have not yet been determined): • Publish NOPRs for test procedures and standards for 13 products • Publish final rules for test procedures and standards for 18 products. • Publish 12 Energy Star test procedure proposals. • Building Energy Codes: DOE will build upon prior year activities to achieve the 50 percent upgrade of the IECC and ASHRAE 90.1. • Building Energy Codes: Provide significant technical assistance to states for code adoption and compliance	—
FY 2014	• Publish standards NOPRs for 6 products. • Publish test procedure NOPRs for 11 products. • Publish standards and test procedure Final Rules for 13 products. • Initiate new rulemakings. • Complete 8 ENERGY STAR test procedure proposals. • Building Energy Codes: Support development of ASHRAE 90.1-2016. Issue Determination of Energy Savings for 90.1-2013. Continue to support an increase in state code adoption towards the 70% goal. Continue to support States in achieving 90% compliance through technical assistance and updated compliance tools. • Begin a commercial product labeling initiative to provide purchasers with information on expected product energy performance.	82,000

Residential Buildings Integration
Funding Profile by Activity

(dollars in thousands)

	FY 2012 Current	FY 2013 Annualized CR	FY 2014 Request
Residential Buildings Integration	31,282	—	24,390
Total, Residential Buildings Integration	31,282	—	24,390

*FY 2013 amounts shown reflect the P.L. 112 175 continuing resolution level annualized to a full year. These amounts are shown only at the "congressional control" level and above; below that level, a dash (—) is shown.

Residential energy consumption accounts for about 22% of total U.S. energy consumption. The residential market is comprised of 116 million occupied single and multi-family homes in the United States. Given the size of this market, there is immense potential for residential retrofits to contribute to energy savings.

The goal of Residential Buildings Integration (RBI) is to cost-effectively reduce the energy required to operate these homes by 50%, 2030 by bringing technologies and practices to market.

RBI works toward these goals through three focus areas:

- Residential Research and Development
- Residential Existing Homes Technology to Market
- Residential New Homes Technology to Market

Residential Research and Development is conducted through a consortium of building science organizations and a network of DOE national laboratories known as the Building America Program. The Building America Program focuses on research required to improve the efficiency of new homes built each year, as well as the approximately 116 million existing homes. Building America works with production builders to improve the energy efficiency, durability, comfort, environmental performance, and quality of new homes. By August 2010, the program had contributed directly to the energy-efficient construction of more than 42,000 homes. In addition, builders and vendors that have worked with the Building America program have influenced over one million new homes.

Building America research has been the primary driver in the development of new approaches to improve energy efficiency in residential housing by examining how to integrate new technologies into the construction of a new home or in a retrofit. DOE has identified over 100 technologies from Building America research that can improve the energy efficiency of homes. We believe that 32 of these innovations have the potential to make a significant impact on residential energy efficiency. Twenty-two of these innovations have been adopted or encouraged as part of the ENERGY STAR New Homes and DOE Challenge Home Programs, enabling ENERGY STAR Homes to achieve approximately 25% market penetration with an average of over 20% energy savings per home. Eight have been incorporated into codes at State or local level. Since its inception, the Building America Program has been responsible for many key innovations in the housing industry including low-cost ventilation methods in production housing, advanced framing systems, and high-R wall systems and ducts in conditioned space. These innovations have allowed builders to more easily meet and exceed existing building code requirements.

In addition to this research, the Building Technologies Office has recently launched the Building America Solution Center, a web–based tool that provides case studies, best practice guidance, technical solutions in user friendly formats including CAD drawings and pictures, and the latest research results from the Building America Research Program. This resource is now electronically available to contractors in the field or on-site. Builders and contractors may electronically call up, through a web-based tool in the field, technical solutions to construction details to make homes more energy efficient.

Residential Existing Homes Technology Adoption: The retrofit or home improvement market is an important sector to address national energy consumption, yet it is the most difficult market to reach. The technology and retrofit practices to achieve 20% to 30% energy savings are already known. However, moving these technologies and practices into the mass market is difficult. The

contractor base is siloed by individual trades, with each trade focusing solely on its specialty.

The objective of this focus area is to increase scale by facilitating infrastructure development through improved business models, workforce development, and resource tool development to help transform the retrofit market. A major initiative in this area is the Better Buildings Neighborhood Program (BBNP) comprised of 41 grantees focused on initiating innovative, locally based retrofit programs. Half a billion dollars in grants was provided to the program initially by the American Recovery and Reinvestment Act. Because of this significant amount of funding, the program is on target to enable the retrofitting of over 100,000 buildings by the end of Fiscal Year 2013. Over 10,000 contractors have participated in this program. More importantly, this effort is yielding important information on how to more effectively implement a retrofit program. The innovative techniques and approaches to recruiting contractors, financing retrofits, driving demand and collecting effective data to measure success will be incorporated into ongoing local retrofit programs.

Other key tools include the Home Energy Score (HES) and Home Performance with ENERGY STAR (HPwES). The Home Energy Score (HES) is a simplified low-cost energy audit tool that allows a trained energy audit assessor to compare the relative energy efficiency of a home to other homes (on a scale of 1 to 10) in the same climate region. This program has been in pilot testing during 2012 to verify the cost and accuracy of this easy to use tool and was rolled out Nationwide in FY 2012. Home Performance with ENERGY STAR is a recognition program for retrofitted homes that meet high standards of energy efficiency. It is based on a whole-house assessment of these sub-systems, noting their capabilities to reduce overall energy demand and how improvements across these systems can enhance the energy efficiency of the home. These improvements are done by a qualified contractor, and completed jobs are inspected by third parties to protect homeowners and ensure proper retrofit installation and implementation. This program addresses several market barriers that industry to date has been unable to address. First, the program leverages the ENERGY STAR name, a nationally recognized brand for energy efficiency. This allows homeowners to identify qualified contractors who can perform whole-house assessments. Second, trained contractors examine the whole house, ensuring that all systems are reviewed comprehensively. Lastly, quality assurance protects the homeowner from poor workmanship, further instilling customer confidence in the contractor's work.

The BBNP and HPwES initiatives provide a sound proving ground for the development and expansion of home retrofit programs. To date, the BBNP and HPwES have driven over 300,000 retrofits, saving owners 15-30% on their energy bills, and have helped push the industry as a whole forward. These best practices will also be available to any retrofit company or individual across the US, where they can take advantage of the lessons learned through this program.

The objective of Residential New Homes Technology-to-Market is to promote highly energy-efficient building technologies and processes that accelerate the adoption of advanced new building construction techniques. This is achieved through R&D focused on whole-home systems moving us toward next-generation buildings, including homes that are durable, enable smarter energy management, and offer substantial energy savings. Our recently introduced Challenge Home Program is a new and compelling way to recognize builders for their leadership in increasing home energy efficiency and incentivize incorporation of such technologies, which would improve indoor air quality, and make homes zero net-energy ready.

DOE's Challenge Home promotes builders adopting cutting-edge building technology. The Challenge Home is a labeling program for new homes that highlights and promotes builders who have built homes that are 40 to 50% more energy-efficient than homes built to the IECC 2006 model energy code. This performance metric and label is based on the Home Energy Rating Score that EPA and DOE have used for years to measure the energy efficiency of new homes. DOE Challenge Homes are verified by a qualified third party and are at least 40-50% more energy efficient than homes built to current model energy codes.

Solar Decathlon. The Solar Decathlon is an award-winning program that challenges collegiate teams to design, build, and operate solar-powered houses that are cost-effective, energy-efficient, and attractive. The winner of the competition is the team that best blends optimal energy production and maximum efficiency with affordability, consumer appeal, and design excellence. The first Solar Decathlon was held in 2002; the competition has since occurred biennially in 2005, 2007, 2009, and 2011. In FY 2013 the event will be held in Orange County Great Park in Irvine, California. The overall goal of the Solar Decathlon is to raise public

awareness about affordable clean-energy products that are available today to save money and reduce energy use. The Program accomplishes this goal by holding a fair and safe competition, supported by effective industry and association partnerships, and disseminating key messages to the public.

Explanation of Funding Changes

(dollars in thousands)

	FY 2012 Current	FY 2014 Request	FY 2014 Request vs. FY 2012 Current
Residential Buildings Integration — Reduction in support for DOE's Challenge Home Program and a reduction in the number of climate zones. Reductions reflect a reallocation in resources to support higher priority activities within the program and EERE. Building America will target approaches enabling 50% energy savings by 2030. Begin new focus to develop and demonstrate methods to reduce cost and increase the data available to assess the actual energy savings achieved by program activities.	31,282	24,390	-6,892
Total, Residential Buildings Integration	31,282	24,390	-6,892

Funding Schedule

Fiscal Year	Activity	Funding (dollars in thousands)
FY 2012	• Residential Research and Development: Verify 30% reduction in energy consumption (compared to IECC 2009 code for new home, current annual consumption for existing) cost effectively. • Residential Existing Homes Technology to Market: Enable retrofits of 100,000 homes. • Launch Home Energy Score (HES). • Residential New Homes Technology to Market: Demonstrate new construction approaches that reduce energy use by 50% or more through Home Challenge and Building America: Enable the construction of over 5,000 homes under Builder Challenge. • Implement Solar Decathlon.	31,282
FY 2013	Planned activities in the FY 2013 Budget (final allocations have not yet been determined): • Residential Research and Development: Verify 30-40% reduction in energy consumption (compared to IECC 2009 code for new home, current annual consumption for existing) cost-effectively. • Residential Existing Homes Technology-to-Market Enable retrofits of 100,000 existing homes. • Enable assessment of 5,000 homes with HES. • Residential New Homes Technology-to-Market: Enable construction of over 600 homes under Builder Challenge. • Implement Solar Decathlon.	—

FY 2014	• Residential Research and Development: Prove 40-50% cost effective savings and integrated solutions. • Residential Existing Homes Technology- to- Market: Enable retrofits of 100,000 existing homes with at least 20% energy savings. • Score more than 8,000 homes with HES. • Residential New Homes Technology- to-Market: Develop tools to achieve Home Challenge performance levels for 1,000 homes. • Energy Performance Data: Apply the holistic, strategic approach to energy performance data, including common structures or taxonomy, data collection and analysis to inform decision making and analysis of energy efficiency projects, programs and trends, described above, to RBI. • Implement Solar Decathlon.	24,390

NREL Site-Wide Facility Support
Funding Profile by Subprogram

(dollars in thousands)

	FY 2012 Current	FY 2013 Annualized CR	FY 2014 Request
NREL Site-Wide Facility Support	0	—	1,000
Total, NREL Site-Wide Facility Support	0	—	1,000

*FY 2013 amounts shown reflect the P.L. 112 175 continuing resolution level annualized to a full year. These amounts are shown only at the "congressional control" level and above; below that level, a dash (—) is shown.

EERE will begin to directly fund NREL site-wide facility support costs that are not included in the Facilities and Infrastructure budget rather than continue to fund these costs in the laboratory overhead rate. This practice is consistent with other national laboratories. NREL's labor rate multiplier will be reduced thereby reducing the cost barrier to accessing unique NREL capabilities (facilities, staff expertise, etc.) by industry and academia to increase the impact on the clean energy market. This change in accounting practice will also make site operating costs more transparent, better facilitating cost control. With the proposed FY 2014 budget, NREL's labor rate multiplier is expected to be reduced between 15% and 20% by directly funding site-wide facility support. The individual program allocations correlate approximately with the program funding and major facilities serving the program. The site-wide facility support funds cover maintenance and engineering support; fire, emergency, and custodial services; general utilities; network infrastructure and licenses; environment, safety, and health support; and sustainability. By moving these costs from laboratory overhead to direct funding, EERE expects to gain a faster and greater impact to the renewable energy and energy efficiency market place.

NREL supports BTO's work through its Thermal Test Facility, and management and operations activities housed in the Research Support Facility, Shipping and Receiving Facility, and related site assets. Starting in FY 2014, EERE programs will fund site-wide costs directly in support of EERE's commitment to enhance NREL's competitiveness by providing direct operating funding for all appropriate activities consistent with Generally Accepted Accounting Principles. There is no net change in funding for research at NREL with this accounting change. The change will lower overhead rates to enable increased use of User Facilities by the external community.

Explanation of Funding Changes

(dollars in thousands)

	FY 2012 Current	FY 2014 Request	FY 2014 Request vs. FY 2012 Current
NREL Site-Wide Facility Support — EERE programs have historically funded NREL facility operations that support EERE's mission and goals. Starting in FY 2014, EERE programs will fund site-wide costs directly in support of EERE's commitment to enhance NREL's competitiveness by providing direct operating funding for all appropriate activities consistent with Generally Accepted Accounting Principles. There is no net change in funding for research at NREL with this accounting change. The change will lower overhead rates to enable increased use of Site-Wide Facility Support by the external community.	0	1,000	+1,000
Total NREL Site-Wide Facility Support	0	1,000	+1,000

Funding Schedule

Fiscal Year	Line Item	Funding (dollars in thousands)
FY 2012	NREL Site-Wide Facility Support.	0
FY 2013	NREL Site-Wide Facility Support.	—
FY 2014	NREL Site-Wide Facility Support.	1,000

Weatherization and Intergovernmental Programs
Funding Profile by Subprograms and Activities

(dollars in thousands)

	FY 2012 Current	FY 2013 Annualized CR*	FY 2014 Request
Weatherization and Intergovernmental Programs			
Weatherization Assistance Program			
Weatherization Assistance Grants	65,000	65,398	181,000
Training and Technical Assistance	3,000	3,018	3,000
Total, Weatherization Assistance Program	68,000	68,416	184,000
State Energy Program	50,000	50,306	57,000
Tribal Energy Program	10,000	10,061	7,000
Total, Weatherization and Intergovernmental Programs	128,000	128,783	248,000

Public Law Authorizations

P.L. 94-163, "Energy Policy and Conservation Act" (EPCA) (1975)
P.L. 94-385, "Energy Conservation and Production Act" (ECPA) (1976)
P.L. 95-91, "Department of Energy Organization Act" (1977)
P.L. 95-619, "National Energy Conservation Policy Act" (NECPA) (1978)
P.L. 96-294, "Energy Security Act" (1980)
P.L. 102-486, "Energy Policy Act of 1992"
P.L. 109-58, "Energy Policy Act of 2005"
P.L. 110-140, "Energy Independence and Security Act of 2007"
P.L. 111-5, "American Recovery and Reinvestment Act of 2009"

FY 2014 Program Summary

The Weatherization and Intergovernmental Programs (program) seeks to establish the capacity to provide strategic leadership and market expertise through its network of state and local agencies that are engaged in accelerating the implementation of energy efficiency and clean energy generation products that ultimately improve America's energy security and economic prosperity. To account for residual funds from the American Recovery and Reinvestment Act of 2009 (ARRA), Congress provided an abnormally low funding amount in FY 2012 for the program's Weatherization Assistance Program (WAP), at a level that cannot effectively sustain operation of a national weatherization infrastructure going forward. This low level of funding was maintained in FY 2013 as a result of the Continuing Resolution, even though weatherization Recovery Act balances will be more than 99% expended in this program year. It is critical that the FY 2014 appropriation is increased to sustain a weatherization network that serves thousands of low-income families across the country—and upon which other agency and private weatherization services operators rely.

The program provides a combination of financial and technical assistance across the value chain—from production to distribution to deployment—and occupy a critical space within DOE's strategic plan regarding greater deployment of innovative technologies the program's network of state and local agencies serves as a readily available conduit for DOE's Office of Energy Efficiency and Renewable Energy (EERE) offices to reach all segments of the economic development spectrum, including the private sector.

The program accomplishes its mission through four programs: WAP, the State Energy Program (SEP), the Tribal Energy Program (TEP); and the Energy Efficiency and Conservation Block Grant (EECBG) Program (ARRA funded only). The program also employs a Policy and Technical Assistance team (P&TA) to assist with the development and replication of policy tools and resources. Priorities in FY 2014 include the following:

- WAP – Formula grants would support 14,000 more energy retrofits than they did in FY 2012; and full-time employment for a large number of skilled weatherization retrofit professionals will continue with nationwide service delivery and professional retrofit worker training programs (+$92.0 million).
- WAP -- Competitively select and manage 9–15 high-impact projects on financing models for the retrofit of low-income, multi-family buildings (+$24.0 million).
- WAP -- Achieve significantly greater energy cost savings for more low-income households through advanced analysis tools and voluntary retrofit standards

- SEP – Maintain the viability and capacity of the State Energy Office network through formula grants and support 15–20 competitively selected projects that are focused on utilizing self-sustaining financing models and policy advancements (+$6.0 million).
- SEP -- Assist state and local governments with the design and implementation of sustainable energy programs through the provision of policy and financial "best practice" tools in coordination with the Better Buildings Challenge and Alliance.
- TEP – Maintain capacity for clean energy project planning and implementation on tribal lands through 15–30 competitively selected high-impact projects (-$3.0 million).
- TEP - Develop an implementation plan with DOE's Office of Indian Energy Policy and Programs to enhance technical assistance and financial support capabilities.

Overview

The program is part of EERE's balanced research, development, demonstration, and deployment approach to accelerate America's transition to a clean energy economy. Key program characteristics include the ability to do the following:

- Utilize state energy and weatherization networks, which play a crucial role in energy program and policy implementation
- Address market, planning, implementation, and financing challenges to encourage the deployment of clean energy policies and technologies.

The program's mission, partnering with state and local organizations, is to significantly accelerate the deployment of clean energy (e.g., energy efficiency and renewable energy) technologies and practices by a wide range of government, community, and business stakeholders. It supports the DOE strategic plan objective of catalyzing the timely, material, and efficient transformation of the nation's energy system and securing U.S. global leadership in clean energy technologies.

The program's strategic objective is to deploy EERE's clean energy technologies. These typically near-term activities produce almost immediate results in the form of greater energy efficiency, lower energy use, expanded renewable energy capacity, and generation, and economic development.

Program Goals and Objectives

- Reduce energy demand by supporting state, local, U.S. territory, and tribal implementation of energy efficiency programs in the buildings, industry, and utility sectors, as well as supporting fuels substitution for vehicles
- Expand the nation's clean energy supply through the deployment of clean, safe, low-carbon renewable energy technologies (e.g., wind, solar, geothermal)
- Assist in the creation of a self-sustaining market for energy-efficient building retrofits
- Enable low-income families to reduce energy costs through residential energy retrofits of their homes
- Set up infrastructure for training and career development in commercial and residential energy retrofit and other energy-related fields.

The program works with state, local, U.S. territory, and tribal governments to advance energy-efficient home retrofits through state-managed networks of local weatherization providers. One of the program's priorities is to retain weatherization grantees at the minimum level for basic program operations. ARRA funding availability offset a historically low FY 2012 program appropriation. Weatherization grantees were able to achieve the national goal of retrofitting 1 million homes as many grantees exhausted their ARRA funding. Restoring funding to pre-ARRA appropriation levels will allow most grantees to avoid reductions to the employment of retrofit professionals and geographical service areas.

The program catalyzes investments in energy efficient and renewable energy technologies, and advances best practices that foster development of a clean energy economy. The $120 million increase in FY 2014 will enable the program to do the following:

- Restore a sufficient level of investment in critical weatherization infrastructure and establish a minimum capacity to serve low-income families throughout the United States.
- Provide maximum potential to leverage up to $3 in other Federal and non-Federal weatherization resources for every $1 of DOE investment.
- Support a 150% increase from the artificially low appropriations amount in FY 2013 ($65.0 million for weatherization formula grants) — to assist more than 24,000 low-income families to reduce energy use and save more than $6 million in the first year alone.
- Develop high-impact innovations and replicable solutions for transforming markets for clean energy technologies—through commitment-driven partnerships with state and local governments.

The program addresses regulatory, financial, and planning market barriers associated with energy efficiency and renewable energy technologies. State energy offices play a crucial role in the set up or reform of local policy and market infrastructures—often the last critical step to successful technology adoption. Challenges at the program or grantee level that the program seeks to address include the following:

- Reforming the market through the inclusion of regulatory incentives for energy efficiency
- Reducing costs and improving the savings of energy efficiency programs through energy awareness, capabilities, best practices, and accurate decisional information
- Lowering the cost of capital through new business models and finance mechanisms
- Standardizing and simplifying renewable and other distributed energy siting, permitting, environmental review, and grid connection policies.

The program also addresses both the supply and demand sides of energy security by facilitating investments in clean energy generation and energy efficiency — providing a combination of financial and technical assistance to state, local, U.S. territory, and tribal governments. Grantees utilize these resources for residential energy retrofits, renewable energy planning, emergency energy management, financing of clean energy projects, and sustainable energy policies development.

Program Accomplishments and Near-Term Milestones[a]

The program has managed more than $10.8 billion in state and local ARRA formula grants through WAP, SEP, and EECBG. Through September 30, 2012, 2,315 funding recipients utilized $10.3 billion of these funds to do the following:

- Improved the energy performance and comfort in the homes of more than 1,000,000 American low-income families across the nation, exceeding the High Priority Performance Goal (HPPG), and saving each family hundreds of dollars on their heating and cooling bills annually, for a national total estimated energy savings of 32 trillion Btus and $480 million in first year energy cost savings with $7 billion in anticipated cumulative savings
- Established $800 million in sustainable lending capacity for energy efficiency improvements and renewable energy systems
- Conduct nearly 185,000 energy (lighting and other) upgrades in buildings
- Installed more than 36,000 renewable energy systems
- Installed approximately 190,000 energy-efficient streetlights and 390,000 energy-efficient traffic signals
- Directly supported more than 15,000 full-time jobs per quarter through ARRA investments
- Trained 30,000 residential energy audit and energy retrofit professionals
- Shared energy information and tools with more than 500,000 people through workshops, trainings, and educational sessions.

Additional program accomplishments include the following:

- Led a comprehensive national certifications and standards process for residential energy retrofit worker training, energy audits, and weatherization methods, which resulted in:
  - Implementing the "Guidelines for Home Energy Professionals" and the "Standard Work Specifications" for single family and mobile homes
  - Creating 14 standard training curricula and professional certifications
  - Developing work specifications and audit protocols for multi-family buildings.
- Since FY 2010, supported annual state formula grants:
  - Retrofitted 28 million square feet of building floor space
  - Conducted energy audits of 3,500 buildings with 18 million square feet of building space
  - Installed more than 150 megawatts (MW) in renewable energy generation capacity.
- Provided resources for tribal activities:
  - Retrofitted 64 tribal buildings with energy savings of about $900,000 per year, conducting 240 energy audits on tribal buildings, and training 150 tribal members in weatherization techniques
  - Installed 11 MW of new renewable energy generation capacity by the end of FY 2015 and planning for more than 4,000 MW in clean energy generation projects on tribal lands.

Program Planning and Management

The goals of the program are to accelerate clean energy technology deployment by state, local, and tribal governments through programs, partnerships, and initiatives. The program adjusts its combination of

[a] For a list of milestones please see "*Strategic Performance Management by Program"* section.

strategic partnerships, financial assistance, and technical assistance regularly to improve overall program performance.

The program is evolving strategically post-Recovery Act, and continues to reshape its activities and priorities based on:

- Expanded stakeholder engagement
- Recommendations from national evaluations of subprograms and peer reviews
- Active web-based project and grants management.

For example, between FY 2010 and FY 2012 WIP established partnerships with:

- 71 public-sector partners to reduce their energy intensity by 20% or more by 2020
- 29 states to develop replicable approaches for improving public buildings, including through the use of energy savings performance contracts.

FY 2014 program priorities include the following:

- Develop innovative and integrated financial structures, business models, and production methods that enhance and transform energy efficiency effectiveness
- Update programmatic targets for energy reduction in specific sectors (e.g., public building and facilities improvements, as well as commercial building energy retrofits)
- Revise the program's strategic plan in coordination with EERE and stakeholders to establish an integrated framework for transformational clean energy deployment.

Improve integrated Web-based systems for reporting, monitoring, communicating, and providing provisions of technical assistance as part of the active management of awardees to inform the program on current activities and ensure the effective and efficient use of funds. The program uses an integrated approach consisting of the following pathways:

- Technical assistance to facilitate clean energy technology delivery through "best practice" tools and "lead-by-example" strategies, peer-to-peer forums, and strategic partnerships
- Competitive financial assistance to support innovative state and local high-impact, self-sustaining clean energy projects
- Formula grants to support the core capabilities of state and weatherization offices
- Active management of awardees through integrated Web-based systems for reporting, monitoring, communicating, and providing provisions of technical assistance.

WAP will complete comprehensive program impact and process evaluations in FY 2014. Variables examined will include energy savings, bill reductions, quality of service delivery, and innovative delivery mechanisms.

SEP will complete its major national evaluation FY 2014, which will identify successful project efforts and provide future opportunities for grantees to select higher-value clean energy policies and programs. Key metrics include energy usage reduction, renewable energy production, emissions reductions, and economic impacts. The analysis will cover 80% of all SEP-funded projects.

EECBG will complete its national evaluation in FY 2014. The analysis will inform Federal, state, and local leaders of successful programmatic activities, including lessons learned. Metrics to be evaluated include energy usage reduction, renewable energy production, emissions reductions, and economic impacts.

The next peer review for the Tribal Energy Program will be conducted in FY 2014; in FY 2012, outside experts conducted a peer review on its activities and rated the program's operational performance as "good." The panel recommended the program develop a strategic plan and refine metrics.

The program utilizes partnerships with national and regional organizations that represent key decision-makers in order to improve the pace of efficiency and clean energy project implementation. Partnership examples include the following:

- The National Association of State Energy Officials, which works with SEP and other DOE offices on deployment strategies, is the primary representative of SEP stakeholders and assists states in developing comprehensive energy plans and improving financial policies and options.
- The National Governors' Association Center for Best Practices works directly with governors and their staff on energy policies, best practices, and implementation planning.
- The National Conference of State Legislatures provides training to legislators on timely and relevant energy policy issues, technologies, and markets; they also track state legislative clean energy efforts.
- The National Association for State Community Services Programs is the primary organization for state weatherization assistance programs; it manages the WAP Technical Advisory Committee website that contains program rules, policies, training procedures, and best practice tools.

The program has a major focus on improving the energy efficiency of new and existing residential and commercial buildings. The program actively supports state-led utilization of EERE's Building Technologies Program products and processes, as well as lessons learned from EERE's Federal Energy Management Program. Examples include the following:

- SEP provides provisions of funding and expertise to the Better Buildings Neighborhood Program, which helps more than 40 competitively selected state and local governments to develop sustainable programs for energy-efficient upgrades of more than 100,000 buildings. These communities are using innovation and investment in energy efficiency to expand the building energy retrofits industry, test program delivery business models, and create jobs.
- WAP leadership works in a comprehensive national certifications and standards process for residential energy retrofit worker training, energy audits, and weatherization methods. These efforts support the shared program goal to create a self-sustaining market for building energy upgrades.
- The program also fosters state and local government policy leadership through the Better Buildings Challenge, assisting public entities to undertake energy efficiency projects, such as, improvements to public facilities, with the objective of helping government partners achieve voluntary commitments that can result in an overall reduction in their communities' energy intensity by 20% or more by 2020.
- TEP and the DOE Office of Indian Energy Policy and Programs work collaboratively with a high level of coordination and cooperation on Indian policy, technical assistance, and financial support issues and options that encourage clean energy deployment.

Strategic Performance Management by Program

Performance Measure	**Weatherization and Intergovernmental Programs Retrofits** – Weatherize homes of low income families (using base DOE funds)		
Fiscal Year	**2012**	**2013***	**2014**
Target	10,000 homes	21,286 homes	24,600 homes
Result	31,871 retrofits		
Endpoint Target	235,000 homes weatherized between FY 2013 and FY 2023		

Performance Measure	**Weatherization and Intergovernmental Programs State Energy Program (SEP)** – First-year energy savings from SEP projects (in trillion British thermal units, TBtu)		
Fiscal Year	**2012**	**2013***	**2014**
Target*	3.5 TBtu	3.5 TBtu	4 TBtu
Result	**Exceeded –** 3.64		
Endpoint Target	Cumulative first-year energy savings of 40 TBtu between FY 2013 and FY 2022.		

*2013 targets represent DOE's FY 2013 Budget Request to Congress. FY 2013 target updates can be found in the upcoming FY 2012-2014 Annual Performance Plan & Report.

Weatherization Assistance Program (WAP)
Funding Profile by Activity

(dollars in thousands)

	FY 2012 Current	FY 2013 Annualized CR*	FY 2014 Request
Weatherization Assistance Grants	65,000	65,398	181,000
Training and Technical Assistance	3,000	3,018	3,000
Total, Weatherization Assistance Program	68,000	68,416	184,000

WAP increases residential energy efficiency and reduces the energy costs of low-income families. Senior citizens with special needs or individuals with disabilities occupy approximately 49% of the homes weatherized annually. Non-energy benefits from WAP's deployment activities include the following:

- Expanded clean energy training and employment opportunities
- Improved health and safety of the homes occupied by low income families.

Weatherization Assistance Grants: The FY 2014 formula grant performance target is to weatherize 24,600 low-income homes—an increase from what the FY 2012 appropriation supported. The request for FY 2014 is a sizable increase from the funding level in FY 2012, which was artificially low due to residual ARRA funding used to supplement appropriations. By the end of FY 2012, many states had expended their ARRA funds, leaving them with a limited ability to absorb reductions without cutting core program delivery and services. Formula grants at the $157 million request level will support the nationwide delivery of services including skilled weatherization retrofit professionals,, and professional retrofit training programs. A lower funding amount than requested in FY 2014 would cause significant disruption to the provider networks, with service cut backs and production delays extending into future years. The program leverages both Federal and non-Federal funding sources to expand the array of services available for each home or increase the number of homes weatherized, which would be harmed by reductions.

Formula grants support the largest (and one of the most technically advanced) network of residential energy retrofit providers in the country. Funds are allocated on a statutory formula basis and awarded to states; U.S. territories; Washington, D.C.; and select Native American tribal governments to increase the energy efficiency of homes occupied by low-income families. These agencies, in turn, contract with more than 1,000 Community Action Agencies, local governmental and nonprofit agencies to deliver weatherization services to low-income clients in every geographic area of the country. Weatherization service providers choose the best package of efficiency measures for each home based on a comprehensive energy audit. The consistent delivery of quality services is addressed through active Federal, regional, and state training and technical assistance programs ($157.0 million).

The objectives of WAP's competitively selected weatherization projects is to demonstrate new ways to increase the number of low-income homes weatherized and lower the Federal cost per home for residential energy retrofits. Currently, more than 50% of low-income residents reside in multi-family housing stock. The expansion of multi-family financing programs is the most practical means to dramatically increase the impact of Federal funds utilized in the weatherization of low-income households. In FY 2014, the program will competitively select and manage 9–15 high-impact projects that would establish financing and loan models for the retrofit of low-income, multi-family buildings. Competitive assistance activities will incorporate data collection and sharing resulting from awardee projects and will use existing best practices or evaluate new potential best practices ($24.0 million).

Training and Technical Assistance: Program-directed weatherization training and technical assistance activities improve program effectiveness, service delivery, and efficiency. Requested resources would support the expansion of certified training programs for a network of workers in residential energy retrofits and other energy-related fields. Other activities include strategic planning and analysis; program performance measurement and documentation; and facilitation of advanced techniques and collaborative strategies (e.g., through pilot programs, publications, training programs, workshops and peer exchange). An ongoing national evaluation is assessing the overall energy savings and cost-effectiveness of the program.

Explanation of Funding Changes

(dollars in thousands)

	FY 2012 Current	FY 2014 Request	FY 2014 Request vs. FY 2012 Current
Weatherization Assistance Grants — The $92 million increase for formula grants will support the weatherization of an additional 14,000 low-income homes, maintain critical state and national infrastructure, and avoid disruptions to provider networks, service area cutbacks, and production delays associated with a lower funding amount. The $24 million increase for competitive assistance will be used to assess the efficacy of financing structures such as revolving loan funds in multi-family housing to develop replicable models for expanding energy-efficient retrofits for this underserved sector. The increase also returns the Weatherization Assistance programs toward historical funding levels, as ARRA Funds for the program will be almost completely (more than 99.8%) expended by the start of FY 2014.	65,000	181,000	+116,000
Training and Technical Assistance — No funding change.	3,000	3,000	0
Total, Weatherization Assistance Grants	68,000	184,000	+116,000

Funding and Activity Schedule

Fiscal Year	Activity	Funding (dollars in thousands)
FY 2012	• Awarded and monitored 59 weatherization formula grants. • Weatherized more than 10,000 homes. • Continued development of work standards, audit tools, and financial initiatives to facilitate energy-efficient retrofits in multi-family housing. • Cooperated with other Federal agencies in the Federal Healthy Homes Work Group (U.S. Department of Housing and Urban Development (HUD), Environmental Protection Agency (EPA), Centers for Disease Control and Prevention, Department of Labor, White House Council on Environmental Quality) and local non-profit organizations to establish strong and effective partnerships between programs.	68,000
FY 2013	• Award and monitor 59 weatherization formula grants. • Continue development of work standards, audit tools, and financial initiatives to facilitate energy-efficient retrofits in multi-family housing. • Cooperate with other Federal agencies in the Federal Healthy Homes Work Group (HUD, EPA, Centers for Disease Control and Prevention, Department of Labor, White House Council on Environmental Quality) and local non-profit organizations to establish strong, effective partnerships between programs.	68,416
FY 2014	• Award and monitor 59 weatherization formula grants ($157.0 million). • Competitively select and manage 9–15 high-impact projects on financing models for the retrofit of low-income, multi-family buildings ($24.0 million). • Weatherize more than 24,000 homes. • Continue development of work standards, audit tools, and financial initiatives to facilitate energy-efficient retrofits in multi-family housing. • Cooperate with other Federal agencies in the Federal Healthy Homes Work Group (HUD, EPA, Centers for Disease Control and Prevention, Department of Labor, White House Council on Environmental Quality), and local non-profit organizations to establish strong, effective partnerships between programs.	184,000

State Energy Program (SEP)
Funding Profile by Subprogram

(dollars in thousands)

	FY 2012 Current	FY 2013 Annualized CR*	FY 2014 Request
State Energy Program	50,000	50,306	57,000
Total, State Energy Program	50,000	50,306	57,000

SEP assists states in establishing and implementing clean energy plans, policies, and programs to reduce energy costs, increase competitiveness, enhance economic development, improve emergency planning, and improve the environment. States have purview over many of the policy and program levers that can catalyze greater investment in clean energy and help the country realize the associated suite of economic and environmental benefits. SEP provides states capacity building resources, technical assistance, and best practice sharing networks to facilitate the adoption of plans, policies, and programs that are appropriate based on state and regional circumstances.

Specific goals and objectives are to do the following:

- Develop and deploy assessment, planning, and decision-making tools for the adoption of self-sustaining financial, utility, and other policy infrastructures to facilitate clean energy technology deployment
- Strengthen partnerships with national and regional organizations that represent key decision-makers to improve the pace of efficiency and clean energy project implementation.

SEP leverages $11 in non-Federal contributions for each $1 in state energy grants.[a] Typical leveraged results[b] from an annual non-ARRA SEP appropriation are as follows:

- 15,000 energy audits of residential, commercial, and industrial buildings
- 13,000 energy efficiency building retrofits
- 6,400 alternative fuel vehicles purchased or converted
- 92,000 energy-efficient LED traffic signals installed
- $30 million in loans and $12 million in grants awarded to businesses and non-profits to support energy efficiency and clean energy projects
- 600,000 students taught about energy efficiency
- 78 energy emergency plan elements developed and adopted.

Formula-based grants allow states; Washington, D.C.; and U.S. territories to advance their energy priorities through the design and implementation of energy efficiency and renewable energy programs. These grants support the work of the State Energy Office network and its development and maintenance of energy emergency planning at state and local levels, which provides a critical security benefit. Examples of the types of projects supported by the program, and administered by State Energy Offices include financing mechanisms for institutional retrofit programs; loan programs; energy savings performance contracting; comprehensive residential energy programs for homeowners; transportation programs that accelerate the use of alternative fuels; and programs that remove barriers and support supply side and distributed renewable energy ($35.0 million).

In FY 2014, the program requests funding to support competitive financial assistance that would allow states to meet nationally focused initiatives, while addressing regional and state circumstances. They also provide opportunities for states to submit innovative proposals that leverage other funding to create sustainable, high-impact solutions in clean energy development. The primary objective is for states and territories to develop public-private partnerships to deploy technologies that have the best opportunity for local geographic and economic impact. In FY 2014, DOE will utilize the experience and capabilities of 20–25 states to advance transformative best practices, benchmarking, and lead-by-example policy strategies for the building retrofit market ($16.0 million).

[a] Oak Ridge National Laboratory (ORNL) report, "Estimating Energy and Cost Savings and Emissions Reductions for the State Energy Program Based on Enumeration Indicators Data" (January 2003)
[b] ORNL report, "An Evaluation of State Energy Program Accomplishments: 2002 Program Year" (June 2005)

Technical assistance is an interdependent component to the financial assistance activities—making technology deployment more efficient and effective and enhancing the likelihood of program success. Thousands of states and communities have obtained technical assistance to become more energy efficient, and they benefit economically from the transition to clean energy. Communities rely on data collected, analysis of technologies and policies, technology transfer to communities, and peer-to-peer exchange that are made possible through local capacity-building efforts.

Technical assistance resources are integral to (1) tools development, decisional information, and other technical assistance to grantees and sub-recipients; (2) national energy initiatives and strategic partnerships focused on deployment and best practices; (3) development of Web-based reporting and monitoring systems; and (4) metrics and evaluation of state planning, analysis, and evaluation activities. An ongoing national evaluation is assessing the overall energy savings and cost effectiveness of the program.

Explanation of Funding Changes

(dollars in thousands)

	FY 2012 Current	FY 2014 Request	FY 2014 Request vs. FY 2012 Current
State Energy Program – The additional resources will support transformational competitive energy projects that address barriers and provide assistance on developing policies and programs that can help reduce statewide energy use by up to 1% or more per year.	50,000	57,000	+7,000
Total, State Energy Program	50,000	57,000	+7,000

Funding Schedule

Fiscal Year	Line Item	Funding (dollars in thousands)
FY 2012	• Competitively selected and managed 22 transformational clean energy projects. • Managed the award process and monitored 56 formula grants. • Facilitated state adoption of aggressive energy efficiency targets which help 5–10 state adopt updated building codes and compliance plans, and also facilitated 15–20 policy-oriented projects that will yield models and solutions that can help states achieve up to 1% or more in energy efficiency improvements per year. • Continued effective technical assistance activities.	50,000
FY 2013	• Competitively select and manage 8–12 projects for transformative statewide energy savings frameworks or for significantly increasing energy efficiency in public facilities. • Manage the award process and monitor 56 formula grants. • Utilize cross-cutting teams to deliver technical and policy assistance to state and local governments. • Closeout ARRA grants.	50,306
FY 2014	• Manage the award process and monitor 56 formula grants ($35.0 million). • Competitively select and manage 20–25 projects to improve energy efficiency, economic development, energy security, and the environment ($16.0 million). • Complete a major national evaluation of the program. • Utilize cross-cutting teams to deliver technical and policy assistance to state and local governments. • Complete a strategic plan that identifies desired long-range outcomes and the sequence of actions for successful implementation.	57,000

Tribal Energy Program (TEP)
Funding Profile by Subprogram

(dollars in thousands)

	FY 2012 Current	FY 2013 Annualized CR*	FY 2014 Request
Tribal Energy Program	10,000	10,061	7,000
Total, Tribal Energy Program	10,000	10,061	7,000

TEP builds partnerships with the 566 federally recognized tribal governments to address residential, commercial, and industrial energy and environmental priorities. The program employs a three-pronged approach, which includes a combination of financial, technical, and training resources. Specific goals and objectives are to do the following:

- Reduce energy use and increase renewable energy generation capacity on tribal lands
- Address tribal government priorities for energy sufficiency and economic development.

Tribal energy activities are particularly valuable in advancing sustainable clean energy development and deployment on tribal lands. TEP utilizes financial assistance to support the assessment and planning of sustainable energy options, renewable energy installations, and cost-effective energy efficiency projects. Since 2002, the program has invested $41 million into 175 tribal clean energy projects. Average leveraged cost share is approximately $1 in non-Federal contributions for each $1 in tribal energy grants. ($5.0 million)

The emphasis is on methods to better leverage existing public and private financing to accelerate the deployment of tribal energy projects. In FY 2014, the program will continue to provide technical assistance through improving and distributing these tools via the EERE website, webinars, and regional and national training sessions.

Continuing technical assistance efforts include the following:

- Regional and national workshops on energy efficiency and renewable energy technologies
- Access to clean energy deployment experts on specific project and crosscutting issues
- Renewable energy internships for Native American graduate students through Sandia National Laboratories.

TEP and the DOE Office of Indian Energy Policy and Programs work cooperatively on the provision of resources and tools, which spur tribal energy self-sufficiency.

Explanation of Funding Changes

(dollars in thousands)

	FY 2012 Current	FY 2014 Request	FY 2014 Request vs. FY 2012 Current
Tribal Energy Program – The $3 million reduction represents an adjustment that will maintain capacity at prior investment levels for clean energy project planning and implementation on tribal lands through 15–30 competitively selected high-impact projects.	10,000	7,000	-3,000
Total, Tribal Energy Program	10,000	7,000	-3,000

Funding Schedule

Fiscal Year	Line Item	Funding (dollars in thousands)
FY 2012	• Competitively selected 17 tribal high-impact clean energy projects. • Trained 200 tribal leaders and staff on energy efficiency, renewable energy, financial structures, and business models. • Provided 2–4 student internship opportunities through Sandia National Laboratory. • Provided direct short-term technical assistance to 10–15 individual tribes per year. • Monitored approximately 100 tribal 3-year energy project grants.	10,000
FY 2013	• Competitively select and fund 25–35 tribal high-impact clean energy projects. • Continue training, providing internships and direct technical assistance, and monitoring activities.	10,061
FY 2014	• Competitively select and fund 15 –30 tribal high-impact clean energy projects ($5.0 million). • Continue training, providing internships and direct technical assistance, and monitoring activities. • Complete strategic plan, which identifies desired long-range outcomes and the sequence of actions for successful implementation.	7,000

Office of Energy Efficiency and Renewable Energy
Program Direction
Funding Profile by Category

(dollars in thousands)

	FY 2012 Current	FY 2013 Annualized CR*	FY 2014 Request
Headquarters (HQ)			
Salary and Benefits	73,786	—	91,800
Travel	3,173	—	6,550
Support Services	22,911	—	14,890
Other Related Expenses	18,678	—	21,660
Total, HQ	118,548	—	134,900
Full Time Equivalents	549	—	642
Golden Field Office (GO)			
Salary and Benefits	20,053	—	22,484
Travel	345	—	562
Support Services	6,103	—	9,781
Other Related Expenses	4,443	—	3,373
Total, GO	30,944	—	36,200
Full Time Equivalents	139	—	157
National Energy Technology Laboratory (NETL)			
Salary and Benefits	7,255	—	5,800
Travel	288	—	500
Support Services	5,419	—	5,400
Other Related Expenses	2,546	—	2,200
Total, NETL	15,508	—	13,900
Full Time Equivalents	61	—	61
Total Program Direction			
Salary and Benefits	101,094	—	120,084
Travel	3,806	—	7,612
Support Services	34,433	—	30,071
Other Related Expenses	25,667	—	27,233
Total, Total Program Direction	165,000	166,010	185,000
Total, EERE FTE	688	699	799
Total, NETL Reimbursable FTE[a]	61	61	61

*FY 2013 amounts shown reflect the P.L. 112 175 continuing resolution level annualized to a full year. These amounts are shown only at the "congressional control" level and above; below that level, a dash (—) is shown.

[a] Fossil Energy employees

Overview

Program Direction funds Federal employees, contract support, and operational costs required for the implementation and execution of Energy Efficiency and Renewable Energy (EERE) programs, including funding for the coordination of the energy portfolio by the Office of the Under Secretary for Energy. This funding allows EERE to advance the Administration's priorities by enabling accelerated research, development, demonstration and deployment (RDD&D) of EERE technologies to address energy security, economic growth, and the environment with increased emphasis on transparency, accountability and oversight. This funding enables the EERE workforce to effectively administer and actively manage all current projects and EERE general operations. EERE manages thousands of contracts, grants, and agreements in various stages of the budget execution process.

Program Direction funding consists of four main categories: Salaries and Benefits, Travel, Support Services, and Other Related Expenses.

Salaries and Benefits will fund approximately 799 full-time employees needed to effectively execute the EERE portfolio. EERE personnel provide expertise in implementing and integrating technology programs through comprehensive program and project management and technical assistance. This funding also supports business administration expertise in human resources, budget and financial management, program evaluation, procurement, contract administration, legal services, IT business systems, and information services management.

Travel funds enable the proper management and oversight of approximately 6,000 federally-funded projects, and agreements, and grants. These activities include additional audits and on-site monitoring of both new and continuing technology projects and Federal energy assistance programs. This funding allows EERE to employ Active Program Management methodologies to continuously monitor EERE's portfolio of geographically-dispersed reviews, and contracts. Travel also supports international activities necessary to address global climate change and supports a number of key bilateral and multilateral initiatives that further DOE's RDD&D goals.

Support Services funding provides technical and administrative contract support; accurate reports and analyses critical for decision-making, and automated data processing such as IT, internal and external information management, and network systems, including connectivity to separate office building locations, as well as the purchase and installation of desktop computers and systems to ensure rapid response capabilities. This funding also contributes to training, education, safety and health support, DOE headquarters (HQ) safeguards and security, computer configuration, and maintenance. Additionally, this request provides for a 77% indirect overhead charge for reimbursable work provided by direct/technical Fossil Energy employees at National Energy Technology Laboratory (NETL), which includes business administration (budget and financial management, human resources, technical assistance, procurement, etc.); technical and administrative assistance to project managers; facilities and space management; and IT and local-area network operations.

Funding also provides for reports, oversight and analysis assistance, management information, and general administrative support services for project planning and analysis. These services increase accountability and transparency instituted by Congress and the Administration, and enables employees to respond rapidly, efficiently, and professionally to the requirements for corporate level planning, evaluation, reporting, analysis and administrative services.

Other Related Expenses provides funds for office space at DOE HQ and the Field; EERE's contribution to the Department's Working Capital Fund (WCF) for common administrative services, such as rent and building operations, telecommunications, network connectivity, supplies/equipment, printing/graphics, copying, mail, contract closeout, purchase card surveillance, and salary and benefit expenses for Federal employees who administer the WCF business lines per the Department's new policy implemented in FY 2012. In addition, WCF services assessed to and used by Headquarters and the Field include online training, the Corporate Human Resource Information System, payroll processing, and the Project Management Career Development Program. Other Related Expenses also includes funding for GSA rent for the Golden Field Office (GO), as well as supplies and materials for both GO and NETL, such as computer equipment, hardware, software, licenses and support, utilities, postage, printing, graphics, administrative expenses, and security, plus workers compensation, publications, conferences, and reimbursable expenses at NETL.

Accomplishments and Strategic Initiatives

EERE is implementing some small, but important, organizational reforms. These reforms are intended to ensure that EERE consistently practices good government principles by being flat, organizationally uniform, transparent, and effective in order to serve our mission

of creating American leadership in the transition to a global clean energy economy.

To this end, the FY 2014 EERE Program Direction budget supports the Strengthening Operations for Accountability and Results (SOAR) initiative based on process and workforce analysis. SOAR, which comprises a complete reorganization of EERE's offices, was launched in FY 2012 and includes implementing active project management (APM), enterprise IT consolidation and reform, and an EERE Human Capital Reform Initiative (HCRI). APM will be implemented for all of EERE's U.S. Department of Energy (DOE) national laboratory and non-laboratory projects to upgrade the technical skills and knowledge of EERE project management staff and to conduct regular monitoring visits to clean energy research, development, and demonstration projects that EERE supports.

In order to perform best practice active project management, including the creation and enforcement of rigorous "Go-No, Go" milestones in EERE's projects, performance of regular in-depth project site visits/reviews, and termination of under-performing projects, EERE is simplifying its organizational structure. This will better achieve program success by creating more uniform roles and responsibilities with clear accountability for APM within our programs.

EERE is conducting an IT reform initiative that will consolidate and replace more than 100 IT systems—ranging from sophisticated spreadsheets to outdated corporate IT systems—with a single Enterprise IT solution. The HCRI will lead to a federalization of contractor positions within EERE and a talent management program that rewards high performance, supports diversity and inclusion efforts, and provides improved training and succession planning opportunities for the current workforce.

The APM, IT, and HCRI initiatives will lead to increased management efficiencies, allow for workload balancing among existing EERE Federal staff, and reduce the need for costly support service contractors. Operationally, the IT reform initiative will standardize work flows within EERE, reducing duplicative efforts and enabling more effective project management and oversight. Project management will change by more consistently overseeing existing projects, as well as developing rigorous project management processes that are implemented across EERE. Overall, the three initiatives will enable EERE to "right size" its organization following the post-American Recovery and Reinvestment Act of 2009 era, and will result in adaptive talent and project management strategies that fit emerging and new requirements.

Alignment to Strategic Plan

The goal is to achieve operational and technical excellence by optimizing staffing and developing a performance-based culture that ensures EERE projects are properly executed with transparency, oversight and accountability to maximize mission success.

Major Programmatic Shifts or Changes

Program Direction continues to support all core areas to enable and sustain the workforce.

Explanation of Program Changes

(dollars in thousands)

	FY 2012 Current	FY 2014 Request	FY 2014 Request vs. FY 2012 Current
Salaries and Benefits			
Increased funding is necessary to promote the federalization of the EERE workforce, and SOAR initiative, as well as to increase qualified technical and active project management personnel to oversee existing competitively awarded grants and cooperative agreements in all EERE programs, with a focus on those programs (Vehicles, Advanced Manufacturing, Buildings and Solar) that are high Administration priorities and have been proposed for additional funding in FY 2014.	101,094	120,084	+ 18,990
Travel			
In order to fully support and implement the APM initiative, significant additional travel is required to meet with stakeholders, clarify project parameters and expectations, and ultimately to effectively monitor awardees.	3,806	7,612	+3,806

(dollars in thousands)

	FY 2012 Current	FY 2014 Request	FY 2014 Request vs. FY 2012 Current
Support Services			
A decrease in contracted services is proposed to retain only the most essential services. The reduction reflects a reprioritization of funds to support other activities within Program Direction. Support service funding is necessary to fund necessary training for APM and to enable consolidation of EERE's Golden offices into a smaller footprint.	34,433	30,071	-4,362
Other Related Expenses			
Increased funding is needed for DOE's WCF as well as overhead increases at GO related to the federalization of the EERE workforce and the HCRI.	25,667	27,233	+ 1,566
Total Funding Change, Program Direction	165,000	185,000	+20,000

Support Services by Category

(dollars in thousands)

	FY 2012 Current	FY 2014 Request	FY 2014 Request vs. FY 2012 Current
Support Services			
Technical Support Services	18,567	14,088	- 4,479
Administrative/Management Support Services	15,866	15,983	+ 117
Total, Support Services	34,433	30,071	- 4,362

Other Related Expenses by Category

(dollars in thousands)

	FY 2012 Current	FY 2014 Request	FY 2014 Request vs. FY 2012 Current
Other Related Expenses			
Other Services	7,960	8,426	+ 466
Working Capital Fund	17,707	18,807	+ 1,100
Total, Other Related Expenses	25,667	27,233	+ 1,566

Strategic Programs
Funding Profile by Subprogram

(dollars in thousands)

	FY 2012 Current	FY 2013 Annualized CR*	FY 2014 Request
Strategic Programs			
Technology-to-Market (formerly Innovation and Deployment)	6,500	—	14,250
Strategic Priorities and Impact Analysis	7,000	—	11,000
International	5,000	—	4,750
Communications and Outreach	6,500	—	6,000
Total, Strategic Programs	25,000	25,153	36,000

*FY 2013 amounts shown reflect the P.L. 112 175 continuing resolution level annualized to a full year. These amounts are shown only at the "congressional control" level and above; below that level, a dash (-) is shown.

FY 2014 Program Summary

- The Technology-to-Market (formerly Innovation and Deployment) subprogram will launch a new effort to dramatically increase the rate of clean energy technology commercialization from the national laboratories, including implementation of a new competitive initiative to replicate, enhance, and expand the "LabStart" model (+$7.0 million).
- The Strategic Priorities and Impact Analysis subprogram will ramp up efforts to evaluate EERE's impacts and returns on investments, and support the Clean Energy Manufacturing Initiative's "Clean Energy Manufacturing Strategic Analysis" work (+$4.0 million).

Overview

The Office of Strategic Programs (SP) is a core cross-cutting EERE office focused on accelerating development, commercialization, and adoption of energy efficiency and renewable energy technologies through strategic EERE corporate-level partnerships to support the transition of EERE technologies to market, communications and engagement with energy stakeholders, development of international markets for U.S. clean energy companies, and analytical support for decision making and management of the EERE portfolio. SP pursues its mission by building partnerships with industry and small businesses, national laboratories and universities, entrepreneurs and venture capital companies, local and international governments, and non-profits. SP performs four critical functions that crosscut EERE programs:

- Leveraging EERE cross-cutting capabilities; private-sector, academic, and laboratory partners; and existing authorities to support technology commercialization, reduce market barriers, and assist pursuit of first market opportunities
- Providing a robust portfolio-based analytical foundation to support strategic planning and decision making and evaluation of EERE impacts
- Catalyzing international markets for U.S. clean energy solutions through collaboration on policy approaches, resource assessment, research and development, and standards and certification for a range of technologies
- Communicating objectively and transparently to Members of Congress, multiple stakeholder groups, and the public about the progress and impacts of clean energy research, development, demonstration, and deployment (RDD&D) to improve understanding about EERE's activities and speed adoption of new technologies and practices.

Many of SP's activities focus on breaking down cross-cutting barriers to the successful commercialization of clean energy technologies, including finance, entrepreneurship, and the development of regional innovation ecosystems. SP also supports the use of information technology innovations to increase the interactivity, transparency, and accessibility of EERE information, projects, data, modeling solutions, and state-of-the-art training. Through robust analysis, SP provides core support for analysis-based decision making and strategic planning in EERE and DOE. International activities accelerate the progress of DOE's domestic R&D programs through international collaboration, coordination, and international market priming. Finally, SP serves a key role in communicating information on the progress and impacts that EERE investments achieve.

The Technology-to-Market subprogram will prioritize activities that catalyze and support nationwide clean energy innovation, educate the next generation of energy entrepreneurs, and enable increased market

adoption of clean energy technologies. These activities are aligned with the need to deploy technologies to meet national clean energy goals.

The Strategic Priorities and Impact Analysis subprogram will continue to prioritize activities that provide essential decision support by demonstrating the possible results and impacts of various research portfolios and technology policy scenarios, as well as help identify important new opportunities for EERE research, development, and demonstration (RD&D) activities. Analysis best practices will be shared across EERE and DOE. Particular emphasis will also be placed on examining ways to increase U.S. manufacturing competitiveness in support of EERE's Clean Energy Manufacturing Initiative (CEMI) and in evaluating the full portfolio of EERE activities.

The International subprogram will continue to prioritize partnerships with key countries that provide the greatest opportunities "to increase learning rates, promote the global adoption of clean energy technologies, and… ease foreign market entry for U.S. firms," as noted in the Department's Strategic Plan (May 2011). Considerations include a partner county's policy environment, size of potential market opportunity for renewable energy or energy efficiency technology deployment, and strength of partner country participation. Externalities that could affect selection of priority countries and/or topics for cooperation include Administration-negotiated bilateral commitments, trade or other disputes that affect bilateral relationships, and policy changes in partner countries. On the latter, for example, in June 2012, Japan passed a feed-in tariff and other policies favorable for renewable energy deployment. As it considers phasing out nuclear power, Japan is more open now than ever to foreign renewable energy technology providers—making Japan a new high priority for cooperation.

The Communications and Outreach subprogram will continue to prioritize activities that help ensure key information is accessible, reliable, and delivered through multiple channels. The subprogram's choice of communication approaches will be better informed by the its increased activities to develop and disseminate EERE's corporate strategic messages; its evaluation of external trend data related to knowledge and adoption of energy efficiency and renewable energy technologies; and its use of a broader range of communications analytics that determine the most high-impact communications channels to effectively target key stakeholder audiences and the public.

Program Accomplishments and Near-Term Milestones

Technology-to-Market (formerly Innovation and Deployment)

- Technology-to-Market activities led to the creation of 80+ business partnerships, attracted more than $30 million in private sector funding, and led to the launch of more than 25 clean energy start-up companies.
- Saved more than $1 million by deploying the National Training and Education Resource (NTER) as a cost-effective advanced training solution for several EERE programs, including Weatherization and Intergovernmental Activities, Solar Energy, Vehicle Technologies, and Advanced Manufacturing.
- The Energy Innovation Portal (http://techportal.eere.energy.gov) supported more than 1,300 private-sector requests for information about DOE-owned Intellectual property (IP), with more than 300 requests remaining active and 16 licensing "deals" closed.
- Community investments and integrated deployment activities in Hawaii and the U.S. Virgin Islands enabled them to generate 12% and 14%, respectively, of their energy from clean sources in 2012. In 2012, DOE and NREL supported the analysis and the development of a Native American wind energy site on Fire Island in Cook Inlet near Anchorage.

Strategic Priorities and Impact Analysis

- Completed the Renewable Electricity Futures Study, an unprecedented analysis of the implications of high penetrations of renewable electricity on the grid, providing the utility industry with information essential to long-term planning (http://www.nrel.gov/analysis/re_futures/).
- Supported Digital Government Strategy's goal of unlocking the power of government data to spur innovation by providing public stakeholder access to government data and analyses on energy efficiency, renewable energy, and transportation through OpenEI.org (http://en.openei.org/wiki/Main_Page).
- Provided first-time consolidated public access to a collection of technology cost and performance estimates and goals and provided contextual data from other published studies in the Transparent Cost Database (http://en.openei.org/wiki/Transparent_Cost_Database).
- Developed and deployed the Utility Access Heat Map on OpenEI, enabling consumers to find out what type and quality of electric use data their utility provides

(http://en.openei.org/wiki/OpenEI:Utility_data_access_map).

- Completed the Transportation Energy Futures Study, analyses of the transportation system to fill in cross-cutting analysis gaps not covered by the EERE R&D programs and enable more robust long-term planning (http://www.nrel.gov/analysis/transportation_futures/).

International

- Conducted industrial efficiency workshops in Costa Rica focused on process heating and steam systems, in connection with the University of Costa Rica's Regional Energy Efficiency Center. Workshop led to a concrete plan for the University to purchase energy efficiency equipment made in the United States.
- Introduced U.S. supported labeling program in Brazil to promote competitiveness of U.S.-made building energy efficiency products; industry cost share of 50% indicates market relevance and export potential.
- Accelerated joint research on 10 innovative clean energy technologies likely to lead to product commercialization and jobs in both the U.S. and Israel; also, DOE funding is leveraged at least 3:1 with cost share from Israeli government and from industry partners in the U.S. and Israel.

Communications and Outreach

- In alignment with Federal Web reform and digital government strategies, met key milestones toward completing a comprehensive, user-centered Web redesign project to enable stakeholders and the public to access key information more quickly and effectively.
- Improved information management and vetting processes in FY 2013, with increased engagement with traditional and social media, to better disseminate information on EERE's successes, as well as improved strategic messaging through more visible, frequent, targeted, and compelling presentations to external communications channels through building out corporate/executive communications function.
- Increased return on investment (earned media) of the *Saving Energy Saves You Money* campaign from 25:1 in FY 2012 to at least 30:1 in FY 2013 through development of new low-cost public service announcement assets.

Program Planning and Management

The Technology-to-Market subprogram will conduct a peer review of its innovative ecosystems efforts to accelerate high-growth entrepreneurship and job creation by moving energy efficiency and renewable energy technologies to market. The effort funded five 3-year projects for $5.25 million and the next stage is to apply lessons learned and best practices to help design and build improved ecosystems in FY 2014 to spur clean energy economic growth and create jobs in different regional economies of the U.S. market. Analyses conducted in FY 2013, combined with workshops with experts from universities, large and small businesses, national laboratories and the private sector, will guide the design and development of an expanded tech-to-market initiative in FY 2014 that accelerates the commercialization of innovative clean energy technologies developed at national laboratories and other research institutions. The subprogram will prioritize activities that best catalyze and support nationwide clean energy innovation, educate the next generation of energy entrepreneurs, and work with the private sector to enable the deployment of clean energy technologies to meet national clean energy goals.

The Strategic Priorities and Impact Analysis subprogram will continue to prioritize activities that provide essential decision support by demonstrating the possible results and impacts of various research portfolios and technology policy scenarios. The subprogram will help identify important new opportunities for EERE RD&D activities and share analysis best practices across EERE and DOE. The subprogram will place particular emphasis on examining ways to evaluate the impact of EERE activities and on increasing U.S. manufacturing competitiveness.

The International subprogram will continue to use prioritization criteria in its strategic plan to guide investment decisions; consult with U.S. export promotion agencies, EERE technology programs, and DOE Policy and International Affairs to identify the best opportunities to accelerate development and deployment of clean energy technologies; actively manage projects and funding opportunity announcements (FOAs); work with project performers to define scopes of work, monitor progress through monthly or quarterly reporting; assess outcomes and impacts on U.S. exports, investments, and implementation of favorable policies and standards through post-project evaluations; and coordinate project activities with other Federal agencies, partner country representatives, international organizations, and the U.S. private sector.

In FY 2013, the Communications and Outreach subprogram will implement an internal restructuring to better support, facilitate, and lead cross-cutting communications for EERE across media, Web, strategic and internal communications, outreach, and inquiries functions. It will prioritize activities that best disseminate information to key stakeholders and the public to enable greater understanding of EERE programs and technologies.

Technology-to-Market
Funding Profile by Subprogram

(dollars in thousands)

	FY 2012 Current	FY 2013 Annualized CR*	FY 2014 Request
Technology-to-Market	6,500	—	14,250
Total, Technology-to-Market	6,500	—	14,250

*FY 2013 amounts shown reflect the P.L. 112 175 continuing resolution level annualized to a full year. These amounts are shown only at the "congressional control" level and above; below that level, a dash (-) is shown.

The Technology-to-Market subprogram accelerates the commercialization and market adoption of EERE technologies. The subprogram works with universities, small businesses, non-profits, national laboratories, venture capital companies, entrepreneurial organizations, and state/local governments through the use of collaborations, competitive grants and prizes, and partnerships to bridge the gap between technology development and market adoption. The subprogram also supports activities that help ensure a qualified clean energy workforce. The subprogram leverages DOE resources from the private sector to accelerate movement of clean energy technologies to the U.S. market, increasing the impact of public investment in R&D and spurring economic growth and creating jobs.

The subprogram will continue to focus on innovation and integrated deployment activities that serve as high impact pathways to achieve the EERE goals of clean energy adoption and improved U.S. economic competitiveness ($14.25 million).

- Innovation – Includes innovation ecosystems, the National Clean Energy Business Plan Competition, oversight of commercialization assistance to EERE-supported Small Business Innovation Research (SBIR) companies that demonstrate considerable market adoption potential and alignment with EERE RD&D, and other activities that help bridge the commercialization "valley of death" and accelerate the movement of innovative technologies to market.
  - The innovation ecosystem projects—which are led by universities and nonprofits across the United States, and convene more than 80 project partners—are regional accelerators that encourage the development and growth of entrepreneurial small businesses focused on national energy challenges. The ecosystem projects are nurturing and mentoring entrepreneurs; pursuing IP protection for their technological innovations; engaging the surrounding business and venture capital community; and integrating sustainable entrepreneurship and innovation across university schools and departments.
  - The National Clean Energy Business Plan Competition spurs innovations by providing clean energy startup business experience to hundreds of university students each year, and awarding prize funding for winning teams to further develop and implement their business plans. These activities encourage the commercialization of new and cost-effective scientific and engineering solutions to America's energy challenges.
  - Activities will be enhanced to enable a more comprehensive approach to accelerating the transfer of technologies developed at national laboratories, small businesses, and universities. New efforts will better enable DOE laboratory IP to move to the proof of concept phase, and new approaches will aim to bridge the gap between labs, hubs, entrepreneurs, and industry. As part of this effort, EERE plans to launch a new commercialization effort at a number of the national laboratories. The subprogram will start pilots to provide seed funding for laboratory scientists to investigate the commercialization potential of their inventions, and bridge the gap between national laboratories, DOE hubs, entrepreneurs, and industry.
  - In addition and complementary to the above, the subprogram will implement a new initiative to support the replication, enhancement, and expansion of the LabStart model based at Los Alamos National Laboratory. This joint venture represents an innovative and high-impact technology transfer model with the potential to

significantly increase the rate of successful technology commercialization from the National Laboratories. Since 2008, LabStart has worked with Los Alamos and Sandia Laboratories to evaluate 450 technologies, launch 19 companies, and leverage over $18 million in private financing through only $1.1 million of investment. Through a new, open and competitive solicitation, EERE's initiative will replicate and expand this success across other labs for energy efficiency and renewable energy technologies. By working closely with DOE laboratory scientists to perform technological due diligence, assess market opportunities, and link promising opportunities to investment networks, this activity will leverage Federal investments to increase cooperative R&D, start-up options, licensing, deal flow, and acquisitions.

- Opportunities for the private sector to develop and deploy technologies based on national laboratory IP will continue to be encouraged through the use of the Energy I-Portal, which provides searchable information about DOE-owned IP available for licensing, patents, and patent applications.

- Integrated Deployment – Accelerates first-market adoption of energy efficiency and renewable energy technologies in the most expensive energy markets in America—as high-energy-cost markets are likely to benefit from being early adopters of such technologies and because the size and geographic location of these areas typically lend themselves to investigating, understanding, and addressing the impacts of high levels of renewable energy penetration. Committed state and local governments in areas with unusually high energy costs receive technical assistance to decrease fossil-fuel-derived energy use through efficiency and utilization of renewable energy sources. The subprogram coordinates with these local communities to expand the deployment and integration of EERE technologies to cost effectively achieve clean energy goals. Innovative partnerships, analysis, and technical assistance serve to inform financing arrangements, as well as provide context for policy options that are used to cost effectively accelerate energy project development. This subprogram will also support DOE's Office of Electricity Delivery and Energy Reliability, upon request, with renewable technology expertise related to recovery activities with local, state, territorial, and Federal stakeholders following natural and manmade disasters.

- Workforce Development and Education – Develops improved approaches for, and expands access to, the workforce training needed to ensure the availability of a highly skilled workforce for jobs in clean energy sectors. The subprogram adapts advanced training strategies (such as using an open source online training platform and simulation-based assessments) for new energy technologies and growing clean energy industries to facilitate response to immediate job needs. Long-term strategies include a broader Energy Literacy effort. The subprogram activities are coordinated with other government agencies and external stakeholders to maximize program effectiveness. In order to facilitate optimized workforce efforts across EERE, the subprogram will create a process to coordinate assessments and evaluation of EERE workforce and education ongoing projects through more consistent data collection, standardized performance metrics, and the use of an online management system to maintain data for program improvement. These techniques are in line with the Committee on STEM Education strategic planning process and ongoing interagency discussions. Evaluation will enable EERE to achieve greater consistency in measurement of effectiveness across workforce development initiatives. Centralized coordination will further help ensure that results of these evaluations are reflected in project redesign and/or new projects that better address workforce needs associated with energy efficiency and renewable energy technologies and industries.

- Technology Information Management – Focuses on improving the transparency and accessibility of EERE technical information, energy data, and software tools through the use of online resources, such as interactive destinations, distributable content, and mobile applications. Low cost, state-of-the-art, user-friendly tools make EERE's content available to the broadest possible technical audience groups, ensure data can be opened up for entrepreneurs to use, and travel beyond websites and traditional media channels to get to research organizations and other technical stakeholders. These activities are coordinated with the Communications & Outreach subprogram to ensure they are well-integrated and leveraged, and accessible by EERE's multiple audiences.

Explanation of Funding Changes

(dollars in thousands)

	FY 2012 Current	FY 2014 Request	FY 2014 Request vs. FY 2012 Current
Technology-to-Market — The funding increase will enable a more comprehensive approach to bridge gaps across and accelerate clean energy technology business development among national laboratories, small businesses, and universities. This includes activities that inspire regional and nationwide clean energy innovation clusters, develop the next generation of energy entrepreneurs, accelerate the deployment of clean energy technologies, and create clean tech startups and jobs.	6,500	14,250	+7,750
Total, Technology-to-Market	6,500	14,250	+7,750

Funding Schedule

Fiscal Year	Line Item	Funding (dollars in thousands)
FY 2012	• Continued support for five regional energy incubation networks through Innovation Ecosystems grant program. • Ran the first year of National Clean Energy Business Plan Competition. • Publicly launched the National Training and Education Resource (NTER) learning technology platform to advance workforce training. • Aligned efforts to improve public understanding of energy with the development of interagency guidelines for Energy Literacy.	6,500
FY 2013	Planned activities in the Fiscal Year 2013 Budget (final allocations have not yet been determined): • Continue support for regional energy incubation networks through the Innovation Ecosystems grant program, identify best practices, and implement improvements. • Continue National Clean Energy Business Plan Competition in order to support entrepreneurial training for students and encourage tech transfer from universities. Renewed focus on technology transfer from the national labs to accelerate technology transfer and increase the number of clean technology start-up companies. • Identify and promote best practices for commercialization within applied energy programs to bridge commercialization gaps. • Coordinate intra and interagency efforts that contribute to Energy Literacy. • Implement activities that meet Federal and DOE Strategic Plan STEM goals, including using evidence-based approaches to assess EERE's clean energy workforce development activities, thereby increasing efficiency and coherence. • Ensure mobile IT strategies for disseminated EERE information are high impact and effectively deployed.	—
FY 2014	• Continue support for regional energy incubation networks through the Innovation Ecosystems grant program, identify best practices, and implement improvements. • Continue National Clean Energy Business Plan Competition, expanding the subprogram's reach and engaging, as appropriate, with regional clean tech ecosystems activities. • Implement a new initiative to significantly increase the rate of successful technology commercialization from the National Laboratories. • Pilot Proof of Concept activity for DOE laboratory scientists to investigate the commercialization potential of their technologies.	

	• Pilot new approaches that bridge the gap between national laboratories, DOE hubs, entrepreneurs, and industry. • Further develop national laboratory technology transfer programs. • Add simulation-based assessments to NTER platform in order to support meaningful assessment and more rapid qualification of clean energy workforce. • Continue development and implementation of evaluation framework to assess the effectiveness of EERE's workforce training activities.	14,250

Strategic Priorities and Impact Analysis
Funding Profile by Subprogram

(dollars in thousands)

	FY 2012 Current	FY 2013 Annualized CR*	FY 2014 Request
Strategic Priorities and Impact Analysis	7,000	—	11,000
Total, Strategic Priorities and Impact Analysis	7,000	—	11,000

*FY 2013 amounts shown reflect the P.L. 112 175 continuing resolution level annualized to a full year. These amounts are shown only at the "congressional control" level and above; below that level, a dash (-) is shown.

The Strategic Priorities and Impact Analysis subprogram provides a comprehensive basis for EERE decision-making. Integrated, cross-cutting analysis informs EERE corporate and program decisions and optimizes EERE RD&D efforts.

The subprogram supports program implementation and decision-making by conducting analyses using a portfolio-wide approach. Each analysis project fits into an iterative, comprehensive framework, so each new result builds long-term capabilities. The subprogram collaborates with EERE program offices, national laboratories, and industry experts to evaluate investment tradeoff decisions and identify new opportunities.

Supported analytical work advances the understanding of technologies and systems, as well as the related legislative, regulatory and market landscape. The subprogram's analyses are widely available to public stakeholders and used to facilitate private investment, promoting the rapid development and adoption of clean energy technologies.

The activities of this subprogram provide consistent EERE-wide methodologies for impact analysis, performance evaluation, and strategic planning; provide core support for EERE and DOE decision making by demonstrating the possible results and impacts of various research portfolios and technology policy scenarios; and help identify important new opportunities for EERE RD&D activities. The subprogram thus informs decisions and helps to optimize the allocation of resources within and among EERE and the other DOE applied energy programs. The subprogram's analyses assist EERE's senior management and technology offices to select portfolios and pathways that will most effectively and productively advance DOE's economic, environmental, energy security, and management excellence goals. The work also provides a structure and approach for estimating and integrating the impacts of RD&D activities across all of EERE's technology offices.

The subprogram's evaluation activities help monitor and measure success, assess and compare the value of different programmatic approaches, increase program effectiveness, and meet requirements for objective, independent assessment. In cooperation with the EERE technology offices, the subprogram works to determine the return on investment of EERE RD&D investments. Increased funding in FY 2014 will enable the subprogram to continue to build its capacity to apply rigorous, consistent impact analysis methods across EERE, including through improved tracking of relevant data from EERE-supported projects. The subprogram's impact findings will inform actionable steps to enhance investment effectiveness, support active project management, incorporate evidence-based analysis into EERE business practices, and enable clear communication to EERE senior management and external stakeholders.

- Data Resources – Includes characterizing technologies to provide cost and performance data for EERE technologies essential for both private and public decision-makers. This focus area provides high-quality, continuously improved, peer-reviewed data on EERE technologies in formats that can be directly accessed by users online. The subprogram will build and maintain databases that contain real-world market data, modeled cost and performance data, and reviews of published studies.

- Market Intelligence – Includes analysis of technology financing structures and tools, identification of supply-chain bottlenecks, and implications of market conditions for manufacturing and supporting industries. The subprogram explores the market conditions that would support reaching national objectives, including infrastructure requirements and

reduction of non-cost and market barriers. This focus area explores the role of private-sector funding to ensure that EERE avoids investing in areas that are highly supported by private companies. It examines factors influencing competitiveness of domestic manufacturing of advanced technologies and provides recommendations to maintain or increase competitiveness.

- Energy Systems Analysis – Informs EERE strategic planning and helps identify long-term pathways for meeting national clean energy goals. These studies examine future markets and technologies for the buildings, transportation, industry, and electricity generation sectors—integrating across the EERE technology programs. The work is used to set realistic goals across EERE and provide a foundation for program technology road mapping.

- Portfolio Impacts Analysis – Estimates specific and economy-wide benefits of the EERE portfolio to inform investment tradeoff decisions and assess new opportunities. Where not otherwise available, tools are developed to estimate the prospective business, environmental, and direct employment impacts of different energy futures scenarios. This focus area continues to develop common approaches to evidence-based evaluation and works with EERE programs to apply rigorous evaluations across all aspects of EERE RD&D and program management.

Each of these four areas supports a major focus: strategic analysis underpinning the Clean Energy Manufacturing Initiative. Market analysis examines the impacts of manufacturing on the economy and the roll of innovation in strengthening different parts of the clean energy sector. Industry validated techno-economic analysis quantifies the specific factors that drive U.S. competitiveness. Findings provide an understanding of specific cost and policy advantages in other regions – and allow EERE to tailor investments to ensure domestic competitiveness.

Explanation of Funding Changes

(dollars in thousands)

	FY 2012 Current	FY 2014 Request	FY 2014 Request vs. FY 2012 Current
Strategic Priorities and Impact Analysis — The funding increase reflects a greater emphasis on impact analysis and evidence-based evaluation of EERE's activities, including improved data collection from awardees in support of that evaluation. These analyses will help assess alternate approaches within EERE programs to identify those that are most effective. The portfolio also includes a continuation of analysis EERE's "Clean Energy Manufacturing Strategic Analysis" activities, begun in FY 2012, which analyze a wide array of clean energy technologies to inform detailed EERE U.S. manufacturing supply-chain strategies that are most likely to result in major increases in U.S. clean energy manufacturing.	7,000	11,000	+4,000
Total, Strategic Priorities and Impact Analysis	7,000	11,000	+4,000

Funding Schedule

Fiscal Year	Line Item	Funding (dollars in thousands)
FY 2012	• Developed transparent technology and performance cost of energy metrics to enable consistent comparison of R&D investments across technology programs and made cost data publically available online. • Completed analyses of the transportation system to identify and fill in cross-cutting analysis gaps not currently covered by the EERE R&D programs and enable more robust long-term planning. • Completed first-of-a-kind analysis of high penetrations of renewable electricity, providing the	7,000

Fiscal Year	Line Item	Funding (dollars in thousands)
	utility industry with information essential to long-term planning.	
FY 2013	Planned activities in the Fiscal Year 2013 Budget (final allocations have not yet been determined): • Focus on U.S. clean energy technology manufacturing competitiveness, identifying overarching criteria for EERE investment and specific supply chain needs. • Perform comprehensive, retrospective assessments of past EERE activities to better determine impact of Federal investments and inform future investments. • Complete grid integration and demand response/storage integration work in order to inform and enable high penetrations of renewable energy in cooperation with the Office of Electricity Delivery and Energy Reliability. • Examine impacts of energy efficiency and renewable energy, building on existing portfolio analysis and providing a strong basis for policy technical support.	—
FY 2014	• Finalize clean energy technology manufacturing analysis methodology, combine with market analysis of private investments, and provide as decision structure for ongoing use across EERE technologies. • Link retrospective and prospective impacts analysis, standardizing and connecting existing tools and methods. Work will enable benchmarking future investments against successful past investments. • Complete ongoing energy systems analysis of futures scenarios, compiling results from renewable energy, transportation, industry, and buildings work. Results inform long-term DOE strategic planning and are available to the public. • Work with each EERE program to expand and standardize impact evaluation approach. Develop and execute best practice guidance on grantee data collection, evaluation approaches, appropriate rigor levels, and calculation methods.	11,000

International
Funding Profile by Subprogram

(dollars in thousands)

	FY 2012 Current	FY 2013 Annualized CR*	FY 2014 Request
International	5,000	—	4,750
Total, International	5,000	—	4,750

*FY 2013 amounts shown reflect the P.L. 112 175 continuing resolution level annualized to a full year. These amounts are shown only at the "congressional control" level and above; below that level, a dash (-) is shown.

The EERE International subprogram accelerates the development and deployment of clean energy technologies through international collaboration, funding U.S.-based technical experts to lead engagement in targeted opportunity spaces to fulfill mission.

The subprogram:

- Accelerates the progress of EERE's domestic R&D programs by leveraging the resources and expertise of major developed partner countries
- Collaborates primarily with large emerging economies to establish innovative and replicable platforms for testing new U.S. technologies and policy approaches
- Primes markets in major emerging economies for renewable energy and energy efficiency goods and services from U.S. companies
- Helps increase U.S. exports of clean energy technologies and create U.S. jobs through collaborative projects focused on harmonized test procedures for quality and performance, energy efficiency standards, labels, and certification.

In managing its activities, the subprogram will:

- Continue to focus on partnerships with about 10 to 15 key countries and a few multilateral organizations that provide the best opportunity to accelerate development and deployment of clean energy technologies
- Guide project investment choices (both partner countries and topic areas) using analysis and prioritization criteria from the subprogram's strategic plan, consultations with EERE technology programs, and interagency work products of the Renewable Energy and Energy Efficiency Export Initiative (export.gov/reee), and partner country interests
- Measure project impacts in terms of U.S. export promotion, clean energy deployed, and favorable renewable energy or energy efficiency policy changes facilitated.
- Accelerating Domestic R&D Results – Through partnerships with other countries at the cutting edge of clean energy R&D, EERE will accelerate domestic development and cost reductions for energy efficiency and renewable energy technologies. These partnerships can help EERE achieve its RD&D technical and cost goals. For example, the subprogram facilitates R&D collaborations between the United States and Canada under the Clean Energy Dialogue (CED), including projects in the areas of biofuels, vehicles, and marine hydropower. Collaboration developed through CED can help EERE programs learn from Canadian experience and better target FOAs on key technological hurdles, reducing the time and resources needed for the program to meet its goals.
- Priming Markets for U.S. Exports – EERE investments in diverse clean energy technologies set the stage for the development of a robust clean energy export market for the United States with commensurate employment and related economic effects. Rapidly growing countries like China, India, and Brazil are constructing power plants, commercial buildings, industrial facilities, and housing at an unprecedented rate. Priming markets and building capacity in these countries through technical assistance on policy options—developing codes and standards, as well as evaluating and addressing technology product reliability from different sources —will help this development occur with the cleanest energy profile possible. These activities also generate market pull for energy efficiency and renewable energy technologies, which can be met with U.S. clean energy exports. For example, the subprogram sponsored a technical workshop in Brazil aimed at developing a market for small wind turbines. The workshop created an export opportunity by linking U.S. wind equipment manufacturers with Brazilian electricity regulators, project developers, and

financiers and U.S. trade promotion agencies. Technical workshops—in this case, focused on wind turbine certification and interconnection issues in Brazil—are within and well-suited to DOE's mission space and expertise. Well-coordinated subprogram activities could lead to U.S. industry tapping the trade promotion tools (e.g., low-cost financing, risk insurance, et cetera) of other Federal agencies to promote exports.

- Promoting Global Deployment of Clean Energy Technologies – Partnerships with key countries advance the deployment of clean energy technologies and can achieve substantial, measurable environmental impacts on the reduction of GHG emissions and related sustainability factors. For example, the subprogram teamed with the U.S. Trade and Development Agency to co-host a training visit by 24 Chinese mayors and staff to U.S. cities to share information about sustainable policies, practices, and technology solutions. The trip resulted in a $4 million order for products made by a U.S.-based manufacturer of innovative day lighting solutions that reduce electric lighting needs. The subprogram will also continue to monitor long-term outcomes, such as whether subnational relationships established during the trip could lead to even more sales of U.S. goods and services, foreign direct investment in U.S. cities, and new sustainability policy approaches in U.S. cities, informed by China's experience.

Explanation of Funding Changes

(dollars in thousands)

	FY 2012 Current	FY 2014 Request	FY 2014 Request vs. FY 2012 Current
International — The funding decrease eliminates activities deemed lowest-priority, while the subprogram will sustain priority partnerships with key countries that provide the greatest opportunities; collaborations with China and India will focus on core activities developed under bilateral agreements.	5,000	4,750	-250
Total, International	5,000	4,750	-250

Funding Schedule

Fiscal Year	Line Item	Funding (dollars in thousands)
FY 2012	• Conduct collaborative activities with 12 strategic partner countries and three multilateral organizations in EERE's mission areas: International Renewable Energy Agency (IRENA), International Partnership for Energy Efficiency Cooperation (IPEEC), and the Asia Pacific Economic Cooperation (APEC) Energy Working Group. • Depending on country or organization, collaborative activities areas could include one or more of the following: appliance standards and labeling, building efficiency, industrial efficiency, data center efficiency, advanced vehicles, fuel cells, biofuels, solar, wind, geothermal, water power, sustainable cities, grid integration, resource assessment, renewable energy policy development, energy performance contracting, certification and testing procedures.	5,000
FY 2013	Planned activities in the Fiscal Year 2013 Budget (final allocations have not yet been determined): • Continue work with partner countries on many of the same topic areas as in FY 2012, negotiating beneficial next steps in annual bilateral Action Plans as appropriate. • Launch a new competitively selected project focused on Indonesia—a major opportunity space identified through strategic analysis. Working with the Government of Indonesia, Indonesia's main utility, the U.S. private sector and other partners, focus on promoting renewable energy solutions to replace diesel generation on small island grids. • Launch new competitively selected projects focused on the promotion of "sustainable city"	—

Fiscal Year	Line Item	Funding (dollars in thousands)
	design and demonstration with China and India, incorporating U.S. technology and service solution providers as these countries deal with rapid urban migration. • Meet 90% of key milestones/deliverables on time and on budget across the portfolio of projects. • Continue coordinating beneficial R&D collaborations with Australia, Canada, European Union, Israel, Japan, and others.	
FY 2014	• Focus market-priming collaborations on a few key partnerships, likely to include China, India, Indonesia and Brazil, and perhaps new expanding markets, such as Saudi Arabia and South Africa. • Guide project investment choices (i.e., topic areas) using analysis and prioritization criteria from the subprogram's strategic plan. The criteria focus on contributions to the subprogram's strategic goals, or, the ability for a project to either accelerate domestic R&D progress or reduce energy demand or increase renewable energy deployment— while priming markets for exporting U.S. clean energy technology goods and services. Other criteria include the relative priority of a country for engagement based on existing commitments or new analysis, as well as the strength of the partner country's participation in projects. The subprogram also considers consultations with EERE technology programs and DOE's Office of Policy and International Affairs, as well as interagency work products of the Renewable Energy and Energy Efficiency Export Initiative (export.gov/reee).	4,750

Communications and Outreach
Funding Profile by Subprogram

(dollars in thousands)

	FY 2012 Current	FY 2013 Annualized CR*	FY 2014 Request
Communications and Outreach	6,500	—	6,000
Total, Communications and Outreach	6,500	—	6,000

*FY 2013 amounts shown reflect the P.L. 112 175 continuing resolution level annualized to a full year. These amounts are shown only at the "congressional control" level and above; below that level, a dash (-) is shown.

The Communications and Outreach subprogram provides strategic communications leadership and support for EERE. By deploying a wide array of informational tools and products, the subprogram educates stakeholders and the public on EERE programs, activities, and technologies, as well as their associated impacts. This information promotes and raises awareness, overcomes informational barriers to understanding and adopting EERE technologies, and accelerates adoption of EERE technologies and practices.

The subprogram activities will continue to ensure that EERE information is available to the general public and other stakeholders in coordination and consultation with EERE's programs. The subprogram's externally facing tools and communications include Web content and services, print products, displays and events, exhibits, multimedia, social media, content for mobile devices, and letters to the public. Through these channels, the subprogram proactively communicates with or provides responses to EERE stakeholders, most often to reach the media; industry; students; educators and educational institutions; other Federal, state, and local government entities; and non-governmental organizations. It also conducts internal communications activities for EERE to encourage cross-cutting internal coordination and collaborations among EERE offices. EERE activities result in considerable information flow to, through and from the communications team; the subprogram typically develops, processes, or approves more than 300 different communications items each month. The subprogram will continue to regularly align its levels of effort in functional areas to align with EERE priorities, as well as public and stakeholder needs.

To expand EERE's reach, the subprogram also leverages informational assets, such as public service announcements (PSAs), to raise energy awareness and provide timely, objective, and relevant information to help consumers make informed energy choices to reduce energy use, demand, and associated costs; to identify cost-effective alternatives; and to reduce environmental impact.

- Web Enterprise Management – The subprogram manages and updates the EERE website enterprise, including EERE's main website (eere.energy.gov) and a large majority of content for consumers on the EnergySaver presence, which attracts millions of online visitors per year. The subprogram also enables EERE's expanded use of widgets, mobile applications, and other electronic and online communications technologies, to disseminate information to multiple user audiences, in concert with the Technology-to-Market subprogram's Tech Information Management area. This collaboration includes discerning what new hardware and Web tools are required to best operate and maintain EERE's robust public website enterprise assets that are for specific technical audiences. In managing and enhancing EERE's Web enterprise in FY 2014, primary emphasis will be on content redesign; architecture transition to a more user-friendly and distributable-content environment; and integration or movement of certain content to DOE's energy.gov environment.
- Media Relations – The subprogram engages stakeholders, the media, and the public through frequent news updates and program information, in coordination with EERE programs and DOE's Office of Public Affairs. This includes issuing press announcements and alerts about key activities such as funding opportunity announcements, emailing bulletins to tens of thousands of subscribers, and facilitating interviews with media outlets. The subprogram also heavily uses new (social) media to provide updates on EERE project milestones and successes, as well as online multimedia channels to

provide information about energy efficiency and renewable energy technologies. While maintaining these activities in FY 2014, the subprogram will focus on deepening its media analytics capabilities—continuing to balance frequency and impact in executing media strategies and ensuring sufficient Solar Decathlon media support.

- Executive Communications – The subprogram develops, executes, and updates all EERE senior leader materials for presentations and events; maintains the overall EERE identity through guidelines and standards; and develops cross-cutting informational materials about EERE's activities, project successes, and accomplishments. The subprogram's FY 2014 activities will focus on designing and executing, in concert with EERE programs, at least three major cross-cutting EERE publications for dissemination to stakeholders and the public. The subprogram also maintains EERE's online catalogue of thousands of information products.
- Communications Analysis and Public Outreach – The subprogram conducts a modest level of consumer views analysis and public outreach to gauge and increase understanding of EERE-related technologies and practices. The subprogram's activities primarily include synthesis work on national surveys conducted about EERE-related practices to identify knowledge gaps, and the use of PSA methods such as for the *Saving Energy Saves You Money* campaign, which in FY 2012 reached an earned media ROI of approximately 30:1. The subprogram's FY 2014 activities include dialoguing with stakeholders on knowledge gaps, and developing updated PSA or other engagement strategies in concert with EERE programs.
- Public Inquiries – The subprogram manages congressional and public inquiry/letter correspondence flows across EERE, responding to a wide variety of requests on a daily basis. FY 2014 activities include leveraging planned IT reform solutions (see Program Direction) to improve efficiency and effectiveness of this function.
- Internal Communications – The subprogram provides an internal communications function through providing biweekly news to the EERE community and supporting other cross-EERE internal communications activities and will maintain this function in FY 2014.

Explanation of Funding Changes

(dollars in thousands)

	FY 2012 Current	FY 2014 Request	FY 2014 Request vs. FY 2012 Current
Communications and Outreach — The funding decrease will reduce the subprogram's national information/education campaign activities and delay the schedule for the transition of EERE's website to a new architecture, while sustaining activities that help ensure key information is accessible, reliable, and delivered through multiple high-impact channels.	6,500	6,000	-500
Total, Communications and Outreach	6,500	6,000	-500

Funding Schedule

Fiscal Year	Line Item	Funding (dollars in thousands)
FY 2012	• While enhancing overall Web governance function, continued into next phase of DOE's approach to Web/digital reform, including completion of usability analysis, planning and implementation of URL consolidation, and planning and initial implementation of alignment of eere.energy.gov with energy.gov. • Continued high-volume output on traditional and social media, including media communications for Solar Decathlon, as well as development and deployment of crosscutting EERE products such as the EnergySaver Guide. Began to considerably improve strategic messaging and information dissemination on EERE project successes through initial	

Fiscal Year	Line Item	Funding (dollars in thousands)
	development of more presentation materials for external speaking engagements, as well as EERE's first sector-based publications on EERE's activities and recent project successes and program accomplishments (see eere.energy.gov/office_eere/oe_main.html and http://apps1.eere.energy.gov/states/state_summaries.cfm). • Continued high-impact public awareness work, which included participating and exhibiting in public events; conducting EISA-required targeted public awareness efforts in lighting in Quarter (Q) 1–3 and seeking lower-cost solutions for further lighting education work (Q4); conducting internal evaluation/synthesis of external national survey information; and with carry-in funds, continuing *Saving Energy Saves You Money* awareness/education campaign. • Considerably reduced Information Center scope of activities to focus on broader impact activities, and continued congressional and public correspondence activities. • Stood up EERE internal communications function in Q4.	6,500
FY 2013	Planned activities in the Fiscal Year 2013 Budget (final allocations have not yet been determined): • Continue to implement enhanced web governance function and introduce similar tiered product governance function for the more than 350 annually issued written products and publications that are EERE-funded and branded, from "fact sheets" to major studies, to ensure a high level of accuracy, targeting, and quality. • Significantly complete second phase of web/digital reform, primarily the redesign of EERE content on 100+ websites and additional subsites of the EERE enterprise. • Continue high volume output on traditional and social media as possible, while de-emphasizing certain areas, including 101 videos and management of major communications strategies such as Solar Decathlon, while still enabling sufficient support presence and high-impact activities. • Provide enhanced guidance, information development, and greater EERE cohesion regarding strategic messaging, as well as several substantial, cross-cutting EERE corporate products. • Continue high-impact public awareness work; deploy lower-cost lighting education activities; develop augmenting approaches for *Saving Energy Saves You Money* campaign; and continue evaluation/synthesis work. • Continue congressional and public correspondence activities, and aim to improve efficiencies to reduce workload and improve response times. • Re-scope and evaluate EERE internal communications function to focus more heavily on sharing employee news, such as recent recognitions and contributions to external project successes, and less on supporting the provision of EERE management guidance in light of activities through support offices that can meet these needs.	—

Fiscal Year	Line Item	Funding (dollars in thousands)
FY 2014	• Complete Web/digital reform efforts, and seek means to obtain user feedback on results; continue product and web governance and advisory functions to programs with greater emphasis on content management and review. • Improve level of activity and impact regarding EERE's cross-cutting and area-specific media strategies; update EERE's 101 video series and develop/facilitate at least three cross-cutting new publications; heavily utilize such strategies as e-books when possible; and continue to maintain and coordinate strategic messaging/executive communications function. • Continue high-impact public awareness work, with activities contingent on leadership and program needs; maintain *Saving Energy Saves You Money* awareness activities and determine whether to continue based on year-2 analysis of market saturation; develop materials for publication on public awareness of energy efficiency and renewable energy technologies. • Continue congressional and public correspondence activities to improve efficiencies in order to reduce workload. • Evaluate and accordingly update EERE internal communications function.	6,000

Facilities and Infrastructure
Funding Profile by Subprogram and Activities

(dollars in thousands)

	FY 2012 Current	FY 2013 Annualized CR*	FY 2014 Request
Facilities and Infrastructure			
Operations and Maintenance			
General Plant Projects (GPP)	11,419	–	7,800
General Purpose Equipment (GPE)	3,185	–	3,600
Maintenance and Repair (M&R)	3,300	–	5,400
Safeguards and Security (S&S)	8,407	–	9,200
Facility Management			
Energy Systems Integration Facility (ESIF)	0	–	20,000
Total, Facilities and Infrastructure	26,311	26,472	46,000

*FY 2013 amount shown reflect the P.L. 112 175 continuing resolution level annualized to a full year. These amounts are shown only at the "congressional control" level and above; below that level, a dash (-) is shown.

FY 2014 Office Summary

The most significant change in the Facilities and Infrastructure program is the base support for the National Renewable Energy Laboratory's (NREL) Energy Systems Integration Facility (ESIF) (+$20 million).

Overview

Stewardship of the National Renewable Energy Laboratory resides with the Office of Energy Efficiency and Renewable Energy (EERE). NREL is a single-purpose national laboratory dedicated to the research and development (R&D) of energy efficiency, renewable energy, and related technologies. NREL provides the nation's energy technology, policy, and market leaders with world-class research, development, demonstration, and deployment (RDD&D), as well as expert and objective counsel on energy efficiency and renewable energy matters. NREL also provides this expertise to DOE's Offices of Electricity Delivery and Energy Reliability, Science, Nuclear Energy, and the National Nuclear Security Administration.

EERE funds the majority of NREL operations. The program provides funding for General Plant Projects, General Purpose Equipment, Maintenance and Repair, Construction Line Item projects, Safeguards and Security, and the operation of the Energy Systems Integration Facility as construction is completed and research operations begin in FY 2014, ensuring of this important new user resource to EERE and EERE's partners from other DOE offices, universities, and the private-sector. Operating ESIF as a user facility is critical to addressing grid integration challenges. The line also funds NREL's science and support infrastructure, helping maintain it in good condition and available for EERE's use, and ensuring that the workplace is safe and secure for employees and the public. The program's General Plant Projects and General Purpose Equipment investments have decreased as the need for additional improvements to accommodate research activities has decreased. Conversely, direct-funded Maintenance and Repair activities are increasing as the expansion of the NREL campus over the last five years has been completed. The Safeguards and Security investments effectively remain constant with the exception of increases due to inflation and the need to bring contractor badges into HSPD-12 compliance.

Beginning in FY 2014, EERE will begin to directly fund NREL's site-wide facility support costs that are not included in the program's budget, rather than continue to fund these costs in the laboratory overhead rate. This practice is consistent with the practices of laboratories. Because of this direct funding strategy, NREL's labor rate multiplier will be significantly reduced, thereby reducing the cost barrier to accessing unique NREL capabilities (facilities, staff expertise, etc.) by industry and academia, and increasing our impact on the clean energy market. This change in accounting practice will also make site operating costs more transparent, better facilitating cost control. With the proposed FY 2014 budget, NREL's labor rate multiplier is expected to be reduced between 15% and 20% by directly funding site-wide facility support, which lowers the cost to potential users. The individual program allocations correlate approximately with the program funding and major facilities serving the program. The site-wide facility support funds cover: maintenance and engineering support; fire, emergency,

and custodial services; general utilities; network infrastructure and licenses; environment, safety and security, and health support; and sustainability. By moving these costs from laboratory overhead to direct funding, EERE expects to attract more users and gain a faster and greater impact to the renewable energy and energy efficiency marketplace through lower user costs. The EERE Programs that are providing funding for this activity are: Vehicle Technologies; Building Technologies; Wind Technologies; Hydrogen Fuel Cell Technologies; Solar Technologies; and Biomass Technologies.

Program Strategy: EERE is committed to maintaining and enhancing NREL's viability and position as the nation's premier energy efficiency and renewable energy research facility. To this end, EERE is completing three years of significant investment in the science and support infrastructure at NREL that tripled the amount of space under roof and owned by DOE These investments greatly increased EERE's grid integration capability and moved NREL research and support staff from leased space to the South Table Mountain campus. During this period, EERE increased the NREL Replacement Plant Value (RPV) from approximately $200 million in FY 2010 to over $600 million in FY 2013.

The Facilities and Infrastructure Program Strategy is designed to:

- Provide the Laboratory with a safe and secure work environment and protect EERE partners and the public.
- Maintain EERE's science and support infrastructure investments through regular annual reinvestments reflecting age, condition, risk and DOE and industry standards.
- Renovate science and support infrastructure on a regular schedule to ensure the availability of a world-class RDD&D environment and support future EERE mission challenges.
- Acquire new mission-critical capabilities when warranted to ensure EERE's ability to execute its mission. All acquisitions will be designed to achieve the highest levels of energy performance and mission value.
- Enhance NREL's competitiveness by providing direct operating funding for all appropriate activities consistent with Generally Accepted Accounting Principles.

Benefits**:** Through its stewardship of NREL, EERE ensures that its core scientific and support infrastructure is planned, acquired, maintained, renovated, and available in support of EERE's current and future missions. Moreover, EERE uses these investments in NREL facilities to showcase the clean energy technologies and practices necessary to achieve the nation's energy, economic, and environmental goals in a cost effective and safe manner.

The major activities included in the Operations and Maintenance subprogram budget are:

- General Plant Projects investments to maintain and enhance the real property portfolio, renovate general science capabilities and buildings, and create a safe and secure work environment
- General Purpose Equipment investments to acquire shared science and support equipment
- Maintenance & Repair, which provides direct funding for a portion of small-scale, regular M&R of real property and science and support equipment
- Safeguards and Security investments to fund annual S&S operations to provide a safe work environment for staff and the public, to protect cyber networks, and to protect both physical and intellectual property.

The major activity of the Facility Management subprogram budget is ESIF operations funding for core ESIF operations. This subcomponent is new for FY 2014.

Program Accomplishments and Milestones

The program's GPE, GPP, and M&R subprograms maintain real property and equipment investments at or above DOE standards and maintain them in safe and secure operating order.

The program's Construction line item component funded seven major construction projects in FY 2011 through FY 2013 totaling approximately 450 million. All projects were independently reviewed and validated by organizations external to the DOE prior to project start. All projects were managed using a DOE-approved Earned Value Management System to demonstrate monthly adherence to cost, scope, and schedule baselines. All projects met or exceeded cost, scope, and schedule baselines.

All project performance was reported to the Deputy Secretary of Energy on a monthly basis through the Office of Acquisition and Project Management (OAPM) Project Accounting and Reporting System (PARS). One of the premier projects, the Research Support Facility at NREL, has won over 36 management, design, and construction awards for demonstrating that high energy

performance and net-zero energy buildings can be constructed today at a cost equal to or lower than standard buildings using available materials and techniques pioneered by EERE.

The program's S&S investments enabled a greater than 99.9% availability of cyber networks with no significant impact despite daily cyber-attacks. The investment also enabled the completion and commissioning of a significantly upgraded security system, providing greatly expanded surveillance capability without expanding the security workforce.

The program's Facility Management subprogram provides the core funding necessary to operate ESIF in support of EERE's mission. The ESIF subcomponent is new for FY 2014.

To ensure the relevance, availability, and security of EERE's scientific and support infrastructure, and to ensure a safe and secure environment for employees and the public, EERE assumes that sufficient funding will be available to:

- Provide the laboratory with a safe and secure work environment and protect employees, partners, and the public.
- Maintain EERE's scientific and support infrastructure investments through regular annual reinvestments reflecting age, condition, and risk and DOE and industry standards.
- Renovate scientific and support infrastructure on a regular schedule to ensure the availability of a world-class RDD&D environment to support future EERE mission challenges.
- Acquire new mission-critical capability when warranted to ensure EERE's ability to execute its mission.

Program Planning and Management

The program planning goals are to:

- Ensure that EERE's science and support infrastructure at NREL is safe, maintained to meet or exceed DOE and applicable industry standards, is regularly refreshed, and is dependably available to EERE for current and future missions.
- Ensure that EERE's corporate and program strategic and support infrastructure investments at NREL are inventoried, assessed and benchmarked against DOE or industry standards, and described in sufficient detail to demonstrate NREL's stewardship of these investments, in order to develop and defend budget requests and prioritize expenditures.
- Ensure that new strategic or support capabilities are identified early in the planning cycle, are fully coordinated within EERE, and fulfill DOE process requirements.
- Provide direct funding for all institutional facilities and infrastructure general operations, equipment, maintenance and repair, and other activities through the program's budget.
- Ensure direct funding for all facility operations and equipment allocable to a specific EERE program through EERE's program budgets.

The program's planning principles for Real Property Management specific goals:

- All real property is maintained to standards ensuring safe operations.
- All real property is inventoried and assessed against DOE, industry, and manufacturers' operational, safeguards and security, and obsolesce benchmarks. This information is available to NREL and DOE and is the foundation for all stewardship budgeting.
- Real property maintenance and repair, general improvements, or new capability is funded directly in the appropriate subprogram of the program's budget.
- Budget requests reflect specific real property needs based on actual conditions to the extent possible and on specific data assessed against the benchmarks.
- Budget requests include a contingency subcomponent reflecting undefined but not unanticipated investments based on statistical or other analysis of the data collected through condition assessment.
- Budget requests include regular renovation of laboratories and supporting capabilities to ensure continued relevance and availability of the science and support infrastructure to EERE's future mission.
- New real property acquisitions address a specific EERE mission need and are managed in accordance with DOE Order 413.3B, Program and Project Management for the Acquisition of Capital Assets.

The program's planning principles for equipment management are:

- All equipment is maintained to standards ensuring safe operations.
- Institutional and program science and support equipment is inventoried and assessed against DOE, industry, and manufacturers' operational, safeguards and security, and obsolesce benchmarks. This information is available to NREL and DOE and is the foundation for all stewardship budgeting. Budget requests reflect specific equipment needs based on actual conditions to the practicable extent possible.

- Institutional equipment is funded through the EERE General Purpose Equipment subcomponent of the program's budget, and program capital equipment is funded by the appropriate EERE program.

The program's planning principles for S&S are:

- The physical and property security program ensures a safe and secure work environment and protection of EERE's investments in compliance with DOE security requirements.
- The cyber security program ensures the availability and protection of NREL cyber resources in compliance with DOE security requirements.

The program's planning principles for ESIF are:

- Provides an optimal cost structure for all potential users
- Provide annual funding for ESIF core operations
- Provide annual funding to ensure ESIF science capabilities remain relevant to the user community.

Operations and Maintenance
Funding Profile by Activity

(dollars in thousands)

	FY 2012 Current	FY 2013 Annualized CR*	FY 2014 Request
Operations and Maintenance			
General Plant Projects (GPP)	11,419	–	7,800
General Purpose Equipment (GPE)	3,185	–	3,600
Maintenance and Repair (M&R)	3,300	–	5,400
Safeguards and Security (S&S)	8,407	–	9,200
Total, Operations and Maintenance	26,311	–	26,000

*FY 2013 amounts shown reflect the P.L. 112 175 continuing resolution level annualized to a full year. These amounts are shown only at the "congressional control" level and above; below that level, a dash (-) is shown.

The Operations and Maintenance subprogram provides funding for GPP, GPE, M&R, Construction line item projects, and Safeguards and Security at NREL. EERE's investments ensure that its scientific and support infrastructure at NREL is maintained in good condition and available for EERE's use, and that the workplace is safe and secure for employees and the public.

General Plant Projects: The subprogram maintains and enhances the real property portfolio, renovates general science capabilities and buildings, and creates a safe and secure work environment. GPP investments reflect the highest institutional priorities in a given year consistent with EERE's Investment Principles.

General Purpose Equipment: The subprogram supports general scientific and support equipment shared by multiple users across the laboratory. Subprogram investments reflect the highest institutional priorities in a given year consistent with EERE's investment principles.

Maintenance & Repair: The subprogram funds the direct portion of small-scale, regular M&R of the laboratory's science and support infrastructure.

Safeguards and Security: The subprogram works to ensure that EERE's laboratory security programs provide a safe working environment for staff and the public. It also funds the personnel and IT investments required to protect cyber networks, business systems, and physical and intellectual properties.

Explanation of Funding Changes

(dollars in thousands)

	FY 2012 Current	FY 2014 Request	FY 2014 Request vs. FY 2012 Current
GPP: Reflects highest priority general projects in a limited funding environment consistent with EERE's investment principles. GPP funding decreased due to a robust funding stream during the two previous years, resulting in a decreased need for FY 2014 funding.	11,419	7,800	-3,619
GPE: Reflects highest priority equipment acquisitions in a limited funding environment consistent with EERE's investment principles. GPE funding increased slightly to accommodate a need for the replacement of aging laboratory equipment.	3,185	3,600	+415
M&R: Reflects increased replacement plant value and a shift from indirect to direct funding for a greater percentage of the total M&R subcomponent at NREL consistent with EERE's investment principles. M&R funding continues to increase to support the required maintenance activities for the recently added Research Support Facility.	3,300	5,400	+2,100

(dollars in thousands)

	FY 2012 Current	FY 2014 Request	FY 2014 Request vs. FY 2012 Current
S&S: Reflects inflationary increases in S&S operating costs and additional costs for compliance with HSPD-12 badging requirements. S&S funding increased to accommodate the need to fund HSPD-12 badging of contract employees.	8,407	9,200	+793
Total, Operations and Maintenance	26,311	26,000	-311

Funding Schedule

Fiscal Year	Activity	Funding (dollars in thousands)
FY 2012	• The GPP supported a portion of the annual investment used to upgrade and provide new capabilities to EERE's existing real property and related infrastructure at NREL. These projects apply to both the South Table Mountain (STM) and National Wind Technology Center (NWTC) locations in Golden, Colorado. These projects include: safeguards and security improvements; replacement of building systems and components; replacement and upgrades to building and site utilities; site-wide energy efficiency improvements; reconfiguration of existing buildings to accommodate changes or growth in RDD&D programs or research support needs; and other site improvements to maintain the viability of EERE's capital investments at NREL consistent with EERE investment principles. • The GPE maintained EERE's general scientific and administrative equipment value through replacement of expired equipment and the addition of new equipment. This portfolio includes: general scientific equipment with multiple users across NREL; information technology; safeguards and security equipment; administrative equipment; communications equipment; and other categories of general equipment consistent with EERE's investment principles. • Direct funded maintenance and repair allows for the predictive, preventive, and corrective maintenance of real property that is required to sustain property in a condition suitable for its intended designated purpose. Maintenance of real property equipment, systems, and facilities is required to maintain their intended functions or design conditions to ensure availability of equipment and facilities for research activities. Maintenance and repair funding is needed to fund recurring day-to-day work required to maintain and preserve plant and capital equipment in a condition suitable for its intended purpose, and not for betterments which are funded through GPP and GPE. This funding (previously funded within GPP and GPE) is being broken out separately to improve transparency consistent with EERE's investment principles. • Funded S&S staff and support costs and cyber security costs.	26,311
FY 2013	Planned activities in the Fiscal Year 2013 Budget (final allocations have not yet been determined): • The FY 2013 request allows the program to continue to maintain and enhance the real property portfolio, renovate general science capabilities and buildings, and create a safe and secure work environment consistent with EERE's investment principles. • The FY 2013 request allows EERE to continue to maintain EERE's general scientific and administrative equipment value through replacement of expired equipment and the addition of new equipment consistent with EERE's investment principles. • Continue general maintenance and repair projects across all NREL buildings and infrastructure. • Fund S&S staff and support costs and cyber security costs.	–

Fiscal Year	Activity	Funding (dollars in thousands)
FY 2014	• In FY 2014, the program will to continue to maintain and enhance the real property portfolio, renovate general science capabilities and buildings, and create a safe and secure work environment consistent with EERE's investment principles, and continue projects such as the Phased Upgrade of Field Test Laboratory Building HVAC System and 20MW Electrical Interconnection Upgrade to the National Wind Technology Center. • In FY 2014, the program will continue to maintain and enhance the real property portfolio, renovate general science capabilities and buildings, create a safe and secure work environment consistent with EERE's investment principles, and continue projects such as the Integrated Electric Drive Thermal Test System for Power Electronics and the Electric Motors and Ultra-Low Temperature Scanning Tunneling Microscope. • Continue general maintenance and repair projects across all NREL buildings and infrastructure. • Fund S&S staff and support costs and cyber security costs.	26,000

Facility Management
Funding Profile by Subprogram

(dollars in thousands)

	FY 2012 Current	FY 2013 Annualized CR*	FY 2014 Request
Facility Management			
Energy Systems Integration Facility (User Facility Operations)	0	–	20,000
Total, Facility Management	0	–	20,000

*FY 2013 amounts shown reflect the P.L. 112 175 continuing resolution level annualized to a full year. These amounts are shown only at the "congressional control" level and above; below that level, a dash (-) is shown.

The Facility Management subprogram provides funding for core operations at EERE's signature Energy Systems Integration Facility (ESIF), ensuring the continual availability of this important new user resource to EERE and EERE's other DOE, university, and private sector partners.

DOE's Energy Systems Integration Facility, located at the National Renewable Energy Laboratory (NREL), is a unique new national asset that has the capability to conduct the public- and private-sector research and development (R&D) necessary to accelerate commercialization and adoption of renewable energy and energy efficiency technologies into today's energy systems where they can operate synergistically with other energy resources and technologies. While DOE-sponsored research and development investments in individual EERE technologies have been successful in lowering cost and improving performance and reliability, these accomplishments are necessary but not sufficient to enable high levels of market penetration in the nation's existing energy and built infrastructures. Moreover, NREL's *Renewable Electricity Futures Study* found that U.S. electricity demand in 2050 could be met with 80% generation from renewable technologies, but that high levels of renewable sources would create technical issues with grid operation. These issues could potentially inhibit widespread adoption of clean energy technologies, stymying realized progress from past and current Department efforts. ESIF can help address these challenges.

ESIF provides utilities and other stakeholders a safe research facility to reduce the risk of these integration barriers without jeopardizing current grid operations or reliability. ESIF also combines high performance computing and system component experimentation and testing capabilities to identify and resolve the technical, operational, and financial risks of large-scale integration of renewable energy and energy efficiency technologies in today's energy environment. No such capability exists today. ESIF provides the transformative capabilities needed to help advance the nation's energy system into a cleaner, more intelligent and modernized infrastructure.

Since construction began in May 2011, ESIF has remained on budget and on schedule. The 182,500 sq. ft. facility contains 15 state-of-the-art laboratories and several outdoor test areas. These facilities will be used by approximately 200 NREL researchers and support staff and provide office space for external users as well as access to its unique experimental and testing capabilities. Starting in spring 2013, after major equipment installation and check-out, ESIF will be commissioned and open for business for utilities and other energy stakeholders in industry, government research laboratories, and academia on both a non-proprietary and proprietary basis.

Purpose of the Facility

As more diverse and sustainable energy resources are integrated in systems that scale from individual buildings to national grids, the nation's electricity systems are faced with planning, design, and operational challenges. Over the next decades, the increasing diversity of supply, greater demand for electricity, and an aging infrastructure require different approaches to ensure that investments to sustain or build new infrastructure yield systems that are safe, resilient, reliable and sustainable. Research and development at ESIF is aimed at overcoming the systems challenges of integrating new technologies into today's energy infrastructure to support a more reliable, cost-effective, cleaner, and secure system for consumers across the country.

The technological challenges to be addressed by ESIF span the entire energy system — from generation, to transmission, distribution and end-use applications. The ESIF has a broad range of capabilities to address challenges facing a variety of systems including: advanced electrical systems (storage, power electronics, etc.), buildings systems and controls, industrial systems and controls, community power generation and microgrids, utility generation, thermal and hydrogen systems, energy efficient and advanced grid technologies, electricity system architectures, device and system interoperability, demand response data and control integration, and grids that incorporate distributed and/or variable renewable energy (solar, wind, water, fuel cells, etc.) and advanced vehicles.

Technological Capabilities

ESIF is the nation's first research facility that can conduct integrated megawatt-scale RD&D of the components and strategies needed to safely integrate clean energy technologies seamlessly into electrical grid infrastructure and utility operations at the speed and scale required to meet national goals. Unique capabilities include the following:

- Megawatt-scale power-in-the-loop, which allows researchers and manufacturers to conduct integration tests at full power and actual load levels in real-time simulation, as well as evaluate component and system performance before going to market.
- Petascale computing at the facility's high performance data center will enable unprecedented large-scale modeling and simulation of material properties, processes, grid operations, and fully integrated systems that would otherwise be too expensive, too dangerous, or even impossible to study by direct experimentation.
- Research electrical distribution bus, connecting multiple sources of energy, interconnecting "plug-and-play" testing components and ensuring interoperability.
- Supervisory control and data acquisition systems to gather and exchange real-time, high-resolution data for collaboration and visualization.
- Data analysis and grid visualization to create complex systems simulations and operations in a virtual environment.

These state-of-the art technologies provide scientists and engineers with the tools necessary to address barriers to modernizing energy systems at all scales, with a major focus on the electricity system.

ESIF as a Technology User Facility

DOE plans to designate ESIF, see Figure 1, as a formal technology user facility to maximize its benefit as a tool to accelerate system-ready energy technology development and effective system integration of new technologies, meeting the purpose of technology user facilities as identified in the DOE Quadrennial Technology Review. Unlike science user facilities where the research community is the predominate user, ESIF capabilities are intended to attract the commercial sector individually or in partnership with the research community to conduct RD&D that reduces risk and provides solutions to energy system integration challenges.

Figure 1. The Energy Systems Integration Facility at the National Renewable Energy Laboratory

ESIF will have the necessary staff expertise and equipment capabilities in a constant state of readiness to facilitate all types of users and to conduct many different types of experiments. Throughout the design of the facility and in the development of the user program model, more than 250 technical experts and potential users from across industries, laboratories and universities have been consulted. The capabilities of ESIF, both human and equipment, provide external stakeholders access to high-value assets that one organization (e.g., business, university, utility, etc.) alone could not afford to build, maintain and operate.

To attract the user community and deliver outcomes that enable clean energy to be implemented and operated at scale, DOE will support the base operating costs of the ESIF, consistent with the model at other DOE user facilities. This will ensure that the facility is kept operationally ready, equipment is maintained to be state-of-the-art, and operations are conducted safely. By operating in this manner, the facility will attract funding and intellectual assets from external users that leverage the Federal Government's investment. Without this model, the availability and value of the capabilities could erode, leading to user attrition, a loss of intellectual value and a decrease in leveraged funding from external users. A user program will be initiated in FY 2014 and reach full maturity in FY 2016. A breakdown of ESIF's costs can be found in Table 1.

Table 1 FY 2014 ESIF Operating Costs Breakdown

(dollars in thousands)

	FY 2014 Request Labor[a]	FY 2014 Request Non-Labor[b]	FY 2014 Request Total
ESIF Administration: ESIF director, operations director and administrative support. Also includes other labor and non-labor costs to implement a user program, e.g., user outreach, engagement and education; developing calls for proposal; conducting technical peer reviews of proposal; scheduling RD&D projects in the facility and reporting ESIF status and progress.	480	170	650
Scientific Staff: ESIF-dedicated technical staff (28 FTEs) that steward individual capabilities, including experimental and high-performance computing. Technical staff supports users in designing, setting up and conducting experiments in the ESIF.	4,350	0	4,350
Equipment: Recapitalization based on average research and scientific computing equipment life. Initial costs address older equipment that is moving to the ESIF in FY 2013.	0	1,000	1,000
Operations & Maintenance: Labor for 13.5 FTEs includes one dedicated ESIF building engineer and the labor associated with other NREL site operations staff or service contractors drawn on as needed to maintain facility systems and sustain readiness. Examples include custodial services, fire & emergency systems, HVAC maintenance, and small parts. Also includes a prorated share of site operating costs, such as road maintenance, snow removal.	1,825	8,775	10,600
Utilities: Power, water, natural gas, dedicated exhaust, house nitrogen, compressed air	0	3,400	3,400
Total, ESIF Costs	6,655	13,345	20,000

[a] Labor includes ESIF-assigned staff as well as labor associated with NREL central services provided to ESIF.
[b] Non-labor costs include materials and supplies, small parts, service contracts, and travel.

Types of Users

The primary users of the ESIF are the owners and operators of energy generation, delivery, and consuming systems and the suppliers to these companies. These include utilities, system operators, large campus or community energy system owners and operators, building fleet owners and managers, equipment suppliers, and information system suppliers. Additionally, the research community is also a user, inclusive of national laboratories, universities, and private laboratories. NREL research staff (beyond those dedicated to the operation of the ESIF) is a part of this user community.

User Access

Users will apply through a formal application process that includes peer review of proposals. Peer reviews will be conducted using a panel of independent experts. Users can access ESIF both onsite and remotely by logging onto ESIF's network.

User models will differ depending on the type of user and on what entity derives the value from the use of the ESIF capability. Research, development, testing and validation will be conducted under standard proprietary or non-proprietary user agreements that are in use at other user facilities. Even under a non-proprietary agreement, some data may be held as proprietary while making some information available to benefit the larger user community. Table 2 summarizes the two major types of user agreements.

Operations

All aspects of ESIF operations are detailed in the ESIF Operations Plan, including a discussion of research capabilities and opportunities, the types of users and proposals, the user access process, governance principles and roles, and policies to ensure safe and appropriate operation in compliance existing requirements.

Table 2 Types of User Agreements

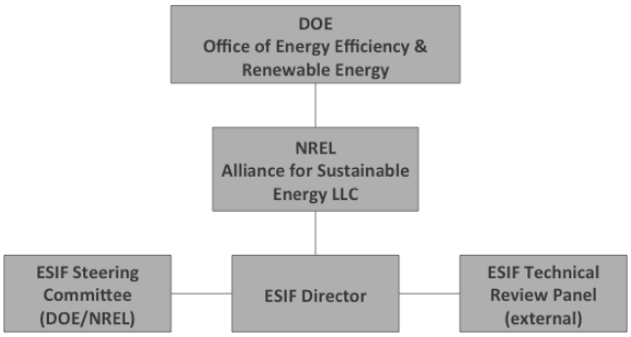
Type of Agreement	Value Delivered	Example Users	Cost Model
Non-Proprietary	Data and Published Papers	•Utilities •EV Fleet Owners •National laboratories •Universities	User pays labor and materials associated with the specific experiment; technical support for set up and base operating costs covered within ESIF base cost
Proprietary	Results Held Privately	•Energy Equipment Developers/ Suppliers •System Integrators	User pays full cost of the experiment + prorated share of prorated share of operating cost

Governance

The ESIF governance model is illustrated in Figure 2. Governance and oversight of ESIF is provided by EERE, which has stewardship responsibility for NREL. Through the prime contract, EERE establishes and implements requirements for mission outcomes and operations. The laboratory management and operations leadership team is responsible for assuring that the objectives of ESIF are accomplished within the DOE prime contract, and the policy and regulatory environment within which NREL operates.

The responsibility for management and operation of ESIF is vested in the ESIF Director and the ESIF management team. The management team is responsible for assuring that the DOE assets in the ESIF are appropriately maintained, operated, and protected and that these national assets are made broadly available to the user community to deliver the value for which the facility was constructed. The ESIF director consults with an ESIF Steering Committee, comprising EERE, the Office of Electricity Delivery and Energy Reliability and other offices as required. The Steering Committee will also include grid integration capability experts, regarding appropriate use of capabilities, capital investments, operational matters and success metrics.

Figure 2 ESIF Governance Model

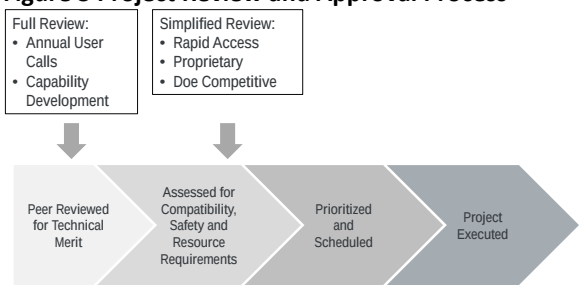


The ESIF Director convenes an expert peer review panel to review the quality and relevance of proposed work in ESIF and to seek advice on ESIF strategy and operational matters.

The Alliance for Sustainable Energy, a Federal Government contractor, is responsible for delivering a world-class integrated user program supporting ESIF's vision and mission. From issuing calls for proposals to facilitating the reviews, scheduling training, arranging access, and collecting and reporting results, the EMO works closely with users and management to provide streamlined and safe access to ESIF's unique capabilities for researchers from around the world through a competitive, peer-review process. A variety of different proposal options are available to facilitate researchers' access to the facility based on needs and to confirm that ESIF capabilities are used to address cutting-edge science questions. Options include user proposals that are open to all researchers and proposals that are restricted to ESIF staff or NREL staff who own or co-own resources that are located in ESIF's user program. Figure 3 shows the general proposal review and approval process.

The ESIF Technical Review Panel (TRP) is chartered to render advice, guidance, and counsel on the effective management and strategic objectives of ESIF. The TRP is chartered by the NREL Director and serves as NREL's key external advisor and advocate of ESIF strategy, operations, and scientific relevance and quality. The TRP does not perform management functions nor does it direct the ESIF Director or his/her management team how to operate and manage ESIF.

Figure 3 Project Review and Approval Process



User Facility Success Metrics

DOE will work with ESIF management to develop a full set of success metrics with which to measure the return on the taxpayer investment. Preliminary metrics and targets for FY 2014 are provided in Table 3. As operational experience and user engagement grows, the knowledge base to refine near and long term metrics will be developed.

Table 3 Initial Success Metrics and Targets

Success Metric	FY 2014 Target
Operating Hours	2,300
Number of Users	100
Research Output (papers, patents, awards)	25
Private Sector Leverage (cost share $)	$20 million
Safe Operations	No reportable incidents

R&D Priorities

There are a variety of solutions that need to be investigated and deployed. Some solutions to address the integration of variable generation that cut across individual technology areas need to be implemented at a systems level. To address these system-level challenges and opportunities, the following RD&D themes have been identified as priority areas of focus for ESIF capabilities:

- Systems Experimentation, Testing and Validation of Advanced Technologies consists of testing and evaluating high penetration and large-scale deployments of distributed renewable energy systems, controllable loads, and electric vehicles
- Complex Systems, System Interfaces and Controls Research consists of developing standard secure monitoring, information exchange, and control technologies to link the performance and operations of a wide variety of energy technologies – allowing interoperability between devices and systems
- System Simulation, Design and Data consists of developing comprehensive models that include electricity, thermal, and fuel system layers, as well as data and communications layers, and that can scale from building to continental systems.

While the funding request is for core staffing and equipment at ESIF, examples of major challenges which could be tackled at the facility are worth mentioning:

- Linking Renewable Energy to Dynamic Load Control - Demonstrate technology to control loads dynamically without affecting occupant comfort on various scales (including single building, campus and multi-site) to smooth solar PV variability. Integrate with real-time predictive model of PV generation and loads.
- Linking Renewable Energy to Energy Storage - Demonstrate the same concept as dynamic load control with energy storage (such as battery vehicle-to-grid, natural gas through compressed air energy storage natural gas through compressed air energy storage, and large-scale hydrogen). Validate the

performance of local energy storage to reduce the variability of solar at the distribution level, or validate the use of large-scale hydrogen as storage for wind. Integrate at test using power hardware in the loop to evaluate storage at various distribution locations and feeder types or in larger transmission systems.

- Making High Efficiency Building Energy Use Grid Compatible - Demonstrate integration of advanced sensors and control technology to modify high energy, low energy building use and campus load shapes.
- Value High Efficiency Energy to Utilities - Demonstrate the value to utilities and other key stakeholders of high penetrations of high efficiency, low energy use buildings. High penetrations of these distributed buildings may be able to provide new services to utilities based on new load models.
- Integration of Renewable Energy and Natural Gas - Demonstrate the ability to have renewable energy work synergistically with natural gas generators at both the local level where waste heat can be collected and used, and at the larger system level to reduce system variability.
- Distributed Control Architectures - Link power system controls that integrate combined heat and power (CHP) applications for wind and solar energy systems to demand controls. Develop new grid architectures that enable cell controllers to allow microgrids for improved reliability and security.
- Transportation - Develop and apply large-scale transportation system simulation scenarios highlighting options for charging, fuel flexibility and response to events affecting availability and cost. Model creation should be supported by scale system demonstrations of vehicles with autonomous operation and ability to be recharged or refueled in a variety of ways.
- Empowered Consumers - Demonstrate utility value when consumers are enabled to make energy decisions. Gather data from a large residential sample and examine impacts of consumer choice on utility operations.
- Applied Energy Value Creation Models – Develop and test scenarios of technology options that accelerate transportation, commercial and residential energy efficiency technology adoption. Value creation is the key to market growth and achieving the stated DOE goals. A collaborative team would define possible synergies between future energy scenarios and identify the core enablers to market growth.
- Energy Model Verification - Data mining for advanced model verification. Use real-time data to validate energy system models for production and end-use that incorporate system interfaces.
- Energy Value Streams - Linking economics to energy data to formulate value steams. Techno-economic analysis link real data to models and assumptions and enable exploring the system from multiple perspectives simultaneously (including the energy user, system operator, regulator, and national good).
- Open Energy Information Challenge - Host open access to energy information databases and support grand challenge research that draws on these data sets to create insights and applications.

Benefits

Integrating EERE technologies into the electricity grid and other energy infrastructure is a major component in providing reliable, safe, and cost-effective power across the country. The unique, national capability available at ESIF will allow scientists and engineers from the private and public sector to conduct critical research, development, testing and validation that would otherwise not be afforded by one organization. Extending these capabilities to external energy stakeholders through partnerships will create a synergistic intellectual exchange and create a U.S. world-leading knowledge base while providing the risk mitigation that will aid equipment providers, utilities, public utility commissions, legislative bodies and other entities modernizing the nation's electricity grid and related infrastructure.

Explanation of Funding Changes

(dollars in thousands)

	FY 2012 Current	FY 2014 Request	FY 2014 Request vs. FY 2012 Current
Energy Systems Integration Facility — Establishment of a direct funding line for ESIF operations as directed by Congress.	0	20,000	+20,000
Total, Facility Management	0	20,000	+20,000

Funding Schedule

Fiscal Year	Activity	Funding (dollars in thousands)
FY 2012	No funding requested.	0
FY 2013	No funding requested.	–
FY 2014	Launch Initial ESIF user program. Core ESIF operating costs including labor, utilities, general operating costs, etc.	20,000

Supporting Information

Capital Operating Expenses

Capital Operating Expenses Summary

(dollars in thousands)

	FY 2012 Current	FY 2013 Annualized CR**	FY 2014 Request
Capital Equipment > $500K (including Major Items of Equipment (MIE))	3,794	—	3,600
General Plant Projects (GPP) (< $10M)	10,810	—	7,800
Accelerator Improvement Projects (AIP) (< $5M)	0,000	—	0,000
Total, Capital Operating Expenses	14,604	—	11,400

Capital Equipment > $500K (including MIE)

(dollars in thousands)

	Total	Prior Years	FY 2012 Current	FY 2013 Annualized CR**	FY 2014 Request
Total Non-MIE Capital Equipment (>$500K)	0	0	3,794	—	3,600
Total, Capital Equipment (including MIE)			3,794	—	3,600

General Plant Projects (GPP) (TEC < $10M)

(dollars in thousands)

	Total	Prior Years	FY 2012 Current	FY 2013 Annualized CR**	FY 2014 Request
Total GPP (TEC > $5M)	0	0	10,810	—	11,400
Total, GPP (TEC < $10M)			10,810	—	11,400

Accelerator Improvement Projects (AIP) (TEC < $5M)

(dollars in thousands)

	Total	Prior Years	FY 2012 Current	FY 2013 Annualized CR	FY 2014 Request
No AIP Planned	0,000	0,000	0,000	0,000	0,000
Total, AIP			0,000	0,000	0,000

Construction Projects Summary

Construction Projects

(dollars in thousands)

	Total	Prior Years	FY 2012 Current	FY 2013 Annualized CR**	FY 2014 Request
Project Number 08-EE-01, Energy Systems Integration Laboratory, and NREL					
TEC	132,018	132,018	0	0	0
Other Projected Cost (OPC)	2,982	2,982	0	0	0
Total Project Cost (TPC), Project Number 08-EE-01	135,000	135,000	0	0	0
Total All Construction Projects					
Total Estimated Cost (TEC)	132,018	132,018	0	0	0
Total OPC	2,982	2,982	0	0	0
TPC, All Construction Projects	135,000	135,000	0	0	0

Outyears Construction Projects

(dollars in thousands)

	FY 2015 Request	FY 2016 Request	FY 2017 Request	FY 2018 Request	Outyears to Completion
No Projects Currently Planned					
TEC	0	0	0	0	0
OPC*	0	0	0	0	0
TPC	0	0	0	0	0
Total Construction All Projects					
Total TEC	0	0	0	0	0
Total OPC	0	0	0	0	0
TPC, All Construction Project	0	0	0	0	0

*Indicates a project where the cost of the Conceptual Design Report (CDR) is estimated to exceed $3M.
** FY 2013 amounts shown reflect the P.L. 112 175 continuing resolution level annualized to a full year. These amounts are shown only at the "congressional control" level and above; below that level, a dash (—) is shown.

Construction Project Data Sheets: For each project listed above which requests TEC funding in the budget year, attach a Construction Project Data Sheet (PDS). All funding in each PDS must match the amounts shown in the tables above.

Other Supporting Information

Scientific User Facility Operations

(dollars in thousands)

	FY 2012	FY 2013 Annualized CR	FY 2014 Request
Energy Systems Integration Facility	0	0	20,000
Total, National Renewable Energy Laboratory	0	0	20,000
Total, Scientific User Facility Operations	0	0	20,000

Facilities Users and Hours

	FY 2012	FY 2013	FY 2014
NREL			
Energy Systems Integration Facility			
Achieved Operating Hours	0	0	0*
Planned Operating Hours	0	0	0*
Optimal Hours	0	0	0*
Percent of Optimal Hours	0	0	0*
Unscheduled Downtown	0	0	0*
Number of Users	0	0	0*
Total, All Facilities	0	0	0*
Achieved Operating Hours	0	0	0*
Planned Operating Hours	0	0	0*
Optimal Hours	0	0	0*
Percent of Optimal Hours	0	0	0*
Unscheduled Downtime	0	0	0*
Number of Users	0	0	0*

Scientific Employment

	FY 2012 Actual	FY 2013 Estimate	FY 2014 Estimate
# of University Grants	0	0	0*
Average Size per year	0	0	0*
# Permanent Ph.D.'s (FTEs)	0	0	0*
# Postdoctoral Associates (FTEs)	0	0	0*
# Graduate Students (FTEs)	0	0	0*

*NOTE: The Energy Systems Integration Facility (ESIF) is currently in the final stages of construction and is seeking 'User Facility' designation in time for the beginning of FY 2014. NREL is capturing operational costs and developing its operations model for the ESIF. Once the information for Facilities Users and Hours and Scientific Employment are available for the ESIF, the data will be populated in the above tables.

Electricity Delivery and Energy Reliability

Electricity Delivery and Energy Reliability

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Electricity Delivery and Energy Reliability

Proposed Appropriation Language

For Department of Energy expenses including the purchase, construction, and acquisition of plant and capital equipment, and other expenses necessary for electricity delivery and energy reliability activities in carrying out the purposes of the Department of Energy Organization Act (42 U.S.C. 7101 et seq.), including the acquisition or condemnation of any real property or any facility or for plant or facility acquisition, construction, or expansion, $169,015,000, to remain available until expended: Provided, That $27,615,000 shall be available until September 30, 2015 for program direction.

Explanation of Change

No change

Office of Electricity Delivery and Energy Reliability

Overview
Appropriation Summary by Program

(Dollars in Thousands)

	FY 2012 Current	FY 2013 Annualized CR	FY 2014 Request
Electricity Delivery and Energy Reliability			
Clean Energy Transmission and Reliability	24,665	25,569	32,000
Smart Grid	23,203	24,055	14,400
Energy Storage	19,336	20,046	15,000
Cybersecurity for Energy Delivery Systems	29,007	30,072	38,000
Electricity Systems Hub	0	0	20,000
National Electricity Delivery[a]	6,976	7,019	6,000
Infrastructure Security and Energy Restoration	5,981	6,018	16,000
Program Direction	27,010	27,175	27,615
Total, Electricity Delivery and Energy Reliability	136,178	139,954	169,015

[a] The National Electricity Delivery program was previously known as Permitting, Siting, and Analysis and has been renamed to reflect OE's new organizational structure.

*SBIR/STTR:

- FY 2012 Transferred: SBIR: $2,587; STTR: $348
- FY 2013 Annualized CR: SBIR: $2,693; STTR: $349
- FY 2014 Request: SBIR $3,091: STTR: $442

Office Overview and Accomplishments

The Office of Electricity Delivery and Energy Reliability (OE) drives electric grid modernization and resiliency in the energy infrastructure through research, partnerships, facilitation, modeling and analytics, and emergency preparedness. OE serves as the Federal government's energy sector-specific lead in responding to energy security emergencies, both physical and cyber.

A modernized power system is critical to meeting the nation's energy, environmental, and security goals. In support of these goals, OE pursues activities to improve the following four key characteristics, which together describe a modern grid:

- *Reliability* – high quality , consistent power flow;
- *Flexibility* – the ability to accommodate changing supply and demand patterns and technologies;
- *Efficiency* – delivery of electricity with reduced losses and greater asset utilization rates; and
- *Resiliency* – the ability to withstand and quickly recover from disruptions and maintain critical function.

Reliable, affordable, efficient, and secure electric power delivery is fundamental for the information age, it is necessary for expanding the economic recovery and enabling the transition to low-carbon energy sources. Over the next several decades, the U.S. electric power industry must modernize in order to address three critical challenges simultaneously:

- Meeting demand changes for electricity driven by growth in population, adoption of energy efficient technologies, changing economic output, and electrification, including possible mass-markets for electric vehicles;
- Integrating a new class of clean energy resources into the nation's generation portfolio, including centralized and distributed renewables, advanced nuclear energy, natural gas, and coal with carbon-capture; and providing access to loads and markets, and
- Increasing resilience in the energy sector through diversified resources, faster and more secure

controls, improved situational awareness, and advanced mitigation and recovery strategies.

If the grid does not modernize, it could become a barrier to the adoption of cleaner energy supplies and more energy-efficient demand-side measures; opportunities for innovation and entrepreneurship would be lost in the electricity sector; and sectors that depend on electricity – such as telecommunications, banking and finance, water, and public health and safety – would be left vulnerable. Moreover, the Nation's energy aspirations – from clean energy to energy efficiency to transport electrification – depend on the ability to modernize the grid by overcoming technical challenges while understanding the implications from existing legal, market, and policy arrangements that affect the grid.

OE is leading the development of "next generation" grid technologies, tools, and techniques; working with stakeholders to support deployment of these systems amidst a variety of policy and regulatory structures; and enhancing the security of the nation's energy infrastructure essential to achieving national energy, economic, and environmental goals.

More active grid control and security provides significant capabilities needed for a modern grid. These capabilities will require advances in data, communications, modeling, sensing, power electronics, and storage technologies. It also will require understanding of human behavior as consumers become more involved in energy systems through technology. For example, smart meters hold the promise that timely information will change energy use patterns, but well designed apps (like those developed through the OE–led Green Button Data Initiative) are critical to make energy data more accessible and informative.

The Department's Quadrennial Technology Review (QTR) recognized the value of an appropriate balance between new research that generates next-generation technologies, and analyses, modeling and simulation that is needed in the nearer term. In that vein, OE maintains a core analytic, assessment, and engineering capability that can evolve as the technology and policy needs mature. OE also supports the findings of the President's Council of Advisors on Science and Technology calling for long term research to develop advanced grid monitoring, diagnostics, data mining techniques and new algorithms, and resistance to cyber attack.

Within the appropriation, OE funds:

- *Research and Development* – pursues technologies that improve grid reliability, efficiency, flexibility, functionality and security; investments and demonstrations are aimed at bringing new and innovative technologies to maturity and helping them transition to market;
- *Coordination of Federal Transmission Permits, and Technical Assistance* – streamlines permits, special use authorizations, and other approvals required under Federal law to site electric transmission facilities; and provides technical assistance to states and regions to improve policies, utility incentives, state laws, and programs that facilitate the modernization of the electric infrastructure; and
- *Emergency Response and Restoration* – enhances the reliability, survivability and resiliency of energy infrastructure, and facilitates recovery from disruptions to energy supply.

In the prior year, OE accomplishments include:

- Developed several advanced technologies and tools to enhance cybersecurity in energy delivery systems, including an advanced intrusion protection system for control system networks and the Electricity Subsector Cybersecurity Capability Maturity Model to help electric utilities and grid operators assess their cybersecurity capabilities and prioritize actions and investments.
- With the Electric Power Research Institute, completed study and strategy on the deployment of additional geomagnetic induced current (GIC) sensors in strategic locations across North America to provide information and real-time monitoring during solar storms.
- Assisted state utility commissions to quantitatively evaluate electric utility financial impacts under different energy efficiency scenarios, and to better integrate variable generation, such as wind and solar, into the electricity grid.

Explanation of Changes

The Department's request of $169 million for OE in FY 2014 is an increase of $33 million (24%) from the FY 2012 current appropriation. This increase highlights the Administration's continued commitment to modernizing the electric grid, which is critical to transforming the nation's energy system and enabling clean energy technologies.

Recognizing the Department is currently not fully equipped to respond to the new challenges that stronger, more destructive storms like the most recent Hurricane Sandy and other natural and man-made threats present, the FY 2014 request lays the foundation to develop an enhanced capability that will enable the Department to better protect and mitigate these threats and hazards, with the ultimate goal of quicker recovery between industry and the communities they serve. To meet these challenges, the FY 2014 request provides $16 million, an increase of $10 million, for a new Operational Energy and Resilience subprogram in the **Infrastructure Security and Energy Restoration** program.

The 2014 request provides $38 million for **Cyber Security for Energy Delivery Systems** to enhance protection of the Nation's energy infrastructure against cyber threats, an increase of $9 million from FY 2012. The increase supports efforts to enhance situational awareness and improve capabilities to manage cybersecurity risks in the energy sector and expands efforts to improve cybersecurity technologies for control systems used in energy critical infrastructure.

The FY 2014 request emphasizes activities to enhance transmission reliability, including $32 million for **Clean Energy Transmission and Reliability**, an increase of $7.3 million from FY 2012. The increase accelerates efforts to develop applications and tools to move towards real-time assessment of transmission system health, and activities to facilitate data standardization and data exchange to strengthen planning and operational decisions. It also includes a new subprogram line, Energy Systems Predictive Capability to develop simulations and predictive analytic tools that can provide real time situational awareness to assist Federal, State and local agencies during energy supply disruptions such as electricity and fuel outages.

The request provides $20 million for the **Electricity Systems Hub**, a multi-disciplinary approach to addressing challenges to grid modernization and accelerating grid innovation.

OE Establishes a New Organizational Structure

As a response to heightened visibility and growing scope and demands, OE put a new organizational structure in place in late 2012 that will enable OE to become more nimble, strategic, and innovative in an increasingly complex and rapidly-changing environment. The reorganization created opportunities for OE to rebalance workloads, improve communications, offer more growth opportunities, and better deliver high-quality products and services to the Nation. The new Divisions include:

- *Power Systems Engineering R&D* – PSE R&D Division is responsible for the development and management of projects for "next generation" electricity delivery technologies and supporting activities to accelerate their introduction to the marketplace. PSE R&D manages funding in Cybersecurity for Energy Delivery Systems, Smart Grid Research and Development, and the Energy Storage programs.
- *National Electricity Delivery* –The NED Division's scope of responsibilities is the same as the Division formerly called Permitting, Siting, and Analysis. NED provides technical assistance to states, regional entities, and tribes to help them develop and improve their programs, policies, and laws that will facilitate the development of reliable and affordable electricity infrastructure. It also authorizes the export of electricity, issues permits for the construction of cross-border transmission lines, and is leading efforts to improve the coordination of Federal transmission permitting on Federal lands.
- *Energy Infrastructure Modeling and Analysis* – The EIMA Division includes electric system and environmental modeling, synchrophasor-based tool development, transmission reliability research, reliability assessments, energy security modeling and visualization, and energy infrastructure risk analyses. EIMA manages funds primarily in the Clean Energy Transmission and Reliability program.
- *Infrastructure Security and Energy Restoration* –ISER Division leads efforts for securing the U.S. energy infrastructure against all hazards, reducing the impact of disruptive events, and responding to and facilitating recovery from energy disruptions, in collaboration with all levels of industry and State and local governments. The ISER division's scope of responsibilities remain the same under the new organization.
- *Smart Grid Investment Program* – This new Division leads OE's grid modernization through advanced grid integration concepts by fostering the deployment of smart grid technologies. It manages the smart grid

investment projects funded by the American Recovery and Reinvestment Act (ARRA) and advances smart grid interoperability and cybersecurity through standards, information exchange, and products that increase the efficiency and effectiveness of grid modernization investments. Its activities are primarily funded through previously obligated ARRA funds.

Protection of the nation's electric grid and energy infrastructure from cyber threats remains a strategic priority across the organization, reflecting OE's view that cybersecurity must be built into technology from the beginning and be a crucial element at all stages, including the culture, operations, and strategy of the energy sector. The reorganization reinforces the critical importance of this area, with a clear, consistent focus on cybersecurity integrated seamlessly throughout OE.

Alignment to Strategic Plan

A modern electric power system is fundamental to achieving many of the long-term goals outlined in the Department's May 2011 Strategic Plan. OE activities directly support the strategy to *Modernize the Electric Grid*, within the goal to *Transform our Energy Systems*.

OE's mission supports the Secretary's goal to *Catalyze the timely, material, and efficient transformation of the nation's energy system and secure U.S. leadership in clean energy technologies.* OE has established five inter-related and interdependent strategic goals that inform program investment:

1. Enhance **grid flexibility** to incorporate a variety of energy sources, including large amounts of variable and distributed energy resources

2. **Maintain reliability** by developing real-time situational awareness to improve grid operations

3. Build **system-level understanding** needed for innovative approaches to technology and regional planning

4. Promote regulatory structures and develop technologies that encourage **efficiency in electricity markets and operations**

5. **Secure energy systems and assets** against threats and facilitate rapid recovery from disruptions to electricity supply (resiliency)

Highlight on OE's Research and Development Activities

Goal-Subprogram Alignment Summary

	1. Flexibility	2. Reliability	3. System Under-standing	4. Efficient Markets	5. Security
Office of Electricity Delivery and Energy Reliability					
Clean Energy Transmission and Reliability	15%	45%	25%	10%	5%
Smart Grid Research and Development	40%	20%	25%	5%	10%
Electricity Systems Hub	20%	15%	50%	10%	5%
Cyber Security for Energy Delivery Systems	0%	20%	10%	0%	70%
Energy Storage	50%	50%	0%	0%	0%
National Electricity Delivery	10%	10%	30%	50%	0%
Infrastructure Security and Energy Restoration	0%	10%	15%	0%	75%
Program Direction	20%	25%	20%	10%	25%
Total, Electricity Delivery and Energy Reliability	17%	26%	21%	7%	29%

OE's research and development activities are managed through five programs. Clean Energy Transmission and Reliability focuses on grid modernization technologies at the transmission level, while Smart Grid primarily focuses on technologies needed at the distribution level. The Energy Storage program is developing a transformative capability that benefits the entire grid, and the Cybersecurity for Energy Delivery Systems program supports technologies that are critical for system wide security and resiliency. The Electricity Systems Hub targets challenges at the interface between transmission and distribution to enable seamless connectivity and system wide interoperability.

	(Dollars in Thousands) FY 2014 Request
Clean Energy Transmission and Reliability*	28,000
Smart Grid	14,400
Energy Storage	15,000
Cybersecurity for Energy Delivery Systems*	33,000
Electricity Systems Hub	20,000
Total	**110,400**

** These OE program lines also include activities that are not typically considered research and development.*

OE research programs are aligned with the Department's strategy to modernize the grid and are critical to the Department's goal of transforming our energy systems. In partnership with industry, academia, and government, OE develops advanced technologies and capabilities to enhance the reliability, flexibility, efficiency, and resiliency of the Nation's electric power delivery system. These efforts promote scientific innovation, and leverage the investments of other DOE offices, including the Offices of Science, Energy Efficiency and Renewable Energy, and ARPA-E. OE also leverages investments from other Federal agencies such as the National Science Foundation, the Department of Defense, the National Institute of Standards and Technology, and the Department of Homeland Security.

OE is focusing efforts to enable the utilization of data from smart meters and phasor measurements units (deployed through the American Recovery and Reinvestment Act) to provide unprecedented visibility and situational awareness of the grid, leading to more efficient system operations and faster restoration times. New tools and improved modeling and simulation capabilities support efficient use of assets, increases reliability and resiliency amidst changes in supply mix, electricity demand, and threats to grid security, and facilitates system planning and operations with growing complexities in electricity markets and new technologies. Advances in computational capabilities and controls are also needed to achieve the benefits of a smarter grid.

Overcoming integration challenges within and between the transmission and distribution systems are necessary for seamless grid modernization and allowing diverse players, such as customers and microgrids, to participate in electricity markets. OE also plays an important role in developing the technologies and capabilities to help the electric industry become more secure and resilient to cyber threats as the grid modernizes.

A modern electric power system provides the necessary infrastructure to maintain reliability, enable the adoption of diverse energy supplies (centralized and distributed), and foster the use of energy-efficient demand-side technologies. Without prudent investments, the electric system could become a major barrier to (rather than an asset towards) securing America's clean energy future. OE provides national leadership by addressing these technical challenges in a holistic and comprehensive manner.

Strategic Plan and Performance Measures

Performance Goal (Measure)	**Energy Storage** - Lower the cost of grid-scale (>1 mw) energy storage technologies. Note: this is the same measure used in FY2011 but is now expressed in kilowatt hours (kWh).		
Fiscal Year	**2012**	**2013***	**2014**
Target	560 $/kWh for a 4 hour system	475 $/kWh	400 $/kWh
Result	Met		
Endpoint Target	By 2020 improve cost-benefit ratio of storage to compete with current peak generation resources and increase commercial use of grid scale storage to buffer renewable to 5%.		

Please see Annual Performance Plan/Report (APPR) for a full list of measures and targets.
*2013 targets represent DOE's FY 2013 Budget Request to Congress. FY 2013 target updates can be found in the upcoming FY 2012-2014 Annual Performance Plan & Report.

Performance Goal (Measure)	**Cyber Security** - Demonstrate new protective measures to reduce risks from cyber incidents.		
Fiscal Year	**2012**	**2013***	**2014**
Target	Conduct a power system control component study	Demonstrate control component capability for substation control systems	Demonstrate tool that designs-in enhanced communications security for 1 substation control system component
Result	Met		
Endpoint Target	By 2020, resilient energy systems are designed, installed, operated and maintained to survive a cyber incident while sustaining critical functions.		

Please see Annual Performance Plan/Report (APPR) for a full list of measures and targets.
*2013 targets represent DOE's FY 2013 Budget Request to Congress. FY 2013 target updates can be found in the upcoming FY 2012-2014 Annual Performance Plan & Report.

Small Business Innovation Research/Small Business Technology Transfer (SBIR/STTR)

(Dollars in Thousands)

	FY 2012 Current	FY 2013 Annualized CR	FY 2014 Request
Office of Electricity Delivery and Energy Reliability			
Clean Energy Transmission and Reliability	752	780	896
Smart Grid	708	734	461
Electricity Systems Hub	0	0	640
Cyber Security for Energy Delivery Systems	885	917	1,056
Energy Storage	590	611	480
Total, SBIR/STTR	2,935	3,042	3,533

Office of Electricity Delivery and Energy Reliability
Funding by Site by Program

	(Dollars in Thousands)		
	FY 2012 Current	FY 2013 Annualized CR	FY 2014 Request
Argonne National Laboratory			
Clean Energy Transmission and Reliability	1,050	1,300	1,000
Smart Grid	300	610	200
Cybersecurity for Energy Delivery Systems	213	0	200
Total, Argonne National Laboratory	1,563	1,910	1,400
Chicago Operations Office			
Smart Grid	45	0	0
Total, Chicago Operations Office	45	0	0
Idaho National Laboratory			
Smart Grid	100	100	0
Cybersecurity for Energy Delivery Systems	4,673	350	1,925
Total, Idaho National Laboratory	4,773	450	1,925
Lawrence Berkeley National Laboratory			
Clean Energy Transmission and Reliability	4,723	4,912	4,800
Smart Grid	1,020	500	700
Cybersecurity for Energy Delivery Systems	0	200	200
National Energy Delivery	3,000	2,275	3,000
Total, Lawrence Berkeley National Laboratory	8,743	7,887	8,700
Lawrence Livermore National Laboratory			
Clean Energy Transmission and Reliability	0	200	0
Infrastructure Security and Energy Restoration	200	175	125
Total, Lawrence Livermore National Laboratory	200	375	125
Los Alamos National Laboratory			
Clean Energy Transmission and Reliability	0	2,000	1,000
Smart Grid	400	345	250

	(Dollars in Thousands)		
	FY 2012 Current	FY 2013 Annualized CR	FY 2014 Request
Cybersecurity for Energy Delivery Systems	400	200	200
Total, Los Alamos National Laboratory	800	2,545	1,450
National Energy Technology Laboratory			
Clean Energy Transmission and Reliability	9,482	2,050	9,500
Smart Grid	7,378	13,903	5,250
Cybersecurity for Energy Delivery Systems	9,499	25,665	27,185
National Energy Delivery	1,250	1,000	1,000
Infrastructure Security and Energy Restoration	702	27	77
Program Direction	7,216	7,579	6,938
Total, National Energy Technology Laboratory	35,527	50,224	49,950
National Renewable Energy Laboratory			
Clean Energy Transmission and Reliability	400	1,125	500
Smart Grid	2,620	225	1,700
National Energy Delivery	775	825	1,000
Total, National Renewable Energy Laboratory	3,795	2,175	3,200
Oak Ridge Institute for Science & Education			
Program Direction	740	0	0
Total, Oak Ridge Institute for Science & Education	740	0	0
Oak Ridge National Laboratory			
Clean Energy Transmission and Reliability	1743	2,350	2,500
Smart Grid	3355	700	1,200
Cybersecurity for Energy Delivery Systems	5096	275	1,350
Energy Storage	1428	1,900	1,000
National Energy Delivery	243	325	300
Total, Oak Ridge National Laboratory	11865	5,550	6,350
Pacific Northwest National Laboratory			
Clean Energy Transmission and Reliability	4,550	5,425	3,250
Smart Grid	4,430	2,260	3,000
Cybersecurity for Energy Delivery Systems	6,558	856	1,500

	(Dollars in Thousands)		
	FY 2012 Current	FY 2013 Annualized CR	FY 2014 Request
Energy Storage	6,000	7,698	5,500
Infrastructure Security and Energy Restoration	775	500	575
Total, Pacific Northwest National Laboratory	22,313	16,739	13,825
Richland Operations Office			
Infrastructure Security and Energy Restoration	1,350	2,005	1,370
Total, Richland Operations Office	1,350	2,005	1,370
Sandia National Laboratory			
Clean Energy Transmission and Reliability	300	300	0
Smart Grid	2,490	1,156	1,100
Cybersecurity for Energy Delivery Systems	687	0	1,000
Energy Storage	11,680	10,448	8,350
Infrastructure Security and Energy Restoration	150	150	225
Total, Sandia National Laboratory	15,307	12,054	10,675
Washington Headquarters			
Clean Energy Transmission and Reliability	2,417	5,907	9,450
Smart Grid	1,066	4,256	1,000
Cybersecurity for Energy Delivery Systems	1,881	2,526	4,440
Energy Storage	227	0	150
Electricity Systems Hub	0	0	20,000
National Energy Delivery	1,708	2,594	700
Infrastructure Security and Energy Restoration	2,804	3,161	13,628
Program Direction	19,054	19,596	20,677
Total, Washington Headquarters	29,157	38,040	70,045
Total, Electricity Delivery and Energy Reliability	136,178	139,954	169,015

Clean Energy Transmission and Reliability
Funding Profile by Activity

(Dollars in Thousands)

	FY 2012 Current	FY 2013 Annualized CR*	FY 2014 Request
Clean Energy Transmission and Reliability			
Transmission Reliability and Renewables Integration	15,482	---	18,000
Advanced Modeling Grid Research	9,183	---	10,000
Energy Systems Predictive Capability	0	---	4,000
Total, Clean Energy Transmission and Reliability	24,665	25,569	32,000

*FY 2013 amounts shown reflect the P.L. 112 175 continuing resolution level annualized to a full year. These amounts are shown only at the "congressional control" level and above; below that level a dash (—) is shown.

*SBIR/STTR:

- FY 2012 Transferred: SBIR: $663; STTR: $89
- FY 2013 Annualized CR: SBIR: $690; STTR: $89
- FY 2014 Request: SBIR $896: STTR: $128

Public Law Authorizations

Public Law 95–91, "Department of Energy Organization Act", 1977
Public Law 102-486, "Energy Policy Act, 1992"
Public Law 109-58, "Energy Policy Act, 2005"
Public Law 110-140, "Energy Independence and Security Act , 2007

Program Overview and Benefits

In supporting the Secretary's goal of *Energy: Build a competitive, low-carbon economy and secure America's Energy Future*, the Clean Energy Transmission and Reliability (CETR) Program supports the modernization of the electric grid and the reliability of interdependent energy systems.

The mission of the CETR program is focused on modeling and analysis to achieve the goals of enhanced reliability and resiliency of U.S. energy systems. The CETR program builds utility-level applications and controls to increase the reliability of the Nation's electricity infrastructure and enable a modernized grid. Predictive modeling and analysis capabilities will improve emergency response efforts at the state and Federal levels, as well as better inform grid modernization. Recent events, such as Superstorm Sandy, have reinforced the urgent need for a reliable and robust Federal analytical ability to not only help emergency responders but enhance predictive capabilities to identify at-risk assets in advance of events.

The CETR program develops advanced monitoring, modeling, analytical decision support, and control applications to reliably operate the electric system, fed by real-time data collected by synchrophasors as well as various other measurement networks (e.g. advanced metering infrastructure; supervisory control and data acquisition). CETR's activities also include reliability assessments, risk and interdependent systems analyses, modeling and visualization of energy infrastructure, predicting impacts on the energy infrastructure, and providing mitigating solutions for resilient approaches to energy assurance.

CETR is managed by the Energy Infrastructure Modeling and Analysis Division under the new OE reorganization.

To realize the full benefits of a modern electric system, the CETR subprogram within OE addresses current industry challenges of:

- Sharing real-time data and development of high-fidelity system models to support wide area visualization, analysis and assessment
- Performing predictive analysis to identify reliability concerns in advance of occurrence and improve resiliency of the overall system
- Addressing operational uncertainties associated with the evolving characteristics of generation, delivery system, and load
- Understanding energy infrastructure interdependencies and cyber-physical relationships
- Accelerating and enhancing operator tools to detect and respond to system dynamics

The FY 2014 request includes support for existing programs under CETR, including funding for the Transmission Reliability and Renewables Integration subprogram and the Advanced Modeling Grid Research subprogram. It also includes a request for a new subprogram, Energy Systems Predictive Capability, to better highlight expanded analytic efforts that include reliability assessments, energy security modeling and visualization, and energy infrastructure risk analyses.

Program Accomplishments and Milestones

FY 2012 Clean Energy Transmission and Reliability program accomplishments included:

- Demonstrated a distributed dynamic state estimator at two utility locations that uses synchronized measurements to monitor the state of the grid in seconds rather than minutes.
- Made competitive awards to 5 projects for advanced computational techniques that would achieve "faster than real-time" dynamic simulation capabilities, improving reliability through enhanced system stability.

Milestones	Date
• Develop framework for Advanced Grid Modeling research efforts, such as online stability analysis	Q3 FY13
• Finalize NASPI research plan and roadmap to support SGIG synchrophasor projects	Q4 FY13
• Conduct a competitive solicitation that enables university/electricity industry partnerships to conduct research using synchrophasor data collected from utility distribution systems	Q4 FY13
• Achieve the ability to provide near real-time analysis of current and future events that could impact energy reliability.	Q4 FY14

Program Planning and Management

The Program will implement two key strategies to more efficiently and effectively manage the program:

1. Engage industry, vendors and university partners through competitive solicitations to achieve reliability and resiliency objectives
2. Leverage the breadth of energy industry knowledge as well as Federal, state, and local agency expertise, while respecting the regional and institutional diversity.

Two external factors present the strongest impacts to the overall achievement of the program's strategic goal:

1. Resolution of agreements for sharing real-time data among utilities and with researchers in a way that limits liability and preserves market integrity
2. Development of power systems expertise to position university collaborations as engines of innovation that could solve the challenges identified by industry.

Program Goals and Funding

In support of Office and Departmental goals, the Clean Energy Transmission and Reliability program uses five strategic goals to inform program investment:

1. Enhance grid flexibility to incorporate a variety of energy sources and responsive loads, including large amounts of variable and distributed energy resources
2. Maintain reliability by developing real-time monitoring, control and protection to improve grid operations
3. Build system-level understanding needed for innovative approaches to technology and regional planning
4. Promote regulatory structures that encourage efficiency in electricity markets.
5. Secure energy systems and assets against cyber and physical threat

Goal Areas

	1. Flexibility	2. Reliability	3. System Understanding	4. Efficient Markets	5. Security
Clean Energy Transmission and Reliability	15%	45%	25%	10%	5%

Explanation of Funding and Program Changes

(Dollars in Thousands)

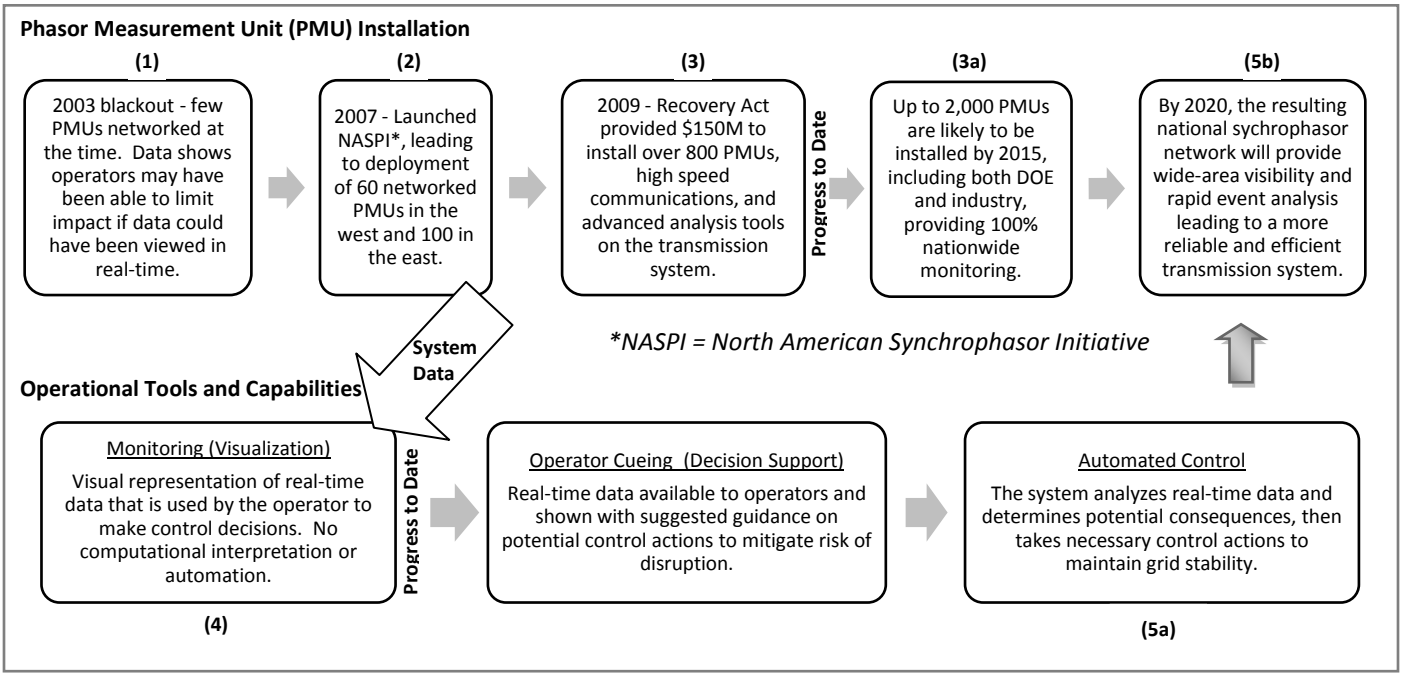
	FY 2012 Current	FY 2014 Request	FY 2014 Request vs FY 2012 Current
Transmission Reliability and Renewables Integration			
Increase accelerates synchrophasor applications demonstrated in FY 2013 into pre-commercial products, as well as supports efforts to facilitate data exchange standardization.	15,482	18,000	+2,518
Advanced Modeling Grid Research			
No change. Increase reflects SBIR/STTR transferred in FY 2012 Current Appropriation.	9,183	10,000	+817
Energy Systems Predictive Capability			
Increase supports analytic efforts that include reliability assessments, energy systems modeling and visualization, and energy infrastructure risk analyses including development of a modeling and analysis capability to assist in assessing the risk and reliability of energy assets. Establishes new activity line to highlight increased efforts.	-	4,000	+4,000
TOTAL, Clean Energy Transmission and Reliability	24,665	32,000	+7,335

Transmission Reliability and Renewables Integration

The Transmission Reliability and Renewables Integration (TRRI) subprogram supports partnerships between DOE national laboratories, universities and the electricity industry to develop and deploy advanced technologies that enhance the reliability of the Nation's electric transmission infrastructure. Competition and market forces (at the wholesale level) are increasing the volume of power transactions exponentially. In addition, supply transformation (driven by coal plant retirements, abundant, low-cost natural gas, and integration of large wind plants) is causing the grid to be used in ways for which it was not designed. Time synchronized measurements from advanced sensors installed on the transmission system, known as phasor measurement units (PMUs) or synchrophasors, can monitor the flow of electricity with much greater precision and provide unprecedented insight and information on system health. This activity funds the development of synchrophasor data applications which are cyber secure and can be used to enhance the flexibility and reliability of the Nation's power system.

In FY 2014, OE will accelerate the development and deployment of synchrophasor-based cyber-protected applications that were demonstrated on utility systems in FY 2013 that will now become operational, real- time systems installed in grid operator control rooms. These applications will monitor and control the grid with advanced analysis, visualization and decision-support tools. Acceleration of the development of applications is driven in part by the deployment of PMUs funded by the American Recovery and Reinvestment. These applications will help maximize the value of the data to grid operators to improve reliability.

In addition, OE will focus on the issue of data exchange between entities to ensure seamless (cyber resilient) operations and operations planning. Although there is some real time data exchange today between some neighboring utilities, this is not done consistently and uniformly across interconnections. Moreover, the data exchanged is often not in a form that can be processed by neighbors' applications. This effort will enable neighboring utilities to exchange not only raw SCADA or synchrophasor data but also processed data like state estimation and contingency results.



As illustrated above, the 2003 Northeast blackout (1), and subsequent review and report, made clear the need for real-time situational awareness of grid conditions at a system level. This need was reinforced by events that led to the 2011 Southwest blackout. Following the 2003 Northeast blackout report and findings, DOE and NERC joined with North American electric utilities, vendors and researchers to form the North American Synchrophasor Initiative (NASPI) with the goal of improv-

ing the reliability of the power system through wide-area measurement, analysis tools, and control. The collaborative has worked to deploy networked phasor measurement units and visualization tools nationwide (2). Funding from the Recovery Act accelerated this process, with over 800 additional units planned for deployment by the end of 2013 (3).

As data has become available from the networked PMUs, the TRRI program has accelerated the development of advanced operational tools that detect and track grid dynamics and provide system operators with better monitoring through real-time visualization (4). These capabilities will continue to improve over time as more data is collected to feed advanced visualization for operator decision support tools in 2016, quickly leading to fully automated system control capabilities (5a), full system visibility (5b), and decreases in both the spread and duration of system outages by 2020.

Benefits

- Enhances sensing of and response to actual grid conditions (rather than reliance on conservative off-line studies) to allow the transmission system to operate closer to its load limits, reduce operating margins and system congestion, and increase utilization of existing transmission corridors and assets
- Enables integration of transmission-level, variable generation (such as utility-scale solar and wind) into routine operation of the power system, thereby helping to maintain reliability
- Improves situational awareness for faster identification and response to deteriorating or abnormal grid conditions, improved reliability, reduced number and spread of blackouts, and faster restoration of power following blackouts

Other Information

"Real Time Application of Synchrophasors for Improving Reliability." NERC report.
http://www.nerc.com/docs/oc/rapirtf/RAPIR%20final%20101710.pdf

Funding and Activity Schedule

Fiscal Year	Activity	Funding (Dollars in Thousands)
FY 2012	• Continued development of a prototype adaptive protective relaying approach based on high-speed synchrophasor data at two substations in California. • Demonstrated a distributed dynamic state estimator at a utility location that uses synchronized measurements which measure the state of the grid in seconds rather than minutes. • Continued Investigation of the load profiles of individual demand response resources to quantify their capability in terms of timing and capacity to respond to grid efficiency and reliability needs. • Initiated dynamic analysis (on regional scale) under scenario of high penetration of variable generation	15,482
FY 2013	Planned activities in the FY 2013 Budget: • Demonstrate (through simulation studies) adaptive islanding in an interconnection that performs a controlled separation of the grid into smaller islands to improve protection from wide-area blackouts. • The DOE-developed NASPInet, for high-speed, secure and dependable transmittal of synchrophasor data, will demonstrate its speed and accuracy at grid control centers in the Western Interconnection. • Publish results of advanced research in protective relaying based on high-speed synchrophasor data to assess and, if necessary, establish new, corrected relay settings every few seconds to match system conditions.	---

Fiscal Year	Activity	Funding (Dollars in Thousands)
	• Coalesce load profile investigations from promising demand response sources (residential water heating, air conditioning, and electric vehicles, commercial building systems, industrial processes, etc.) and combine them into temporally-based virtual and flexible aggregated demand response "units". • Expand research on SuperOPF and Security-Constrained Unit Commitment for scenarios that include high penetrations of variable generation. • Continue regional, dynamic analysis studies (frequency response; voltage support/regulation; transients) to develop innovative system operational control approaches for scenarios. • Complete Western Electricity Coordinating Council-based-scenario balancing area study (in collaboration with EERE).	
FY 2014	• Complete a publish/subscribe network for NERC reliability coordinators and control area balancing authorities to exchange data with each other for complete and reliable wide-area visibility of the grid that was missing in the last three major U.S. blackouts. • Implement a wide-area, real-time visualization of system frequency, voltage and current contours for grid security monitoring, on-line identification of major events and event "instant" replay • Install a synchrophasor-based automatic, adaptive protection relay system that adjusts relays to respond to real-time system stress conditions • In collaboration with industry, establish a roadmap for consistent and compatible data exchange across regions	18,000

Advanced Modeling Grid Research

This subprogram will develop the computational, mathematical, and scientific understanding (for suitable application in a large-scale, dynamic environment) needed to transform the tools and algorithms that underpin electric system planning and operations. In achieving this goal, it will also foster strategic, university-based power systems research capabilities.

Integration of large amounts of variable generation, mass deployment of electric vehicles, and actively engaged end-users will greatly increase uncertainty in grid operations and planning. Decision tools to inform national scale electric grid expansion, regional system operation and electricity markets must be dramatically enhanced to overcome current computational limitations by using real-time measurements and better predictive modeling and simulations.

Over time, this subprogram will take scientific discoveries made in data management, mathematics, and advanced computation (e.g., through the Office of Science) and combine them with the real-time data and sensing from the Transmission Reliability program to improve grid reliability and functionality.

In FY 2014, Advanced Modeling Grid Research will leverage developments in parallelization and optimization solvers and initiate integration of these advancements into cyber-resilient power system software platforms (e.g. next-generation energy management systems; stability analysis tools).

Benefits

- Accelerate performance – improving grid resilience to fast time scale phenomena that drive cascading network failures and blackouts by developing dynamic state estimation and contingency analysis at a sub-second level based on SCADA and PMU data
- Enable predictive capability – relying on real-time measurements and improved models to represent with more fidelity the operational attributes of the electric system, enabling better prediction of system behavior and thus potentially reducing equipment redundancies needed to cover uncertainties

Other Information

"Computational Needs for the Next Generation Electric Grid." http://certs.lbl.gov/pdf/lbnl-5105e.pdf

Funding and Activity Schedule

Fiscal Year	Activity	Funding (Dollars in Thousands)
FY 2012	• Made awards through a competitive solicitation for research associated with "faster than real-time" simulations that improve understanding of system dynamics to help guide operational decision-making	9,183
FY 2013	Planned activities in the FY 2013 Budget: • Integrate fast state estimation and parallel contingency analysis approaches into operational tool(s) • Initiate algorithmic and computational research for "online" transient analysis	---
FY 2014	• Develop contingency screening methods to reduce computational complexity • Develop software repository for mathematical methods and solvers relevant to power system applications • Issue competitive solicitation supporting initial stage development of next-generation energy management system • Initiate human factors research (i.e. user/tool interface), critical to effective cueing	10,000

Fiscal Year	Activity	Funding (Dollars in Thousands)
	techniques and decision-making • Explore integration of energy infrastructure models over various spatial-temporal scales. (e.g., protection and controls; operations and planning; cyber and physical)	

Energy Systems Predictive Capability

Hurricane Sandy (and previous events such as Hurricanes Katrina and Rita), Mississippi floods, western Wildfires, ice storms, and recent cyber threats have reinforced the need for analytic products during high profile events that present the current status as well as the impact to the electric grid and critical energy assets. Simulations and predictive analytic tools are critically needed to provide real time situational awareness to assist Federal, State and local agencies in their coordination and response to energy supply disruptions such as electricity and fuel outages.

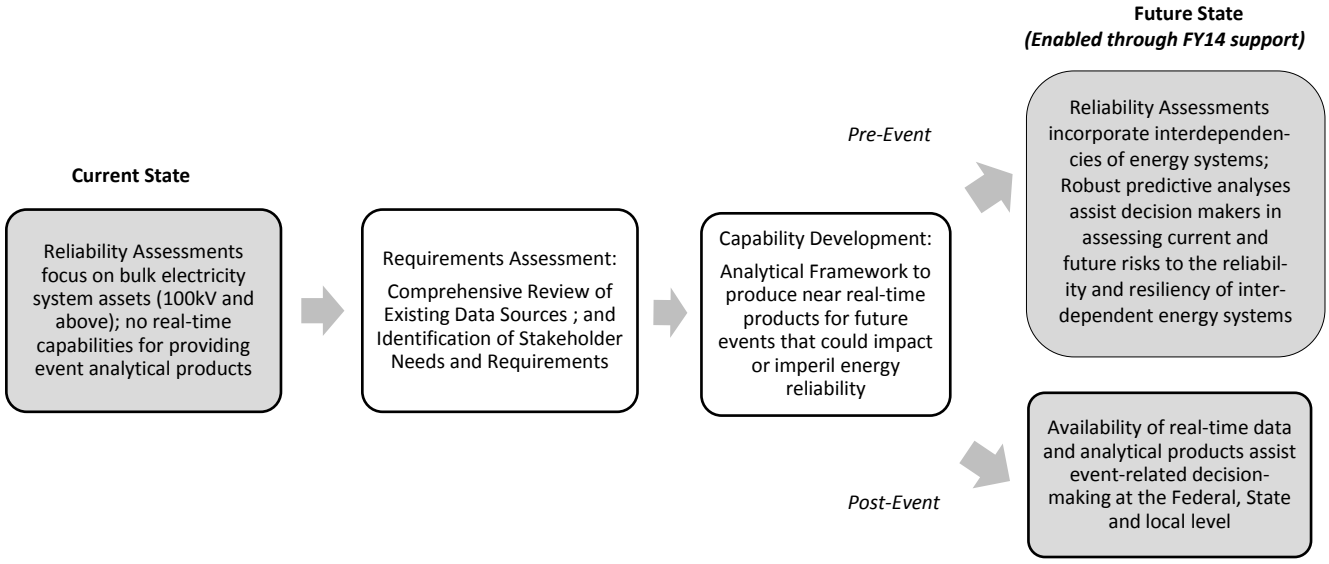
This subprogram will provide states, Federal agencies, and sector stakeholders with independent and transparent analyses of energy infrastructure systems and supply chain impacts.

Included will be a review and assessment of energy datasets (from both public and non-public sources), taxonomy, collection methodologies, and data base requirements. It will also include specification and development of tools to perform energy infrastructure analyses. Applications and simulation tools will be built to conduct geographical risk analyses and reliability assessments. The current visualization system will be expanded to display energy supply systems and will also incorporate risk analysis products.

The outcome will be a predictive capability that will provide robust analyses to assist decision makers in developing appropriate strategies when assessing the risk and reliability of energy assets, systems and networks. The capability will include risk assessments, systems analyses, and modeling/simulations to assess energy trends and interdependencies and predict impacts on energy infrastructure and systems.

The Energy Systems Predictive Capability subprogram will build on engagement with Federal agencies such as the Energy Information Administration, Department of Homeland Security, and the Federal Energy Regulatory Commission; the energy industry (electricity, oil, and natural gas sectors); university researchers; National Laboratories; and state and local agencies.

Planned Progress



Benefits

- DOE, as the Sector Specific Agency for Energy, will have a centralized, core capability to conduct analyses and address issues related to risk, and/or the loss of energy assets or systems.
- Enhanced Situational Awareness, with results of analytical products integrated in visualization platform (Environment for Analysis of Geo-Located Energy Information, or EAGLE-I)
- Improved Analytic products for DOE decision makers as well as Federal, State, local and industry stakeholders
- Improved Information Sharing

Other Information

- Understanding Bulk Power Reliability: The Importance of Good Data and A Critical Review of Existing Sources http://emp.lbl.gov/sites/all/files/lbnl-5125e.pdf

Funding and Activity Schedule

Fiscal Year	Activity	Funding (Dollars in Thousands)
FY 2012	N/A	0
FY 2013	N/A	0
FY 2014	• Develop Analytical Framework to produce near real-time analysis of future events that could impact or imperil energy reliability, including assessment of available data sets. • Achieve the ability to provide near real-time analysis of current and future events that could impact energy reliability. • Initiate efforts to integrate real-time energy data across Federal agencies' visualization platforms • Continue OE's role in implementing E.O. "Improving Critical Infrastructure Cybersecurity" and the "Critical Infrastructure Security and Resilience "Presidential Policy Directive (PPD-21), such as update of critical infrastructure identification.	4,000

Smart Grid
Funding Profile by Activity

(Dollars in Thousands)

	FY 2012 Current	FY 2013 Annualized CR*	FY 2014 Request
Smart Grid			
Smart Grid	19,336	---	14,400
Power Electronics	3,867	---	0
Total, Smart Grid	23,203	24,055	14,400

*FY 2013 amounts shown reflect the P.L. 112 175 continuing resolution level annualized to a full year. These amounts are shown only at the "congressional control" level and above; below that level a dash (—) is shown.

*SBIR/STTR:

- FY 2012 Transferred: SBIR: $624; STTR: $84
- FY 2013 Annualized CR: $649; STTR:$84
- FY 2014 Request: SBIR $403: STTR: $58

Public Law Authorizations

Public Law 95–91, "Department of Energy Organization Act", 1977
Public Law 102-486, "Energy Policy Act, 1992"
Public Law 109-58, "Energy Policy Act, 2005"
Public Law 110-140, "Energy Independence and Security Act, 2007

Program Overview and Benefits

In supporting the Secretary's goal of *Energy: Build a competitive, low-carbon economy and secure America's Energy Future*, the Smart Grid program targets modernization of the electric system at the distribution level, with the goals of self-healing from grid disturbances for improved reliability, and integration of demand-side management for improved system efficiency. This program builds on the work accelerated by the American Recovery and Reinvestment Act of 2009 (ARRA) and the increased interest by regulators of the distribution system. Increased reliability is paramount for the distribution system (as evidenced by Superstorm Sandy) and local energy optimization and control will be key to achieving reliability improvements.

Program activities focus on:

- advanced communications and controls for coordinated operation and protection of grid-connected energy storage, plug-in electric vehicles, and distributed generation (including renewables);
- microgrid development to provide energy security to critical loads including commercial and military installations, allowing for incorporation of cybersecurity standards such as encryption, firewalls, strong password requirements, and other measures for significantly improved control system cybersecurity;
- Smart Grid standards and protocols for interoperability of components, devices, and systems connected to the electricity delivery network, from generators to consumers;
- market-based control of multiple resources in buildings for energy, capacity, and other ancillary services that is capable of functioning in multiple scales, services, and time horizons; and
- advanced sensing and measurement for prognostic health management of grid components, such as transformers, cables, and other field devices, to predict failure of the component.

To maximize the benefits of nationwide smart grid development, work must be done to address the following challenges:

- Integrating demand-side assets, such as photovoltaics and electric vehicles, for improved system efficiency and reliability
- Managing two-way power flow necessitated by integration of high penetration of renewable and distributed generation sources
- Enabling interoperable operations of all grid-connected devices and systems, including legacy systems.

Program Accomplishments and Milestones

In FY 2012, the Smart Grid program accomplishments in the development of smart grid technologies include:

- Demonstrated, in two electric utility service territories, a wireless network solution for below-ground distribution automation, resulting in reduction of outage duration (SAIDI) by more than 10%.
- Implemented a dual-objective control framework in the GridLAB-D simulation tool to manage dual benefit streams (e.g., environmental, cost, or efficiency benefits) from a smart grid technology such as demand response, energy storage, and PEV charging to build a viable business case.
- Developed a demand response tool and made it available for use by utilities to measure changes in electricity demand as a function of electricity prices and to design future dynamic pricing programs.

Milestone	Date
• Demonstrate fast responding voltage regulator and dynamic VAR compensator under high penetration renewable energy application at two utilities	4th Q 2013
• Develop an integrated, standalone tool for decision analysis for the design of microgrids	4th Q 2013
• Complete the final phase of microgrid demonstrations at military installations (SPIDERS)	4th Q 2014

Program Planning and Management

The program has been engaging national laboratories, industry, and academia, as well as other Federal and State programs, in jointly planning and implementing R&D activities to meet the challenges to smart grid transformation. This engagement began with developing the Smart Grid Research & Development Multi-Year Program Plan (MYPP) to identify key R&D activities, followed by establishing partnerships for their implementation. The MYPP is updated annually to reflect the current state of smart grid advances, priority needs, and resource availability, with incorporation of any gap areas unveiled through ongoing analysis of ARRA smart grid implementation and demonstration projects. The updated MYPP is used to guide ongoing projects and development of the program portfolio of projects.

The program follows a multi-step management process designed to ensure that all funded technical R&D projects are chosen based on qualifications in meeting clearly defined criteria. This process entails the following:

- Competitive solicitations and peer reviews for financial assistance awards.
- Rigorous national lab annual operating plan review process.
- Peer reviews of in-progress projects on scientific merit, likelihood of technical and market success, actual or anticipated results, and cost effectiveness of research management. The biennial review was last conducted on June 2012.[a]
- OE internal review of the program annually to ensure continuous improvements and proper alignment with R&D priorities and industry needs.

The value of R&D projects, individually and collectively, in achieving the program's strategic goals is made transparent by applying this management process consistently throughout the program. This value is analyzed with respect to the metrics such as peak demand reduction, system efficiency, grid reliability and resilience, penetration of renewable and distributed energy resources and PEVs. The analysis results are further communicated, via program presentations and publications, to industry, the public, and other smart grid stakeholder organizations.

[a] http://energy.gov/oe/articles/smart-grid-rd-program-peer-review-june-7-8-2012

Three external factors that can impact the overall achievement of the program's strategic goal are:

1. Potentially insufficient growth in electricity demand that could discourage additional private industry investment in smart grid development.
2. Slow development and implementation of national smart grid standards, protocols, and assessment frameworks.
3. Low rates of multi-stakeholder participation in formulation and acceptance of a common set of practices for utilities and third parties to address privacy related to data enabled by smart grid technologies to stimulate the market for energy related products and services.

The program will mitigate the impact of these external factors on the achievement of goals by being alert to changes in economic, institutional, and societal conditions, continuing to work with stakeholder communities to identify the proper course of action to deal with the changes, and quickly redirecting program resources for needed actions.

Program Goals and Funding

In support of Office and Departmental goals, the Smart Grid program uses five strategic goals to inform program investment:

1. Enhance grid flexibility to incorporate a variety of energy sources and responsive loads, including large amounts of variable and distributed energy resources
2. Maintain reliability by developing real-time monitoring, control and protection to improve grid operations
3. Build system-level understanding needed for innovative approaches to technology and regional planning
4. Promote regulatory structures that encourage efficiency in electricity markets
5. Secure energy systems and assets against cyber and physical threat

Goal Areas

	1. Flexibility	2. Reliability	3. System Understanding	4. Efficient Markets	5. Security
Smart Grid	40%	20%	25%	5%	10%

Explanation of Funding and Program Changes

(dollars in thousands)

	FY 2012 Current	FY 2014 Request	FY 2014 Request vs FY 2012 Current
Smart Grid			
Decrease reflects the last year of funding for the Power Electronics activity in FY 2012, and the last year of funding for projects competitively awarded in FY 2010 and FY 2011. Decrease also reflects ramping down of the DOE/Department of Defense collaborative work on Smart Power Infrastructure Demonstration for Energy Reliability and Security (SPIDERS) and smart grid stakeholder engagement and outreach activities, as the emphasis shifts to new microgrid R&D projects focused on technical performance and cost metrics required for commercial viability, and on enhancing resiliency and fast recovery of distribution systems.	23,203	14,400	-8,803
TOTAL, Smart Grid	23,203	14,400	-8,803

Smart Grid

Today's electric distribution system is primarily based on a one-way power flow. Beyond substations, the system employs few measuring and control devices for situational awareness and control, and most devices are capable of only one-way communication. As the distribution grid becomes increasingly decentralized with growing use of distributed energy resources by both utilities and non-utilities, including consumers, two-way power flow will be essential; thus, there is a need for two-way communications and decentralized controls to better match supply and demand in real time, as well as for system integration and adaptive protection coordination.

Further, consumers today have limited information and no opportunity to participate with the electric power system because the system currently lacks the means for two-way information exchanges between the grid operator and consumers. Limited consumer participation hampers the ability to fully realize the market potential for energy conservation and demand response. To address these challenges, the Smart Grid program undertakes projects in the following R&D areas:

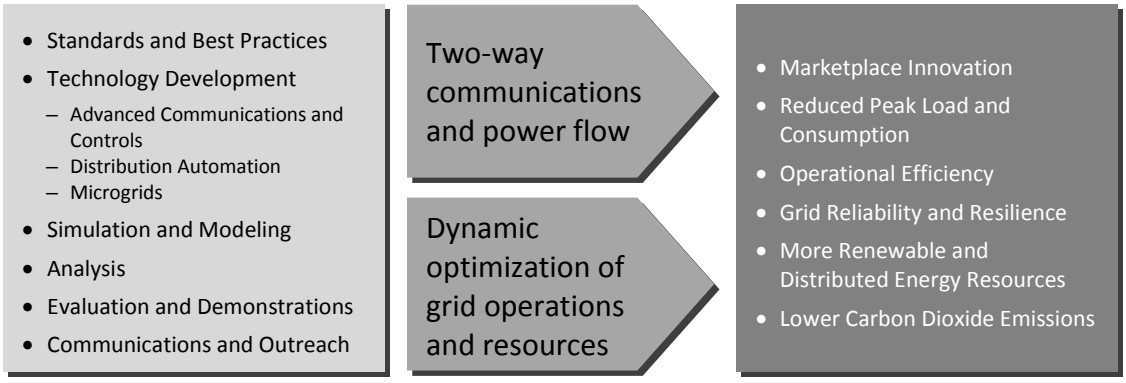
- **Technology Development, Evaluation and Demonstrations** encompasses advanced sensing and measurement, integrated communications and security, advanced components and subsystems, advanced control methods and system topologies, and decision and operations support. Included is development of microgrids, which comprise a grouping of local generation/loads that normally operate in connection with the grid, but can disconnect and function autonomously as physical and/or economic conditions dictate. Technologies to integrate distributed energy resources, electric vehicles, and demand response with the distribution grid are also an area of focus. Evaluation and demonstration of new technologies and methods are conducted for technical and economic performance as well as for conformance with emerging interoperability and cybersecurity standard requirements. Included is the SPIDERS project involving microgrid demonstrations at three military bases to standardize the design approach, contracting, installation, security, and operation of microgrids to support future applications.
- **Simulation and distribution architecture modeling** includes development of the open-source analytic, GridLAB-D, that provides a multi-disciplinary simulation environment to design, test, and optimize smart grid technologies before they are deployed in the field. This area also encompasses operational tool development for the distribution system, such as integrated distribution management system (IDMS) tools, which complements the research on advanced modeling and computational techniques for the transmission system supported in the Clean Energy Transmission and Reliability program.

Additionally, the Smart Grid program supports activities in the following areas:

- **Standards & Best Practices** for electrical and communications interconnection, interoperability, testing, and operating practices.
- **Benefits Analysis** of measured data and simulations to better understand the impacts and benefits concerning capacity usage, power quality and reliability, energy efficiency, operational efficiency, and clean technology, as well as economic/business environment and crosscutting goals. The ARRA-funded projects also offer a unique opportunity to evaluate benefits and understand consumer behavior as smart grid technologies are deployed.

Smart Grid Communications and Outreach to leverage successful ARRA investments including smart infrastructures and communities and increase consumer awareness of the smart grid and available tools for energy savings, and outreach to state regulatory bodies and national smart grid communities to inform them of the importance and status of development.

In the near term, the Department will focus on the development of smart grid architectures enabling two-way power flow and two-way communications and information exchanges through advanced circuit designs, sensing, communication, and control technologies. These smart grid capabilities can help meet new requirements on the grid from like integration of high penetration levels of renewable energy, plug-in electric vehicles, advanced microgrid operations, and distribution automation.



Benefits

System Efficiency Benefits

- Reduce peak demand through enhanced distribution asset utilization. Currently, 10 - 20% of total electricity costs in the U.S. are attributable to around 100 hours during peak periods each year (i.e., ~1% of the total year-hours).
- Defer investments in generation, transmission, and distribution upgrades and expansion, which would be required if peak demand were not reduced.

System Reliability Benefits

- Reduce duration and frequency of power outages. Currently, one in five electricity dollars is lost to power outages.
- Economic benefits from improved power reliability from smart grid are estimated at $282 billion to $445 billion for the period of 2010 to 2030, in a 2011 report from the Electric Power Research Institute (EPRI).
- Microgrids provide energy and cybersecurity to critical loads including hospitals, data centers, telecom switch centers, semiconductor fabrications and foundries, and military installations.

Environmental Benefits

- Potential reductions in electricity consumption and CO2 emissions.

Other Information

Smart Grid Research and Development Multi-Year Program Plan, 2010-2014:
http://www.smartgrid.gov/sites/default/files/oe_mypp.pdf

Smart Grid Peer Reviews (June 2012):
http://energy.gov/oe/articles/smart-grid-rd-program-peer-review-june-7-8-2012

Funding and Activity Schedule

Fiscal Year	Activity	Funding (Dollars in Thousands)
FY 2012	• Made competitive awards for smart grid-capable electric vehicle supply equipment to enable smart charging of PEVs and achieve 50% cost reduction in 2-3 years. • Awarded smart grid data access projects to enable residential consumers to better manage their electricity consumption through use of standardized data access architecture and consumer-oriented information tools. • Continued collaboration with Department of Defense (DoD) on design and implementation of microgrids at military facilities to increase energy security and ensure availability of mission critical assets, including the SPIDERS (Smart Power	19,336

Fiscal Year	Activity	Funding (Dollars in Thousands)
	Infrastructure Demonstration for Energy Reliability and Security) joint capability technology demonstration with DoD • Advanced development of an open-source simulation tool, via a collaborative environment, from a single-objective control framework to a dual-objective one to strengthen business cases for smart grid technologies. • Issued the biennial "The Smart Grid System Report" for submission to Congress, required by the Energy Independence and Security Act of 2007 (EISA).	
FY 2013	Planned activities in the FY 2013 Budget: • Complete industry and university led projects from FY2010 FOA demonstrating technical feasibility of smart grid technologies. • Continue R&D on integration of distributed energy resource models with distribution system models and testing of advanced sensing, monitoring, and control • Continue R&D on communications for smart grid-capable EVSE • Continue demonstration of tools for smart grid data access by consumers • Continue national lab R&D on modeling and analysis, smart grid standards, and control algorithms; complete microgrid demonstrations at military installations (SPIDERS)	---
FY 2014	• Demonstrate a grid-connected microgrid, equipped with an advanced control algorithm, to achieve enhanced distribution system restoration. • Complete the final phase of microgrid demonstrations at military installations (SPIDERS). • Adopt the tool for smart grid data access by consumers across a service territory of a utility (awarded through smart grid data access projects in FY11). • Award new projects through a Microgrid R&D competitive solicitation to meet metrics for commercial viability. • Continue national lab R&D on modeling and analysis, smart grid architectures, and control algorithms. • Continue support of interoperability and conformance testing to promote standards acceptance by utilities.	14,400

Power Electronics

The Power Electronics subprogram has been concentrating on the development of wide bandgap semiconductor based devices, emphasizing the development of Gallium Nitride (GaN) on Silicon based power devices. In FY 2012, a GaN on Silicon based power device operating at more than 2kV was successfully demonstrated. Starting in FY 2013, the program for applied research into grid-scale power electronics devices is closing out its existing projects and re-evaluating its direction. The Power Electronics program will continue to collaborate closely with other DOE offices performing foundational research, including ARPA-E and the Office of Science, to identify promising technologies for future development into grid-scale power electronics applications.

Funding and Activity Schedule

Fiscal Year	Activity	Funding (Dollars in Thousands)
FY 2012	• Scaled the operating voltage of developed devices to more than 2000 V.	3,867
FY 2013	• Close out projects funded in prior years.	0
FY 2014		0

Cyber Security for Energy Delivery Systems
Funding Profile

(Dollars in Thousands)

	FY 2012 Current	FY 2013 Annualized CR*	FY 2014 Request
Cybersecurity for Energy Delivery Systems	29,007	30,072	38,000

*FY 2013 amounts shown reflect the P.L. 112 175 continuing resolution level annualized to a full year. These amounts are shown only at the "congressional control" level and above; below that level a dash (—) is shown.

*SBIR/STTR:

- FY 2012 Transferred: SBIR: $780; STTR: $105
- FY 2013 Annualized CR: SBIR: $812; STTR: $105
- FY 2014 Request: SBIR $924: STTR: $132

Public Law Authorizations

Public Law 95–91, "Department of Energy Organization Act", 1977
Public Law 93-438, "Energy Reorganization Act", 1974
Public Law 110-140, Energy Independence and Security Act, 2007

Program Overview and Benefits

In support of the Secretary's goal for *Energy: Build a competitive, low-carbon economy and secure America's Energy Future*, the Cybersecurity for Energy Delivery Systems (CEDS) program develops advanced technologies, cybersecurity capabilities, and expands situational awareness to enhance the reliability and resiliency of the Nation's energy infrastructure by reducing the risk of energy disruptions due to cyber events.

Reliable and resilient energy infrastructure is vital to our nation's economy, human health and safety, and national security. Cybersecurity for energy delivery systems has emerged as one of the Nation's most serious grid modernization and infrastructure security issues. Innovative solutions designed specifically to meet the unique requirements of high-reliability energy delivery systems are needed to ensure the success of grid modernization and transformation of the nation's energy systems. Effective solutions must be based on improved situational awareness and require multi-disciplinary collaborations and shared expertise in power systems engineering and the computer science of cyber security.

On February 12, 2013, in recognition of the growing cyber threats to critical infrastructure, President Obama signed an Executive Order titled "Improving Critical Infrastructure Cybersecurity", with the top priority being enhanced cybersecurity information sharing between the Government and infrastructure owners and operators. OE's cybersecurity efforts, as the Energy Sector-Specific Agency, play a significant role in implementing this Order as well as Presidential Policy Directive 21 – "Critical Infrastructure Security and Resilience", also signed on February 12, 2013. The new PPD addresses both physical and cyber threats to critical infrastructure and relies extensively on the Sector-Specific Agencies to implement the directive.

The Roadmap to Achieve Energy Delivery Systems Cybersecurity, updated in 2011, outlines a comprehensive framework to coordinate efforts in the public and private sectors, and helps align the CEDS program. The Roadmap identifies a number challenges that must be addressed:

- Most cybersecurity solutions are developed for desktop information technology (IT) systems, and cannot be implemented on energy delivery systems that control real-time physical processes without risking a power disruption that rivals that of an intentional cyber attack.
- Real time solutions are needed to keep pace with increasingly sophisticated cyber threats that are unpredictable and evolve faster than the sector's ability to deploy countermeasures.
- The energy sector uses many legacy devices that were designed decades ago when cybersecurity was not a central concern; these devices may not have the computing resources needed to support cybersecurity upgrades.

The CEDS program will continue to collaborate with DOE national laboratories, academia, and the private sector to address the rapidly advancing capabilities of the adversary, increase information sharing and risk

assessment capabilities, and proactively manage and reduce the risk of energy disruptions due to cyber attacks. In FY 2014, the CEDS subprogram continues to be aligned with the goals of the Roadmap:

- Build a Culture of Security – CEDS activities focus on improved communications and information sharing, including the Cybersecurity Risk Information Sharing Pilot (CRISP) project.
- Assess and Monitor Risk – Key CEDS activities include integrated risk analyses that consider threat, vulnerability and physical consequence of energy sector cyber events. The Electricity Subsector Cybersecurity Capability Maturity Model (ES-C2M2) effort supports situational awareness tool development and risk assessments.
- Develop and Implement New Protective Measures to Reduce Risk – Key CEDS activities include a research call for National Laboratory-led projects to advance energy sector cybersecurity capabilities.
- Manage Incidents – CEDS will continue to provide the core capabilities developed by National SCADA Test Bed participants, as well as outreach to stakeholders.
- Sustain Security Improvements – CEDS will continue to advance cybersecurity capabilities - such as Lemnos for interoperable, secure energy sector routable communications - that make the operator's job easier and that decrease the cost of operations and make energy sector communications more secure.

Program Accomplishments and Milestones

In FY 2012 the CEDS program accomplishments include:

- Developed capabilities that prevent unexpected communications or processes on protected system components, such as control system LANs, substation computers, and field devices. These are expected to become commercially available in 2013.
- National Laboratory research initiated in FY 2010 resulted in an energy delivery control system mapping and visualization capability that several utilities are now using to visualize and ensure the communications taking place on their control system networks are appropriate.
- ES-C2M2 was released. This tool helps utilities to identify areas for cybersecurity investment, prioritize cybersecurity resources in a way that most effectively reduces risk, and compare their cybersecurity capabilities with other utilities.

Milestones	Date
• Complete draft of requirements for cryptographic key management for Role-Based Access Control for the energy sector	Q2 FY13
• Complete a preliminary set of cyber event scenarios for energy delivery systems to characterize survivability properties that will inform cyber-resiliency metrics	Q2 FY13
• Transition to the energy sector a secure communications capability that also detects physical tampering of remote field devices	Q4 FY13
• Complete Oil and Natural Gas (ONG)-C2M2 functional model	Q1 FY14

Program Planning and Management

OE will implement three key strategies to efficiently and effectively manage the program:

1. Collaborate with all energy sector stakeholders including national laboratories, academia, technology vendors, energy asset owners and operators, and federal partners.
2. Foster research in national labs and academia and engage in industry-led projects to transfer promising technologies into the energy sector through competitive solicitations.
3. Actively engage with the Networking and Information Technology Research and Development (NITRD) multi-agency forum to share and leverage R&D capabilities across the federal government and other Sector-Specific Agencies.

Two external factors present the strongest impacts to the overall achievement of the program's strategic goal:

1. The constant evolution of the threat and its increasing sophistication.
2. The increasing public availability of software that can be downloaded from the internet to automate cyber-attacks that exploit known vulnerabilities in energy delivery control systems. This makes more advanced attacks easier to execute by unskilled adversaries.

Program Goals and Funding

In support of Office and Departmental goals, the CEDS program uses the following strategic goals to inform program investment:

1. Maintain reliability by developing real-time monitoring, control and protection to improve grid operations
2. Build system-level understanding needed for innovative approaches to technology and regional planning
3. Secure energy systems and assets against cyber and physical threat

Goal Areas

	1. Flexibility	2. Reliability	3. System Understanding	4. Efficient Markets	5. Security
Cyber Security for Energy Delivery Systems	0%	20%	10%	0%	70%

Explanation of Funding and Program Changes

(Dollars in Thousands)

	FY 2012 Current	FY 2014 Request	FY 2014 Request vs FY 2012 Current
Cybersecurity for the Energy Delivery Systems	29,007	38,000	+8,993
Increase expands efforts to improve cybersecurity technologies and capabilities for control systems used in critical energy infrastructure, such as a public-private partnership of energy sector stakeholders supported by National Laboratory R&D that will analyze the relative risk a disclosed cyber-vulnerability represents and recommend mitigations to reduce the risk of power disruption. It expands critical efforts to improve situational awareness and develop operational capabilities in the energy sector including developing ES-C2M2 benchmarks; initiating a C2M2 pilot for the oil and natural gas sector; and expanding the Risk Management Process guideline.			
TOTAL, Cyber Security for Energy Delivery Systems	29,007	38,000	+8,993

Cybersecurity for Energy Delivery Systems

In the last 18 months, the energy sector cybersecurity environment has experienced a dramatic increase in focused cyber attacks. The sophistication and effectiveness of malware designed to attack critical energy infrastructure, most recently Shamoon, marks a significant new era of state actor level threats to the U.S. economy. Because of the Nation's dependence on cyberspace, the United States has been engaged in enhancing the national cybersecurity posture by creating a more robust front line of defense, enhancing shared situational awareness, augmenting capabilities in support of network defense, and moving toward "machine speed" responses, among other activities. As the energy sector-specific agency (SSA), DOE has the domain expertise to understand the cyber-physical energy environment and has ongoing activities that maintain and expand situational awareness and information sharing needed to reduce cyber risk within the energy sector.

As the energy sector-specific agency, the Department is responsible for collaborating with the energy sector vendors, utility owners and operators to enhance the cybersecurity of critical energy infrastructure against current and future threats. These activities include the development of effective risk management programs, secure and reliable information sharing and situational awareness and next-generation R&D of energy sector cybersecurity capabilities. OE R&D activities recognize that energy delivery control systems are uniquely designed and operated to control real-time physical processes that deliver continuous and reliable power to support national and economic security. As such, CEDS supports R&D of cybersecurity solutions tailored to meet the energy sector's unique performance requirements, design, and operational needs. All of OE's cybersecurity activities align with the 2010 Energy Sector-Specific Plan and the *2011 Roadmap to Achieve Energy Delivery Systems Cybersecurity* (Roadmap), build on and expand ongoing efforts to strengthen the industry's baseline cybersecurity capabilities and promote ongoing development of cybersecurity capabilities within the energy sector.

CEDS Research and Development

R&D efforts in the CEDS program are founded on collaborations of all energy sector stakeholders to transition innovative ideas from academia, national laboratories and industry to provide cybersecurity for energy delivery systems. In FY 2012, DOE/OE also became a formal member of the Federal Networking and Information Technology Research and Development (NITRD) program. CEDS actively engages with NITRD by providing expertise in cybersecurity for the energy sector. Research is aligned with the Roadmap and the five themes described in the NITRD strategic plan. Below are specific examples of ongoing activities organized by each NITRD theme.

Designed-in security is a fundamental principle of CEDS R&D and focuses on innovative, graded security architectures comprised of built-in security techniques and methodologies to ensure security while keeping up with a dynamic technology environment. Projects such as secure code analysis and testing, secure coding for energy delivery systems and developing designed-in white-listing capabilities that allow only expected cyber activity exemplify efforts to advance the theme of designed-in security.

Tailored Trustworthy Spaces is a natural match to the cybersecurity needs of energy delivery system architectures that span engineering domains – generation, transmission, distribution, into the home area network and smart meters, and also span organizational domains such as balancing authorities, regional transmission operators and independent system operators. A biologically-inspired solution developed by the Pacific Northwest National Laboratory is demonstrating that Digital Ants can be successfully deployed across multiple organizational and technological domains found in energy sector architectures to implement cybersecurity policies tailored to each domain.

Moving Target is addressed in the Roadmap as, "the industry eventually needs security state monitoring tools that trigger autonomic (i.e., quick device response) and/or dynamic (i.e., can evolve) corrective actions within the control system, while allowing operators to override them, if necessary." Any moving target approach in the energy sector must be able to keep the predictable timing of communications, as determined by the latency requirements for the particular part of the architecture being addressed. A project led by Sandia National Laboratories is developing a moving target capability to randomize the routable path through a network while respecting the requirements of latency and determinism needed for energy delivery system communications.

Science of Security is addressed in the Roadmap as, "while many asset owners and operators are performing self-assessments of their control systems, the methods and metrics they use continue to vary across the sector. Without consistent criteria or metrics, benchmarking and comparing energy delivery systems risk and evaluating the impact of security

efforts is difficult.[a]" A project, led by the Software Engineering Institute, is intended to develop a suite of metrics and models for assessing, comparing, and gaining actionable insight into the cyber-physical survivability properties of large-scale, highly-networked energy delivery systems (EDS). These systems are characterized by an increasingly sophisticated digital overlay of computation, communication, and control. The metrics and models will provide the capability to evaluate, quantify, and improve the survivability of existing EDS and to engineer new EDS that exhibit the intended survivability properties in the context of explicit engineering tradeoffs.

CEDS Situational Awareness and Operational Capabilities

The CEDS program is also focused on enhancing situational awareness capabilities and strengthening capabilities for management of cybersecurity risks, to help energy sector asset owners to cost effectively strengthen cybersecurity protections and increase the resiliency of the Energy Sector.

In FY 2012, in partnership with industry and other Federal agencies such as the Department of Homeland Security (DHS) and the National Institute of Standards and Technology (NIST), the Department led two initiatives, the Electricity Subsector Cybersecurity Capability Maturity Model (ES-C2M2) and Risk Management Process (RMP) guideline, aimed at developing cybersecurity operational capabilities within the energy sector. The ES-C2M2 developed a common tool that can be used consistently across the industry to evaluate their cybersecurity capabilities.

The CEDS program continues to ***advance adoption of the ES-C2M2 and RMP*** by the energy sector, with the goal of helping the energy sector evaluate the maturity of the cybersecurity capabilities and applying effective risk management processes within the energy sector. A key outcome of these initiatives is a common language and point of reference to facilitate information sharing and lessons learned concerning risk-based cybersecurity practices in the sector. Specific objectives include the following:

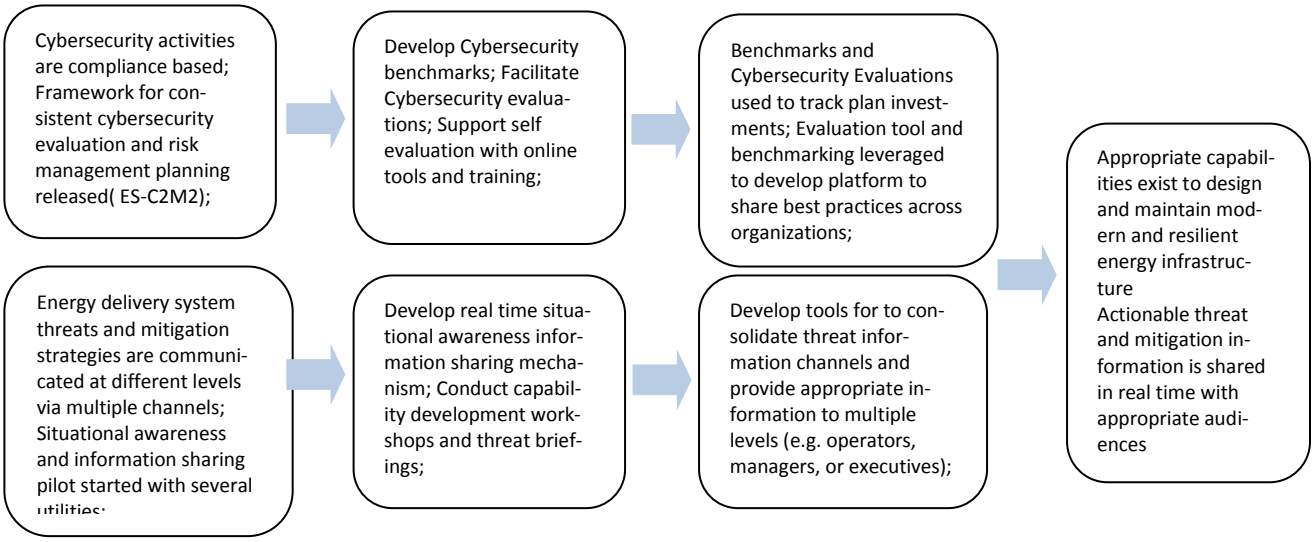
- Enable sector owners and operators to effectively and consistently evaluate and benchmark cybersecurity capabilities based on risk.
- Share knowledge, best practices, and relevant references within the sector as a means to improve cybersecurity capabilities.
- Enable sector owners and operators to prioritize actions and investments to improve cybersecurity.

In FY 2014, OE will work with industry to use their self assessments to benchmark their performance and to support investment decisions, share best practices within the sector, and measure progress towards strengthening the security of the energy infrastructure.

OE has initiated a pilot effort, referred to as the *Cybersecurity Risk Information Sharing Pilot (CRISP)*, which is focused on **improving situational awareness and information sharing** within the electric sector. This effort leverages capabilities within the DOE National Laboratory complex and includes partnerships with electric sector owners and operators to develop an integrated situational awareness capability and information sharing capability. In FY 2014, this work will move beyond the pilot stage to formalize cyber-threat information sharing and analysis in accordance with specific needs of the energy sector. As new tools are developed through the R&D program or elsewhere, OE envisions that CRISP will be one aspect of a suite of tools owned and operated by the electric sector. In addition, OE will facilitate partnerships with other federal agencies to create forums to share cyber threat and vulnerability information and with energy sector owners and operators, determine the impact to the sector, and develop flexible sector specific mitigations.

[a] https://www.controlsystemsroadmap.net/ieRoadmap%20Documents/roadmap.pdf, 29

Continuum for Improving Operational Capabilities and Situational Awareness



Benefits

- Reduce the risk of power outages arising from an energy sector cyber event
- Work toward achieving the Roadmap vision, that resilient energy delivery systems are designed, installed, operated and maintained to survive a cyber event while sustaining critical functions
- Cost effective risk-based management of key cybersecurity practices for energy delivery systems
- Real-time awareness of cybersecurity threats to the energy sector, allowing timely mitigation and ability to rapid return to normal operations

Other Information

Roadmap to Achieve Energy Delivery Systems Cybersecurity, 2011:
http://energy.gov/sites/prod/files/Energy%20Delivery%20Systems%20Cybersecurity%20Roadmap_finalweb.pdf

Electricity Subsector Cybersecurity Capability Maturity Model:
http://energy.gov/oe/services/cybersecurity/electricity-subsector-cybersecurity-capability-maturity-model

Electricity Subsector Cybersecurity Risk Management Process Guideline:
http://energy.gov/oe/services/cybersecurity/cybersecurity-risk-management-process-rmp

Executive Order -- Improving Critical Infrastructure Cybersecurity:
http://www.whitehouse.gov/the-press-office/2013/02/12/executive-order-improving-critical-infrastructure-cybersecurity

Presidential Policy Directive -- Critical Infrastructure Security and Resilience:
http://www.whitehouse.gov/the-press-office/2013/02/12/presidential-policy-directive-critical-infrastructure-security-and-resil

Funding and Activity Schedule

Fiscal Year	Activity	Funding (Dollars in Thousands)
FY 2012	• Provided final year of funding for industry-led research and development projects awarded in FY 2010 to enhance cyber security of energy delivery systems. • Continued national laboratory integrated risk analysis, research of vulnerability mitigation techniques, and initial proof-of-concept reviews. • Continued the Trustworthy Cyber Infrastructure for the Power Grid (TCIPG), completing development of two control systems cyber security applications • Demonstrated and evaluate bio-inspired technology – digital ants – via hardware implementation and large-scale simulations in energy delivery and information technology systems • Initiated competitively selected research projects for the National Laboratories that will foster cutting edge research with the vision to transition this high-risk/high-payoff research into the energy-sector. • Initiated pilot of CRISP capability to share cyber risk information within the electric sector to advance wide-area situational awareness	29,007
FY 2013	Planned activities in the FY 2013 Budget: • Complete industry-led projects by transitioning the R&D to the private sector for energy sector cybersecurity, including alpha versions of software, initial network designs, and testing of hardware prototypes. • Continue integrated threat analysis, developing actionable information for sharing with energy stakeholders • Initiate new high-risk, high-payoff cybersecurity research through national laboratories in collaboration with energy sector stakeholders • Complete research developing next-generation technologies to enhance security of energy delivery system platforms including Smart Grid Devices, and initiate a new FOA for the development of secure, resilient Smart Grid architectures and components, including the capability to secure real-time communications • Develop enhanced cybersecurity protective measures for synchrophasors, a critical smart grid component that provides engineering data needed for wide-area situational awareness of grid operation	---
FY 2014	• Issue a competitive research call for the National Laboratories to develop the next-generation cybersecurity capabilities in research areas aligned with the needs of the energy sector as articulated in the Roadmap strategy, such as tools and techniques that protect supply chain integrity for energy delivery control systems and components • Support additional awards for the development of secure, resilient Smart Grid architectures and components • Continue high risk/high payoff frontier and core research at the National labs, including research areas such as integrated risk analysis of threat, vulnerability and consequence; and development of tools using innovative mathematical- and physics-based algorithms to identify advanced persistent cyber threats in energy control systems • Continue support for the Trustworthy Cyber Infrastructure for the Power Grid (TCIPG) academic collaboration that brings expertise in power system engineering and the computer science of cybersecurity to the research and development of energy delivery	38,000

Fiscal Year	Activity	Funding (Dollars in Thousands)
	systems that sustain critical functions even during a cyber event • Continue to enhance information sharing and situational awareness capabilities through CRISP development and initiate a framework for information exchange within and across regions and similar utilities (e.g., municipals, rural co-operatives, investor owned utilities, transmission operators) • Develop the ES-C2M2 benchmark methodology; develop the Oil and Natural Gas-C2M2 pilot model; and expand the RMP guidelines • Support OE's responsibilities in implementing the new Executive Order "Improving Critical Infrastructure Cybersecurity" and the "Critical Infrastructure Security and Resilience" Presidential Policy Directive (PPD-21).	

Energy Storage
Funding Profile

(Dollars in Thousands)

	FY 2012 Current	FY 2013 Annualized CR*	FY 2014 Request
Energy Storage	19,336	20,046	15,000

*FY 2013 amounts shown reflect the P.L. 112 175 continuing resolution level annualized to a full year. These amounts are shown only at the "congressional control" level and above; below that level a dash (—) is shown.

*SBIR/STTR:

- FY 2012 Transferred: SBIR: $520, STTR: $70
- FY 2013 Annualized CR: SBIR: $541; STTR: $70
- FY 2014 Request: SBIR $420: STTR: $60

Public Law Authorizations

Public Law 95–91, "Department of Energy Organization Act", 1977
Public Law 102-486, "Energy Policy Act, 1992"
Public Law 109-58, "Energy Policy Act, 2005"
Public Law 110-140, "Energy Independence and Security Act , 2007

Program Overview and Benefits

In supporting the Secretary's Goal of *Energy: Build a competitive, low-carbon economy and secure America's Energy Future,* the Energy Storage program is designed to develop and demonstrate new and advanced energy storage technologies that will enhance the stability and reliability of the future electric grid, which includes substantial dispatch of intermittent renewable energy resources such as wind and solar power generation. The OE energy storage program focuses on accelerating the development and deployment of grid-scale energy storage in the electric system. Increasing the affordable use of energy storage in the electric grid will enhance system reliability and enable both greater adoption of renewable energy resources and more effective utilization of the existing electric system.

Energy storage projects are increasingly gaining support and acceptance. For example the California Public Utility Commission has recently mandated installation of 50MW of energy storage by Southern California Edison to compensate for increasing renewable generation. Microgrids involving storage are being installed by the Military for energy surety and by states like Connecticut and Massachusetts for emergency preparedness. Also the Federal Energy Regulatory Commission (FERC) has mandated fair pricing for frequency regulation, which will double the value of Energy storage facilities offering this service. Many of these projects are based on technology developed under the OE energy storage program.

The program focus areas include:

- Storage System R&D,
- Demonstrations,
- Power Management and Distribution (e.g. voltage and frequency regulation), and
- Analytic Studies

R&D activities focus on improving the economic competitiveness and technical performance of a suite of emerging energy storage technologies. Testing and field demonstration efforts are collaborative with manufacturers, states, and utilities to establish experience and confidence in storage technologies. Analysis, including the development of analytic tools, serves to inform stakeholders and guide R&D investments. Together these efforts will accelerate implementation of emerging storage technologies to advance the modernization of the electrical utility grid.

To maximize the benefits of energy storage, work must be done to address the following challenges:

- **Improving the cost/benefit ratio** of energy storage through advancements in materials engineering and device architectures;
- **Field Validation** of first-of-a-kind systems in life-like simulations in utility environments to optimize storage devices for diverse utility applications;
- **Modeling and Analysis of Storage Systems** to assess the use, costs and benefits of energy storage, identify institutional and policy barriers, and devel-

op tools for utilities and users planning to introduce and use energy storage.

Program Accomplishments and Milestones

Responding to key challenges for storage deployment, the cost effectiveness of energy storage technologies continued to improve significantly in FY 2012 through technology advances and outreach activities:

- Evaluated 21 Lead-Carbon (PbC) negative electrodes following performance testing to understand mechanism of 10x enhancement in cycle life
- Designed and demonstrated 1kW/1kWhr vanadium redox flow battery utilizing new mixed acid electrolytes which can operate at 75% greater current density with 2x the energy density
- Published a Guidebook for Public Utility Commission (PUC) regulators for evaluation of energy storage rate recovery, reflecting information from PUC staff of 15 states.

Milestone	Date
• Design and demonstrate 1kW/1kWhr vanadium redox flow battery operating at 2X greater current density resulting in 2x reduction of stack cost	Q4 FY13
• Complete a National Stationary Grid Storage assessment evaluating the benefits of energy storage systems for balancing services and energy arbitrage and the potential to lower the cost of delivering electricity	Q4 FY13
• Demonstrate at least 100 cycles at low <100°C temperature for Na-iodine battery	Q4 FY14

The program will include some programmatic shifts in FY 2014. As vanadium redox battery research will be completed and the technology transitioned to industry; development work will begin on the nitrogen-oxygen battery to evaluate technical feasibility and potentially cost effectiveness; and construction of an advanced medium temperature planar sodium (Na) battery prototype will begin.

Program Planning and Management

OE will implement three key strategies to efficiently and effectively manage the program:

1. Partner with the private sector, other DOE departments, national laboratories, and universities to accelerate development of advanced energy storage devices
2. Partner with other DOE offices and other Federal and state agencies in leveraged field testing of pioneering storage systems and establishing the regulatory framework for energy storage applications
3. Jointly with industry, develop promising ARPA-E, Recovery Act, and SBIR technologies to enable next generation market ready storage systems

Three external factors present the strongest impacts to the overall achievement of the program's strategic goals:

4. Lack of clear, proven strategies for decision makers to use storage to help manage increasing power demand, more stringent environmental factors, new technologies (renewables, EV, smart grid) and operational uncertainties
5. Absence of regulatory framework and mature market structures create difficulty in cost recovery for utilities and storage providers
6. Lack of tested and proven storage technologies meeting utility needs for cost, cycle life, and energy efficiency

Program Goals and Funding

In support of Office and Departmental goals, the Energy Storage program uses the following strategic goals to inform program investment:

1. Enhance grid flexibility to incorporate a variety of energy sources and responsive loads, including large amounts of variable and distributed energy resources
2. Maintain reliability to improve grid operations

Goal Areas

	1. Flexibility	2. Reliability	3. System Understanding	4. Efficient Markets	5. Security
Energy Storage	50%	50%	0%	0%	0%

Explanation of Funding AND/OR Program Changes

(Dollars in Thousands)

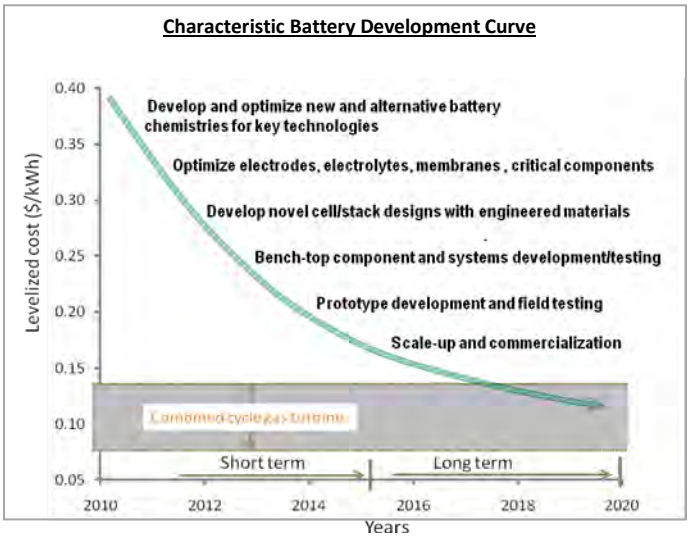
	FY 2012 Current	FY 2014 Request	FY 2014 Request vs FY 2012 Current
Energy Storage			
Decrease reflects decreased monitoring and evaluation of ARRA projects as they near completion; and reduced numbers of highly leveraged field validation projects.	19,336	15,000	-4,336
Total, Energy Storage	19,336	15,000	-4,336

Energy Storage

The development of cost-effective energy storage is vital to maintaining electric system reliability with high penetration levels of variable generation resources, effective use of existing transmission and distribution systems, electrification of transportation, and broad smart grid deployment. OE is focused on lowering the cost of storage devices, proving their performance in utility applications, facilitating industrial development, and addressing regulatory framework and market maturity for storage adoption. The program involves the development, testing and demonstration of cost effective energy storage technologies as well as development and application of analytic tools.

Following the 2011 Energy Storage Plan, the program will continue to develop a suite of promising technologies such as lead-carbon, sodium metal halide, metal air, and advanced flow batteries; as well as flywheel and compressed air storage. Applications of these technologies will be pursued in highly leveraged small- to medium-sized demonstrations in diverse application areas. High voltage, wide band gap power conversion and management devices appropriate for storage facilities will be developed. Analytical studies will inform distribution of storage on the grid for optimal benefits.

Program efforts typically follow a characteristic development curve. Different technologies are at different stages of development toward cost/performance goals, as shown in the accompanying chart. Technologies exit the development pipeline either through transition to industry, or determination they have a low probability of entering commercialization. Analyses are conducted to address market, system development, grid integration, or regulatory and market questions/issues. Testing is conducted to validate storage performance under utility conditions. Levelized Cost, which combines $/kwh with life cycle figures, can be used as a simplified metric of research progress. The long term goal is cost parity with gas turbines.



Benefits

Over the past decade, industry, utilities, and regional balancing authorities have come to realize that energy storage can have important benefits for the future grid, making cost-effective energy storage an ever more pressing need. Specific benefits include:

Enhancing System Stability

- Frequency and voltage regulation
- Reduction of peak load
- Minimizing grid congestion and defer upgrades

Enabling Large-scale Renewable Integration and Improved Asset Utilization

- Reducing variability of wind and solar
- Mitigation of ramping

- Allow load shifting (ie. Diurnal Wind)

Enabling distributed generation and electric vehicle deployment

- Reducing impact of roof top photovoltaic cells
- Providing electric vehicle fast charging
- Improving local voltage management

Other Information

In 2010 stakeholders from industry and academia helped DOE assess the utility needs for energy storage and develop goals for various technologies to meet power system needs. These were, in turn, used to develop a program plan that addressed the technology development and analysis needs.

OE Energy Storage Program Planning Document (Feb. 2011): http://energy.gov/node/238771

Funding and Activity Schedule

Fiscal Year	Activity	Funding (Dollars in Thousands)
FY 2012	• Analyzed 21 Lead-Carbon (PbC) negative electrodes following performance testing to understand mechanism of 10x enhancement in cycle life • Designed and demonstrated 1kW/1kWhr vanadium redox flow battery utilizing new mixed acid electrolytes which can operate at 75% greater current density with 2x the energy density • Demonstrated >20 cycles of ionic liquid electrolytes (MetILs) for higher energy density flow batteries • Developed performance based testing and evaluation standards for storage devices and systems to support industry adoption • Published a Guidebook for PUC Regulators for evaluation of energy storage rate recovery, reflecting information from PUC staff from 15 states.	19,336
FY 2013	Planned activities in the FY 2013 Budget: • Carry out Lead-Carbon (PbC) functional mechanistic studies of performance enhancement to determine chemical mechanism • Develop Mixed-Electrolyte and metallic ionic liquid flow batteries with greater energy density, cycle life, and cost effectiveness • Analyze technical accomplishments of storage projects and share results, • Develop regulatory framework, and market structure impediments assessments for storage applications on the grid.	---
FY 2014	• Demonstrate advanced prototype of planar Na battery operating < 200°C • Complete development of second generation redox flow battery design and transfer to industry • Initiate small-scale durability testing of low-cost rechargeable Na-ion battery. • Evaluate feasibility of cost effective nitrogen oxygen battery and establish go/no-go points for continued development • Complete research on carbon nano-fiber enhanced flywheels and find industrial partner for demonstration and commercialization	15,000

Electricity Systems Hub
Funding Profile

(Dollars in Thousands)

	FY 2012 Current	FY 2013 Annualized CR	FY 2014 Request
Electricity Systems Hub	0	0	20,000

*FY 2013 amounts shown reflect the P.L. 112 175 continuing resolution level annualized to a full year. These amounts are shown only at the "congressional control" level and above; below that level a dash (—) is shown.

*SBIR/STTR:

- FY 2012 Transferred: SBIR: N/A; STTR: N/A
- FY 2013 Annualized SBIR: N/A; STTR: N/A
- FY 2014 Request: SBIR $560: STTR: $80

Public Law Authorizations

Public Law 95–91, "Department of Energy Organization Act", 1977
Public Law 102-486, "Energy Policy Act, 1992"
Public Law 109-58, "Energy Policy Act, 2005"
Public Law 110-140, "Energy Independence and Security Act, 2007

Program Overview and Benefits

In support of the Secretary's goal of *Transforming our Energy Systems* through *Modernizing the Electric Grid*, the Electricity Systems Hub will address science, technology, economic, and policy issues that impede the necessary blurring of transmission and distribution. To reliably increase the amount of clean energy resources on the bulk transmission system, deploy more electric vehicles and distributed generation on local distribution systems, and leverage advances in information and communication technologies for the electric power system (Smart Grid), these diverse systems need to be integrated and operated seamlessly across transmission and distribution systems in a safe, secure, resilient, and cost-effective manner.

The electric power system is a key enabler to economic prosperity, reducing greenhouse gas emissions, and increasing energy independence. Grid modernization must factor in the on-going changes in policies, economics, weather patterns, and technologies to ensure reliability, flexibility, efficiency, and resiliency. The Electricity Systems Hub will embrace a holistic perspective and call on a diverse, multidisciplinary group of experts from industry, academia, and government to coordinate, identify, and accelerate solutions to overcome the complex barriers and critical systems integration and operational challenges between transmission and distribution.

To successfully achieve seamless grid modernization, work must be done to address the following challenges:

- Ensuring that an integrated, systems-level approach is taken when looking for transformative solutions including interdependencies (e.g., natural gas, telecommunications, cyber-physical systems)
- Developing technologies that can adapt to the constantly evolving power system while maintaining reliability and cost-effectiveness
- Addressing stakeholder fragmentation along with building consensus on the benefits and value streams of modernization
- Developing a platform for demonstrating and testing grid technologies

Program Planning and Management

OE will implement three key strategies to efficiently and effectively manage the program:

1. Develop analytical basis and multi-year roadmap including engineering and economic analysis.
2. Conduct multidisciplinary studies that define the linkages between technology, economics, and policy.
3. Leverage cost-share (50%) on Hub projects to increase funding, encourage stakeholder interactions, and gain industry buy-in.

External factors present challenges to the overall achievement of the program's strategic goal:

1. Regional differences in the power system may require different solutions or inhibit adoption of proven solutions.

2. Access to data and privacy concerns may limit program efficacy.
3. Lack of regulatory innovation and willingness to pilot new policies or technologies may limit grid modernization.
4. Many technologies, like-wide area control, are difficult and risky to test on the real grid.

Program Goals and Funding

In support of Office and Departmental goals, the Electricity Systems Hub program uses five strategic goals to inform program investment:

1. Enhance grid flexibility to incorporate a variety of energy sources and responsive loads, including large amounts of variable and distributed energy resources
2. Maintain reliability by developing real-time monitoring, control and protection to improve grid operations
3. Build system-level understanding needed for innovative approaches to technology and regional planning
4. Promote regulatory structures that encourage efficiency in electricity markets
5. Secure energy systems and assets against cyber and physical threat

Goal Areas

	1. Flexibility	2. Reliability	3. System Understanding	4. Efficient Markets	5. Security
Electricity Systems Hub	20%	15%	50%	10%	5%

Explanation of Funding and Program Changes

(Dollars in Thousands)

	FY 2012 Current	FY 2014 Request	FY 2014 Request vs FY 2012 Current
Electricity Systems Hub			
The increase reflects the initial year of funding for the new Electricity Systems Hub, first requested in FY 2013 Budget Request.	0	20,000	+20,000
TOTAL, Electricity Systems Hub	0	20,000	+20,000

Electricity Systems Hub

The Electricity Systems Hub will address the critical issues and barriers associated with integrating, coordinating, and facilitating the numerous changes that are happening on distribution systems with consideration of changes on the transmission system. By taking a systems-level approach and a "grid-to-edge" perspective, the Hub will focus on advancements that will enable the seamless modernization of the electric grid to drive resiliency and address climate change. It will also help accommodate changes in the generation mix (an "all of the above" portfolio, distributed generation, etc.), changing loads (electric vehicles, energy storage, LED lighting, etc.), and the increasing use of information and communication technologies (building energy management systems, demand response, sensors, phasor measurement units (PMUs), etc.).

It is vital that a systems-level approach is taken to achieve seamless systems integration. One critical segment of the grid that has not been sufficiently addressed is the "seam" between transmission and distribution, nominally at the distribution substation/feeder level. For example, coordinated operation of distributed resources at high levels of deployment can influence the performance of the transmission system. Maintenance and system upgrades can affect the contingency analysis shared between utilities (Southwest Blackout, 2011). These interactions are not well understood and the impacts on electricity prices, implications for reliability standards, and impacts to system resiliency are also unknown. The main focus of the Electricity Systems Hub will be at this nexus of power flows, information flows, markets, and regulations (see Figure 1). The integrated Hub approach that brings together a broad, multidisciplinary group of experts covering applied science, technology, economics, and policy serves well to address the barriers and challenges associated with this "pinch point" of grid modernization.

Systems integration of the numerous technologies and concepts that are being developed is needed for a seamless and modernized grid. Potential technologies include advanced devices, components, software, and systems that will provide the future power grid with the ability to expand its capability, to sense its own conditions, and to reconfigure as necessary to achieve resiliency. Solutions that enable safe two-way power flows, securely integrate information technology with power controls, and optimize operational paradigms will be emphasized. Exploration of utility business models, improved system understanding, and the cultivation of multidisciplinary thought leaders, in addition to policy and market analyses, can help reduce barriers to innovation and system transformation.

For example, the next generation control center will be a critical platform to the evolution of the distribution system and its interaction with the transmission system. Advanced applications have been developed through the American Recovery and Reinvestment Act including outage management systems, volt-var optimization, and improved asset management but have not been sufficiently integrated. Advancements in computational, modeling, and systems integration will allow for control centers to have more functionality and responsibility in the future, allowing for more efficient management of the electric system and the segmentation of the electrical system to support resiliency.

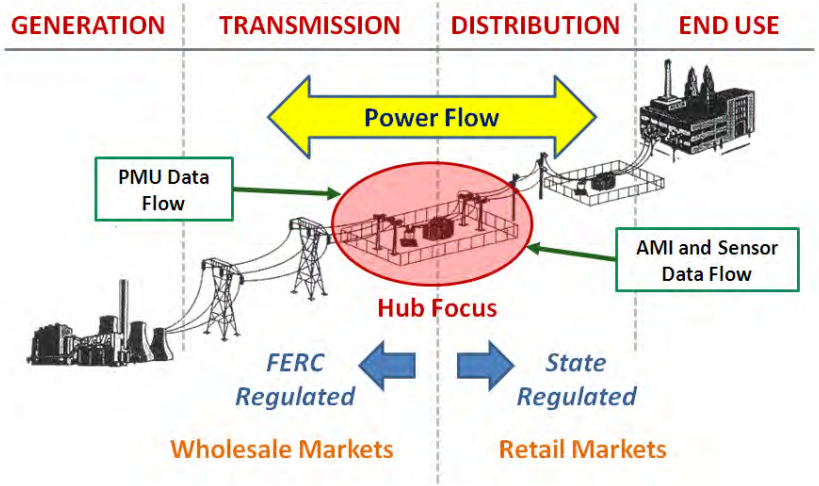


Figure 1 – Schematic portraying the various domains of the grid and the main focus of the Electricity Systems Hub

Benefits

Societal Benefits

- Helps reduce greenhouse gas emissions by enabling the increased deployment of renewable energy resources.
- Supports a safe, reliable, and cost-effective transition to a seamless, modernized grid.
- Enables more consumer choice with the optimal integration of electric vehicles, energy management systems, distributed generation, and other technologies with the power system.

Industry Benefits

- Explores new business models and addresses potential institutional barriers to modernization.
- Serves as a live test bed to explore new technologies and concepts in an interdisciplinary environment.
- Focuses on critical concerns of the industry and develops viable solutions.

Economic Benefits

- Spurs technology innovations that can contribute to economic growth and US leadership in a clean energy economy.
- Increased utilization of assets can lower electricity costs, freeing up capital to be spent on other goods and services.

Funding and Activity Schedule

Fiscal Year	Activity	Funding (Dollars in Thousands)
FY 2012		0
FY 2013		---
FY 2014	• Establish a Hub, or several regional Hubs, through a competitive solicitation • Begin R&D on critical systems integration issues for grid modernization • Assess and form a plan to bridge transmission and distribution data, markets, power, and standards	20,000

National Energy Delivery
Funding Profile

(Dollars in Thousands)

	FY 2012 Current	FY 2013 Annualized CR*	FY 2014 Request
National Electricity Delivery **	6,976	7,019	6,000

*FY 2013 amounts shown reflect the P.L. 112 175 continuing resolution level annualized to a full year. These amounts are shown only at the "congressional control" level and above; below that level a dash (—) is shown.

** This program was previously called *Permitting, Siting and Analysis*. It has been renamed the National Electricity Delivery program in the recent OE re-organization. The scope of work funded under this program has not changed.

P.L. Authorizations

Public Law 95–91, "Department of Energy Organization Act", 1977
Public Law 95-617, Public Utilities Regulatory Policy Act, 1978
Public Law 109-58, Energy Policy Act, 2005
Public Law 110-140, Energy Independence and Security Act, 2007

Program Overview and Benefits

In support of the Secretary's goal to *Transform our Energy Systems*, the National Electricity Delivery (NED) program helps states, regional entities, and tribes to develop and improve their programs, policies, and laws to facilitate the development of reliable and affordable electricity infrastructure, whether generation, transmission, or demand side resources.

NED provides expert guidance to state policy makers and the electric power industry to deal with major new challenges, some of which include integrating variable generation; utility energy efficiency; utility business models; demand response and smart grid; the effect of cheaper natural gas from increasing shale gas development on utility resource planning, including gas/electric interdependencies; new approaches to transmission planning; management of risk under continued electricity policy uncertainty; the future of coal generation; and the potential effect of EPA regulations on system reliability.

NED also executes its Federal responsibilities by authorizing the export of electric energy and permitting the construction of transmission infrastructure across international borders; conducting a tri-annual transmission congestion study; and helping better coordinate permitting of transmission on Federal lands – all in accordance with the Federal Power Act.

Program Accomplishments and Milestones

In FY 2012 the National Electricity Delivery program accomplishments include:

- Hosting four regional pre-study workshops and three webinars to receive input and suggestions concerning the 2012 National Electric Transmission Congestion Study.
- Issued two cross-border Presidential Permits, processed four new electricity Export Authorizations (EAs), 12 renewals of EAs, and rescinded one EA.
- Developed a modeling tool to help several state utility commissions quantitatively evaluate electric utility financial impacts under different energy efficiency scenarios.
- Helped western states with their request for better ways to integrate variable generation, such as wind and solar energy, into their electricity grid.

Milestone	Date
• Provide Technical Assistance to 35 States/Governors Offices/Tribes	3rd Q 2013
• Coordinate and review draft revisions of regulations for Presidential Permits and Export Authorizations	4th Q 2013
• Coordinate and review draft revisions of regulations for Federal permitting of transmission infrastructure pursuant to section 216(h) of the Federal Power Act	4th Q 2013

Program Planning and Management

OE recognizes that the development of a flexible electricity system begins when states and regions have the necessary expertise to make informed technology and market decisions. Through the NED program, OE plays a helpful role in bridging states' interests for the purpose of realizing solutions appropriate for them while encouraging regional and national views as appropriate.

NED partners with state, regional, and tribal entities and provides, upon request, technical assistance to them on electricity-related policies. Through the interconnection planning process funded under the American Recovery and Reinvestment Act, OE facilitates dialogues among regional electricity stakeholders, recognizing that many critical challenges require regional collaboration in order to build future electricity infrastructure.

States, regional entities, and tribes may have limited in-house expertise in these technical and policy areas. We expect increased demand for our technical assistance as they consider the effects of evolving policies, new electricity sector technologies (such as demand response and smart grid), cheaper natural gas for electricity generation, oversight of environmental retrofits to coal generation due to EPA regulations, transmission siting, and state renewable mandates. NED provides improved efficiency by sharing technical and policy expertise among these entities.

NED will implement three key strategies to more efficiently and effectively manage the program.

1. Provide assistance to states: NED provides technical assistance to states, other federal partners, and tribes on electricity-related topics.
2. Promote regional thinking: NED will continue to promote regional thinking (beyond traditional utility, system operator or state boundaries) among state and local electricity stakeholders, especially regarding transmission, demand-side and generation planning, and analysis.
3. Promote Federal coordination on transmission permitting and review process to provide a transparent, consistent, and predictable path for both project sponsors and affected communities.

Two external factors present the greatest potential impact to the overall achievement of the program's strategic goal:

1. The lack of available, highly skilled and experienced state and regional electricity policy analysis experts to provide technical assistance.
2. Information sharing and data standardization practices for electricity grid planning and operations; measurement and verification of progress towards policies and performance metrics (e.g. state energy efficiency goals) as well as system operations.

Program Goals and Funding

The NED program supports the development of informed state policies, laws, and programs that encourage modernization of the Nation's electricity grid. To encourage efficient project management and foster teamwork among personnel, NED focuses its activities in three goal areas:

1. Implementing transmission-related **Statutory Requirements** - including provisions of EPAct 2005, referring to the National Congestion Study and Transmission Tracking (216(h) of the Federal Power Act), and EISA 2007.
2. **International Regulatory Program** – includes authorizing the export of electricity across borders, and permitting the construction of cross-border transmission infrastructure.
3. Expert **Technical Assistance** – to states, tribes and regional entities, upon request, on electricity topics.

Goal Areas

	Statutory Requirements	International Regulatory Program	Technical assistance
National Electricity Delivery	15%	25%	60%

Explanation of Funding and Program Changes

(Dollars in Thousands)

	FY 2012 Current	FY 2014 Request	FY 2014 Request vs FY 2012
National Electricity Delivery			
This decrease reflects a reduction of collaborative efforts with states, regional entities, and tribes, as well as a one-time payment in FY 2012 to settle litigation.	6,976	6,000	-976

National Electricity Delivery

NED undertakes a wide range of activities that cover many aspects of electricity policy, from permitting and authorizing cross-border electricity flows to better Federal permitting of transmission lines on Federal lands. Another important function is providing technical assistance to states, tribes and regional entities, upon request, on electricity policy-related topics.

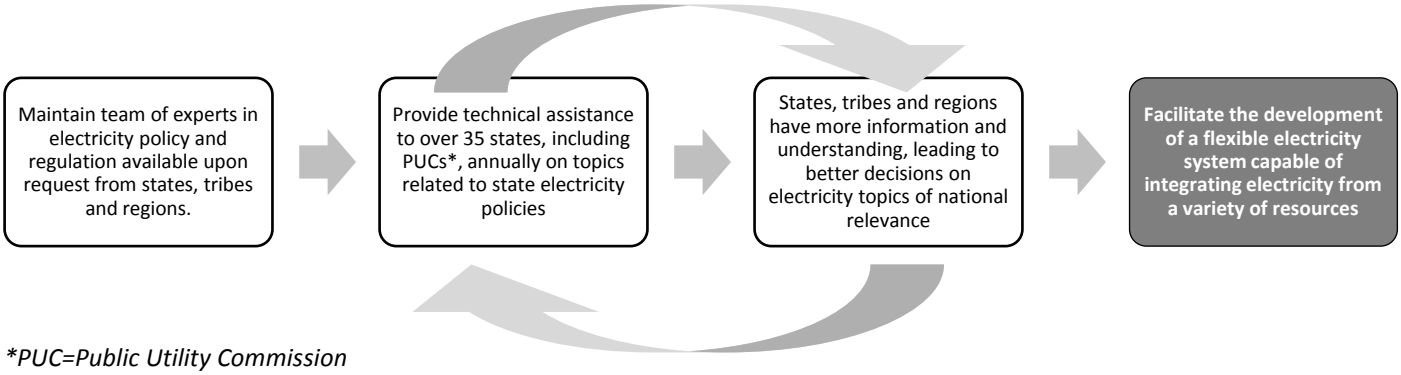
Federal Permitting: Modernizing our Nation's electric transmission grid requires improvements in how transmission lines are sited and permitted by Federal agencies. Section 1221(a) of the Energy Policy Act of 2005 (EPAct05) added a new section 216 to the Federal Power Act (FPA) which deals with the siting of interstate electric transmission facilities. Because a single project may cross multiple governmental jurisdictions, strong collaboration among Federal agencies is critical to the successful siting of such facilities.

Section 216(h) of the FPA provides for DOE to coordinate Federal transmission siting determinations for entities seeking permits, special use authorizations, certifications, opinions, or other approvals required under Federal law to site electric transmission facilities. This coordination will avoid duplicative review processes, and will improve uniformity, consistency, and transparency by various Federal agencies. NED manages implementation of DOE's 216(h) program, and represents DOE as the designated federal lead agency tasked with fulfilling statutory obligations to coordinate all applicable federal authorizations and related environmental reviews in siting electric transmission facilities, to negotiate and facilitate 216(h) schedules among all involved agencies, and to implement relevant requirements for NEPA compliance. In this capacity, NED has taken the lead in developing a pre-application process to encourage early coordination between Federal agencies and potential applicants. This process identifies agency expectations and technical information needs for potential transmission developers prior to the formal filing of applications with Federal agencies. A robust pre-application process that involves all pertinent Federal agencies early with the potential applicant will lead to the development of more robust applications for Federal agencies' consideration, and will aid in identifying potentially sensitive areas and/or resources to be avoided when applicants design potential routes. NED's activities in leading this effort are critical for positively transforming the Federal siting, permitting, and review process for transmission projects, and directly support DOE's implementation of Executive Order 13604, *Improving Performance of Federal Permitting and Review of Infrastructure Projects,* issued by President Obama on March 22, 2012.

Technical Assistance: NED helps to develop and improve policies, state laws, and programs that facilitate the development of infrastructure and markets needed to bring electricity from a variety of resources to consumers. Successfully achieving this goal requires close coordination with states, regional entities, and Tribes. NED assists with their electricity policies by providing objective expert technical assistance, on an as-requested basis, to state public utility commissions, state legislatures, regional state associations, Governors' offices, and Tribes.

For example, topics requiring assistance or analysis include: electricity resource planning; regional transmission planning; emerging gas/electric interdependencies due to new availability of cheap shale gas; renewable energy policies and portfolio standards, and particularly variable renewables integration, utility energy efficiency, utility business models, demand-response; and smart grid; and management of risk under continued policy uncertainty. The program continues to encourage the development of regional institutions, regional collaboration, and regional thinking on these and other topics that help to modernize the grid and meet the needs of a 21st Century economy.

NED maintains a team of experts in electricity policy and regulations, available upon request, to help states, regional entities, and Tribes understand the potential effects, and improve the design of state and regional policies. The program provides objective technical assistance, leading to informed policy decisions based on the best solutions for each region. The result is a modern, flexible electricity system, capable of integrating electricity from the resources that best serve its users.



**PUC=Public Utility Commission*

Benefits

- Improve the ability of states and regions to make better informed electricity-related policy decisions
- Increase access to a variety of electricity resources, improve system reliability
- Provide a better understanding of where there is transmission congestion
- Ensure efficient siting for all Federal authorizations as the coordinating agency
- Facilitate regional access to new energy resources and sources of power from Canada and Mexico by authorizing international electricity transmission lines

Other Information

National Electric Transmission Congestion Study: http://energy.gov/oe/services/electricity-policy-coordination-and-implementation/transmission-planning/2012-national

Funding and Activity Schedule

Fiscal Year	Activity	Funding (Dollars in Thousands)
FY 2012	• Implemented appropriate parts of FERC's National Action Plan for Demand Response issued under the Energy Independence and Security Act of 2005, as part of a 2011 Implementation Proposal for FERC's Action Plan. • Provided major analytical support to the West for its consideration of methods to better integrate wind and solar into the electricity grid. • Provided technical assistance on electricity policies, upon request, to approximately 30 public utility commissions and other federal, state and regional entities. • Provided technical support to tribal entities in partnership with the DOE Office of Indian Energy Policy and Programs. • Provided additional analysis and planning to the West for its interconnection-wide transmission planning, specifically focused on the wind and solar grid integration requested as part of their planning efforts. • Initiated the third National Electric Transmission Congestion Study, including hosting four regional pre-study workshops and three webinars to receive input and suggestions. • Issued Record of Decision for the Energia Sierra Juarez U.S.-Mexico cross-border transmission line. • Issued Record of Decision for the International Transmission Company U.S. – Canada cross-border transmission line. • Continued processing Presidential permit application Environmental Impact Statements (EISs) Champlain Hudson Power Express Transmission Line; and the Northern Pass	6,976

Fiscal Year	Activity	Funding (Dollars in Thousands)
	Transmission Line, both proposed to cross the U.S.-Canadian border. • Completed 2 Presidential Permit, processed 4 new electricity Export Authorizations (EAs), 12 renewals of EAs, and rescinded 1 EA. • As co-lead to the State of Hawaii in the development of the Hawaii Inter-island Renewable Energy Program, DOE and Hawaii began an inter-island cable Programmatic Environmental Impact Statement (PEIS), which is a modification of the wind PEIS.	
FY 2013	Planned activities in the FY 2013 Budget**:** • Provide technical assistance on electricity policies, upon request, to approximately 40 public utility commissions and other federal state and regional entities. • Respond to any request for DOE emergency orders under the Federal Power Act for reliability issues associated with environmental retrofits or closures of power plants that may occur under various new EPA regulations.	---
FY 2014	• Structure the 216(h), Presidential Permit and Section 1222 programs in a consistent manner to leverage office resources and provide potential applicants with familiar concepts across each program. Explore avenues for cost recovery to implement each of these permitting programs. • Institutionalize implementation of EPACT Section 1222 into the NED program. • Continue preparation of the EISs for Champlain Hudson Power Express Transmission Line Project and Northern Pass Transmission Line. • Implement regulations for revised Federal permitting of transmission infrastructure pursuant to section 216(h) of the Federal Power Act. • Provide technical assistance on electricity policies, upon request, to public utility commissions, tribes, and other Federal, state and regional entities.	6,000

Infrastructure Security and Energy Restoration
Funding Profile

(Dollars in Thousands)

	FY 2012 Current	FY 2013 Annualized CR*	FY 2014 Request
Infrastructure Security and Energy Restoration			
Infrastructure Security and Energy Restoration	5,981	6,018	6,000
Operational Energy and Resilience	0	0	10,000
Total, Infrastructure Security and Energy Restoration	5,981	6,018	16,000

*FY 2013 amounts shown reflect the P.L. 112 175 continuing resolution level annualized to a full year. These amounts are shown only at the "congressional control" level and above; below that level a dash (—) is shown.

P.L. Authorizations

P.L. 95–91, "Department of Energy Organization Act", 1977
P.L. 93-319, "The Energy Supply and Environmental Coordination Act," 1974
P.L. 93-275, "Federal Energy Administration Act, 1974

Overview

In supporting the Secretary's Goal: *Transform Our Energy Systems*, the Infrastructure Security and Energy Restoration (ISER) division leads national efforts, in cooperation with public and private sector stakeholders (including asset owners and operators), to enhance the reliability, survivability, and resiliency of the U.S. energy infrastructure (electricity, petroleum, natural gas), while also improving national energy security by addressing energy infrastructure interdependencies based on risk and consequences.

ISER's primary responsibility is to help secure the U.S. energy infrastructure against all hazards, whether natural or man-made, physical or cyber. It also develops tools and identifies advanced technology for deployment to enhance the ability of the energy sector to be resilient. In addition, ISER partners with state and local governments, responding to and recovering from energy disruptions, to ensure seamless collaboration at all levels.

These activities place ISER in a unique role to help define the technology needs of the energy sector. ISER uses its expertise and partnerships to identify potential technical solutions and suppliers of technology, evaluate risk and cost, and drive innovation by facilitating the seamless integration of advanced technologies developed by OE's research and development programs into energy infrastructure. ISER contributes to the Department's and the energy sector's long-term responsibilities to secure the US energy supply by addressing topics like High Impact Low Frequency (HILF) events such as a geomagnetic (GMD) storm.

In collaboration with the Department of State, ISER provides engineering assessments to key energy-producing partners to assist in securing their energy infrastructure which may be critical to the US energy supply. Upon request, and on a cost reimbursable basis, ISER provides assistance to secure these critical energy assets abroad. Also on a cost reimbursable basis, ISER provides strategic advice through Energy Advisors to the US Combatant Commands (COCOMs) on a broad range of energy and national security issues.

The Department is currently not fully equipped to respond to new challenges caused by: stronger, more destructive storms like Hurricane Sandy; more sophisticated cyber attacks; potential accidents as a result of aging infrastructure or human error; and potential HILF threats such as GMD storms or a catastrophic earthquake can bring to the energy infrastructure. FY 2014 lays the foundation to develop an enhanced capability that will enable the Department to better protect against and mitigate these threats and hazards, with the ultimate goal of quicker recovery by industry and the communities they serve. The new Operational Energy and Resilience (OER) sub-program, in conjunction with the continued ISER sub-program, is set up to meet these challenges.

The FY 2014 request for the OER supports the modification and expansion of the Energy Resilience and Operations Center (E-ROC) within the Department of Energy's Washington, D.C. headquarters. It will be a steady-state operations center, where the Department can monitor, receive and analyze real-time threat and energy sector status and can coordinate and share this information with all Energy Sector stakeholders. During emergencies, the E-ROC will serve as the collaboration hub between the Department of Energy, other Federal Agencies and Energy Sector partners, including critical infrastructure owners and operators, and will be responsible for status and information sharing between DOE and other emergency operation centers (Federal and State). A state-of-the-art "knowledge wall" (screen) in the E-ROC will be capable of receiving multiple and disparate near real-time data feeds, simultaneously visualizing and overlaying over the impacted area, so that decision makers can appropriately respond.

The OER subprogram will also to place DOE Energy Advisors in Federal Emergency Management Agency (FEMA) regional offices to support response and restoration efforts during emergencies. This cadre of permanent advisors will also implement regionally tailored, energy resilience approaches for facility owners and States (including territories and tribal) to mitigate, prepare, prevent, respond and recover from major disasters and events that impact energy infrastructure.

Program Accomplishments and Milestones

In FY 2012, ISER's major accomplishments include:

- **Situational Awareness Dashboard** – Developed a near-real time monitoring situational awareness system to collect and analyze performance data on energy infrastructure systems to improve decision makers' capacity to better mitigate, and recover faster from disruptions.
- **Electricity Sector Cybersecurity Risk Management Process Guideline** – Published the Risk Management Process (RMP) Guidelines, a public-private collaboration to develop a cybersecurity risk management guideline that will provide a consistent, repeatable, and adaptable process to proactively manage cybersecurity risk in the electricity sector.
- **Electricity Sector Geomagnetic Disturbance (GMD) SUNBURST Support Effort –** Completed a study and developed a strategy, in coordination with Electric Power Research Institute (EPRI), that will lead to the deployment of additional geomagnetically-induced (GIC) sensors in strategic locations across North America. This will be done through EPRI's SUNBURST program. These sensors will provide the data needed to understand which areas are most affected by GICs, and allow those utilities to mitigate the effects on their system. It will also provide real-time, wide area monitoring during solar storms to provide industry important operational information.
- **ESF-12 Long-Distance Learning Online Training –** Leveraging existing technology, the creation of an interactive training capability has allowed each trainee to take required course at their own computer eliminating the need for costly travel. Trainees interacted with each other and trainers throughout the online course and participated in an energy emergency exercise which more closely replicated an actual response. Received the "Innovation Award" and "Excellence in e-Learning Award" from the Federal Government Distant Learning Association and the Chief Learning Officer Magazine, respectively.

Milestone	Date
Develop, validate, and implement the Energy Sector Criticality Methodology.	2nd Q 2013
Develop and execute a process to validate the risk of a GMD on system operations and transformers, the impact of the event, and risk mitigation solutions. Deploy GIC sensors to strategic areas in North America.	3rd Q 2013
Modify space and expand Energy Resilience and Operations Center (E-ROC) and knowledge wall .	3rd Q 2014
Permanently locate on a full time basis one FTE in each of the 10 FEMA Regional Offices to provide energy expertise and coordinate response and resiliency efforts.	4th Q 2014

Program Planning and Management

All activities are facilitated by effective coordination with Federal, state and industry partners to leverage complimentary efforts. Specifically, ISER will implement the following strategies to effectively manage the program:

1. **Use of Volunteers**. In addition to the permanent regional presence with FEMA proposed in the 2014 Budget, ISER maintains a cadre of trained energy emergency response volunteers capable of deploying to the ten regional FEMA offices to assist in organizing and coordinating emergency response activities. Given that natural disasters tend to occur more often during certain times of the year, ISER supplements with full-time staff during those surges.

This strategy reduces ISER's costs while ensuring mission accomplishment; responders rapidly deploy to areas where energy infrastructure has been severely damaged.

2. **Build Internal Technical Capability**. ISER continues to develop and expand its infrastructure reliability capabilities by enhancing its monitoring, situational awareness and response capabilities through advancements in outage and restoration visualization.
3. **Enhance Sector Partnerships and Collaboration**. ISER actively partners and collaborates with federal, state, local and industry partners through forums, web-based training, and face-to-face sessions to exchange ideas for better resiliency and security and share information.
4. **Modify and Expand Energy Resilience and Operations Center (E-ROC) and Knowledge Wall.** The E-ROC, will serve as a steady-state operations center that can receive and analyze real-time infrastructure status and threat information and coordinate the sharing of that information to all energy sector stakeholders and other Federal and State governments. During emergencies impacting energy infrastructure, the center will become DOE's focal point where coordination with energy owners and operators and other Federal and States (including tribal and territorial) emergency centers will occur. Included will be the acquisition of data feeds on the real time status of energy infrastructure. The E-ROC will then synthesize and summarize this data for use by stakeholders including federal policy officials.
5. **Regionalize Energy Situational Awareness.** FY 14 will allow for the deployment of 10 DOE Regional Energy Advisors at the 10 FEMA Regional offices (one DOE Advisor in each Regional Office.) These advisors will serve as on the ground experts in an energy emergency. They will coordinate and communicate consistent and comprehensive energy-system status in an emergency and engage in resilience activities with other Federal agencies in the region, including the State emergency management offices, DHS, FEMA, EPA, among others.

Three external factors present the strongest impacts to the overall achievement of ISER's strategic goals:

1. The intensity and frequency of the natural and/or man-made disasters,
2. The ability to protect industry data and information shared,
3. The dynamic nature of a constantly changing threat – both physical and cyber – to U.S. energy systems.

ISER executes the Department's role as:

1. The Sector Specific Agency for Energy under Presidential Policy Directive–21,
2. DOE Preparedness lead under Presidential Policy Directive–8, and
3. Emergency Support Function–12 (ESF-12) when activated by FEMA, pursuant to Presidential Policy Directive –8.

Program Goals and Funding

ISER's mission, program goals, and focus area activities are aligned with DOE Strategic Plan Goals and US National Security Strategy. In an effort to maximize its capabilities within an efficient framework, ISER aligns its activities into focus areas:

- Executing effective **emergency preparedness, response, and restoration** operations;
- Providing reliable energy infrastructure **analysis and situational awareness** to all stakeholders; and
- Encouraging a risk-based approach to **physical and cyber system assurance**.
- Laying the foundation to develop **operational energy and resilience** capabilities that currently does not exist.

Goal Areas

	Emergency Preparedness, Response, and Restoration	Analysis and Situational Awareness	Physical and Cyber System Assurance	Operational Energy and Resilience
TOTAL, Infrastructure Security and Energy Restoration	13%	15%	9%	63%

Explanation of Funding and Program Changes

(Dollars in Thousands)

	FY 2012 Current	FY 2014 Request	FY 2014 Request vs FY 2012 Current
Infrastructure Security and Energy Restoration			
No significant changes	5,981	6,000	+19
Operational Energy and Resilience			
Reflects development of Operational Energy and Resilience Capability, which includes modification and enhancement to a state-of-the-art Energy Resilience and Operations Center, and placing Federal staff at FEMA Regional Offices to provide expertise		10,000	+10,000
TOTAL, Infrastructure Security and Energy Restoration	5,981	16,000	+10,019

Infrastructure Security and Energy Restoration

ISER's mission, strategic goals, and activities support the Department's objective to "Modernize the Electric Grid" and U.S. National Security Strategy's top security objective: "Strengthen Security and Resilience at Home".

Emergency Preparedness, Response, and Restoration

- Improves mobilization of response teams ahead of storms to ensure rapid and coordinated response with federal partners, affected states, and energy sector leaders. Building on energy assurance plans funded by the 2009 American Recovery and Reinvestment Act (ARRA), ISER conducts exercises to test state and local energy assurance plans in states and select US territories and cities.
- Defines prevention, protection, mitigation, response and recovery options for newly identified and evolving threats.
- Conducts national and regional-level exercises, workshops and forums to enhance information sharing with federal, state and industry partners in support of national preparedness mission areas (prevention, protection, mitigation, response and recovery).

Analysis and Situational Awareness

- Provides information to the public on the status of energy infrastructure, and briefs senior government officials, the White House and Congress.
- Publishes analytic reports on issues of concern impacting the energy sector; for example, ISER's leadership of a joint public-private effort to determine the impact of geomagnetic disturbances on the North American power grid. ISER provides federal leadership and technical guidance, and will produce a technical mitigation paper in FY 2013.
- Maintains energy system data sets to:
  - support impact projection analysis prior to events;
  - improve awareness of actual system impacts to support response operations; and
  - facilitate the analysis of system conditions and influences in post-event forensics.

Physical and Cyber System Assurance

- Develops risk-based decision-making and resiliency planning, allowing the best return on investment. A good example is ISER's leadership of the interagency effort to develop Risk Management Process Guidelines for Cybersecurity, released in FY 2012.
- Facilitates the exchange of actionable information with industry partners on new and evolving threats, vulnerabilities, and mitigation options. These exchanges are vital to the economy and public safety, and key stakeholders have come to rely upon them. ISER's Energy Sector Criticality Methodology will significantly improve asset owners' risk management decisions.
- Manages and Coordinates the Department's activities under the 2010 DOE-DOD Energy Security MOU. The MOU has led to several high-profile collaborations between the Departments that enhance national energy security and provide Federal leadership in transforming the US energy system.

Benefits

- Rapid response to natural disasters through improved mobilization of response teams ahead of storms
- Protection against physical and cyber threats through open exchange of threat information and mitigation options
- Reduced impact from disruptive events through close coordination with both the public and private sectors
- Development and implementation of National preparedness and resilience policy (in accordance with Presidential Policy Directive-8 and PPD).

Other Information

- National Security Strategy (May 2010) http://www.whitehouse.gov/sites/default/files/rss_viewer/national_security_strategy.pdf
- Presidential Policy Directive (PPD)-8 National *Preparedness* – http://www.dhs.gov/xabout/laws/gc_1215444247124.shtm
- Department of Homeland Security, National Infrastructure Protection Plan – http://www.dhs.gov/nipp

- National Response Framework – http://www.fema.gov/pdf/emergency/nrf/nrf-core.pdf
- Presidential Policy Directive (PPD) – 21 Critical Infrastructure Security and Resilience – http://www.whitehouse.gov/the-press-office/2013/02/12/presidential-policy-directive-critical-infrastructure-security-and-resil

Funding and Activity Schedule

Fiscal Year	Activity	Funding (Dollars in Thousands)
FY 2012	• Trained 80% of Regional Coordinators and 20% of Voluntary Responders on regional energy infrastructure to provide the Responders with the skill set necessary to be self-sufficient and apply sub-set of analytical expertise during emergencies. • Building on workshops sponsored by DOE and North American Electric Reliability Corporation (NERC), supported efforts with industry and government stakeholders to analyze the potential impact of a geomagnetic disturbance (GMD) on electric power grid operations. • Improved situational awareness capabilities through the advancement in power outage and restoration visualization tools; natural gas and petroleum modeling visualization tools; and near-real time reporting capabilities. • Developed a framework to address three functions: o Identify assets, systems, networks, and functions o Assess risk based on consequences, threats, and vulnerabilities o Prioritize assets, systems, networks and functions • Completed a draft strategic analytic framework for identifying and modeling foreign energy infrastructure that if disrupted would negatively impact global energy supplies.	5,981
FY 2013	Planned activities in the FY 2013 Budget: • Train 100% of Regional Coordinators and 50% of Voluntary Responders on regional energy infrastructure; test training by participating in National Level Exercise 2013 (NLE13) • Continue support for efforts with NERC and government and industry stakeholders to analyze the potential impact of GMD on electric power grid operations, producing a technical mitigation paper for use by the energy sector. • Expand infrastructure reliability and analytical capabilities by continuing to apply a robust systems analysis process that incorporates surveys (OE-417, RSR and EIA surveys), field data collection, and modeling results. • Begin development of the cyber-physical threat centralized reporting system, which will have the ability to provide real-time information back to the energy infrastructure community. • Using ISER's criticality framework, conduct a pilot analysis of a country's energy system to identify critical energy infrastructure and characterize the impact on global energy supplies.	---
FY 2014	• Train 100% of Regional Coordinators and 70% of Voluntary Responders on regional energy infrastructure; test training by participating in National Level Exercise 2014 (NLE14) • Continue to develop and implement sensor technologies and other procedural enhancements to address GMD and the potential impact on grid resiliency through the information sharing/visualization portal for the GIC nodes deployed for the SUNBURST program. • Re-design the Energy Sector Coordinating Councils to improve information sharing between DOE and the private sector. • Facilitate the necessary actions to bring together key oil and natural gas stakeholders for the establishment of an ISAC-like structure for information sharing and dissemination.	6,000

Fiscal Year	Activity	Funding (Dollars in Thousands)
	• Continue support for the Executive Order, "Improving Critical Infrastructure Cybersecurity" and "Critical Infrastructure Security and Resilience" Presidential Policy Directive (PPD-21).	

Operational Energy and Resilience

Over the past decade, the U.S. has suffered the effects of a number of major disasters that have destroyed the essential components of the energy infrastructure and resulted in significant economic loses. Most recently for example, the total economic loss caused by Hurricane Sandy in 2012 is estimated to be in the range of $30 to $50 billion. With 8 of the top 10 hurricanes having occurred in the last decade with estimated total economic costs (not adjusted for inflation) ranging from $8 billion (Jeanne, 2004) to $108 billion (Katrina, 2005), these events have resulted in a considerable loss of vital energy supplies to homes, businesses, and the critical energy infrastructure.

In addition to increasing variability and costs resulting from weather-related events, the Energy Sector[a] is facing new, emerging threats, including threats to our nation's cybersecurity. The global cyber threat landscape has changed dramatically in the last two years with the appearance of malwares and a variety of new control system vulnerabilities. Emerging technologies, the convergence of Information Technology (IT) and Operational Technology (OT), and increased connectivity across traditionally segmented operations have also increased cybersecurity risk for the Energy Sector. These risks exacerbate the challenges of maintaining situational awareness of internal and external cyber threats.

Given the current state of our energy infrastructure, the evolving threat picture, the nation's overall dependence on energy, and the complexities of addressing integrated physical and cyber energy risks, it is imperative that the Department expand and enhance its capability to organize and lead a robust energy infrastructure resilience program that is well prepared to provide timely and effective emergency response and restoration activities. This enhanced capability will be met through establishment of the Operational Energy and Resilience program.

To accomplish this, the Department needs an integrated capability that provides real-time situational awareness of threats to critical nodes within the energy sector. The new Energy Resilience and Operations Center (E-ROC) will provide continuous monitoring of the status of the nation's critical energy infrastructure, and a robust, state of the art ability to assess, visualize, and synthesize data resulting in a more focused, regionally based, rapid response to emergencies. As a result of these enhanced capabilities, the Department will be able to provide state and local partners, including private industry, and federal policy officials with essential information on threats, warnings, hazards, and best practices, and the real-time situational awareness capability will provide first responders and energy system owners/operators with the information they need for prioritization of restoration efforts and for distribution of back-up power. This will help the nation recover from disruptive events more quickly and effectively and reduce the economic impact of the event.

Energy resilience requires a collaborative approach that involves the entire energy community, which is diverse, complex, and widely dispersed. This level of interaction and collaboration depends on trusted relationships that cannot be established and maintained exclusively from DOE headquarters in Washington, DC. Therefore a DOE energy expert would be located on a permanent basis in each of the 10 FEMA Regional Offices. This will provide needed energy expertise on the ground for federal emergency response efforts and will enable the Department to build and maintain essential relationships with all energy stakeholders within the states and their respective regions.

The request of $10 million in FY 2014 for the Operational Energy and Resilience program will expand and enhance the Department's ability to organize and lead an effective energy infrastructure preparedness program with a swift and efficient emergency response and restoration capability that inspires confidence. Of the $10 million, $6 Million will be used for the build-out of a state-of-the-art Energy Resilience and Operations Center (E-ROC) at DOE headquarters through the reconfiguration of current DOE office space. The E-ROC will provide immediate monitoring and situational awareness of the energy systems through advanced visualization technology, including multi-source data feeds for real-time monitoring, synthesis capability to foster a more rapid and targeted response, unclassified and classified information sharing, and effective and efficient coordination between private industry and the federal, state and local government (including tribal and territorial).

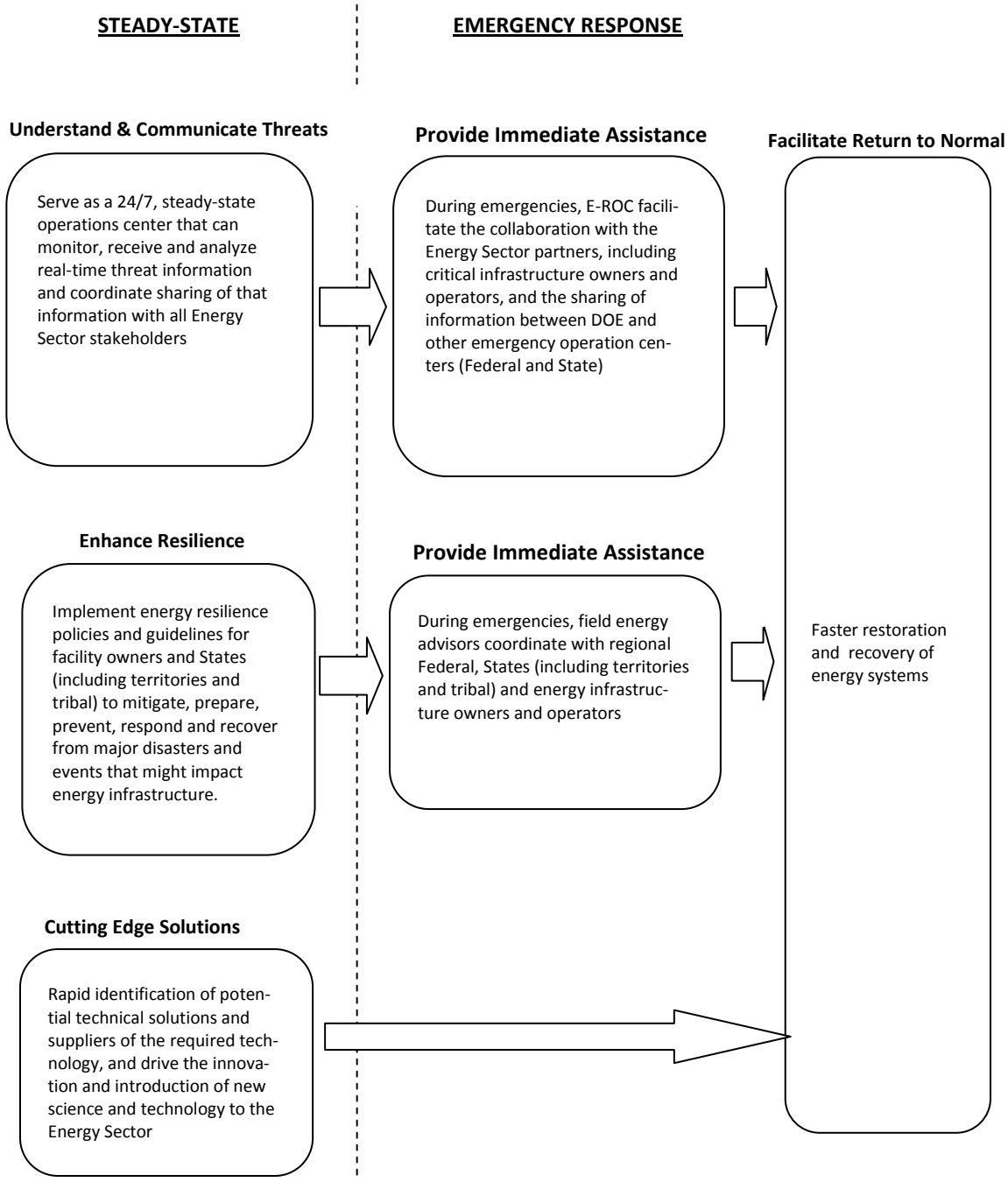
The remaining $4 Million will support the Federal staffing of 10 subject matter experts located at 10 FEMA Regional Offices responsible for the implementation of resilience solutions. Placing energy expertise in the field will help minimize the impacts of the diverse threats on the Nation's critical energy infrastructure system and implement innovative solutions to im-

[a] The Energy Sector, as delineated by the Homeland Security Presidential Directive 7, includes the production, refining, storage, and distribution of oil, gas, and electric power, except for hydroelectric and commercial nuclear power facilities.

prove response time during actual emergencies. The funds will also support the initial staffing of 7 Federal headquarters personnel providing awareness and logistical support in the enhancement of the E-ROC.

Steady-State and Emergency Response Operations

Energy system disruptions occur daily across the country, but not all events rise to national significance. The Energy Resilience and Operations Center (E-ROC) will maintain a Steady-State mission that is proactive in assessing live data feeds and information on "normal" day-to-day events. The Emergency Response mission is reactive and supports significant emergencies that affect larger segments of the energy infrastructure and require interagency and intradepartmental engagement on a large-scale. During Steady-State and during Emergency Response, the E-ROC and the capabilities provided by the Knowledge Wall improve the understanding of threats allowing for clear communication. Development of a permanent energy expertise presence in the field enhances the resilience of energy infrastructure and allows for the deployment of cutting edge technology, which in turn will allow immediate assistance to stakeholders in the Capitol Region and the affected Regions. The end result of both elements is a faster restoration and recovery of energy systems.



Benefits

- Faster restoration and recovery of energy infrastructure systems.
- Better coordination between DOE and the Energy Sector partners, including critical infrastructure owners and operators during emergencies.
- Regionally tailored approach to protection and mitigation programs and energy resiliency policies.
- Increased availability of information through real-time situational awareness between DOE and other emergency operation centers (Federal and State).
- Enhance the protection of energy resources and mitigate impacts of disasters and malevolent acts

Other Information

- Presidential Policy Directive (PPD) – 8 *National Preparedness* – http://www.dhs.gov/xabout/laws/gc_1215444247124.shtm
- Presidential Policy Directive (PPD) – 21 Critical Infrastructure Security and Resilience – http://www.whitehouse.gov/the-press-office/2013/02/12/presidential-policy-directive-critical-infrastructure-security-and-resil
- Department of Homeland Security, National Infrastructure Protection Plan – http://www.dhs.gov/nipp
- National Response Framework – http://www.fema.gov/pdf/emergency/nrf/nrf-core.pdf
- National Disaster Recovery Framework – http://www.fema.gov/pdf/recoveryframework/ndrf.pdf

Funding and Activity Schedule

Fiscal Year	Activity	Funding (Dollars in Thousands)
FY 2012		0
FY 2013		0
FY 2014	• Build the E-ROC and knowledge wall. • Recruit 10 Federal subject matter experts located at the 10 FEMA regional field offices responsible for the implementation of resilience solutions to minimize the impacts of the diverse threats on the Nation's critical energy infrastructure system and implements innovative solutions to improve response time during actual emergencies. • Recruit 7 Headquarter Federal personnel providing analytic/logistic support in the standup and build out of the E-ROC. • Conduct a regional energy assurance training exercise to assess state and local governments' response to energy events.	10,000

Program Direction
Funding Profile by Category

(Dollars in Thousands)

	FY 2012 Current	FY 2013 Annualized CR*	FY 2014 Request
National Energy Technology Laboratory			
Salary & Benefits	6,100	---	5,890
Travel	361	---	300
Support Services	1,105	---	500
Other Related Expenses	400	---	248
Total, National Energy Technology Laboratory	7,966	7,579	6,938
Full Time Equivalents[a]	(33)	(32)	(31)
Headquarters			
Salary & Benefits	11,025	---	12,871
Travel	882	---	650
Support Services	3,760	---	2,915
Other Related Expenses	3,377	---	4,241
Total, Headquarters	19,044	19,596	20,677
Full Time Equivalents	73	80	80
Electricity Delivery and Energy Reliability			
Salary & Benefits	17,125	---	18,761
Travel	1,243	---	950
Support Services	4,865	---	3,415
Other Related Expenses	3,777	---	4,489
Total, Headquarters	27,010	27,175	27,615
Full Time Equivalents	73 (33)	80 (32)	80 (31)

*FY 2013 amounts shown reflect the P.L. 112 175 continuing resolution level annualized to a full year. These amounts are shown only at the "congressional control" level and above; below that level a dash (—) is shown.

[a]The FTEs reported at NETL are displayed in parenthesis to indicate that they are a non-add in the OE budget because they are counted in the Fossil Energy budget.

Overview

Program Direction provides for the costs associated with the federal workforce, including salaries, benefits, travel, training, building occupancy, IT services, and other related expenses. It also provides for the costs associated with contractor services that, under the direction of the federal workforce, support OE's mission. It also includes funding for the coordination of the Energy portfolio by the Office of the Under Secretary for Energy.

Salaries and Benefits supports 111 FTEs that provide executive management, programmatic oversight, and analysis for the effective implementation of the OE program. Of these, 80 FTEs are planned for Headquarters and 31 FTEs are planned at NETL. While OE supports 31 FTEs at NETL within its budget, the FTEs are counted in the Fossil Energy Budget. Therefore, the 31 FTEs are a non-add in the OE budget.

Travel includes transportation, subsistence, and incidental expenses that allow OE to effectively manage R&D electricity technology programs and projects in the field; provide the Department's electricity-related outreach to regional, State, and Tribes with regard to planning needs and issues, policies, siting protocols and new energy facilities; and assist the Department of Homeland Security, the Department of State and local governments, and the private sector to help protect against and recover from disruptions in the energy infrastructure.

Support Services includes contractor support directed by the federal staff to perform administrative tasks and provide analysis to management. These efforts include issue-oriented support on science, engineering, environment, and economics that benefit strategic planning; technology and market analysis to improve strategic and annual goals; development of management tools and analyses to improve overall Office efficiency; assistance with communications and outreach to enhance the Office's external communication and responsiveness to public needs; development of program-specific information tools that consolidate corporate knowledge, performance tracking and inventory data, improve accessibility to this information, and facilitate its use by the entire staff; and also may include support for post-doctoral fellows and Intergovernmental Personnel Act (IPA) assignments.

Other Related Expenses includes corporate IT support and working capital expense, such as rent, supplies, copying, graphics, mail, printing, and telephones. It also includes equipment upgrades and replacements, commercial credit card purchases using the simplified acquisition procedures to the maximum extent possible, and other needs.

Major Program Shifts or Changes

There are no significant changes.

Explanation of Funding Changes

(Dollars in Thousands)

	FY 2012 Current	FY 2014 Request	FY 2014 Request vs FY 2012 Current
Salaries and Benefits: Increase reflects additional FTE's to provide technical expertise in the implementing OE's mission.	17,125	18,761	+1,636
Travel: Significant reduction in travel supports the administration's travel reduction initiatives	1,243	950	-293
Support Services: Decrease reflects efforts to increase efficiencies in contractor support	4,865	3,415	-1,450
Other Related Expenses: Increase reflects transfer of function from Support Services to Working Capital Fund.	3,777	4,489	+712
Total, Program Direction	27,010	27,615	+605

Support Services by Category

(Dollars inThousands)

	FY 2012 Current	FY 2014 Request	FY 2014 Request vs FY 2012 Current
Support Services			
Technical Support Services	1,376	1,317	-59
Management Support Services	3,489	2,098	-1391
Total, Support Services	4,865	3,415	-1,450

Other Related Expenses by Category

(Dollars in Thousands)

	FY 2012 Current	FY 2014 Request	FY 2014 Request vs FY 2012 Current
Other Related Expenses			
DOE/COE	600	500	-100
Other Services	977	855	-122
Working Capital Fund	2,200	3,134	+934
Total, Other Related Expenses	3,777	4,489	+712

Nuclear Energy

Nuclear Energy

Table of Contents

The Department of Energy's Congressional Budget justification is available on the Office of Chief Financial Officer, Office of Budget homepage at http://www.cfo.doe.gov/crorg/cf30.htm.

Nuclear Energy

Proposed Appropriation Language

For Department of Energy expenses including the purchase, construction, and acquisition of plant and capital equipment, and other expenses necessary for nuclear energy activities in carrying out the purposes of the Department of Energy Organization Act (42 U.S.C. 7101 et seq.), including the acquisition or condemnation of any real property or any facility or for plant or facility acquisition, construction, or expansion, $735,460,000, to remain available until expended, of which $24,000,000 shall be derived from the Nuclear Waste Fund: Provided, That , of the amount made available under this heading, $87,500,000 shall be available until September 30, 2015, for program direction.

Explanation of Change

No change.

Nuclear Energy
Office of Nuclear Energy

Overview
Appropriation Summary by Program

(dollars in thousands)

	FY 2012 Current[a]	FY 2013 Annualized CR*	FY 2014 Request
Nuclear Energy Appropriation			
Integrated University Program	5,000	5,031	0
SMR Licensing Technical Support	67,000	67,410	70,000
Reactor Concepts Research, Development and Demonstration	110,652	115,574	72,500
Fuel Cycle Research and Development	180,993	187,400	165,100
Nuclear Energy Enabling Technologies	71,307	75,127	62,300
Radiological Facilities Management	69,510	69,935	5,000
Idaho Facilities Management	154,097	155,040	181,560
Idaho Sitewide Safeguards and Security	0	0	94,000[b]
International Nuclear Energy Cooperation	2,983	3,001	2,500
Program Direction	91,000	91,557	87,500
Subtotal, Nuclear Energy Appropriation	752,542	770,075	740,460
Transfer from Department of State	7,924	0	0
Use of Prior Year Balance	0	0	-5,000
Total, Nuclear Energy Appropriation	760,466	770,075	735,460
Other Defense Activities Appropriation			
Idaho Sitewide Safeguards & Security	93,350	93,921[b]	0
Total, Other Defense Activities	93,350	93,921	0
Total, Office of Nuclear Energy	853,816	863,996	735,460

*FY 2013 amounts shown reflect the P.L. 112-175 continuing resolution level annualized to a full year. These amounts are shown only at the "congressional control" level and above; below that level a dash (—) is shown.

*Appropriation Year SBIR/STTR:

- FY 2012 Transferred: SBIR: $9,770,838; STTR: $1,315,306 (FY 2012) and SBIR: $1,574,440; STTR: $188,934 (FY 2011)
- FY 2013 Annualized CR: SBIR $10,208,727: STTR: $1,323,354
- FY 2014 Request: SBIR $7,557,200: STTR: $1,079,600

[a] The FY 2012 Current column reflects Reactor Concepts ($830,447) and NEET ($932,927) FY 2011 SBIR/STTR carryover that transferred to the Office of Science in FY 2012.
[b] Idaho Sitewide Safeguards & Security is being moved from Other Defense Activities to Nuclear Energy in FY 2014.

Office Overview and Accomplishments

The primary mission of the Office of Nuclear Energy (NE) is to advance nuclear power as a resource capable of contributing to meeting the Nation's energy supply, environmental, and energy security needs. To ensure that nuclear energy remains a viable energy option for the Nation, NE supports research, development, and demonstration activities, if appropriate, which are designed to resolve the technical, cost, safety, waste management, proliferation resistance, and security challenges of increased use of nuclear energy. NE leads the Federal research effort to develop nuclear energy technologies, including generation, safety, waste storage and management, and security technologies to help meet energy security, proliferation resistance, and climate goals.

Within the Nuclear Energy Appropriation, NE funds the following major programs: SMR Licensing Technical Support, Reactor Concepts Research, Development and Demonstration (RD&D), Nuclear Energy Enabling Technologies (NEET), Fuel Cycle R&D, Radiological Facilities Management (RFM), Idaho Facilities Management (IFM), Idaho Safeguards and Security (S&S), International Nuclear Energy Cooperation and Program Direction. In FY 2014 the Idaho Sitewide S&S program is being requested under the Nuclear Energy Appropriation.

A prerequisite to the continued use of nuclear power is public confidence in the safety of nuclear plants and commercial confidence that the plants can be operated safely, reliably and economically. The Department will explore improvements to light water reactor systems and fuel forms to further enhance safety and reliability under severe accident conditions. Our R&D efforts will be coordinated with reactor vendors, utilities, universities, regulators and the international community to ensure that lessons learned from the events at Fukushima, Japan are appropriately incorporated and that these efforts are integrated and efficient.

Strategy for the Management and Disposal of Used Nuclear Fuel and High-Level Radioactive Waste:

Finding a consent-based, long-term solution to managing the nation's nuclear waste and used nuclear fuel is a long standing challenge. Such a solution, however, is necessary to assure the future viability of an important carbon-free energy supply and further strengthen America's standing as a global leader on issues of nuclear safety and nonproliferation.

In FY 2010, the Secretary of Energy chartered a Blue Ribbon Commission (the Commission) on America's Nuclear Future composed of experts from government, academia and industry. The Commission charter charged the Commission to "conduct a comprehensive review of policies for managing the back end of the nuclear fuel cycle, including all alternatives for the storage, processing, and disposal of civilian and defense used nuclear fuel, high-level waste, and materials derived from nuclear activities… [and to] provide advice, evaluate alternatives, and make recommendations for a new plan to address these issues." The Commission issued its final report on January 26, 2012.

In January 2013, the Department released its *Strategy for the Management and Disposal of Used Nuclear Fuel and High-Level Radioactive Waste*. This Strategy lays out a broad outline for a stable, integrated system capable of transporting, storing, and disposing of high-level nuclear waste from civilian nuclear power generation, defense, national security and other activities. The Administration looks forward to working with Congress to build and implement the principles and elements of this strategy.

To support the nuclear waste management program over the long term, reform of the current funding arrangement is necessary and the Administration believes the funding system should consist of the following elements: ongoing discretionary appropriations, access to annual fee collections provided in legislation either through their reclassification from mandatory to discretionary or as a direct mandatory appropriation, and eventual access to the balance or "corpus" of the Nuclear Waste Fund.

The FY 2014 Budget includes a proposal to implement such reform. Discretionary appropriations are included for this new program within Fuel Cycle Research and Development – Used Nuclear Fuel Disposition beginning in 2014 and continue for the duration of the effort. These funds would be used to fund expenses that are regular and recurring, such as program management costs, including administrative expenses, salaries and benefits, studies, and regulatory interactions. Mandatory appropriations in addition to the discretionary funding are proposed to be provided annually beginning in 2017 to fund the balance of the annual program costs.

The program envisioned is a very long term, flexible, multi-faceted approach to dispose of the nation's commercial and defense waste. The estimated programmatic cost of this effort over its first 10 years is $5.6 billion. As part of this program, the Budget assumes the construction and operation of a pilot interim waste storage facility within the next 10 years as well as notable progress on both full-scale interim storage and long-term permanent geologic disposal. The deployment of pilot interim storage within this first 10 years allows the government to begin picking up waste, thus enabling

the collection of one-time fees owed by certain generators that will offset some of the projected mandatory spending. Over the 10-year period (FY2014-FY 2023), the projected net mandatory cost would be in the range of $1.3 billion.

The sooner that legislation enables progress on implementing a nuclear waste management program, the lower the ultimate cost will be to the taxpayers.

Technical Support for the Licensing of Small Modular Reactors:

A high priority of the Department has been to accelerate the timelines for the commercialization of small modular reactor (SMR) technologies through the SMR Licensing Technical Support program. The mission of the program is to support first-of-a-kind costs associated with design certification and licensing activities for SMR designs through cost-shared arrangements with industry partners (industry contributions are a minimum of 50% of the cost) to promote the deployment of SMRs that can provide safe, clean, affordable power. If industry chooses to widely deploy these technologies in the U.S., they could help meet the nation's economic, energy security and climate change goals.

In 2012, the Department selected an SMR vendor and utility partnership to support development of the licensing documentation that would lead to SMR deployment in 2022.

The Department is conducting a second solicitation for one or two additional awards that will support industry's use of additional innovative and competitive SMR technology options and improve safety profiles.

This follow-on solicitation will be funded within the $452 million envelope of the SMR Licensing Technical Support program and extend the duration of the program an additional year through FY 2017.

Radioisotope Power Systems (RPS):
The Office of Nuclear Energy provides radioisotope power systems for non-NE and non-DOE space missions. These activities have been split funded by NE, through the Radiological Facilities Management program, and by the user agencies, primarily the National Aeronautics and Space Administration. Starting in FY 2014 these activities are shifting to a full cost recovery strategy and as such the funding request for RPS is included in the NASA budget.

Idaho Safeguards and Security:
The Department is requesting that the safeguards and security program for the Idaho National Laboratory be aligned with other Office of Nuclear Energy programs within the Nuclear Energy appropriation. Aligning safeguards and security funding with a national laboratory's primary program sponsor and lead secretarial officer, a standard within the Department, facilitates program execution and facility management.

Significant Office of Nuclear Energy Accomplishments in FY 2012:

In FY 2012, NE achieved significant accomplishments or milestones in program management and program development. Such accomplishments include:

- Initiation of a new public-private partnership to support Small Modular Reactor deployment,
- Provision of new technology to support the NASA mission to Mars
- Development of new integrated, multi-physics simulation capabilities of an existing pressurized water reactor under the Energy Innovation Hub for Modeling and Simulation
- Completed qualification testing of the TRISO fuel compacting line and irradiation of the second Advanced Graphite Creep test experiment for NGNP
- Conducted proof of concept Supercritical CO2 Brayton Cycle energy conversion system testing at the 1MW level
- Initiating alternative analyses for the Advanced Post-Irradiation Examination Capabilities Project and for resuming transient nuclear fuel testing
- Completion of construction on the Materials and Fuels Complex Dial Room Replacement Project, establishing continuity and reliability of service with new, state-of-the-art telecommunications hardware and software
- Conducting an independent, peer review of the S&S Program and implementing recommendations to reduce costs and completing cyber security Certification and Accreditation (C&A) activities for INL's unclassified moderate enclaves
- Began drafting a roadmap for evaluating, developing, and deploying light water reactor fuels with enhanced accident tolerance
- Completing the development of a total system performance assessment model for processes affecting performance of a salt repository for disposal of heat-generating nuclear waste.

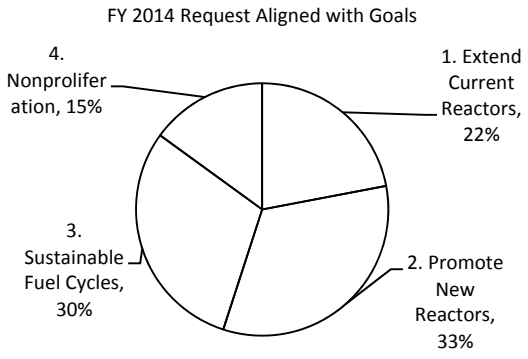
Alignment to Strategic Plan

The Department's May 2011 Strategic Plan outlines two primary objectives to which NE aligns its activities: 1) Deploy the Technologies We Have; and 2) Discover the New Solutions We Need. Targeted plans that support these objectives include:

- Accelerate the commercialization of SMR technology through cost-shared technical support.
- Complete a comprehensive assessment—by September 2012—of materials degradation issues for light-water reactor plants operating beyond 60 years.
- Demonstrate advanced inspection techniques for irradiated fuel at the Irradiated Materials Characterization Laboratory (IMCL) by April 2013.

In April 2010, the Department released its Nuclear Energy R&D Roadmap which describes four main R&D objectives targeted toward addressing key challenges to nuclear power. NE activities are aligned with these goals and the goals guide program planning and execution. They provide a concrete framework for NE's activities and link to the Department's strategic priorities.

1. Develop technologies and other solutions that can improve the reliability, sustain the safety, and extend the life of current reactors.
2. Develop improvements in the affordability of new reactors to enable nuclear energy to help meet the Administration's energy security and climate change goals.
3. Develop sustainable nuclear fuel cycles.
4. Understand and minimize the risks of nuclear proliferation and terrorism.



Explanation of Changes

The Office of Nuclear Energy requests a total of $735.460 million in FY 2014 in budget authority, a decrease of $118.4 million from the FY 2012 current appropriation. Of the $118.4 million, $77.4 million reflects non-programmatic financial adjustments including transfers from the Department of State (-$7.9 million), use of prior year balances (-$5.0 million), completion of the FY 2012 Congressional add-on for Oak Ridge infrastructure (-$15.0 million), and the transition of the radioisotope power systems program to full cost recovery (-$49.5 million).

The remaining reductions of $40.9 million, 4.8% of the FY 2012 current appropriation, primarily reflect realignments within the Nuclear Energy Research and Development programs:

The Reactor Concepts Research, Development and Demonstration is reduced by $38.2 million as activities under the Next Generation Nuclear Plant Demonstration Project are refocused from development and deployment activities towards longer term research. Consistent with these actions NGNP is eliminated as a separate subprogram and the ongoing research activities will be funded along-side other Advanced Reactor Concepts research.

The Fuel Cycle Research and Development program sees a $15.9 million reduction as a result of a de-emphasis on long-term R&D into advanced transmutation fuels.

The Nuclear Energy Enabling Technologies program is reduced by $9.0 million including Crosscutting Technologies (-$5.9 million) and Nuclear Energy Advanced Modeling and Simulation (-$4.3 million). Offsetting these decreases is increased funding for the R&D and operational infrastructure of the Idaho National Laboratory. An additional $13 million is requested to support the resumption of transient testing; $16.3 million for in line item funding for the Remote-Handled Low Level Waste Disposal Project; and $3.4 million for increased maintenance activities. These increases are offset by $5.3 million in reduced design activities associated with the RH-LLW project transitioning to construction activities. The Advanced Post-Irradiation Examinations Capabilities environmental and technical options studies are continued in FY 2014.

The Idaho Safeguards and Security program funding level changes from $93.4 million in FY 2012 to $94.0 million in FY 2014 and in FY 2014 will be funded within Nuclear Energy, not Other Defense Activities.

Crosscuts - Nuclear Energy University Program

The Department strives to engage the U.S. university community to achieve its overall NE research and development mission. As part of this effort the Department allocates up to 20% of its NE research and development appropriations for university-based program and mission-supporting R&D, and related infrastructure improvements.

Within the NEUP framework, the Department is investigating options for increasing opportunities for transformative and innovative nuclear energy research that explore "game changing" major breakthrough solutions across the full range of nuclear energy technologies. These activities support and complement the development of new and advanced reactor concepts and fuel cycle technologies, encourage development of transformative, "out-of-the-box" solutions across the full range of nuclear energy technology issues, and focus innovative research relevant to multiple reactor and fuel cycle concepts that offer the promise of dramatically improved performance.

(dollars in thousands)

	FY 2012 Current	FY 2013 Est.	FY 2014 Est.
Nuclear Energy University Program			
Reactor Concepts RD&D	22,174	23,115	14,500
Fuel Cycle R&D	34,607	37,480	27,020
NE Enabling Technologies	2,918	3,242	1,907
Total, NEUP Funding	59,699	63,837	43,427

Goal Program Alignment Summary

	1. Extend Life of Current Reactors	2. Enable New Reactors	3. Sustainable Nuclear Fuel Cycle	4. Nonproliferation
Nuclear Energy				
SMR Licensing Technical Support	0%	100%	0%	0%
Reactor Concepts RD&D	30%	58%	10%	3%
Fuel Cycle Research and Development	7%	17%	67%	10%
Nuclear Energy Enabling Technologies	56%	22%	20%	2%
Radiological Facilities Management	25%	25%	25%	25%
Idaho Facilities Management	25%	25%	25%	25%
Idaho Safeguards and Security	25%	25%	25%	25%
International Nuclear Energy Cooperation	20%	20%	0%	60%
Program Direction	25%	25%	25%	25%
Total, Nuclear Energy	22%	33%	30%	15%

Performance Measures

Performance Goal (Measure)	**Facility Availability - Idaho Facilities Management Program** - Enable nuclear research and development activities by providing operational facilities and capabilities, as measured by availability percentages.		
Fiscal Year	**2012**	**2013***	**2014**
Target	80 % availability	80 % availability	80 % availability
Result	Not met – Advanced Test Reactor 73.2% available; Materials and Fuels Complex 67.8% available.		
Endpoint Target	Maintain the percentage of facilities and capabilities that are available for research and development activities at 90% or better.		

*2013 targets represent DOE's FY 2013 Budget Request to Congress. FY 2013 target updates can be found in the upcoming FY 2012-2014 Annual Performance Plan & Report.

Performance Goal (Measure)	**Facility Operability Index - RAD (Space and Defense)** - To ensure unique nuclear facilities are available to support critical Departmental missions, maintain a facility operability index of 0.9 for key Radiological Facilities Management program facilities.		
Fiscal Year	**2012**	**2013***	**2014**
Target	Not met – 0.77 FOI.	0.9 RAD (Space and Defense) facility availability	N/A
Result	0.9 RAD (Space and Defense) facility availability		
Endpoint Target	Maintain key RFM program facilities at a level of high operational status (FOI = 0.9 or better) to ensure unique nuclear facilities are available to support critical Departmental missions.		

*2013 targets represent DOE's FY 2013 Budget Request to Congress. FY 2013 target updates can be found in the upcoming FY 2012-2014 Annual Performance Plan & Report.

Performance Goal (Measure)	**Light Water Reactor Sustainability** - This program is developing the scientific basis to extend existing nuclear power plant operating life beyond the current 60 year limit. The scientific basis will assist the NRC in making life-extension regulatory decisions. For FY2012 and beyond the performance measure is to meet 90% of planned annual milestones.		
Fiscal Year	**2012**	**2013***	**2014**
Target	90 % annual program milestones met	90 % annual program milestones met	90 % annual program milestones met
Result	Met – 100% milestones completed.		
Endpoint Target	NE-developed tools and assessments will help establish the scientific bases for existing plants to receive license extensions from the NRC in the 2030 timeframe.		

*2013 targets represent DOE's FY 2013 Budget Request to Congress. FY 2013 target updates can be found in the upcoming FY 2012-2014 Annual Performance Plan & Report.

Facilities Maintenance and Repair

The Department's Facilities Maintenance and Repair activities are tied to its programmatic missions, goals, and objectives. Facilities Maintenance and Repair activities funded by this budget are displayed below.

Costs for Direct-Funded Maintenance and Repair (including Deferred Maintenance)

(dollars in thousands)

	FY 2012 Actual Cost	FY 2012 Planned Cost	FY 2013 Planned Cost	FY 2014 Planned Cost
Idaho National Laboratory	15,309	14,113	---	19,430
Total, Direct-Funded Maintenance and Repair	15,309	14,113	---	19,430

Costs for Indirect-Funded Maintenance and Repair (including Deferred Maintenance)

(dollars in thousands)

	FY 2012 Actual Cost	FY 2012 Planned Cost	FY 2013 Planned Cost	FY 2014 Planned Cost
Idaho National Laboratory	12,709	17,584	---	13,107
Total, Indirect-Funded Maintenance and Repair	12,709	17,584	---	13,107

Report on FY 2012 Expenditures for Maintenance and Repair

This report responds to legislative language set forth in Conference Report (H.R. Conf. Rep. No. 108-10) accompanying the Consolidated Appropriations Resolution, 2003 (Public Law 108-7) (pages 886-887), which requests the Department of Energy provide an annual year-end report on maintenance expenditures to the Committees on Appropriations. This report compares the actual maintenance expenditures in FY 2012 to the amount planned for FY 2012, including directed changes.

Total Costs for Maintenance and Repair

(dollars in thousands)

	FY 2012 Actual Cost	FY 2012 Planned Cost
Idaho National Laboratory	28,018	31,697
Total, Maintenance and Repair	28,018	31,697

Each year, the "Planned Amount" for maintenance and repair is a target number. The *Idaho National Laboratory* did not meet its planned target in FY 2012. The negative variance from the target was due to an unpredicted depth of the indirect business volume reductions that the INL experienced. Loss of direct business volume reduced indirect recovery below previously submitted plans resulting in fewer funds available for maintenance. However, high level measures, such as the Asset Condition Index (ACI) and the Maintenance Investment Index (MII), are expected to remain above targets. The strategy for managing maintenance spending was focused on funding more essential activities at mission-critical and mission-dependent facilities. There has not been a negative impact on worker safety, environmental safety or mission deliverables.

Small Business Innovation Research/Small Business Technology Transfer (SBIR/STTR)

(dollars in thousands)

	FY 2012 Current[3]	FY 2013 Annualized CR	FY 2014 Request
Reactor Concepts Research, Development and Demonstration	4,219	3,525	2,320
Fuel Cycle Research and Development	5,267	5,716	4,323
Nuclear Energy Enabling Technologies	3,363	2,291	1,994
Total, SBIR/STTR	12,849	11,532	8,637

[3] The FY 2012 Current column reflects Reactor Concepts ($830,047) and NEET ($932,927) FY 2011 SBIR/STTR carryover that transferred to the Office of Science in FY 2012.

Nuclear Energy
Office of Nuclear Energy
Funding by Site by Program

(dollars in thousands)

	FY 2012 Current	FY 2013 Annualized CR*	FY 2014 Request
Argonne National Laboratory			
Fuel Cycle Research and Development	10,020	9,545	8,622
International Nuclear Energy Cooperation	1,036	1,045	870
Nuclear Energy Enabling Technologies	2,304	4,400	850
Reactor Concepts Research, Development and Demonstration	13,110	5,600	10,350
Total, Argonne National Laboratory	26,470	20,590	20,692
Brookhaven National Laboratory			
Fuel Cycle Research and Development	1,960	2,650	2,426
Nuclear Energy Enabling Technologies	150	0	0
Reactor Concepts Research, Development and Demonstration	545	60	130
Total, Brookhaven National Laboratory	2,655	2,710	2,556
Chicago Operations Office			
Radiological Facilities Management	22	0	0
Total, Chicago Operations Office	22	0	0
Idaho National Laboratory			
Fuel Cycle Research and Development	63,928	34,859	29,170
Idaho Facilities Management	148,493	149,000	175,460
International Nuclear Energy Cooperation	590	892	787
Nuclear Energy Enabling Technologies	18,111	19,377	22,755
Radiological Facilities Management	10,265	10,000	0
Reactor Concepts Research, Development and Demonstration	71,137	61,610	29,815
Idaho Sitewide Safeguards and Security	0	0	91,972
SMR Licensing Technical Support	20	0	0
Total, Idaho National Laboratory	312,544	275,738	349,959
Idaho Operations Office			
Fuel Cycle Research and Development	30,078	50,796	55,766
Idaho Facilities Management	4,696	5,100	5,100
Idaho Sitewide Safeguards and Security	0	0	2,028
Integrated University Program	5,000	5,031	0
International Nuclear Energy Cooperation	25	240	135
Nuclear Energy Enabling Technologies	11,436	8,791	5,000
Program Direction	39,152	38,165	36,132
Radiological Facilities Management	7,341	4,996	4,980
Reactor Concepts Research, Development and Demonstration	3,232	435	830
SMR Licensing Technical Support	66,846	62,410	65,000
Total, Idaho Operations Office	167,806	175,964	174,971

(dollars in thousands)

	FY 2012 Current	FY 2013 Annualized CR*	FY 2014 Request
Kansas City Site Office			
Idaho Facilities Management	88	152	65
Total, Kansas City Site Office	88	152	65
Lawrence Berkeley National Laboratory			
Fuel Cycle Research and Development	2,877	3,005	2,675
Total, Lawrence Berkeley National Laboratory	2,877	3,005	2,675
Lawrence Livermore National Laboratory			
Fuel Cycle Research and Development	2,610	2,640	2,488
International Nuclear Energy Cooperation	144	0	0
Nuclear Energy Enabling Technologies	775	250	300
Reactor Concepts Research, Development and Demonstration	342	170	350
Total, Lawrence Livermore National Laboratory	3,871	3,060	3,138
Los Alamos National Laboratory			
Fuel Cycle Research and Development	13,525	13,073	11,179
International Nuclear Energy Cooperation	410	10	90
Nuclear Energy Enabling Technologies	2,790	530	950
Radiological Facilities Management	27,050	27,000	0
Reactor Concepts Research, Development and Demonstration	1,200	820	1,150
Total, Los Alamos National Laboratory	44,975	41,433	13,369
Nevada Site Office			
Idaho Facilities Management	103	110	115
Total, Nevada Site Office	103	110	115
Oak Ridge Institute for Science and Education			
Program Direction	1,096	1,095	1,050
Total, Oak Ridge Institute for Science and Education	1,096	1,095	1,050
Oak Ridge National Laboratory			
Fuel Cycle Research and Development	23,108	18,179	15,227
International Nuclear Energy Cooperation	160	359	309
Nuclear Energy Enabling Technologies	29,255	25,842	26,122
Radiological Facilities Management	19,796	4,600	0
Reactor Concepts Research, Development and Demonstration	14,329	17,930	19,910
Total, Oak Ridge National Laboratory	86,648	66,910	61,568
Oak Ridge Operations Office			
Fuel Cycle Research and Development	320	0	0
Program Direction	1,637	1,640	1,595
Radiological Facilities Management	400	0	0
Total, Oak Ridge Operations Office	2,357	1,640	1,595
Pacific Northwest National Laboratory			
Fuel Cycle Research and Development	8,772	9,469	8,296
International Nuclear Energy Cooperation	225	50	50

	(dollars in thousands)		
	FY 2012 Current	FY 2013 Annualized CR*	FY 2014 Request
Nuclear Energy Enabling Technologies	1,380	848	550
Reactor Concepts Research, Development and Demonstration	2,525	290	590
Total, Pacific Northwest National Laboratory	12,902	10,657	9,486
Sandia National Laboratories			
Fuel Cycle Research and Development	15,328	11,592	10,549
International Nuclear Energy Cooperation	0	124	124
Nuclear Energy Enabling Technologies	2,375	750	600
Radiological Facilities Management	1,736	1,300	0
Reactor Concepts Research, Development and Demonstration	3,706	1,720	2,465
Total, Sandia National Laboratories	23,145	15,486	13,738
Savannah River National Laboratory			
Fuel Cycle Research and Development	0	3,875	3,458
International Nuclear Energy Cooperation	100	0	0
Total, Savannah River National Laboratory	100	3,875	3,458
Savannah River Operations Office			
Fuel Cycle Research and Development	3,300	0	0
Total, Savannah River Operations Office	3,300	0	0
Washington Headquarters			
Fuel Cycle Research and Development	5,167	27,717	15,244
Idaho Facilities Management	717	678	820
International Nuclear Energy Cooperation	293	281	135
Nuclear Energy Enabling Technologies	2,731	14,339	5,173
Program Direction	49,115	50,657	48,723
Radiological Facilities Management	2,900	22,039	20
Reactor Concepts Research, Development and Demonstration	526	26,939	6,910
SMR Licensing Technical Support	134	5,000	5,000
Total, Washington Headquarters	61,583	147,650	82,025
Total, Nuclear Energy	752,542	770,075	740,460

*FY 2013 amounts shown reflect the P.L. 112 175 continuing resolution level annualized to a full year. These amounts are shown only at the "congressional control" level and above; below that level a dash (—) is shown.

Programs Not Funded in FY 2014

Overview

Integrated University Program

In FY 2011, DOE provided no funding in its Operating Plan for the Integrated University Program (IUP) and no funding is being requested in FY 2014 for the program. IUP has consistently been proposed for termination. In the view of the Administration, this program is a less efficient means to advance the Administration's STEM objectives than other existing programs. In addition, as the nuclear industry expands, it will create the incentives necessary for students to enter nuclear-related programs.

Although no funding was requested in FY 2012, $5 million was Congressionally directed for IUP. Funding was used to support nuclear science and engineering study and research by fully funding 31 multi-year student fellowships and 39 single-year scholarships in the nuclear field of study.

All awards under this program are fully funded in the year funding was received. As a result, multi-year student research fellowships do not require support by out-year funds after the appropriation year.

No new funding was requested in FY 2013 for this program.

Funding Schedule

Fiscal Year	Activity	Funding (dollars in thousands)
FY 2012	Provide 39 new scholarships and 31 new fellowship grants with FY 2012 funds. Continue FY 2009 and FY 2010 multi-year activities, including fellowships and investigator initiated research.	5,000
FY 2013	Planned activities in the FY 2013 Budget (final allocations have not yet been determined): Continuation of FY 2010 and FY 2012 multi-year activities, i.e., fellowships.	5,031
FY 2014	No FY 2014- funded activities. Continuation of FY 2012 multi-year activities, i.e., fellowships.	0

SMR Licensing Technical Support
Funding Profile

(dollars in thousands)

	FY 2012 Current	FY 2013 Annualized CR*	FY 2014 Request
SMR Licensing Technical Support	67,000	67,410	70,000

*FY 2013 amounts shown reflect the P.L. 112-175 continuing resolution level annualized to a full year. These amounts are shown only at the "congressional control" level and above; below that level a dash (—) is shown.

Public Law Authorizations

P.L. 112-74, Consolidated Appropriations Act, 2012

Overview

The development of clean, affordable nuclear power options is a key element of the Department of Energy's Office of Nuclear Energy (DOE-NE) *Nuclear Energy Research and Development Roadmap.* As a part of this strategy, a high priority of the Department has been to help accelerate the timelines for the commercialization and deployment of small modular reactor (SMR) technologies through the SMR Licensing Technical Support program. The mission of the program is to support first-of-a-kind costs associated with design certification and licensing activities for SMR designs through cost-shared arrangements with industry partners (industry contributions are a minimum of 50% of the cost) to promote the deployment of SMRs that can provide safe, clean, affordable power. If industry chooses to widely deploy these technologies in the U.S., they could help meet the nation's economic, energy security and climate change goals. The cost of the SMR Licensing Technical Support program is $452 million.

In 2012, the Department selected an SMR vendor and utility partnership to support development of the licensing documentation that would lead to SMR deployment in 2022. DOE determined that the selected team would be the most capable applicant to make progress on the program mission and help gain insights to help address the generic issues that will face the SMR class of reactors.

The Department made the decision to issue a second Funding Opportunity Announcement (FOA) because the near-term licensing horizon dictated by the initial FOA may have inhibited the selection of innovative designs that may have presented more licensing risk than the initial design selected. The second FOA will also provide the industry with additional competitive SMR technology options. The second FOA will focus on innovative technologies to improve safety profiles and in response to the recent nuclear event in Japan.
This second FOA will solicit innovations that can improve SMR safety, operations and economics through lower core damage frequencies, longer post-accident coping periods, enhanced resistance to hazards presented by natural phenomena, and potentially reduced emergency preparedness zones or workforce requirements. The intention is to make one award; however, multiple awards could be made if more than one application of sufficient merit is received. This follow-on solicitation will be funded within the $452M envelope approved for the SMR Licensing Technical Support program. Due to the late start in executing the program beginning in FY 2012, the Department intends to extend the duration of the program through FY 2017.

The program will establish and track progress on milestones in all projects to ensure effective use of funds to support achievement of program goals. This oversight will involve:

- Ensuring industry partners are completing engineering and testing efforts in a timely manner to support licensing efforts.
- Ensuring that industry partners are preparing high quality certification and license applications to facilitate efficient NRC reviews.
- Ensuring early engagement of NRC to address long-lead items on the critical path to licensing and deployment.
- Helping to demonstrate the potential of the nascent SMR technology and encourage new competition in the marketplace.

Program Accomplishments and Milestones

The program supports two key activities:

1) Supporting the cooperative agreement established under the first FOA for the design and licensing of the selected SMR design.

2) Supporting the cooperative agreement(s) established under the second FOA for the design development and certification of one or more SMR technologies.

The SMR Licensing Technical Support program will achieve a number of significant accomplishments and milestones relative to the development of vendor and utility licensing documentation on the initial project and in the selection of innovative SMRs for the follow-on solicitation. Since the near-term program element is focused on accelerating the review and approval of certification and licensing processes that are controlled by the NRC, the thrust of the DOE supported activities will be in expediting and ensuring the completeness, accuracy, and timeliness of vendor and utility technical products.

Program funding is supporting:

- The reactor technology vendor selected under the first FOA for the design, engineering, testing, analysis, and NRC approval of a design certification document (DCD) for their reactor system.
- A specific utility selected under the first FOA for the development and approval of an operating license application specific to the chosen site.
- The execution of the procurement process for the second FOA by selecting one or more innovative SMR designs with which DOE will partner to provide technical support for the design, engineering and certification for the SMR technologies.

In FY 2014 the SMR Licensing Technical Support program is focused on supporting the execution of design, certification and licensing for the selected SMR projects. FY 2014 funding will be used for the following:

- DOE will complete the cooperative agreements for one or more projects selected from the second FOA and begin supporting SMR design development, engineering and certification efforts.
- Awardees will continue design efforts on specific SMR technology selected under the first FOA including engineering, component testing, and supporting evaluation and analysis
- Awardees will continue to efforts to complete Design Certification Document application for the technology selected under the first FOA, including required accident selection, probabilistic risk assessment and safety analysis sections, for submittal to NRC
- Awardees will continue efforts on a construction permit application documentation being developed by the utility partner selected under the first FOA, including addressing site-specific design issues and environmental characterization and monitoring
- Awardees will respond to NRC technical review issues, including requests for additional information and any experimentation or analysis required to close issues for the applications developed by the members of the team selected under the first FOA.

With respect to efforts on the second FOA, DOE will have completed the cooperative agreements for one or more projects and will begin supporting SMR design development, engineering and certification efforts.

The following are the key milestones that will be tracked under the program:

Milestone	Date
Complete cooperative agreement negotiations with the vendor(s) selected under second SMR FOA	Jan 2014
Complete site characterization activities for the selected SMR project site under the first FOA.	Mar 2014
Complete conceptual design reports for SMR design(s) selected under the second FOA.	June 2014
Submit the Design Certification Application to the NRC for the SMR design selected under the first FOA.	Sep 2014

Program Planning and Management

The program has been investing in the first-of-a-kind engineering, design development, and licensing and certification assistance for the SMR design selected under the first FOA to help accelerate the eventual deployment of the technology. The program also expects to initiate vendor partnerships for one or more additional innovative designs with slightly longer licensing horizons in support of design development, engineering and certification. SMRs have the potential

to provide clean, affordable power to the Nation, improve domestic energy security, and strengthen the economy. The program management staff has established a set of meaningful performance measures, including discrete milestones as a part of all of the cooperative agreements, to formally and effectively track project progress. These milestones and performance measures are being evaluated and updated on an annual basis through applications for continued funding submitted by the industry partners. NE is employing an appropriately graded program management system to track cost and schedule performance using these measures.

Strategic Management

In meeting the identified challenges to nuclear power, and SMRs in particular, the Department is implementing three key strategies to more efficiently and effectively manage the program, thus putting the taxpayers' dollar to more productive use.

1. Reduce the financial and regulatory risk of design, licensing, and deployment of first-mover SMR nuclear plant technologies.
2. Leverage innovative, crosscutting research and development (R&D), codes and standards, and regulatory activities carried out by the other DOE NE R&D programs to assist in the development, certification and licensing of SMRs.
3. Provide for partnerships, on a limited basis, with national laboratories, universities and international entities to leverage the capabilities and experiences of these organizations in supporting and accelerating project licensing and deployment schedules.

Three external factors that present the strongest potential impacts to the overall achievement of the program's strategic goal:

1. Whether new SMR technology will eventually be fabricated and deployed depends on power demand and economic and environmental factors beyond the scope of DOE programs. It depends on complex economic decisions made by industry partners;
2. The certification and licensing of nuclear plants is the responsibility of the NRC and the timing of the review and approval processes is entirely independent of DOE influence; and,
3. The price competitiveness of other energy technologies will have the strongest impact on the likelihood of SMRs being embraced as a clean power option by the power industry customers. The current low cost of natural gas factors significantly in utility decisions about how to meet future demand.

The general outlook for new nuclear deployment projects is still uncertain following the events at the Fukushima plants in 2011. The extent of the impact of future regulatory requirements on SMRs will not be known for years. However, domestic support for nuclear power remains reasonably strong in the U.S., suggesting that continued investment in SMRs is a worthwhile strategy.

Program Goals and Funding

The Department believes that SMRs have the potential to notably contribute to meeting the energy security, economic and environmental goals of the United States. Development and deployment of SMRs domestically may provide an opportunity for the United States to meet clean energy goals, promote U.S. technological leadership in the nuclear field and may help the U.S. industry compete in a potentially lucrative global market. If SMRs are manufactured domestically, it could help reinvigorate the domestic manufacturing sector and could create additional U.S. jobs. Finally, domestic deployment of SMR-based nuclear power would allow the United States to reduce greenhouse gas emissions.

The NE R&D Roadmap lays out four goals that programs work toward in support of NE's mission and that guide program planning and execution. These goals provide a concrete framework for NE's activities and link to the Department's strategic priorities:

- Develop technologies and other solutions that can improve the reliability, sustain the safety, and extend the life of current reactors.
- Develop improvements in the affordability of new reactors to enable nuclear energy to help meet the Administration's energy security and climate change goals.
- Develop sustainable nuclear fuel cycles.
- Understand and minimize the risks of nuclear proliferation and terrorism.

Additionally, the SMR Licensing Technical Support program directly addresses the following Departmental objective:

- Support design certification and licensing activities for SMR designs through cost-shared arrangements with industry partners to accelerate the commercialization of the SMR technologies.

Explanation of Funding AND/OR Program Changes

(dollars in thousands)

	FY 2012 Current	FY 2014 Request	FY 2014 Request vs FY 2012 Current
SMR Licensing Technical Support			
This increase from $67,000,000 to $70,000,000 reflects an alignment of funding with increasing certification and licensing project cost estimates consistent with the first-of-a-kind engineering, testing and analyses, and design efforts required to support certification and licensing applications for the selected projects.	67,000	70,000	+3,000
Total , SMR Licensing Technical Support	67,000	70,000	+3,000

SMR Licensing Technical Support
Overview

The mission of the SMR Licensing Technical Support program is to support first-of-a-kind activities for design certification and licensing activities for SMR designs through cost-shared arrangements with industry partners in order to promote accelerated deployment of these technologies. The acceleration provided by the cost-shared funding is expected to improve U.S. global competitiveness, enhance domestic energy security and contribute to meeting greenhouse gas reduction goals. The program will help demonstrate the potential of the nascent SMR technology and encourage new competition in the marketplace. The program involves support for a team selected under the first FOA consisting of a specific reactor technology vendor for the design, engineering, testing, analysis, and design certification document for their reactor system and a specific utility or consortia for the development of an operating license application specific to the chosen site. The program will also support design development, engineering, and design certification activities for one or more additional innovative SMR designs that have a slightly longer licensing horizon through a second FOA. By supporting the licensing of SMR technologies in a phased manner, DOE hopes to support the long term availability of a variety of competitive SMR technology options for use by industry to meet their power generation requirements. The cost of the SMR Licensing Technical Support program is $452 million over six years.

Benefits

Potential benefits of SMRs include:

- Provide owners more flexibility in financing, siting, sizing, and end-use applications;
- Reduce initial capital outlay or investment due to the lower plant capital cost;
- Modular components and factory fabrication can reduce construction costs and schedule duration;
- Additional modules can be added incrementally as demand for power increases with revenue provided by existing performing modules;
- Provide power for applications where large plants are not needed, or may be able to replace aging and carbon-emitting fossil plants, or could be located at sites that may not have the necessary infrastructure to support a large unit such as smaller electrical markets, isolated areas, smaller grids, or restricted water or acreage sites.
- Promote domestic job and manufacturing growth as well as regaining nuclear technology leadership in the United States.

Funding Schedule

Fiscal Year	Line Item	Funding (dollars in thousands)
FY 2012	• Finalized selection of vendor/utility partner on first SMR FOA • Conducted analysis and studies important to efficient SMR licensing and commercialization.	67,000
FY 2013	Planned activities in the FY 2013 budget (final allocations have not yet been determined): • Selected vendor develop design certification documentation for submittal to NRC. • Selected utility partner begin development of operating license application information, depending on licensing strategy selected. • Conduct periodic program status meetings with industry partners to ensure adequate progress against milestones established in cooperative agreements. • Continue analysis and studies important to efficient SMR licensing and commercialization.	---

Fiscal Year	Line Item	Funding (dollars in thousands)
FY 2014	• SMR Project vendor/utility selected under the first FOA will continue development of design certification documentation and license applications for submittal to NRC. • SMR vendor for the SMR project awarded under the first FOA completes design certification documentation and submits certification application to the NRC. • SMR vendor(s) for the second SMR FOA continue(s) activities to design, engineer and develop certification documentation. • Conduct periodic program status meetings with all industry partners to ensure adequate progress against milestones established in cooperative agreements. • DOE will conduct periodic program status meetings with all industry partners to ensure adequate progress against milestones established in cooperative agreements. • Continue analysis and studies important to efficient SMR licensing and technology development.	70,000

Reactor Concepts Research, Development and Demonstration
Funding Profile by Subprogram

(dollars in thousands)

	FY 2012 Current	FY 2013 Annualized CR*	FY 2014 Request
Reactor Concepts Research, Development and Demonstration			
Advanced Small Modular Reactor R&D	24,529	---	20,000
Next Generation Nuclear Plant Demonstration Project	39,644	---	0
Light Water Reactor Sustainability	24,796	---	21,500
Advanced Reactor Concepts	21,683	---	31,000
Total, Reactor Concepts Research, Development and Demonstration	110,652	115,574	72,500

**FY 2013 amounts shown reflect the P.L. 112-175 continuing resolution level annualized to a full year. These amounts are shown only at the "congressional control" level and above; below that level a dash (—) is shown.

*SBIR/STTR:

- FY 2012 Transferred: SBIR: $2,986,646; STTR: $402,049 (FY 2012) and SBIR: $741,470; STTR: $88,977 (FY 2011)
- FY 2013 Annualized CR: SBIR: $3,120,498; STTR: $404,509
- FY 2014 Request: SBIR $2,030,000: STTR: $290,000

Public Law Authorizations

P.L. 112-74, Consolidated Appropriations Act, 2012

Overview

The Reactor Concepts Research, Development and Demonstration (RD&D) program is designed to develop new and advanced reactor designs and technologies that advance the state of reactor technology to improve its competitiveness, and help advance nuclear power as a resource capable of meeting the Nation's energy, environmental, and national security needs. RD&D activities are designed to address technical, cost, safety and security issues associated with reactor concepts including advanced Small Modular Reactors (SMRs) and other advanced reactor concepts such as sodium-cooled, fluoride salt-cooled, and high temperature gas-cooled reactors (HTGRs). The FY 2014 request reflects a consolidation of advanced non-light water reactor technologies and R&D focused on long term core activities and collaborations with industry.

Additionally, Reactor Concepts RD&D will conduct research and development (R&D) on advanced technologies to support life extensions of Light Water Reactors (LWRs) and address the impacts of the Fukushima accident with a focus on enhancing the accident tolerant characteristics of reactors and their operation.

In maximizing the benefits of nuclear power, work must be done to address the following challenges:

- Improving affordability of nuclear energy;
- Addressing the management of nuclear waste;
- Minimizing proliferation risks of nuclear materials; and
- Further enhance safety and incorporate lessons learned from Fukushima.

Subprogram Accomplishments and Milestones

In FY2012, Reactor Concepts RD&D achieved significant accomplishments or milestones in program management and/or program development. Such accomplishments include the following: (1) the NGNP program completed irradiation of the second Advanced Graphite Creep (AGC02) test experiment and completed the qualification testing of the TRISO fuel compacting line at Babcock and Wilcox; (2) the Light Water Reactor Sustainability (LWRS) program completed a comprehensive assessment of materials degradation issues for light-water reactor plants operating beyond 60 years; (3) the Advanced Reactor Concepts (ARC) program commenced Under Sodium Viewing ultra-sonic transducer testing to support in-service-inspection for Sodium-cooled Fast Reactors, began work on a liquid metals mechanisms small-scale experimental test capability, the Metal Mechanisms Engineering Test Laboratory (METL), and commenced recuperated re-

compression cycle Brayton loop operations at Sandia National Laboratory; (4) the Advanced SMR program management staff worked with industry to identify activities important to SMR development and commenced research on high temperature metals and instrumentation and control (I&C) needed by these advanced concepts.

In FY 2014 Reactor Concepts RD&D is working towards the following key milestones:

Milestone	Date
Complete safety framework, PRA development on siting, conduct analysis of potential for reduced staffing requirements and identify and prioritize areas of research interest to guide SMR R&D.	Sep 2014
Test Risk Informed Safety Margin Characterization (RISMC) approach using a light water reactor case study for enhanced accident-tolerance design changes. (LWRS)	Sep 2014
Conduct initial testing of instrumentation and/or hardware in the Mechanisms Engineering Test Laboratory. (ARC)	Sep 2014
Complete irradiation of AGR-3/4 fuel experiment in ATR; complete fuel fabrication and characterization of AGR-5/6/7 fuel qualification experiments, and close out fuel fabrication work at B&W. (ARC)	Sep 2014

Program Planning and Management

The Reactor Concepts RD&D program pursues projects utilizing program guidance contained in the *Nuclear Energy Research and Development Roadmap Implementation Plan for Objective 1* Extend the Life, Improve the Performance, and Maintain the Safety of the Current Fleet *and Objective 2* Develop Improvements in the Affordability of New Reactors. The program management staff has established a set of meaningful performance measures, including discrete milestones to formally and effectively track project progress. NE is employing an appropriately graded program management system to track cost and schedule performance using these measures.

In addition, the Department's Nuclear Energy Advisory Committee (NEAC) conducts periodic evaluations of NE's research and development programs.

Through close coordination between RD&D and the Nuclear Energy Enabling Technologies and the Fuel Cycle R&D program, the Nuclear Energy (NE) program will leverage innovative, cross-cutting R&D activities.

Strategic Management

In meeting the identified challenges to nuclear power, the department will implement three key strategies to more efficiently and effectively manage the program, thus putting the taxpayers' dollar to more productive use.

1. Partner with the private sector, national laboratories, universities and international partners to develop advanced nuclear technologies.
2. Engage the international community in collaborative reactor projects that will benefit the United States with enhanced safety, improved economics and reduced production of wastes.
3. Participate in domestic and international research cost sharing programs, including the Generation IV International Forum, on specified reactor technologies.

Three external factors present the strongest challenges to the overall achievement of the program's goal:

- Power demand and economic and environmental factors beyond the scope of DOE R&D programs, as well as complex economic decisions made by industrial partners;
- Industry's inclination to focus on near-term deployment using proven technologies. Industry may not readily support, or be supportive of, longer-term development of better technologies;
- Data collection for nuclear energy research programs rely in part on collaborations with foreign nations. Should vital data from foreign partners prove unavailable, an increased U.S. effort in technology development would be required.

Subprogram Goals and Funding

This program is guided by the *Nuclear Energy Research and Development Roadmap* (April 2010) in Objectives 1 and 2, which focus on extending the safe operating life of existing nuclear plants and improving the affordability of new reactors to help meet the Administration's energy security and climate change goals. Activities in the Reactor Concepts program are also closely coordinated with Objectives 3 and 4 that focus on developing sustainable nuclear fuel cycles and minimizing the risks of nuclear proliferation and terrorism. By advancing technologies through R&D, NE can help develop the technical basis for keeping existing nuclear plants operating longer than current license periods, support development of advanced concepts for the medium term, and promote design of revolutionary systems for the long term.

The NE R&D Roadmap lays out four goals that programs work toward in support of NE's mission and that guide program planning and execution. These goals provide a concrete framework for NE's activities and link to the Department's strategic priorities:

- Develop technologies and other solutions that can improve the reliability, sustain the safety, and extend the life of current reactors.
- Develop improvements in the affordability of new reactors to enable nuclear energy to help meet the Administration's energy security and climate change goals.
- Develop sustainable nuclear fuel cycles.
- Understand and minimize the risks of nuclear proliferation and terrorism.

In addition, NE designates up to 20 percent of funds appropriated to its R&D programs for Nuclear Energy University Programs (NEUP) infrastructure projects, and R&D to be performed at university and research institutions, through open, competitive solicitations.

Explanation of Funding AND/OR Program Changes

(dollars in thousands)

	FY 2012 Current	FY 2014 Request	FY 2014 Request vs FY 2012 Current
Advanced Small Modular Reactors R&D			
The decrease from $24,529,000 to $20,000,000 reflects a lower priority in the following areas: instrumentation and controls and metals research and economic analysis trade studies.	24,529	20,000	-4,529
Next Generation Nuclear Plant			
The decrease from $39,644,000 to $0 reflects a reduction of thermohydraulic methods and high temperature metals R&D and licensing framework development and consolidation of key ongoing fuels and graphite R&D activities under the Advanced Reactor Concepts program.	39,644	0	-39,644
Light Water Reactor Sustainability			
The decrease from $24,796,000 to $21,500,000 reflects a focus on the most important research - including Fukushima lessons learned.	24,796	21,500	-3,296
Advanced Reactor Concepts			
The increase from $21,683,000 to $31,000,000 reflects the consolidation of the fuels and graphite work formerly conducted under the Next Generation Nuclear Plant program into the Advanced Reactor Concepts program and an R&D emphasis on long term core activities and collaborations with industry.	21,683	31,000	9,317
Total, Reactor Concepts Research, Development and Demonstration	110,652	72,500	-38,152

Advanced Small Modular Reactor R&D
Overview

The Advanced SMR R&D subprogram will support the development of innovative SMR designs that may offer improved safety, functionality and affordability, and build upon existing nuclear technology and operating experience. The program supports laboratory, university and industry projects to conduct nuclear technology R&D, including the development of codes and standards, novel sensors, control systems for multiple units, and other technologies that are unique and would be useful to support development of advanced SMR concepts for use in the mid-to long-term. Emphasis is on advanced reactor technologies to support advanced small reactors that that offer simplified operation and maintenance for distributed power applications, more efficient energy conversion and increased proliferation resistance and security.

R&D activities within the SMR Advanced Concepts subprogram will follow a stepwise process that includes feedbacks and a focus on efficiency and cost-effectiveness. All activities will be reviewed, revisited, and revised as necessary in the annual budget development and program planning processes.

Benefits

- Facilitates the long term development of advanced SMR designs that can offer added functionality and affordability for the production of electricity and high temperature process heat.
- Potential reduction in capital costs of licensing and constructing multiple-unit SMR plants.
- Improvements in SMR safety, proliferation resistance and security profiles.

Funding Schedule

Fiscal Year	Line Item	Funding (dollars in thousands)
FY 2012	• Pursued R&D on assessment methods, sensors, instrumentation and controls. • Conducted advanced materials development and associated codes and standards. • Conducted advanced heat exchanger testing and computer modeling using various coolants. • Performed international collaborations on neutronic and accident analysis on small advanced sodium cooled fast reactors.	24,529
FY 2013	Planned activities in the FY 2013 Budget (final allocations have not yet been determined): • Continue R&D on assessment methods, sensors, instrumentation and controls. • Continue development advanced materials and associated codes and standards. • Continue advanced heat exchanger testing and computer modeling using various coolants. • Issue interim report documenting assessment of seismic safety risk of generic SMR designs. • Complete SMR economic assessment of advanced SMRs utilizing enhanced manufacturing learning and cost information.	---
FY 2014	• Conduct analysis of the potential for reduced staffing to meet NRC criteria (human factors for security, operations and maintenance) requirements. • Conduct SMR workshops to review and update R&D plans for materials, fuels, I&C and Human Machine Interface.	20,000

Next Generation Nuclear Plant Demonstration Project
Overview

The NGNP was envisioned to demonstrate the technical viability of high temperature gas-cooled reactor (HTGR) technology that could provide both electricity and high-temperature process heat for a variety of industrial uses. The program has sponsored collaborative efforts with universities, industry, and the NRC to conduct R&D necessary to license and demonstrate a new generation of gas-cooled, accident-tolerant reactors in the United States. Collaborative efforts have also been conducted with international researchers through the Generation IV International Forum Very High Temperature Reactor System Arrangement. In FY 2012, R&D continued on TRISO coated particle fuels, materials, design methods, and user applications. In FY 2014, remaining fuels and graphite R&D activities are being realigned with other Advanced Reactor Concepts R&D to reflect the synergy that exists among the various advanced reactor concepts being pursued by the Department. This consolidation is expected to gain efficiencies and improve prioritization.

Execution of the NGNP R&D activities has followed a stepwise process that included feedback and a focus on efficiency and cost-effectiveness to ensure maximum usefulness and applicability of results. The Department initiated collaboration with the U.S. private sector to understand industrial end-user requirements, produce trade studies evaluating the integration of NGNP into various industrial applications, and develop cost-sharing strategies to support industry in their efforts to commercialize HTGR technologies. Concurrently, the Department's collaboration with the NRC has resulted in a preliminary framework for licensing gas-cooled reactors in the United States.

Benefits

- HTGRs have the potential to reduce GHG emissions by displacing fossil fuels in the generation of electricity and in the production of process heat for certain applications including petroleum refining and the production of fertilizers and other chemical products.
- Engages the private sector in the development of this important environmental and energy security objective.
- Develops extremely high integrity fuel under all postulated challenges thereby providing inherent safety for this class of reactors.

Funding Schedule

Fiscal Year	Line Item	Funding (dollars in thousands)
FY 2012	• Continued R&D on VHTR fuels, materials, design methods, and user applications.	39,644
FY 2013	Planned activities in the FY 2013 Budget (final allocations have not yet been determined): • Continue R&D on VHTR fuels, graphite, and key issues requiring resolution in establishing a licensing framework.	---
FY 2014	• AGR fuel and AGC graphite qualification activities will transition to the Advanced Reactor Concepts program.	0

Light Water Reactor Sustainability
Overview

The existing U.S. nuclear fleet has an excellent safety and performance record and today accounts for about 20% of the U.S. electricity supply and more than 60% of the low greenhouse-gas-emitting, domestic electricity production. However, with the 60-year operating licenses beginning to expire no later than 2029 and the long planning horizon required to place new generation capabilities in service, utilities are beginning the planning process to obtain a license for operation beyond 60 years or for baseload replacement power. The first relicensing applications are expected in the 2016 to 2018 time frame. Replacing the current 100-GWe fleet with new nuclear plants would cost hundreds of billions of dollars and replacement with traditional fossil plants would lead to significant increases in carbon dioxide emissions. Extending operating licenses beyond 60 years would enable existing plants to continue to provide safe, clean, and economical electricity without significant greenhouse gas emissions, while reducing the pressure to bring new non-greenhouse-gas-emitting capacity on line. The LWRS program has partnered with industry and the NRC to closely coordinate research needs and share costs. Industry will primarily address the near-term research needs and the LWRS program, along with industry and the NRC, will address the long-term research needs. This research will form the technical basis for age-related material degradation management and inform major component refurbishment and replacement strategies related to Instrumentation and Control systems, and safety margin characterization. The research will also address post-Fukushima lessons learned; in particular, research to enhance the accident tolerance of light water reactors, to enhance accident response capabilities and to address emerging issues.

Execution of the LWRS subprogram activities will follow a stepwise process that includes feedback, critical industry involvement and cost-sharing, and a focus on efficiency and cost-effectiveness to ensure maximum usefulness and applicability of results. All activities will be reviewed, revisited, and revised as necessary in the annual budget development and program planning processes.

Benefits

Results of the R&D conducted by this program could help:

- Reduce risk and uncertainty involved in pursuing additional license extensions.
- Inform decisions for investing in plant refurbishment and modernization.
- Reduce potential for aging related failures causing extended shutdowns or asset loss.
- Maintain the existing high level of safety of the current fleet.
- Assist in meeting climate change objectives.
- Maintain a diverse energy supply.
- Minimize cost impacts to ratepayers.

Funding Schedule

Fiscal Year	Line Item	Funding (dollars in thousands)
FY 2012	• Materials Aging and Degradation Assessment - Investigated mechanisms of irradiation-assisted stress corrosion cracking (IASCC), crack initiation in nickel-based alloys, high-fluence effects on stainless steels, IASCC of alloy X-750, reduction in toughness of reactor pressure vessel steels, and swelling effects and phase transformations in high-fluence core internals. Assessed degradation of concrete in unique reactor environments (radiation, high temperature, and moisture) and developed nondestructive examination techniques. Continued existing pilot projects at the Ginna and Nine Mile Point plants to obtain information on materials that supported development of guidance on inspection of containments and reactor internals, assess degradation of cables, and developed tools and methods to measure degradation and predict failures. • Safety Margin Characterization - Demonstrated the RISMC methodology using a test case based on the Idaho National Laboratory Advanced Test Reactor. The prototype version of the RELAP-7 code uses advanced computational tools and techniques to simulate the behavior of nuclear power plants in a way that develops more comprehensive safety insights and enables a more useful risk-informed analysis of plant safety margin. • Instrumentation and Controls - Initiated work in developing advanced display concepts for modernized control rooms; developed and demonstrated real-time collaborative process technologies for improved human performance and outage coordination; developed a process model, user requirements and a working prototype for in-plant computer-based procedures; and initiated work on diagnostic and prognostic models for on-line monitoring of active components. These technologies comprise the initial steps in building a seamless digital environment that will ultimately integrate NPP I&C systems, plant work processes, and mobile worker information requirements. • Advanced LWR Fuel Cladding - Continued development of an advanced cladding material with both high performance and greater tolerance of accident conditions. Begin the examination of test sample from the High Flux Isotope Reactor. • Systems Analysis and Emerging Issues - Continued development of alternative and new cooling technologies that can be applied in the near term to reactors impacted by insufficient cooling water supplies. Completed Severe Accident Analysis of the unit 1-3 reactors and unit 4 spent fuel pool of the Fukushima Daiichi power station accident using the MELCOR computer code. This study collected, verified, and documented data on the accidents and reconstructed the accident progression in order to characterize and model the events. In support of Fukushima lessons learned initiate research on the survivability of instruments during severe accidents.	24,796

Fiscal Year	Line Item	Funding (dollars in thousands)
FY 2013	Planned activities in the FY 2013 Budget (final allocations have not yet been determined): • Materials Aging and Degradation Assessment - Conduct mechanistic studies of high fluence irradiation induced degradation, gather high value materials for life extension studies, and assess alternative specimen surveillance techniques. Publish a database of field and operational data on concrete performance. Complete critical analysis of the potential implementation and data needs for using advanced alloys in LWR replacement components. • Safety Margin Characterization - Release a preliminary version of the plant-level safety analysis code (R7) to advanced users. Complete a partial-scope demonstration of R7 capabilities using the PWR Feed and Bleed case study, the industry-recommended case study for steering code development and methodology/ framework development. Initiate additional safety analysis case studies with industry. Engage a broader group of industry stakeholders in code validation and adaptation. • Instrumentation and Controls - Complete three pilot plant projects with industry to demonstrate the use of advanced digital technologies to address obsolescence and improve plant performance. • Advanced LWR Fuel Cladding - Continue development of advanced cladding designs by conducting irradiation tests at the ATR reactor and at the Halden reactor. The work on silicon carbide cladding will also support a research initiative to investigate accident tolerant fuel. • Systems Analysis and Emerging Issues - Demonstrate alternative technologies that reduce water consumption for application to existing reactors. Address post-Fukushima lessons learned research needs.	---
FY 2014	• Materials Aging and Degradation Assessment - Conduct analysis of irradiation-assisted stress corrosion cracking data and develop mechanistic understanding. Develop an approach to assess the continued-service risk for plants with degraded concrete components. Harvest reactor vessel steel and other material samples from the shutdown Zion plant. Conduct initial demonstration of solid state and laser weld repair tests on irradiated stainless steel specimens. Laboratory-scale demonstration of new non-destructive examination techniques for concrete and reactor pressure vessel inspections. Demonstrate component aging modeling and simulation capabilities for extended service conditions. • Safety Margin Characterization - Complete software structure of the coupled RAVEN/RELAP-7 software tool. Demonstrate the Risk-Informed Safety Margin Characterization (RISMC) methodology on stakeholder-selected case studies using the completed software structure to achieve widespread stakeholder acceptance of the RISMC approach. Assess leading accident resistant fuel technologies to understand changes in safety margin using the RISMC methodology. • Instrumentation and Controls - Complete human factors evaluations and guidance for deployment of automated field activity work packages using mobile technologies. Complete guidance for advanced outage control centers to improve outage coordination, emergent issue resolution, and outage risk management. Publish a technical report on measures, sensors, algorithms, and methods for large active component diagnostic and prognostics monitoring technologies. • Systems Analysis and Emerging Issues - Participate in Japanese-led international effort analyze the accident and develop a sampling and examination plan for collecting key data from the Fukushima Daiichi reactors. Continue research on the survivability of instruments during severe accidents In support of Fukushima lessons learned.	21,500

Advanced Reactor Concepts
Overview

The Advanced Reactor Concepts (ARC) subprogram performs research to develop technologies and subsystems that are critical for advanced reactor concepts that could dramatically improve nuclear power performance including sustainability, economics, safety and proliferation resistance. The program supports research to reduce long-term technical barriers for advanced nuclear energy systems focusing on advanced reactor technologies utilizing fluoride salt and/or gas coolants. The program will continue support for international activities in the Generation IV International Forum, and international collaborations on advanced reactor operations and safety. This program will be focused on high value research for long term concepts, R&D needs of promising mid-range concepts, the development of innovative technologies that benefit multiple concepts and stimulation of new ideas for transformational future concepts.

Reactor concepts are being addressed that reside at different maturity levels. The key R&D needs are being addressed for three advanced concepts: liquid metal-cooled fast reactors, including sodium-cooled fast reactors (SFRs), fluoride salt-cooled high-temperature reactors (FHRs), and high temperature gas-cooled reactors (HTGR). Beginning in FY 2014 R&D for high-temperature reactors includes qualification of TRISO coated particle fuel and graphite previously funded under the Next Generation Nuclear Plant Project. In addition, R&D that could provide wide benefits (e.g., development of advanced energy conversion technology such as a supercritical CO2 Brayton cycle) is being pursued with a view to application in many different reactor technologies. The ARC program will continue to solicit and evaluate new ideas in order to encourage innovation, incorporation of technology advances, and to enhance the safety, as well as performance, of these systems. The ARC program is improving engagement with industry by evaluating advanced concepts through the Technical Review Panel (TRP). ARC will use the TRP to identify R&D needs of advanced concepts and help inform R&D investment decisions.

Execution of the ARC subprogram activities will follow a stepwise process that includes feedbacks and a focus on efficiency and cost-effectiveness to ensure maximum usefulness and applicability of results. All activities will be reviewed, revisited, and revised as necessary in the annual budget development and program planning processes.

Benefits

The ARC program activities are focused on supporting the work on advanced concepts with the following key benefits:

- Research on innovative technologies that resolve key feasibility and performance challenges.
- Research on innovative technologies that reduce fabrication, construction and operating costs.
- Exploration and development of supercritical CO2 Brayton thermal cycle for diverse reactor applications that couple nuclear reactors to power generation with much improved conversion efficiency and reduced plant size.
- Enable, through research, additional long-term nuclear energy options that have the potential to provide significant safety, economic improvements and lower fabrication, construction and operations costs.
- Utilize international collaborations to leverage and expand R&D investments.

Funding Schedule

Fiscal Year	Line Item	Funding (dollars in thousands)
FY 2012	• Commenced Under Sodium Viewing ultra-sonic transducer testing to support in service inspection for SFRs. • Began work on a liquid metals mechanisms small-scale experiments test capability, the Mechanisms Engineering Test Laboratory. • Developed R&D plan to support general FHR general designs. • Commenced recuperated re-compression cycle Brayton Loop operations at Sandia National Laboratory.	21,683

Fiscal Year	Line Item	Funding (dollars in thousands)
FY 2013	Planned activities in the FY 2013 Budget (final allocations have not yet been determined): • Conduct initial component testing of the Liquid Metal Mechanisms Facility. • Complete Analysis of EBR-II Inherent Safety Tests. • Conduct FHR R&D. • Commence testing of 1 MWe Supercritical CO2 Brayton Cycle facility.	---
FY 2014	• Continue component testing in the Mechanisms Engineering Test Laboratory. • Continue development of advanced sensors and technology to enable in-service-inspection of systems and components within liquid metal coolant environments. • Complete irradiation of AGR-3/4 fuel experiment in ATR; perform limited post-irradiation examination of AGR-2 fuel; complete fuel fabrication and characterization for AGR-5/6/7 fuel qualification experiments, and close out fuel fabrication work at B&W. • Perform irradiation of AGC-4 graphite experiment in ATR. • Support international collaborations under bi-lateral agreements and Generation IV International Forum. • Continue industry supporting R&D that aligns with the Technical Review Panel (TRP) results.	31,000

Fuel Cycle Research and Development
Funding Profile by Subprogram

(dollars in thousands)

	FY 2012 Current	FY 2013 Annualized CR*	FY 2014 Request
Fuel Cycle Research and Development			
Separations and Waste Forms	31,273	---	35,300
Advanced Fuels	57,154	---	37,100
Systems Analysis and Integration	16,527	---	21,500
Materials Protection, Acctg, & Control Tech	5,000	---	7,600
Used Nuclear Fuel Disposition	57,890	---	60,000
Fuel Resources	3,501	---	3,600
Spent Nuclear Fuel Analysis	9,648	---	0
Total, Fuel Cycle Research and Development	180,993	187,400	165,100

**FY 2013 amounts shown reflect the P.L. 112-175 continuing resolution level annualized to a full year. These amounts are shown only at the "congressional control" level and above; below that level a dash (—) is shown.

*SBIR/STTR:

- FY 2012 Transferred: SBIR: $4,615,272; STTR: $651,912
- FY 2013 Annualized CR: SBIR $4,060,000: STTR: $656,000
- FY 2014 Request: SBIR $3,783,000: STTR: $540,000

Public Law Authorizations

P. L. 112-74, Consolidated Appropriations Act, 2012
42 U.S.C. 10101, Nuclear Waste Policy Act of 1982

Overview

The Fuel Cycle Research and Development (FCR&D) program supports the goal in the Department's Strategic Plan to "Enhance nuclear security through defense, nonproliferation, and environmental efforts" by supporting responsible civilian nuclear power development and fuel cycle development. The program is also designed to support Nuclear Energy Research and Development Roadmap Objective 3: "Develop sustainable nuclear fuel cycles." Sustainable fuel cycle options are those that improve uranium resource utilization, maximize energy generation, minimize waste generation, improve safety, and complement institutional measures in limiting proliferation risk.

In January 2013, the Department released its *Strategy for the Management and Disposal of Used Nuclear Fuel and High-Level Radioactive Waste*.

Full implementation of the Strategy's principles and components requires new legislation, however the Department will work to implement elements of the Strategy where possible within existing authorities. To support the nuclear waste management program over the long term, reform of the current funding arrangement is necessary and the Administration believes the funding system should consist of the following elements: ongoing discretionary appropriations, access to annual fee collections provided in legislation either through their reclassification from mandatory to discretionary or as a direct mandatory appropriation, and eventual access to the balance or "corpus" of the Nuclear Waste Fund.

The FY 2014 Budget includes a proposal to implement such reform. Discretionary appropriations are included for this new program within the Used Nuclear Fuel Disposition sub-program beginning in 2014 and continue for the duration of the effort. These funds would be used to fund expenses that are regular and recurring, such as program management costs , including administrative expenses, salaries and benefits, studies, and regulatory interactions. In FY 2014 these funds will be for ongoing studies and outreach efforts associated with transportation, storage, and geologic disposal. Mandatory appropriations in addition to the discretionary funding are proposed to be provided annually beginning in 2017 to fund the balance of the annual program costs.

Please see additional discussion of the cost of the government's liability in the Budget Process chapter in the *Analytical Perspectives* volume.

In the first 10 years of the program reflected in the FY 2014 Budget, the program begins operation of a pilot

interim storage facility by 2021, advances toward the siting and licensing of a larger interim storage facility by 2025, and makes demonstrable progress on the siting and characterization of geologic reposity sites.

FCR&D will also research and develop a suite of technology options that will enable future decision makers to make informed decisions about how best to manage nuclear waste and used fuel from reactors. The program employs a long-term, science-based approach to foster innovative, transformational technology solutions to achieve this mission.

FCR&D supports long-term technology research activities and will:

- Support the development of next generation light water reactor fuels with enhanced accident tolerance.
- Continue investigating fuel forms, reactors and fuel/waste management approaches that could dramatically increase the sustainability of nuclear energy including, if economically competitive, improving utilization of fuel resources and reducing the quantity of long-lived radiotoxic elements in the used fuel requiring disposal. Technologies will be considered that require limited separations steps and minimize proliferation risks.
- Work to gain a further understanding of techniques that will enable long-lived actinide elements to be repeatedly recycled, i.e., fully closed fuel cycles.
- Continue a strong focus on researching and developing storage, transportation, and disposal technologies for used fuel and nuclear waste.
- Lay the groundwork that could lead to one or more facilities for used fuel management under a consent-based siting program and prepare for large-scale transport of used fuel.

Subprogram Accomplishments and Milestones

In FY 2012, FCR&D achieved several milestones. These accomplishments include: 1) developing a fuel cycle options set and proliferation and security evaluation criteria for the fuel cycle options screening; 2) completing the first independent relevancy review of a major subprogram: Separations and Waste Forms; 3) start drafting a roadmap for evaluating, developing, and deploying light water reactor fuels with enhanced accident tolerance; 4) evaluating generic engineered barrier design concepts and process models; 5) identifying and prioritizing data gaps for extended storage of used fuel; and 6) completing a preliminary evaluation of removing used nuclear fuel from nine shutdown sites.

In FY 2014, FCR&D is working towards the following key milestones:

Milestone	Date
Develop design concepts for consolidated storage facilities	FEB/2013
Explore the logistics and operations for shipping orphan fuel to a consolidated interim storage facility	AUG/2013
Begin fuel cycle options evaluation and screening to identify most promising options for further research.	AUG/2013
Select a reference separations process for evaluating alternate advanced unit operations and processes	SEP/2013
Identify promising candidate accident tolerant fuel cycle concepts for feasibility studies	SEP/2013
Review the MPACT subprogram for relevancy to and alignment with mission and policy objectives	SEP/2013
Summarize fuel cycle evaluation and screening results to inform decisions about associated R&D directions	SEP/2014
Complete independent peer reviews of two subprograms	SEP/2014
Implement salt field tests to advance salt repository science for disposal of heat-generating waste	SEP/2014
Continue research to further the understanding of deep borehole disposal	SEP/2014
Complete an analysis for initial used fuel shipments from shutdown reactor sites	SEP/2014

Program Planning and Management

FCR&D is primarily focused on supporting NE's goal of developing sustainable fuel cycles. All of FCR&D's subprograms contribute to achieving this goal. In addition, most of FCR&D's subprograms also contribute to NE's goal to enable new reactors. This is especially true in Advanced Fuels and Used Nuclear Fuel Disposition. Advanced Fuels also supports the NE goal to extend the life of current reactors. Finally, FCR&D's Separations and Waste Forms and Material Protection Accounting, and Control Technology subprograms support NE's goal to minimize proliferation and terrorism risks.

Strategic Management

In meeting the identified challenges to achieving the goals of enabling new reactors, developing sustainable nuclear fuel cycles and implementing the waste management Strategy issued in January 2013, the Department will implement three key strategies to efficiently and effectively manage the program, thus putting the taxpayers' dollar to more productive use.

1. FCR&D will investigate a comprehensive range of potential waste management strategies. An objective evaluation and screening assessment will be performed in order to identify the best options for decision makers in the future and to integrate and prioritize needed R&D.
2. The program will employ the following techniques to investigate the range of potential fuel cycle options in a cost-effective manner:
   - A science-based approach that involves small-scale experiments, theory development, and advanced modeling and simulation
   - A dual-path approach simultaneously researching both evolutionary advances and revolutionary transformational breakthroughs
   - A systems approach to identify the most promising technology options in an open, objective, and systematic way
3. FCR&D will partner with the private sector, national laboratories, universities and international partners to leverage our resources.

In addition, NE designates up to 20 percent of funds appropriated to its R&D programs for Nuclear Energy University Programs (NEUP) infrastructure projects, and R&D to be performed at university and research institutions, through open, competitive solicitations.

Subprogram Goals and Funding

The NE R&D Roadmap lays out four goals that programs work toward in support of NE's mission and that guide program planning and execution. These goals provide a concrete framework for NE's activities and link to the Department's strategic priorities:

- Develop technologies and other solutions that can improve the reliability, sustain the safety, and extend the life of current reactors.
- Develop improvements in the affordability of new reactors to enable nuclear energy to help meet the Administration's energy security and climate change goals.
- Develop sustainable nuclear fuel cycles.
- Understand and minimize the risks of nuclear proliferation and terrorism.

FCR&D activities support all four goals; however, FCR&D primarily supports the third goal to develop sustainable nuclear fuel cycles. FCR&D also supports the first and second goals through advanced fuels development, used fuel disposition technologies, and systems analyses. FCR&D contributes to the fourth goal to minimize proliferation and terrorism risks primarily in developing innovative techniques for monitoring nuclear data in Materials Protection, Accounting, and Control Technology and in the development of advanced Separations and Waste Forms technologies.

Explanation of Funding AND/OR Program Changes

(dollars in thousands)

	FY 2012 Current	FY 2014 Request	FY 2014 Request vs FY 2012 Current
Separations and Waste Forms The increase reflects Phase II of the US-ROK Joint Fuel Cycle Studies and continued research on electrochemical separations technologies for domestic applications.	31,273	35,300	+4,027

(dollars in thousands)

	FY 2012 Current	FY 2014 Request	FY 2014 Request vs FY 2012 Current
Advanced Fuels The decrease reflects $10M of awards in FY 2012 to three industry teams to support the development of accident tolerant fuels. These are multi-year awards that will be worked in FY 2013 and FY 2014. Other decreases reflect the revised focus toward light water reactor accident tolerant fuels and away from long-term R&D on advanced transmutation fuels, as well as reductions in funding for lower priority work including irradiation test-ing, post-irradiation examinations, and data collection.	57,154	37,100	-20,054
Systems Analysis and Integration The increase reflects the on-going formal evaluation and screening of fuel cycle options and subsequent analyses based on its results. The second screening activity will be conducted with more quantitative formality and more documentation than the initial pilot screening activity in FY 2011.	16,527	21,500	+4,973
Materials Protection, Accounting, and Control Technology The increase reflects continued expansion of the scope of this subprogram to include consolidated storage of used nuclear fuel, enrichment, and fuel fabrication activities. These increases are partially offset by reductions in the development of sensors, instrumentation and controls that are either transferred to other organizations for further development or are found not worthy of further research.	5,000	7,600	+2,600
Used Nuclear Fuel Disposition The increase reflects increasing activities in laying the groundwork and de-veloping options for decision makers to consider related to the storage and transportation of used nuclear fuel. These activities support the pro-gram of work described in the January 2013 *Strategy for the Management and Disposal of Used Nuclear Fuel and High-Level Radioactive Waste*. These increases are partially offset by decreases in long-term R&D related to geologic disposal.	57,890	60,000	+2,110
Fuel Resources There are no significant changes.	3,501	3,600	+99
Spent Nuclear Fuel Analysis The decrease reflects that this is a one-time activity funded in FY 2012 to initiate enhanced assessment work related to aging and safety of storing used nuclear fuel. Related activities beyond FY 2012 are funded within Used Nuclear Fuel Disposition.	9,648	0	-9,648
Total, Fuel Cycle Research and Development	180,993	165,100	-15,893

Separations and Waste Forms
Overview

Our future ability to sustainably and economically recycle, if economically viable and deemed appropriate, light water reactor fuels, fast reactor fuels, gas-cooled reactor fuels, molten salt fuels, etc., will depend in part on our ability to separate the various elements of the used nuclear fuel into material for reuse and material for disposal. The ability to engineer, produce, and manage fuel cycle waste forms that are chemically and structurally stable over relevant periods of time from decades to hundreds of thousands of years (depending on the radioisotope) would be critical for any advanced fuel cycle. Since used nuclear fuel will vary by initial composition, burn-up, and cooling time, and recycle fuel composition and physical characteristics will depend on reactor requirements, various combinations of separations and waste forms will be researched in this program to provide science-based information for future policy decisions.

Benefits

The potential benefits of the R&D conducted in this subprogram include:

- Can provide initial experimental verification of advanced separations/waste forms processes for future use.
- Some components of possible future fuel cycle systems may be added to existing operations for near-term application.
- Through frequent industry interactions, Departmental R&D will progress along mutually advantageous pathways.
- Regular consultations with National Nuclear Security Administration result in minimum system attractiveness using Safeguards-by-Design.
- Research on advanced process control instrumentation combined with advanced modeling has future potential for accurate, real-time detection of diversion.
- International safeguards collaboration can improve the effectiveness of non-proliferation programs world-wide.

Funding Schedule

Fiscal Year	Line Item	Funding (dollars in thousands)
FY 2012	• Initiated joint electrochemical Feasibility Study with Republic of Korea (ROK) while continuing advanced electrochemical studies for domestic applications. • Continued multi-laboratory study of the simplification of actinide/fission product separations and the capture and immobilization of gaseous radionuclides. • Completed initial hot tests of advanced volatility process for tritium/iodine removal. • Completed formulation of reference alloy waste form.	31,273
FY 2013	Planned activities in the FY 2013 budget (final allocations have not yet been determined): • Select reference separations process for use in evaluating the advantages of alternate advanced unit operations and processes. • Continue ROK pyrochemical feasibility study. • Continue to investigate fluoride volatility and use of ionic liquids for used fuel separations. • Investigate alternative waste forms to pressurized gas storage for krypton-85. • Investigate low temperature glass forms for iodine-129 immobilization and disposal.	---
FY 2014	• Complete plans for initial integrated lab-scale testing of reference flow sheet for aqueous separations. • Comprehensive selection and refinement of advanced waste forms for reference separations flow sheet. • Phase II of US-ROK Joint Fuel Cycle Studies. • Conduct focused research on advanced aqueous separations technologies. • Continue research on the next generation electrochemical separation technology. • Continue limited exploration of used fuel pretreatment technologies as a low-risk extended storage alternative.	35,300

Advanced Fuel Research and Development
Overview

The development of improved and advanced nuclear fuels is a major objective for both existing light water reactors and the entire spectrum of advanced nuclear energy systems. The development of advanced fuels is an essential part of achieving a sustainable fuel cycle. Advanced fuels is pursuing two major paths: (1) the development of next generation light water reactor fuels with enhanced accident tolerance, and (2) development over the long term of transmutation fuels with enhanced proliferation resistance and resource utilization.

Benefits

The potential benefits of the R&D conducted in this subprogram include:

- Research targeted toward advanced accident tolerant LWR fuel options may lead to the development of fuel that could better withstand the effects of severe accidents by minimizing cladding failure, reducing hydrogen generation, reducing fission product release, and exhibiting a higher melting temperature.
- Continuation of research in advanced fuels that can help enhance proliferation resistance and economic benefits for industrial use in the mid- to long-term.
- Research may lead to advanced fuels that can operate for significantly longer periods of time and require less, or limited, recycling.
- Advanced Fuels program R&D activities are of major interest to several leading nuclear developed countries (China, Republic of Korea, Russia, France, and Japan) thereby permitting the United States to remain a major player in advanced nuclear development while leveraging U.S. development funds.

Funding Schedule

Fiscal Year	Line Item	Funding (dollars in thousands)
FY 2012	• Started drafting roadmap for evaluating, developing, and deploying LWR fuels with enhanced accident tolerance. • Initiated research on candidate fuels and materials to determine feasibility for accident tolerant LWR application. • Developed a loss of coolant accident testing capability for candidate LWR fuels with enhanced accident tolerance. • Completed preparation of one innovative LWR fuel irradiation test ready for placement in the Advanced Test Reactor (ATR). • Completed design of an instrumented separate effects test vehicle for ATR plus perform necessary R&D to support the use of this new, unique piece of equipment. • Met international obligations for cooperation with France, Russia, China, Europe, Japan, and ROK. • Completed nondestructive post irradiation examinations of legacy FFTF and EBR-2 high burnup fuels. • Obtained nuclear data needed to support advanced LWR fuel concepts.	57,154
FY 2013	Planned activities in the FY 2013 budget (final allocations have not yet been determined): • Down select one or two initial LWR accident tolerant fuel candidates. • Initiate feasibility demonstration of novel in-situ instrumented fuel assembly for ATR testing to provide direct support modeling and simulation and thereby accelerate advanced fuel qualification. • Initiate operation on a glove box enclosed casting furnace for advanced transmutation metal fuel development supporting objective for reactor usable qualification within the decade. • Continue international collaboration with China, ROK, France, Japan, and Russia to	

Fiscal Year	Line Item	Funding (dollars in thousands)
	leverage program activities, and program R&D necessary to actively support the two objectives. • Continue to deliver nuclear data evaluations and covariance production.	---
FY 2014	• Continue feasibility testing of advanced LWR fuel concepts with enhanced accident tolerance in preparation for down selection of concepts for further study. • Develop additional capabilities for a science-based approach to fuel development by initiating irradiation testing of selected single-crystal UO2 separate effects samples to support model development. • Conduct focused testing/examinations in support of Accident Tolerant Fuel concept evaluation.	37,100

Systems Analysis and Integration
Overview

Systems analysis and integration provides the critical capability needed to analyze complex fuel cycle system options, assess overall performance under various scenarios, and improve understanding of the interdependencies between various sub-systems and associated technologies. Systems analysis coupled with the application of the principles of systems engineering will: (1) help the program objectively and openly identify fuel cycles options worthy of further study; (2) aid identification and prioritization of the R&D needed; (3) help formulate and execute program budgets; (4) enable clearer communication of the rationale for R&D funding decisions; and (5) enhance the ability of the program to rapidly adapt to future decisions.

Hundreds of potential fuel cycle options exist within three broad fuel cycle strategies (once through, limited recycle, and full recycle). The main focus of work in this area is evaluation and screening of fuel cycle options. The screening results will be used to identify a relatively small number of those fuel cycle options that can potentially offer significant performance benefits compared to the current fuel cycle. They will be used to determine fuel cycle component technology functions and requirements to inform future research.

Systems analysis and integration also provides support in knowledge management, communications, fostering innovation, project controls, and program integration. A new activity in FY 2014 is to identify promising basic research results from a variety of sources and conduct limited research to assess and validate their usefulness to meeting program objectives.

Benefits

The potential benefits of implementing systems analysis and engineering in the context of fuel cycle R&D include:

- Improved ability to inform policy development, strategy development, budget formulation.
- Improved ability to manage definition and prioritization of research and development and definition and justification of infrastructure needs.
- Improved public and stakeholder communication of what we are doing and why we are doing it.
- Systematic, open, objective, repeatable, and verifiable justification of program decisions.

Funding Schedule

Fiscal Year	Line Item	Funding (dollars in thousands)
FY 2012	• Prepared for fuel cycle screening in FY 2013 to include fuel cycle options set, develop improved fuel cycle performance information and metrics, and continue development of the screening process. • Developed knowledge management tools including a fuel cycle catalog. • Completed the first independent peer reviews of two subprograms.	16,527
FY 2013	Planned activities in the FY 2013 budget (final allocations have not yet been determined): • Conduct a formal screening of fuel cycle options to define a relatively small set of options for further consideration and use in defining and prioritizing R&D. • Complete independent peer reviews of two additional subprograms.	---
FY 2014	• Integrated fuel cycle analysis: develop fuel cycle data packages, perform detailed technology assessments, develop analysis tools. • Fuel cycle evaluation and screening: identify options with highest potential and evaluate whether further research is warranted, integrate results into ongoing R&D activities. • Program support: information management, communications, quality assurance, knowledge management, program reviews, and innovation. • Program management: facilitate communication of guidance and technical direction	

Fiscal Year	Line Item	Funding (dollars in thousands)
	to participating laboratories; coordinate the development of program R&D objectives, strategies, and activities; administer project control functions. • International Criticality Safety Benchmark Evaluation Project (ICSBEP) and International Reactor Physics Experiment Evaluation Project (IRPhEP). • Complete independent peer reviews of two subprograms. • Identify promising basic research results from a variety of sources and conduct limited R&D to assess and validate their usefulness to meeting program objectives.	21,500

Materials Protection, Accounting and Control Technology

Overview

The Materials Protection, Accounting and Control Technology (MPACT) program strives to develop the technologies and analysis tools to support the next generation of nuclear materials management and safeguards for future U.S. nuclear fuel cycles. It also includes assessing vulnerabilities and security of the consolidated storage of used nuclear fuel. Moving forward to address the energy security needs of the country will require innovative approaches to materials control and accounting to ensure that nuclear material is not misused, diverted, or stolen.

NE works closely with the National Nuclear Security Administration (NNSA), Department of State, and the Nuclear Regulatory Commission on issues related to nuclear nonproliferation. NNSA has broad responsibilities in international nonproliferation and security matters for the present and into the future. MPACT is focused on R&D as it relates to potential future fuel cycle facilities here in the United States.

Challenges facing nuclear materials accountancy in general include:

- Limitations of accuracy and timeliness of detection (especially in high radiation fields)
- New reactor designs and fuel cycle concepts, which require new nuclear material management approaches (SMRs, Gas-Cooled Reactors, Thorium, etc.)
- Traditional material control and accountability challenges, such as uncertainty in large throughput facilities

Benefits

The potential benefits of the R&D conducted in this subprogram include:

- Better designed fuel cycle facilities that could simplify licensing and operations due to up-front consideration of safeguardability and improved instrumentation.
- Increased confidence of safe and secure nuclear materials management.
- Reduced cost of materials safeguards considerations.

Funding Schedule

Fiscal Year	Line Item	Funding (dollars in thousands)
FY 2012	• Completed and documented automatic algorithm for Multi-isotope Process Monitor. • Completed and documented baseline electrochemical model and MPACT sensitivity analysis. • Implemented and documented pattern recognition techniques in MPACT performance model. • Tested and documented baseline electrochemical process monitoring sensor capability in laboratory conditions. • Developed safeguards and security evaluation criteria for next fuel cycle options screening.	5,000
FY 2013	Planned activities in the FY 2013 budget (final allocations have not yet been determined): • Continue R&D on sensors, instrumentation and controls. • Initiate the assessment of vulnerabilities and security of used nuclear fuel consolidated storage in response to the Blue Ribbon Commission's recommendations and in anticipation of upcoming NRC rulemaking regarding long-term challenges. • Extend R&D to assess safeguards and security for enrichment and fuel fabrication. • Support proliferation risk assessment through improvements in "risk-informing" material protection, accounting, and control technology and security.	---

Fiscal Year	Line Item	Funding (dollars in thousands)
FY 2014	• Continue development and initiate testing of improved nuclear materials accountancy technologies to support electrochemical separations processes. (Results of this work will be shared under the US-ROK Joint Fuel Cycle Studies as appropriate.). • Complete initial assessment of reference fuel cycle technologies and establish Safeguards and Security by Design methods and guidance. • Complete detailed assessment of used fuel transportation and consolidated storage safeguards. • Develop and test innovative new methods for proliferation and terrorism risk assessment.	7,600

Used Nuclear Fuel Disposition Research and Development

Overview

The Used Nuclear Fuel Disposition (UFD) subprogram continues with strong focus on researching and developing storage, transportation, and disposal technologies for used fuel and nuclear waste. There are a number of key elements that the Department has recognized as foundational to the nation's used fuel management and high-level waste disposal program and UFD encompasses these elements. R&D efforts in these important areas began in NE in FY 2010. Also, the Department began to work in FY 2012 to lay the groundwork that could lead to one or more facilities for spent fuel management under a consent-based siting program and prepare for large-scale transport of used fuel.

In January 2012, the Blue Ribbon Commission on America's Nuclear Future released its final report, which included near-term priorities that align with how the funding within UFD is allocated in FY 2013. In January 2013, the Department released its Strategy for the Management and Disposal of Used Nuclear Fuel and High-Level Radioactive Waste.

To support the nuclear waste management program over the long term, reform of the current funding arrangement is necessary and the Administration believes the funding system should consist of the following elements: ongoing discretionary appropriations, access to annual fee collections provided in legislation either through their reclassification from mandatory to discretionary or as a direct mandatory appropriation, and eventual access to the balance or "corpus" of the Nuclear Waste Fund.

The FY 2014 Budget includes a proposal to implement such reform. Discretionary appropriations are included for this new program within the Used Nuclear Fuel Disposition sub-program beginning in 2014 and continue for the duration of the effort. These funds would be used to fund expenses that are regular and recurring, such as program management costs, including administrative expenses, salaries and benefits, studies, and regulatory interactions. In FY 2014 these funds will be for ongoing studies and outreach efforts associated with transportation, storage, and geologic disposal. Mandatory appropriations in addition to the discretionary funding are proposed to be provided annually beginning in 2017 to fund the balance of the annual program costs.

The subprogram is organized into two distinct activities: (1) UFD R&D to identify alternatives and conduct scientific research and technology development to enable storage, transportation, and disposal of used nuclear fuel and wastes generated by existing and future nuclear fuel cycles, and (2) activities to lay the ground work and develop options for decision makers on the design of an integrated waste management system.

Please see additional discussion of the cost of the government's liability in the Budget Process chapter in the *Analytical Perspectives* volume.

Benefits

The potential benefits of the activities conducted in UFD R&D include:

- Provides a sound technical basis for alternative disposal systems such that decision makers, stakeholders and the general public would have confidence in an ultimate disposal strategy.
- International collaborations will leverage the Department's knowledge and experience to establish safe and effective solutions for disposal.
- Support the technical basis for licensing storage for extended periods of time and will include gathering data for high burnup fuel, and understanding transportation following extended storage.

The potential benefits of nuclear waste management and disposal system planning activities include:

- A more expedited used fuel removal and storage program will have an impact on reducing the total liability for the government not meeting its contractual obligation to begin receiving used nuclear fuel by 1998.
- A project that takes actions to move spent fuel from shutdown reactor sites will allow the sites to be fully decommissioned and the land to be used for more beneficial uses.
- A new consent-based approach to siting future waste management facilities would increase public confidence in the waste management program.

- Engagement with stakeholder on transportation issues will increase public confidence and will put the program in a position to move faster when a site is developed.
- An integrated approach that links storage, transportation, and disposal would increase the chances of developing a system that would succeed in an economical manner.

Funding Schedule

Fiscal Year	Line Item	Funding (dollars in thousands)
FY 2012	• Initiated system analyses for including initial consolidated interim storage, use of standardized containers, and improving efficiency of transportation. • Conducted R&D on extended storage of used fuel including assessing issues related to the aging and safety of dry and wet storage. • Conduct edR&D on transportation of used fuel following extended storage, particularly related to high burn up fuel. • Conducted R&D on geologic disposal alternative environments, e.g., system modeling, engineered barriers, natural barriers, evaluation of design concepts, experiments. • Initiated in situ characterization of potential geologic repository media, including salt.	57,890
FY 2013	Planned activities in the FY 2013 budget (final allocations have not yet been determined): • Continue system analyses on consolidated interim storage, standardized containers, and transportation. • Continue R&D on extended storage of used fuel. Include material testing in support of modeling and simulation. • Complete plans for a Test Validation Complex to support the technical basis for extended storage of used fuel. • Expand interactions with potential stakeholders on transportation of used fuel. • Begin to implement actions identified in a review of the National Academy of Sciences report on safe transport of used fuel and high-level waste. • Continue R&D on geologic disposal alternative environments. Complete an RD&D plan and roadmap for the borehole disposal concept.	---
FY 2014	<u>Used nuclear fuel disposition research and development ($30 M)</u> • R&D to support extended storage of used fuel. • R&D on alternative disposal environments (modeling, evaluation and experiments). • Implement field tests to advance salt repository science for disposal of heat-generating waste. • Borehole Research: Undertake R&D as necessary to further the understanding of hydro-geochemical, physical geology, structural geology, geophysical state and engineering properties of deep crystalline rocks. • Increase involvement with international organizations and groups working on the disposition of spent nuclear fuel to leverage existing international knowledge. • R&D to support transportation of extended storage fuel: field testing to assess realistic loadings during transport.	
	<u>Nuclear high-level waste management and disposal system design activities ($30M)</u> • Continue developing plans for a consent-based siting process. • Complete an analysis for initial used fuel shipments from shutdown reactor sites: including staffing, routing, procurement, operations, security, quality assurance, emergency response, training, logistics, site servicing, mobilization, operational	

Fiscal Year	Line Item	Funding (dollars in thousands)
	readiness, and site servicing schedules. • Continue the conceptual design for a generic storage facility and supporting transportation system. • Conduct system architecture and operating evaluations of various used fuel management systems: Centralized and/or regional storage facilities, various repackaging scenarios and acceptance rates, update transportation and storage system models, and develop cost data bases. • Continue the evaluation of standardized containers for storage, transportation, and potentially disposal. • Continue to work cooperatively with the state regional groups on transportation issues. • Update the National Transportation Plan to address initial shipments from shutdown reactors to a generic consolidated storage facility.	60,000

Fuel Resources
Overview

For nuclear energy to remain a sustainable energy sources there must be assurance that an economically viable supply of nuclear fuel is available. The availability of fuel resources for each potential fuel cycle and reactor deployment scenario must be understood. Most appropriate for federal involvement in this area is research and development to support investigation of long term, "game-changing" approaches such as the recovery of uranium from seawater.

Benefits

The potential benefits of the R&D conducted in this subprogram include:

- Extended use of nuclear power may drive improvements in defining resource availability. Although currently there is no foreseen shortage of uranium, the R&D will help prove alternate sources of uranium exist, thereby helping to allay concerns of potential issues in the long term.
- Development of alternative long-term, economic supplies of uranium will improve the sustainability of nuclear power
- May ultimately increase the domestic supply of uranium and reduce the reliance on foreign suppliers.

Funding Schedule

Fiscal Year	Line Item	Funding (dollars in thousands)
FY 2012	• Completed sorption testing capabilities in synthetic seawater. • Selected and prepared ligands designed for enhanced sorption capacity for seawater testing. • Completed marine testing laboratory contracts for seawater adsorbent materials evaluation. • Completed initial testing of candidate adsorbent materials at marine facilities.	3,501
FY 2013	Planned activities in the FY 2013 budget (final allocations have not yet been determined): • Select and prepare best adsorbent materials from grafting preparation method for marine testing. • Complete independent cost analysis report on the Japanese seawater uranium recovery technology. • Complete adsorbent materials for marine test to achieve initial double capacity recovery goal. • Test the leading candidate adsorbent (ligand and substrate combination) at marine laboratory facility to achieve initial goal to double world's best uranium adsorption capacity.	---
FY 2014	• Continue utilizing nanosynthesis and nanomanufacturing techniques to develop new polymer sorbents. • Continue optimizing synthesis and the design of new functional ligands via computational tools. • Complete a program review to validate the performance milestone of doubling the best Japanese adsorbent materials.	3,600

Spent Nuclear Fuel Analysis
Overview

This subprogram was initiated at the direction of Congress in FY 2012. The Department has work related to assessing issues related to the aging and safety of storing used fuel in the Used Nuclear Fuel Disposition subprogram. In FY 2012 this work included experimentation, modeling, and simulation for dry storage casks, as well as for spent fuel pools, as necessary. This was a one-time infusion of funds. Related activities beyond FY 2012 are funded within Used Nuclear Fuel Disposition.

Funding Schedule

Fiscal Year	Line Item	Funding (dollars in thousands)
FY 2012	• Expanded the Department's capabilities for assessing issues related to the aging and safety of storing used fuel.	9,648
FY 2013	• No funds were requested for this activity in FY 2013.	---
FY 2014	• No funds are requested for this activity in FY 2014.	0

Nuclear Energy Enabling Technologies
Funding Profile by Subprogram

(dollars in thousands)

	FY 2012 Current	FY 2013 Annualized CR*	FY 2014 Request
Nuclear Energy Enabling Technologies			
Crosscutting Technology Development	19,806	---	13,901
Nuclear Energy Advanced Modeling and Simulation	13,874	---	9,536
Energy Innovation Hub for Modeling and Simulation	23,517	---	24,300
National Scientific User Facility (NSUF)	14,110	---	14,563
Total, Nuclear Energy Enabling Technologies.	71,307	75,127	62,300

*FY 2013 amounts shown reflect the P.L. 112-175 continuing resolution level annualized to a full year. These amounts are shown only at the "congressional control" level and above; below that level a dash (—) is shown.

*SBIR/STTR:

- FY 2012 Transferred: SBIR: $2,168,920; STTR: $261,346; and SBIR $832,970; STTR: $99,957 (FY 2011)
- FY 2013 Annualized Continuing Resolution: SBIR: $2,028429; STTR: $262,945
- FY 2014 Request: SBIR: $1,744,400; STTR; $249,200

Public Law Authorizations

P.L. 112-74, Consolidated Appropriations Act, 2012

Overview

The Nuclear Energy Enabling Technologies (NEET) program is designed to conduct research and development (R&D) in crosscutting technologies that directly support and enable the development of new and advanced reactor designs and fuel cycle technologies, as well as the potential extension of life of the current fleet of nuclear reactors. These technologies will advance the state of nuclear technology, improving its competitiveness, and promoting continued contribution to meeting our Nation's energy and environmental challenges.

The R&D activities will address revolutionary improvements in safety, performance, reliability, economics, and proliferation risk reduction and promote creative solutions to the broad array of nuclear energy challenges related to reactor and fuel cycle development. The activities undertaken in this program complement those within the Reactor Concepts Research Development & Demonstration and Fuel Cycle R&D programs. The knowledge generated through these activities will allow Nuclear Energy (NE) to address key challenges affecting nuclear reactor and fuel cycle deployment (e.g., capital cost, technology risks, and proliferation concerns). Further, these activities will contribute to sustaining nuclear energy as a key component of our energy portfolio and help to achieve energy security and greenhouse gas emission reduction objectives of the United States.

In maximizing the benefits of nuclear power, work must be done to address the broader nuclear energy challenges:

- Improving the affordability and efficiency of nuclear energy;
- Addressing the management of nuclear waste; and
- Minimizing proliferation risks of nuclear materials.

Subprogram Accomplishments and Milestones

In FY 2012, NEET achieved four significant accomplishments or milestones: (1) the completion of version 2 of the Virtual Environment for Reactor Analysis by the Nuclear Energy Innovation Hub for Modeling and Simulation (Hub); (2) the re-launching of a new state-of-the-art reactor systems analysis tool named RELAP7, (3) the initial establishment of crosscutting R&D financial assistance awards in the areas of materials and advanced methods for manufacturing (AMM) and (4) awarded new long-term and rapid turnaround irradiation projects at the NSUF.

In FY 2014, NEET is working towards the following key milestones:

Milestone	Date
Issue version 4.0 of the Virtual Environment for Reactor Analysis (VERA)	Sep/ 2014
Award NSUF projects for irradiation and post-irradiation examination services	Jul/2014
Release NEAMS Toolkit capability for detailed Light Water Reactor oxide fuel analysis	Sep/ 2014
Award competitive research projects on selected crosscutting nuclear concepts topics	Sep/ 2014

Program Planning and Management

The Program includes four subprograms: Crosscutting Technology Development, Energy Innovation Hub for Modeling and Simulation, Nuclear Energy Advanced Modeling and Simulation, and National Scientific User Facility. These subprograms conduct crosscutting R&D research that will advance the state of nuclear technology improving its competitiveness, and ensuring lasting contribution to meeting our Nation's energy and environmental challenges.

Crosscutting Technology Development will focus in advanced materials for developing fuel and reactor concepts, new instrumentation and sensor technologies, and new advanced methods for manufacturing. The program has established meaningful milestones developed for each crosscutting technology area. Program managers monitor spending and milestone completion through a corporate project management and controls system. They conduct periodic program reviews to ensure progress toward the development of innovative technologies in accordance with the integrated program plans.

Nuclear Energy Advanced Modeling and Simulation is defining a new state of the art in computational methodology for the analysis of advanced fuels, reactor systems and components (the NEAMS ToolKit). Research is conducted at the National Laboratories under the cognizance of federal staff who engage with researchers to plan and execute program activities in accordance with established procedures. Progress is reported monthly and cost and schedule performance is evaluated quarterly.

The Energy Innovation Hub for Modeling and Simulation (HUB) is an investment in leading-edge modeling and simulation to improve the performance of currently operating Light Water Reactors. The HUB is integrating NEAMS-developed codes and other commercially available codes to run on DOE supercomputer platforms and to display the results in a user-friendly visual format.

National Scientific User Facility supports strategic partnerships to allow university and other researcher's access to unique capabilities to advance cutting edge research in materials and nuclear fuels. The program manager has established a meaningful set of discrete milestones and monitors spending and progress toward those milestones using the corporate project controls and management system. Periodic program reviews are conducted to ensure the overall success of the program.

Strategic Management

In meeting the identified challenges to nuclear power, the Department will implement three key strategies to more efficiently and effectively manage the program, thus ensuring the productive use of taxpayers' dollars.

1. NE's R&D programs will partner with the private sector, national laboratories, and universities to develop advanced nuclear technologies.
2. Programs will also engage the international community in pursuit of advanced nuclear technologies that will benefit the United States with enhanced safety, improved economics, and reduced production of wastes.
3. Program sub-elements will competitively select research projects and cost share with industry.

In addition, NE designates up to 20 percent of funds appropriated to its R&D programs for Nuclear Energy University Programs (NEUP) infrastructure projects, and R&D to be performed at university and research institutions, through open, competitive solicitations.

Three external factors present the strongest impacts to the overall achievement of the program's goals:

- Power demand and economic and environmental factors beyond the scope of Department of Energy (DOE) R&D programs, as well as complex economic decisions made by industrial partners;
- Industry's inclination to focus on near-term deployment using existing proven technologies. Industry may not readily support or be supportive of longer-term development of better technologies;
- Data collection for nuclear energy research programs relies in part on collaborations with foreign nations. Should vital data from foreign partners

prove unavailable, an increased U.S. effort in technology development would be required.

Subprogram Goals and Funding

The NE R&D Roadmap includes four goals that guide program planning and execution. These goals provide a concrete framework for NE's activities and link to the Department's strategic priorities:

- Develop technologies and other solutions that can improve the reliability, sustain the safety, and extend the life of current reactors.
- Develop improvements in the affordability of new reactors to enable nuclear energy to help meet the Administration's energy security and climate change goals.
- Develop sustainable nuclear fuel cycles.
- Understand and minimize the risks of nuclear proliferation and terrorism.

The NEET program will invest in research and development that supports the NE Roadmap goals. The application of the Department's world leading expertise in super-computing to create significant advances in modeling and simulation for nuclear energy systems will result in better understanding of nuclear fuel performance, plant system safety margins, and improved reliability at both existing and future nuclear plants (Goals 1, 2, and 3), and the application of the National Laboratories capabilities to understand and improve common materials and instrumentation and controls issues for nuclear power will improve reliability and safety at existing and future plants (Goals 1 and 2).

Explanation of Funding AND/OR Program Changes

(dollars in thousands)

	FY 2012 Current	FY 2014 Request	FY 2014 Request vs FY 2012 Current
Crosscutting Technology Development (Target)			
The overall decrease reflects transfer of the Proliferation and Terrorism Risk Assessment element to the Fuel Cycle R&D Program and reduction of funding for Advanced Methods for Manufacturing element.	19,806	13,901	-5,905
Nuclear Energy Advanced Modeling and Simulation (NEAMS)			
NEAMS is curtailing full scope coupled physics simulations of advanced reactors in favor of providing more tailored advances suitable for incorporation in other simulation products such as RELAP7. Fuels work will continue unaffected.	13,874	9,536	-4,338
Energy Innovation Hub for Modeling and Simulation			
No significant change	23,517	24,300	+783
National Scientific User Facility			
No significant change	14,110	14,563	+453
Total, Nuclear Energy Enabling Technologies	71,307	62,300	-9,007

Crosscutting Technology Development
Overview

The Crosscutting Technology Development activities support the Reactor Concepts Research, Development and Demonstration and the Fuel Cycle R&D programs. A balanced science-based R&D approach includes both performance enhancement of evolutionary concepts and investigation of novel concepts. Incorporating these technologies and capabilities as part of an integrated system offers the potential of revolutionary improvement in safety, performance, reliability, economics, and proliferation risk reduction.

In FY 2014, the Crosscutting Technology Development subprogram includes: (1) Reactor Materials (materials for nuclear applications), (2) Advanced Sensors and Instrumentation, and (3) Advanced Methods for Manufacturing. Advanced Modeling and Simulation is a separate program under NEET in FY 2014 and is included in the next section. Proliferation and Terrorism Risk Assessment will be funded under the Fuel Cycle R&D Program.

Benefits

The potential benefits of the technology research activities within this subprogram include:

- High risk research which could overcome current technological limitations.
- Examination of new classes of materials not previously considered for nuclear applications.
- Coordinated capabilities common across NE R&D programs.
- Development of enabling technologies beyond individual programs.
- New capabilities needed by the NE R&D enterprise.

Funding Schedule

Fiscal Year	Activity	Funding (dollars in thousands)
FY 2012	• Issued Funding Opportunity Announcement in Reactor Materials and Advanced Methods for Manufacturing and initiated selected projects. • Evaluated and prioritized potentially useful modern materials science capabilities. • Provided increases in control system performance and self-calibration capability through research on adaptive digital monitoring and control technology. • Improved and adapted fiber optic and wireless digital instrument communication systems for nuclear plants. • Initiated studies of current proliferation risk assessment methodologies (strengths, key components, scopes, applicability) to include: current methodologies in "prototype scenarios;" and effective coordination with other national security (including counter terrorism and game theory) methodologies and entities (DHS, DARPA, etc.). • Supported the National Academy of Sciences study of Proliferation Risk Assessment methods, tools, and applications to develop recommendations for high priority research.	19,806
FY 2013	Planned activities in the FY 2013 budget (final allocations have not yet been determined): • Issue a solicitation and fund up to six proposals to develop innovative materials in current and/or future reactors. • Continue to acquire highest priority modern materials science capabilities. • Initiate research to identify dominant physical mechanisms limiting materials behavior in current and future nuclear applications. • Conduct research on advanced concepts of operation with special emphasis on advanced automation and information technologies specific to nuclear plant applications. • Continue research on advanced sensors to improve physical measurement accuracy and reduce uncertainty.	---
FY 2014	• Complete fabrication and evaluation of prototype harsh environment sensors. (compact fission chamber and thermal flux, fast flux, and temperature detector) • Establish basis for implementing fully digital systems for nuclear power applications. • Issue competitive solicitation to develop advanced sensing and control embedded electronic system, high temperature fission chamber, next generation human system inter-	

Fiscal Year	Activity	Funding (dollars in thousands)
	face technologies, power harvesting for nuclear power, and study sensor degradation and transients' models. • Compete the development of advanced hardened and resilient sensors and instrumentation for high irradiation environment. (Post-Fukushima R&D) • Update Materials and Advanced Sensors and Instrumentation Integrated Research Plans as needed. • Issue a competitive solicitation for crosscutting materials research as multiyear projects and encouraging collaboration amongst the national labs, universities and industry. • Continue acquisition of highest priority materials science capabilities. • Issue a competitive solicitation to develop new methods of additive manufacturing, modular/traditional manufacturing and welding techniques.	13,901

Nuclear Energy Advanced Modeling and Simulation
Overview

NEAMS provides support relevant to both reactor and fuel cycle R&D programs. A balanced science-based R&D approach includes both experimentation and modeling and simulation. NEAMS is developing a computational ToolKit which is comprised of both reactor and fuel systems analysis capabilities that can be exercised either coupled or independently, depending on the needs of the end user. The NEAMS ToolKit offers the promise of a revolutionary new tool for students, professors, researchers, industrialists, and regulators to investigate the designs and performance of advanced fuel and reactor systems using modern computational methods and taking advantage of modern computational architectures.

In FY 2014 the work on the ToolKit will be mainly focused on completing the fuels analysis component for Light Water Reactor oxide fuels and on development of the next-generation RELAP7 reactor systems code. Investments will be made in technology development, code verification and validation, and in refining the user experience.

Benefits

The potential benefits of the modeling and simulation activities within this subprogram include

- Models and methods used to predict advanced reactor and fuel system behaviors with fidelity and resolution well beyond those presently available.
- Orchestration of needed capabilities common across NE R&D programs.
- Development of enabling technologies beyond individual programs.
- New capabilities needed by the NE R&D enterprise.

Funding Schedule

Fiscal Year	Activity	Funding (dollars in thousands)
FY 2012	• Released to the public advanced fuel pin and assembly computer codes (BISON and AMP 3.0). • Developed and validated different mesoscale modeling tools for predicting fission gas behavior in UO2 nuclear fuel. • Completed and started implementing SHARP-RELAP-7 Integration Plan.	13,874
FY 2013	Planned activities in the FY 2013 budget (final allocations have not yet been determined): • Coordinate and integrate materials development activities with modeling and simulation and reactor component and system development to optimize the performance with the service requirements. • Complete a preliminary demonstration of the NEAMS integrated multi-physics reactor simulation capability. • Create improved irradiation performance models for oxide fuel. • Add the ability to simulate anticipated fuel rod transients for UO2 -fueled LWRs using BISON/MARMOT.	---
FY 2014	• Release to early users a production version of the engineering-scale fuel performance tool (BISON) with fully realized analytic capability for Light Water Reactor oxide fuels. • Complete development of RAVEN component of RELAP-7 reactor system code. • Demonstrate coupling of SHARP and RELAP-7 components (neutronics, fluid dynamics, and structural dynamics assembly-scale tools) to the engineering-scale fuel performance tool (BISON) in the Fuels Product Line.	9,536

Energy Innovation Hub for Modeling and Simulation
Overview

The Energy Innovation Hub for Modeling and Simulation (Hub) is creating a virtual reactor model of an actual Tennessee Valley Authority-owned (TVA), Westinghouse-designed, operating pressurized water reactors (PWRs) to simulate reactor behavior. Engineers will be able to use this virtual model to improve the safety and economics of reactor operations by simulating proposed solutions to reactor power production increases and reactor life and license extensions. The combination of data gained from the virtual model and the physical reactor will be used to resolve technology issues that have long confronted nuclear energy development. The Oak Ridge National Laboratory is leading a consortium (CASL – Consortium for Advanced Simulation of Light Water Reactors) of national labs, universities, and industry partners to manage Hub execution. CASL began operations in late June 2010. FY 2014 is the final year of funding for the Hub under its initial award period.

Benefits

Potential benefits of the Hub include:

- Greater understanding of existing light water reactor performance.
- Significant power increases at existing light water reactors.
- Reduced need for costly experimentation in fuel performance and safety.
- Tools with revolutionary resolution made available to industry, academia, and the national labs for further research into this and succeeding generations of light water reactors.

Funding Schedule

Fiscal Year	Activity	Funding (dollars in thousands)
FY 2012	• Issued Version 2.0 of VERA, the Virtual Environment for Reactor Analysis. • Modeled CRUD (Chalk River Unidentified Deposits) deposition and thickness based on best available industry and CASL capabilities. • Modeled interaction of fluid flow distribution with fuel rods to understand fuel rod vibration. • Initialed modeling of peak clad temperature, oxidation, Departure from Nucleate Boiling (DNB), and fuel performance parameters during transients. • Initialed modeling of reactor operation; qualify with operational data.	23,517
FY 2013	Planned activities in the FY 2013 budget (final allocations have not yet been determined): • Issue Version 3.0 of VERA, the Virtual Environment for Reactor Analysis. • Predict CRUD Induced Power Shift (CIPS) by calculating CRUD formation, boron uptake, and resulting axial power shape. • Calculate fuel rod material wear resulting from grid to rod fretting (GTRF). • Model reactor vessel fluence and material property changes that result in material degradation and limit vessel performance. • Model boron uptake from reactor coolant into CRUD on fuel rods. • Complete initial model of TVA PWR operation (Watts Bar1); qualify against operational data. • Complete initial safety challenge problem modeling: clad oxidation, departure from nucleate boiling, and loss of coolant accident fuel performance.	---
FY 2014	• Issue Version 4.0 of VERA, the Virtual Environment for Reactor Analysis, for broad release outside of CASL in accordance with export control restrictions. Implement, associated with the release, a sustainable strategy for community support and evolution of this modeling and simulation technology. • Apply the advanced capabilities within VERA to two CASL challenge problems associated with fuel cladding integrity under relevant loss-of-coolant accident (LOCA) and reactor power change scenarios and one CASL challenge problem on the analysis of departure from nuclear boiling (DNB) prediction maturity. The results will be compared where possible against industry baseline tools and experimental validation data.	

Fiscal Year	Activity	Funding (dollars in thousands)
	• Provide, with advanced fuel performance capabilities within VERA, a multi-physics simulation environment to support actionable recommendations for advanced fuel concepts. • Apply the core simulator capabilities within VERA to PWR operational cycles for a TVA PWR nuclear plant exhibiting CASL challenge problem tendencies and compare the results with available operational data. • Apply the advanced capabilities within VERA to estimate long-life reactor environment phenomena expected in PWRs after 60 or more operational years such as neutron fluences, thermal fatigue and mechanical performance. • Deliver a robust multiphase thermal hydraulics capability within VERA with models for subcooled boiling, bubbly flows, and DNB under transient and steady-state PWR-relevant conditions. • Deliver and demonstrate a functional and robust 3D pin-resolved transport capability within VERA. • Demonstrate a functional 3D fuel performance capability for predictions of in-core PWR fuel behavior by comparing the predictions with relevant in-reactor data and evaluating appropriate safety margins. • Perform uncertainty analyses of CASL challenge problems that incorporate verification and validation, sensitivity analysis, uncertainty quantification, and data assimilation using advanced VERA capabilities.	24,300

National Scientific User Facility
Overview

The National Scientific User Facility (NSUF) subprogram represents a "prototype laboratory for the future" since it promotes the use of unique nuclear research facilities for science-based experiments and encourages active university, industry, and laboratory collaboration in relevant nuclear scientific research. The NSUF, through competitive solicitations, provides a mechanism for research organizations to collaborate and conduct experiments and post-experiment analysis at facilities not normally accessible to these organizations. On an annual basis, researchers propose projects to be conducted at these unique facilities that may last from a few months to a few years. When projects are awarded, the NSUF program pays for experiment support and laboratory services at the user facilities. In this manner, researchers are introduced to new techniques, equipment, and personnel so that their research benefits from new technologies and experimental capabilities. The Idaho National Laboratory Advanced Test Reactor and post-irradiation examination (PIE) facilities of the Center for Advanced Energy Studies and Materials and Fuels Complex are available as user facilities. In addition, research reactors at Oak Ridge National Laboratory, the Massachusetts Institute of Technology, and North Carolina State University, the Advanced Photon Source beam line capabilities at the Illinois Institute of Technology, irradiation experiment design and fabrication capabilities at Pacific Northwest National Laboratory, and examination facilities at the Universities of Wisconsin, Michigan, California-Berkeley, Purdue and Nevada-Las Vegas are partnered with the NSUF bringing additional user facilities to the research community. Since its designation as a user facility in 2007, NSUF has awarded 47 experiments to 20 universities and 3 laboratories. All new awards are fully funded upfront, eliminating mortgages and improving consistency.

Benefits

The program helps further nuclear science and engineering research by:

- Providing universities and their partners' access to world-class, unique research facilities and equipment.
- Supporting DOE-NE research and development mission.
- Training a new generation of nuclear scientists and researchers.

Funding Schedule

Fiscal Year	Activity	Funding (dollars in thousands)
FY 2012	• Continued work on previously awarded multi-year irradiation and/or PIE projects. • Awarded 1 new irradiation and 9 new PIE/rapid turnaround projects. • Conducted NSUF Users Week to provide technical materials-related training and instructed potential users how to design meaningful projects and use equipment. Provided other educational opportunities through Internships and off-site short courses. • Increased partnerships to provide user access to UC-Berkeley PIE capabilities and Oak Ridge National Laboratory's (ORNL) High Flux Isotope Reactor's irradiation capabilities.	14,110
FY 2013	Planned activities in the FY 2013 budget (final allocations have not yet been determined): • Continue work on up to 5 previously awarded multi-year irradiation and/or PIE projects; • Award up to 3 new long-term and up to 5 rapid turnaround irradiation and PIE projects. • Conduct NSUF Users Week to provide technical materials-related training and instruct potential users how to design meaningful projects and use equipment. • Increase partnerships with other nuclear research facilities to provide unique capabilities to users of the NSUF.	---
FY 2014	• Continue work on previously awarded multi-year irradiation and PIE projects. • Award one long-term project with full (forward) funding to eliminate future NSUF mortgages. May be a joint award with a NEUP project. • Award and execute "rapid turnaround" PIE experiments. • Evaluate expansion of testing and monitoring capabilities at ATR and MFC to provide enhanced sensor and mechanical test rigs required to support NSUF-user experiments. Will continue to provide testing upgrades (e.g., SiC temperature monitors, multiple thermocouples, in-pile creep test rigs, and hardware/systems supporting Loop 2A experiments) to ensure NSUF continues to provide irradiation and PIE capabilities broadly sup-	

Fiscal Year	Activity	Funding (dollars in thousands)
	porting the NSUF-user community and to maintain a capability level on par with other national user facilities. • Conduct NSUF Users Week to provide technical materials-related training and instruct potential users how to design meaningful projects and use equipment. Provide other educational opportunities through Internships and off-site short courses.	14,563

Radiological Facilities Management
Funding Profile by Subprogram and Activities

(dollars in thousands)

	FY 2012 Current	FY 2013 Annualized CR*	FY 2014 Request
Radiological Facilities Management			
Space and Defense Infrastructure	64,524	64,919	0
Research Reactor Infrastructure	4,986	5,016	5,000
Total, Radiological Facilities Management*	69,510	69,935	5,000

*FY 2013 amounts shown reflect the P.L. 112-175 continuing resolution level annualized to a full year. These amounts are shown only at the "congressional control" level and above; below that level a dash (—) is shown.

Public Law Authorizations

P.L. 112-74, Consolidated Appropriations Act, 2012

Overview

The Radiological Facilities Management (RFM) program maintains nuclear facilities at the Idaho National Laboratory (INL), provides support to nuclear and associated support facilities at Oak Ridge National Laboratory (ORNL), Los Alamos National Laboratory (LANL), and Sandia National Laboratories (SNL); and provides fresh reactor fuel to, and removes used fuel from, 26 operating university reactors. The RFM program ensures that the United States' radioisotope power systems (RPS) capabilities are maintained and operated in a safe, environmentally-compliant, and cost-effective manner.

Facilities and expertise related to RPS for national security and space exploration missions are maintained through the Space and Defense Infrastructure subprogram. In this subprogram, there are four critical functions that the Department of Energy (DOE) maintains: fabrication of safety critical hardware, Pu-238 fuel processing and encapsulation, RPS assembly and testing, and safety analysis.

In FY 2014, NE is transitioning to a complete full cost recovery strategy for radioisotope power systems required for non-NE and non-DOE missions. Requested FY 2014 funding and justification for these activities are included in the National Aeronautics and Space Administration budget request. Although funding for these activities will be transferred to user organizations, such as NASA, DOE will retain its responsibility and authority to manage its facilities and personnel consistent with Departmental requirements and will retain its independence in nuclear safety determinations.

The Research Reactor Infrastructure (RRI) subprogram supports the continued operation of U.S. research reactors by providing research reactor fuel services and maintenance of fuel fabrication equipment.

Program Accomplishments and Milestones

In FY 2012, RFM achieved three significant accomplishments or milestones in program management and/or program development: 1) enabled launch of the Mars Science Laboratory mission; 2) completed installation of a multi-purpose glovebox at INL; and 3) Completed shipments of fresh and used nuclear fuel to meet the RRI university program needs.

In FY 2014, RFM is working towards the following key milestones:

Milestone	Date
Complete transition to full cost recovery for RPS infrastructure activities.	Oct/2013
Procure 40 and deliver 36 plate fuel elements required annually by MURR and MIT as determined by need and fuel availability.	Sep/2014
Complete up to 6 used fuel shipments to SRS and Idaho National Laboratory (INL), pending resolution of moratorium on such shipments to INL.	Sep/2014

Program Planning and Management

NE conducts various internal and external reviews and audits to validate and verify program performance. Periodic RFM program reviews evaluate progress against established plans. NE holds monthly, quarterly, semi-annual, and annual reviews, consistent with program management plans and project baselines, to ensure technical progress, cost, and schedule adherence, and responsiveness to program requirements. Internally, NE provides continual management and oversight of its programs.

Once the Space and Defense subprogram transitions to full cost recovery, NASA will have a role in the program reviews and planning. Specific planned actions for FY 2014 will be reflected in the NASA budget request.

For the RFM program, the Department's Office of Health, Safety and Security (HSS) provide an important independent oversight role for DOE through a range of approaches. These approaches include inspections, targeted reviews, collaborative reviews, and assist visits to assess safety related activities. HSS provides the results of their evaluation to Departmental leadership and other stakeholders. The results from these assessments provide a critical evaluation of the adequacy of safety-related policies and the effectiveness of their implementation at DOE facilities.

Strategic Management

To efficiently and effectively manage the program, the RFM program will implement the following strategies:

- Maintain the unique infrastructure and capability to deliver RPS for space science and exploration missions and national security applications as needed.
- Aggressively implement contracting reforms, including fixed price competitive bidding, earned value management, capital planning processes in accordance with DOE Order 413.3B, independent external evaluations, etc., to ensure that the infrastructure program is operating effectively and efficiently to meet the Department's highest priority program needs.

The following external factors could affect the program's ability to achieve its strategic goal:

- Program infrastructure activities are interrelated with requirements defined by customer, i.e., NASA and national security agencies, for the development of radioisotope power systems. Changes in long-term projected demands for radioisotope power systems would impact NE's provision of infrastructure and development support, including activities associated with restarting domestic Pu-238 production.

Program Goals and Funding

RFM supports the four objectives identified in the NE R&D Roadmap:

- Develop technologies and other solutions that can improve the reliability, sustain the safety, and extend the life of current reactors.
- Develop improvements in the affordability of new reactors to enable nuclear energy to help meet the Administration's energy security and climate change goals.
- Develop sustainable nuclear fuel cycles
- Understand and minimize the risks of nuclear proliferation and terrorism.

In addition, and more specifically, the RFM program provides:

- The capability to develop and furnish nuclear power systems for use in national security and space exploration missions, and
- Nuclear fuel services to U.S. research reactors.

Explanation of Funding AND/OR Program Changes

(dollars in thousands)

	FY 2012 Current	FY 2014 Request	FY 2014 Request vs FY 2012 Current
Space and Defense Infrastructure			
The reduction reflects the completion of Congressionally directed funding for Oak Ridge nuclear infrastructure in FY 2012 and the transition to full cost recovery for RPS infrastructure support.	64,524	0	-64,524
Research Reactor Infrastructure			
There are no significant changes to the RRI subprogram in FY 2014.	4,986	5,000	+14
Total, Radiological Facilities Management	69,510	5,000	-64,510

Space and Defense Infrastructure
Funding Profile by Activity

(dollars in thousands)

	FY 2012 Current	FY 2013 Annualized CR*	FY 2014 Request
Power System Assembly, Testing and Delivery	9,650	---	0
Heat Source Production	27,000	---	0
Iridium Hardware and Material Testing	19,426	---	0
Safety and Program Analysis	8,448	---	0
Total, Space and Defense Infrastructure	64,524	64,919	0

*Note: The final FY 2013 allocations have not yet been determined.

Overview

In FY 2014, NE is transitioning to a complete full cost recovery strategy for radioisotope power systems required for non-NE and non-DOE missions. Requested FY 2014 funding and justification for these activities are included in the National Aeronautics and Space Administration budget request.

The Space and Defense Infrastructure subprogram maintains the infrastructure and capabilities to provide radioisotope power systems (RPS) for space exploration missions and national security applications as needed. The Department maintains capabilities at the Idaho National Laboratory, Oak Ridge National Laboratory, Los Alamos National Laboratory and Sandia National Laboratories needed to produce these systems. Because this program maintains capabilities to support production operations, it is a system that relies on the full range of functions in order to complete its mission.

The Pu-238 based RPS is needed for certain NASA and national security applications where other power sources, such as batteries, fuel cells, and solar technologies, are not economical or technologically viable. They enable NASA space science and exploration missions that lead to major discoveries and open greater possibilities and opportunities to achieve the nation's space exploration goals.

DOE maintains the infrastructure to develop, manufacture and deliver RPS and assess their safety pursuant to a number of laws and directives including the Atomic Energy Act and the National Space Policy. Beginning in FY 2014, the cost to maintain this infrastructure will be paid by user agencies.

In addition to the funding for base infrastructure support, NASA and national security agencies provide project-specific reimbursable funding for RPS, reactor design and demonstration, material purchases, and launch approval safety activities. The level of reimbursable funding varies from year to year based on build schedules required to support specific NASA missions or national security applications. In FY 2012, DOE initiated project planning and technology development activities to reestablish a domestic plutonium-238 production supply with reimbursable funding from NASA. DOE is in the process of completing environmental analyses and finalizing the project alternative selection and cost range estimate. Key milestones for the technology development activities are to qualify targets for irradiation in the High Flux Isotope Reactor in Oak Ridge and initiate an integrated Pu-238 production demonstration.

Explanation of Funding AND/OR Program Changes

(dollars in thousands)

	FY 2012 Current	FY 2014 Request	FY 2014 Request vs FY 2012 Current
Power System Assembly, Testing and Delivery			
Decrease reflects transition to full cost recovery for RPS infrastructure support.	9,650	0	-9,650
Heat Source Production			
Decrease reflects transition to full cost recovery for RPS infrastructure support.	27,000	0	-27,000
Iridium Hardware and Material Testing			
The reduction reflects the completion of FY 2012 Congressionally directed activities and the transition to full cost recovery for RPS infrastructure support.	19,426	0	-19,426
Safety and Program Analysis			
Decrease reflects transition to full cost recovery for RPS infrastructure support.	8,448	0	-8,448
Total, Space and Defense Infrastructure	64,524	0	-64,524

Power System Assembly, Testing and Delivery
Overview

This budget element was previously named Idaho National Laboratory in prior budget submittals. It was renamed to reflect the covered functions rather than the location. The (1) assembly, (2) testing, (3) storage, and (4) transportation of radioisotope power systems (RPS) of various designs for the NASA space exploration program and National Security is completed at INL. The facilities are housed in three main buildings. These three buildings house 30 major pieces of equipment and four complex gloveboxes. The facilities occupy approximately 25,000 square feet. The contractor staff is made up of 40 Full Time Equivalents (FTE) with additional resources being provided on a project specific basis as needed.

Space and Security Power Systems Facility (SSPSF). RPS fueling, final assembly, and testing and measurement operations are conducted in the SSPSF which is located on the Material and Fuels Complex campus.

Engineering Development Laboratory (EDL). Facility conducts various non-radiological operations and provides a variety of support functions. The EDL is used to fabricate, assemble, mockup, and test various research, development, and production equipment. The majority of work conducted in EDL is for the RPS Program. The facility includes equipment and glove boxes for welding, including an electron-beam welder, furnaces for bake-out of graphite components, forming equipment for heat source hardware, and various machine tools.

Radioisotope Systems Training and Servicing Facility. Radioisotope Thermo-electric Generator Transportation System which moves the RTGs to user sites and two types of shipping containers are stored in this facility. The facility also provides a training area for these systems.

Funding and Activity Schedule

Fiscal Year	Activity	Funding (dollars in thousands)
FY 2012	• Maintained capabilities for RPS integration, assembly, testing and delivery and component manufacturing. • Stored and maintained the flight quality status of the RPS for the NASA Mars Science Laboratory mission. • Supported capital equipment used in RPS assembly activities, including installation of a multi-purpose glove box for system assembly. • Supported launch of the Mars Science Laboratory mission through the use of NE and NNSA for contingency support and emergency planning expertise, personnel, and equipment. Completed commissioning of a five-ton crane for shipping cask disassembly and training at INL. • Upgraded environmental control in two hardware preparation gloveboxes.	9,650
FY 2013	Planned activities in the FY 2013 Budget (final allocations have not yet been determined): • Maintain capabilities for RPS integration, assembly, testing and delivery and component manufacturing. • Commission and upgrade environmental controls for multi-purpose glove box and upgrade environmental controls for the inert atmosphere assembly glovebox.	---
FY 2014	Transition to full cost recovery in FY 2014.	0

Heat Source Production
Overview

This budget element was previously named Los Alamos National Laboratory in prior budget submittals. It was renamed to reflect the covered functions rather than the location. Los Alamos National Laboratory (LANL) produces the encapsulated Pu-238 heat sources, also known as fueled clads, in the Plutonium Facility-4 (PF-4) within TA-55. The Pu-238 heat source facility occupies 12,000 ft^2 within PF-4. Equipment includes 78 glove boxes and 61 pieces of special equipment. User agencies fund the incremental staffing, materials, and equipment required to produce power systems under project-specific reimbursable agreements. In FY 2014 DOE will conduct a study under the Program and Safety Analysis sub element of this program to inform an alternatives analysis and environmental reviews to support decisions related to long-term heat source manufacturing capability reliability.

Gloveboxes and Pu-238 Processing: All processing of Pu-238 must be conducted in tightly sealed gloveboxes maintained under negative pressure to ensure no leaks of material into the work spaces. Special precautions and controls are required to ensure operators are not exposed to Pu-238 or radiation in the fuel from radioactive isotopes embedded as impurities in the fuel or activated by Pu-238 decay. Due to the unique invasive properties of Pu-238 in its powdered form, which can cause significant equipment deterioration problems, continuous servicing and maintenance on the gloveboxes and equipment is required, even between production campaigns.

Isotope Fuels Impact Tester (IFIT): The DOE must ensure flight safety for fueled clads and advise the White House on launch safety issues. In order to test fueled clad integrity under launch or re-entry accident conditions and provide data necessary for safety analyses, a fueled clad impact testing program is maintained at the LANL facility. In order to accomplish a comprehensive safety testing program a complex and highly sophisticated testing capability designated the IFIT is operated and maintained at the LANL facility. Fueled clads are impacted under precisely known conditions replicating a launch/re-entry accident and then subjected to analysis to assess shell and weld integrity and containment of the Pu-238 fuel. Under the full cost recovery that will begin in FY 2014, DOE will continue to be responsible for executing nuclear safety analyses and testing and making related recommendations and specifying requirements.

Funding and Activity Schedule

Fiscal Year	Activity	Funding (dollars in thousands)
FY 2012	• Maintained and operated dedicated Pu-238 processing, encapsulation, and scrap recovery facilities. • Continued transition of chemical analysis capabilities from the Chemistry and Metallurgy Research Building to Pu-238 processing facility at TA-55. • Upgraded hot press power supply for pellet manufacturing process. • Continued fuel production campaign for NASA Discovery class mission.	27,000
FY 2013	Planned activities in the FY 2013 Budget (final allocations have not yet been determined): • Maintain and operate dedicated Pu-238 processing, encapsulation, and scrap recovery facilities. • Complete transition of chemical analysis capabilities from the Chemistry and Metallurgy Research Building to Pu-238 processing facility at TA-55. • Complete fuel production campaign for NASA Discovery 12 mission.	---
FY 2014	Transition to full cost recovery in FY 2014.	0

Iridium Hardware and Material Testing
Overview

This budget element was previously named Oak Ridge National Laboratory in prior budget submittals. It was renamed to reflect the covered functions rather than the location. Oak Ridge National Laboratory (ORNL) is the lead materials development laboratory for the Space and Defense Power Systems program. Unique facilities, equipment, and trained personnel provide:

- Development, testing, welding, and characterization of materials for high temperature heat source applications,
- Expertise in iridium alloys, which is a national asset,
- Refractory and other high temperature metal/materials compatibility and mechanical properties testing (tensile, creep, pressure burst), and
- Expertise in carbon bonded carbon fiber (CBCF) insulator production, which is a unique capability.

ORNL is responsible for the production of two safety critical pieces of hardware for the Space and Defense program:

Iridium Alloy Fueled Clad Vent Set Production. In order to maximize efficiency, the Pu-238 fueled clads must be maintained at a very high temperature. ORNL has developed two alloys of iridium that provide the required safety and performance characteristics. ORNL produces the special iridium alloy metal containment for the Pu-238 fuel pellets that are manufactured at LANL. The containment is used at LANL to make Pu-238 heat sources called fueled clads for the radioisotope power systems assembled at INL.

Manufacture of Carbon Bonded Carbon Fiber Insulation. The CBCF insulation sleeves are produced at ORNL. The insulators are used in the assembly of heat source modules at INL and are critical to the modules safe operation. The insulator helps protect the fueled clads during potential accidents by reducing temperature spikes that could damage the containment system.

The ORNL production facilities are housed in three Buildings on the ORNL. Within these three buildings, the manufacturing facilities are comprised of 60 pieces of equipment occupying a total of 13,500 square feet.

In addition to these activities, Congress provided additional unrequested funding for nuclear infrastructure at Oak Ridge National Laboratory in FY 2012. The funds supported maintenance and refurbishment of ORNL nuclear and materials engineering facilities such as the Radiochemical Engineering and Development Center, which plays a role in heavy-element research.

Funding and Activity Schedule

Fiscal Year	Activity	Funding (dollars in thousands)
FY 2012	• Maintained infrastructure and capabilities to fabricate iridium fuel encapsulation hardware, carbon thermal insulation sleeves used in the re-entry protection system; and materials control, quality control, quality inspection, and documentation. • Replaced an electrical discharge machine for forming iridium hardware components. Completed procurement for iridium hardware furnace. • Utilized additional unrequested Congressionally directed funding to maintain and refurbish ORNL nuclear infrastructure for the Department's nuclear research and development missions. Funds supported activities such as equipment and building maintenance; end-of-life replacement of nuclear safety and facility support components and systems; and safety/environmental documentation updates.	19,426
FY 2013	Planned activities in the FY 2013 Budget (final allocations have not yet been determined):	

Fiscal Year	Activity	Funding (dollars in thousands)
	• Maintain infrastructure and capabilities to fabricate iridium fuel encapsulation hardware, carbon thermal insulation sleeves used in the re-entry protection system; and materials control, quality control, quality inspection, and documentation.	---
FY 2014	Transition to full cost recovery in FY 2014.	0

Safety and Program Analysis
Overview

The Safety and Program Analysis function maintains the capability to prepare nuclear risk assessments and safety analyses, and to conduct testing to assist in evaluating the safety and performance of NASA and national security missions. For NASA missions, the safety analysis supports the National Environmental Policy Act and the Presidential launch approval process. Under this proposed shift to full-cost recovery, the nuclear safety determinations conducted by the Department of Energy shall remain independent of the funding user organizations, such as NASA. This budget element maintains access to a cadre of experts to provide independent technical evaluations of system designs and technical and safety performance. Sandia National Laboratories is the laboratory lead for safety analysis capabilities, including: probabilistic risk analysis (PRA), accident scenarios and probabilities, accident environments, nuclear hardware response modeling, mechanical impact environments, solid propellant fire environments, reentry environments, source terms, radiological consequence analysis, atmospheric transport and dispersion modeling, exposure pathway modeling, technical feasibility analysis, materials analysis, thermal analysis. Physical safety testing of hardware and components are conducted to ensure that hardware response models are updated to reflect the most current understanding of potential accident environments.

National Environmental Policy Act support to NASA on Nuclear Systems
A formal process to evaluate the potential environmental impacts of proposed Federal actions, involving the preparation of Environmental Impact Statements by the lead Federal agency, which DOE will support and provide recommendations under full cost recovery for the user agency.

L**aunch Approval Process—Presidential Directive/National Security Council Memorandum 25 (PD/NSC-25)**
Establishes an ad hoc Independent Nuclear Safety Review Panel for each mission tasked to prepare a safety evaluation. Requires sponsoring agency to request President's approval for flight. DOE prepares the detailed safety assessment for the risks associated with an accident involving a nuclear power system. DOE will continue to have sole responsibility for the detailed safety assessments under full cost recovery.

Funding and Activity Schedule

Fiscal Year	Activity	Funding (dollars in thousands)
FY 2012	• Continued to maintain the required analytical and testing capabilities that enabled the Department to analyze RPS performance and safety for various applications and maintain certification of shipping system. These capabilities are required to meet the presidential launch approval process required under the Presidential Directive/National Security. • Initiated limited activities to increase the understanding of the safety of DOE hardware under the changing and challenging conditions of new launch environments to support the launch approval process. Changes being evaluated include: new launch vehicles, upper stages, and rocket fuel environments; a new general purpose heat source (GPHS) design; new RPS configurations and temperature regimes; and new spacecraft integration configurations (heat shields). In parallel, planned for reduced safety analysis and orbit debris analysis capabilities due to a reprioritization of infrastructure funds.	8,448
FY 2013	Planned activities in the FY 2013 Budget (final allocations have not yet been determined): • Maintain safety analysis and independent technical assessment capability. Terminate safety testing activities and orbit debris analysis capability.	---
FY 2014	Transition to full cost recovery in FY 2014.	0

Research Reactor Infrastructure
Funding Profile by Activity

(dollars in thousands)

	FY 2012 Current	FY 2013 Annualized CR*	FY 2014 Request
Research Reactor Infrastructure			
Idaho National Laboratory	4,986	5,016	5,000
Total, Research Reactor Infrastructure	4,986	5,016	5,000

*Note: The final FY 2013 allocations have not yet been determined.

Overview

The Research Reactor Infrastructure (RRI) subprogram provides fresh reactor fuel to and removes used fuel from 26 operating university reactors thus supporting the continued operation of university research reactors. This in turn provides continued test reactor capability to universities, coupled with research, development, and educational opportunities in support of U.S. nuclear energy initiatives.

The continued operation of university research reactors plays an important role in developing future scientists and engineers in the United States. This subprogram sustains unique capabilities for research and development and educational opportunities supporting U.S. energy initiatives. Used nuclear fuel shipments support U.S. and DOE non-proliferation and national security objectives.

Explanation of Funding Changes

(dollars in thousands)

	FY 2012 Current	FY 2014 Request	FY 2014 Request vs FY 2012 Current
Research Reactor Infrastructure			
There are no significant changes to the RRI subprogram in FY 2014.	4,986	5,000	+14
Total, Research Reactor Infrastructure	4,986	5,000	+14

Research Reactor Infrastructure
Overview

This activity provides fresh reactor fuel to and removes used fuel from 26 operating university reactors. It supports the continued operation of U.S. research reactors by providing research reactor fuel services and maintenance of fuel fabrication equipment.

Funding and Activity Schedule

Fiscal Year	Activity	Funding (dollars in thousands)
FY 2012	Procured 42 and delivered 37 plate fuel elements to MURR, MIT, and Rhode Island Nuclear Science Center. Completed 6 used nuclear fuel shipments to SRS.	4,986
FY 2013	Planned activities in the FY 2013 Budget (final allocations have not yet been determined): Fabricate and ship approximately 42 fuel elements. Complete approximately 5 used fuel shipments. Procure uranium metal, perform receipt inspection, and fabricate 2 lots of highly enriched uranium fuel powder.	5,016
FY 2014	Procure 40 and deliver 36 plate fuel elements required annually by MURR and MIT as determined by need and fuel availability. Complete up to 6 used fuel shipments to SRS and Idaho National Laboratory (INL), pending resolution of moratorium on such shipments to INL.	5,000

Idaho Facilities Management
Funding Profile by Subprogram

(dollars in thousands)

	FY 2012 Current	FY 2013 Annualized CR*	FY 2014 Request
Idaho Facilities Management			
INL Nuclear Research Reactor Operations and Maintenance	67,599	---	81,226
INL Non-Reactor Nuclear Research Facility Operations and Maintenance	57,879	---	60,734
INL Engineering and Support Facility Operations and Maintenance	10,015	---	10,653
INL Regulatory Compliance	14,673	---	10,549
Advanced Post Irradiation Examination (PIE) Capabilities	3,931	---	2,000
Construction	0	---	16,398
Total, Idaho Facilities Management	154,097	155,040	181,560

*Note: FY 2013 amounts shown reflect the P.L. 112 175 continuing resolution level annualized to a full year. These amounts are shown only at the "congressional control" level and above; below that level a dash (—) is shown.

Public Law Authorizations

P.L. 112-74, Consolidated Appropriations Act, 2012

Overview

The mission of the Idaho Facilities Management (IFM) program is to manage the planning, acquisition, operation, maintenance, and disposition of the Office of Nuclear Energy (NE)-owned facilities and capabilities at the Idaho National Laboratory (INL). The IFM program maintains Department of Energy (DOE) mission-supporting facilities and capabilities at INL in a safe, compliant status to support the Department's nuclear energy research, testing of naval reactor fuels and reactor core components, and range of national security technology programs that support the National Nuclear Security Administration (NNSA) and other Federal agencies such as the Department of Homeland Security in the areas of critical infrastructure protection and nuclear nonproliferation.

The IFM program enables long-term nuclear research and development (R&D) activities by providing the people, facilities, equipment, and nuclear materials necessary to conduct a wide array of experimental activities in a safe and compliant manner. The Advanced Test Reactor (ATR) provides unique irradiation capability to further nuclear fuel and reactor component research in support of advanced nuclear reactor design activities. The Materials and Fuels Complex (MFC) contains a comprehensive range of fuel and experiment fabrication, and pre- and post-irradiation examinations to assess material and fuel characteristics and performance in varying reactor environments. The Un-irradiated Fuel Storage Building (CPP-651) and several of the surrounding buildings, all within the Idaho Nuclear Technology and Engineering Center (INTEC), are used for relocation of Low-Enriched Uranium disposition product from the sodium-bonded spent nuclear fuel campaign. The Research and Education Campus is home to a range of research capabilities and facilities supporting research in nuclear energy as well as National and Homeland Security (N&HS) and energy and the environment.

To enable and facilitate R&D activities, strategic priorities for the IFM program include maximizing the utility of facilities through cost effective rehabilitation and implementing critical capability improvements or replacements through line item capital projects and operating projects. Current IFM funded activities meeting these priorities include: constructing a Remote-Handled Low-Level Waste (RHLLW) Disposal facility, assessing possible options for Advanced Post-Irradiation Examination (APIE) capabilities, and resuming transient fuel testing.

- The RHLLW Disposal Project will provide onsite replacement of INL's remote-handled low-level waste disposal capability. The capability is needed to support ongoing and future programs (including NE and Naval Reactors) at INL. This project is funded by NE and Naval Reactors.

- The APIE Capabilities studies will assess options to provide flexible space to house multiprogram, third-generation, PIE equipment to enhance INL's micro-, nano-, and atomic-scale irradiated materials analysis capabilities in the future if determined to be appropriate and necessary.

- Resuming of transient fuel testing will re-establish a transient testing capability, enabling

the NE R&D programs to understand fuel performance phenomenology at the millisecond-to-second time scales as well as meet the need to screen advanced fuel concepts, including accident tolerant fuels, which allows for early identification of the limits of fuel performance.

Subprogram Accomplishments and Milestones

In FY 2014, IFM is working towards the following key milestones:

Milestone	Date
Conduct over 45 irradiation campaigns at ATR as scheduled while maintaining an operating efficiency greater than 80%.	Sep 2014
Complete planned facility modifications identified in the Materials and Fuels Complex (MFC) Documented Safety Analyses (DSAs).	Sep 2014
Complete 1-3 shipments of NE-owned special nuclear material for off-site disposition	Sep 2014
Treat approximately 76 kilograms of EBR-II used nuclear fuel	Sep 2014
Continue planned Life Extension Program (LEP) activities in support of Nuclear Instrumentation Replacement, ATR Core Modeling Update, and Reactor Data Acquisition System (RDAS) and Lobe Power Calculation and Indicating System (LPCIS) replacement.	Sep 2014
Complete all major preparatory activities for the ATR CIC to ensure readiness for start as soon as 2015	Sep 2014
Complete 6 transfers of UNF from wet storage in accordance with the 1995 Idaho Settlement Agreement (ISA).	Sep 2014
Award Design Build Contract, initiate final design, and prepare for construction of the selected alternative to construct a new Remote Handled Low Level Waste disposal Facility at INL.	Sep 2014

Program Planning and Management

NE's R&D Roadmap describes essential research and development programs that require unique nuclear and radiological capabilities. These facilities are difficult and expensive to build and operate, are not commercially available, and are becoming increasingly scarce in the United States and internationally. Although primarily supporting NE activities, other DOE programs, Federal agencies, and commercial entities also rely upon these INL capabilities to accomplish their work. By nature, such nuclear facilities have complex regulatory and operating requirements. IFM assures that these capabilities are available and will remain available and relevant to NE mission needs consistent with the NE Roadmap and implementing strategies.

Strategic Management

The program will use various means and strategies to achieve its goals. However, various external factors may impact the ability to achieve these goals. The program also performs collaborative activities to help meet its goals. The Department will implement the following means:

- Aggressively implement contracting reforms, including fixed price competitive bidding, earned value management, capital planning processes in accordance with DOE Order 413.3B, independent external evaluations, etc., to ensure that the infrastructure program is operating effectively and efficiently to meet the Department's highest priority program needs.
- Ensure that mission essential systems, resources, and services are identified, maintained, and operated in compliance with DOE, Federal, and state safety and environmental requirements in a secure and cost-effective manner.

The Department will implement the following strategies:

1. Identify IFM mission critical facilities and activities through various means, including review of the INL Ten-Year Site Plan and other relevant materials. Develop detailed work planning and funding requests accordingly.
2. Continue maintenance improvement program to clarify priority facilities and reduce deferred maintenance.
3. Continued integration of energy efficiency, petroleum reduction, high performance sustainable building, renewable energy and overall sustainability program planning in all aspects of Idaho facility management.

These strategies will contribute to the efficient and effective management of the program, thus putting the taxpayers' dollars to more productive use.

The following external factors could affect the program's ability to achieve its strategic goal:

- As the IFM program seeks to improve the responsiveness and support provided to a wide range of R&D and national security programs, changes in nuclear energy R&D progress and priorities could impact priorities within the IFM program, but not necessarily impact its overall cost and long-term liabilities.
- Lack of disposition paths for some SNM and waste may present challenges to certain future R&D.

In carrying out the program's mission, the program performs the following collaborative activities: a variety of experiment design, fabrication, irradiation, and post-irradiation work in support of the NNSA, Naval Reactors, universities, partnerships with international governments and industry organizations.

Subprogram Goals and Funding

NE R&D programs require certain key infrastructure to support R&D activities. NE successfully employs a solid approach to maintaining such infrastructure. The approach concentrates the high-risk nuclear facilities at the remote Idaho site, maintains unique capabilities at other sites if required, supports vital university infrastructure, negotiates equitable capability exchanges with trusted international partners, refurbishes and re-equips essential facilities if required, addresses maintenance backlogs to ensure safe operation, and makes efficient use of modeling, simulation, and single-effect experiments.

The NE R&D Roadmap states four goals that the R&D programs support to meet NE's mission and that guide program planning and execution. These goals provide a concrete framework for NE's activities and link to the Department's strategic priorities.

- Develop technologies and other solutions that can improve the reliability, sustain the safety, and extend the life of current reactors.
- Develop improvements in the affordability of new reactors to enable nuclear energy to help meet the Administration's energy security and climate change goals.
- Develop sustainable nuclear fuel cycles.
- Understand and minimize the risks of nuclear proliferation and terrorism.

Those four goals are further supported indirectly by the IFM program through the creation and maintenance of the physical infrastructure necessary for conducting nuclear R&D activities.

Explanation of Funding AND/OR Program Changes

(dollars in thousands)

	FY 2012 Current	FY 2014 Request	FY 2014 vs FY 2012 Current
INL Nuclear Research Reactor Operations and Maintenance The increase from $67,599,000 to $81,226,000 reflects funding to support resumption of transient testing as well as support for Life Extension Program completion in FY 2015.	67,599	81,226	+13,627
INL Non-Reactor Nuclear Research Facility Operations and Maintenance The increase from $57,879,000 to $60,734,000 reflects the additional funding needed to support planned maintenance in nuclear facilities, planned facility modifications identified in MFC Documented Safety Analyses (DSA), and implementation of a material condition assessment program at MFC to improve understanding of facility conditions and long-term maintenance requirements.	57,879	60,734	+2,855
INL Engineering and Support Facility Operations and Maintenance The increase from $10,015,000 to $10,653,000 reflects planned non-nuclear facility disposition activities to reduce unneeded footprint.	10,015	10,653	+638

(dollars in thousands)

	FY 2012 Current	FY 2014 Request	FY 2014 vs FY 2012 Current
INL Regulatory Compliance The decrease from $14,673,000 to $10,549,000 reflects shifting funding for the RHLLW Disposal Project from operating funds to capital funds, consistent with project schedules to meet the FY 2018 completion date.	14,673	10,549	-4,124
Advanced Post Irradiation Examination (PIE) Capabilities The decrease from $3,931,000 to $2,000,000 reflects planned work to support environmental and technical option studies to identify alternatives for conducting advanced post-irradiation examination of fuels and materials.	3,931	2,000	-1,931
Construction The increase from $0 to $16,398,000 reflects the initiation of the Remote-Handled Low Level Waste Disposal Project: Includes $16,398,000 of design and construction funds to support replacement of new disposal capability to meet NE and Office of Naval Reactor (NR) long-term program needs. This project is joint-funded with the Office of Naval Reactors.	0	16,398	+16,398
Total, Idaho Facilities Management	154,097	181,560	+27,463

INL Nuclear Research Reactor Operations and Maintenance
Overview

This category supports nuclear research reactor operations and maintenance at the Advanced Test Reactor (ATR) for the INL, including the associated support infrastructure, the ATR Critical Facility (ATRC), and the Neutron Radiography Reactor (NRAD). It also maintains the Transient Reactor Experiment and Test (TREAT) facility in an inactive standby mode. NRAD and TREAT are located at the Materials and Fuels Complex (MFC).

The primary reactor at INL is the ATR. The ATR supports the majority of NE R&D programs, as well as NNSA programs, including Naval Reactors Program work in support of the U.S. Navy nuclear fleet and Global Threat Reduction Initiatives to support conversion of research and test reactors to low-enriched uranium fuel. All programmatic work is funded by the sponsoring Federal programs. The ATR is also used by universities and industry. The cost to other users is determined in accordance with DOE regulations and depends upon the demands on the reactor and the nature of the user.

This category also funds activities related to the potential resumption of a domestic transient fuel testing capability, such as alternative identification and option analysis; environmental studies; facility and equipment evaluations, designs, and refurbishments; and safety evaluations.

Benefits

- Provides infrastructure capabilities to further nuclear fuel and reactor component research in support of advanced nuclear reactor design activities.
- Supports U.S. Navy nuclear fleet, Global threat Reduction Initiatives, and university/industry users.
- Resuming nuclear fuel testing capability may help improve the safety and reliability of U.S. and international nuclear fuels.

Funding Schedule

Fiscal Year	Line Item	Funding (dollars in thousands)
FY 2012	• Maintained and operated IFM reactor facilities. • Completed ATR Loop 2A installation and began operation. • Completed ATR Life Extension Program activities such as the heat exchanger seismic supports and the auxiliary canal fill system. • Continued long-lead procurements for ATR CIC activities. • Conducted over 45 irradiation campaigns at ATR as scheduled while maintaining an operating efficiency greater than 80%; Maintain and repair ATR Complex infrastructure and INL Reactors (ATR, ATRC, NRAD, and TREAT). • Initiated option studies to resume transient testing. • Completed ATR modifications to enhance accident response capability.	67,599
FY 2013	Planned activities in the FY 2013 Budget (final allocations have not yet been determined): • Maintain and operate INL reactors and supporting infrastructure. • Continue planned ATR LEP activities with the goal of completing LEP in FY 2015. • Complete LEP activities such as Reactor Data Acquisition System (RDAS), Lobe Power Calculation and Indicating System (LPCIS) and initiate safety related Plant Protective System, and Surveillance and Testing System replacements. • Initiate final procurements to support ATR CIC activities. • Conduct over 45 irradiation campaigns as scheduled while maintaining an operating efficiency greater than 80%. • Operate ATR Loop 2A with enhanced instrumentation and fuel ramp capability to support advanced fuel and material testing experiments. • Initiate detailed analyses to sustain ATR and improve long-term reliability, such as replacement of emergency fire water injection system and transition to commercial power.	---

Fiscal Year	Line Item	Funding (dollars in thousands)
	• Initiate detailed plans and activities to resume transient testing capabilities pending outcome of options studies.	
FY 2014	• Maintain and operate INL reactors and supporting infrastructure. • Continue planned LEP activities such as Nuclear Instrumentation Replacement and ATR Core Modeling Update with the goal of completing LEP in FY2015. • Complete all major preparatory activities for the ATR CIC to ensure readiness starting as early as 2015. • Conduct over 45 irradiation campaigns as scheduled while maintaining an operating efficiency greater than 80%. • Initiate procurements to replace obsolete systems and components for resumption of transient testing capability and facility safety documentation development and system replacement design and implementation as deemed necessary based on alternatives studies.	81,226

INL Non-Reactor Nuclear Research Facility Operations and Maintenance
Overview

This category funds operations, maintenance, and support for non-reactor nuclear and radiological research facilities. The non-reactor nuclear research facilities support programmatic activities such as nuclear fuel development, separations research, pre- and post-irradiation fuel examinations, and radiological chemical analysis. This category also funds the management of NE-owned special nuclear material (SNM), including the characterization, packaging, storage, and disposition of surplus SNM.

Benefits

- Consolidation and disposition of SNM frees up facility space enabling it to be used for mission–essential activities.
- Enables mission-critical R&D capabilities as identified in the NE R&D Roadmap.
- Enables R&D programs by ensuring the nuclear safety bases for Materials & Fuels Complex (MFC) nuclear facilities are fully implemented and compliant.

Funding Schedule

Fiscal Year	Line Item	Funding (dollars in thousands)
FY 2012	• Maintained and operated MFC nuclear facilities consistent with Departmental requirements and in support of planned research and development activities. • Conducted nuclear maintenance and repair of MFC facilities, including facility safety system and procedural modifications as identified through revised Documented Safety Analyses (DSA). • Managed NE-owned programmatic and surplus SNM, including characterization, stabilization, and disposal of surplus SNM. • Maintained and operated glove boxes and supporting systems to condition and prepare NE-owned surplus plutonium and uranium for off-site disposition. • Constructed the Irradiated Material Characterization Laboratory (IMCL).	57,879
FY 2013	Planned activities in the FY 2013 Budget (final allocations have not yet been determined): • Provide trained operators and technicians, qualified criticality safety officers, and material balance custodians to operate MFC nuclear facilities. • Analyze and authorize adjustments to operating parameters and facility operations and coordinate programmatic work activities. • Develop and provide nuclear training, quality assurance, document management; systems and safety engineering; environment, safety and health; nuclear materials management and stewardship. • Perform program integration to support effective execution of projects and programs within the nuclear facilities at the MFC. • Transition IMCL to full operations. • Complete planned facility modifications and upgrades identified in MFC DSAs. • Complete 1-3 shipments to disposition special nuclear materials. • Continue maintenance within the MFC nuclear facilities and infrastructure consistent with the approved safety bases.	---

FY 2014	• Provide trained operators and technicians, qualified criticality safety officers, and material balance custodians to operate and maintain MFC nuclear facilities. • Analyze and authorize adjustments to operating parameters and facility operations and coordinate programmatic work activities. • Perform program integration to support effective execution of projects and programs within the nuclear facilities at the MFC. • Support planning for and execution of compliance level operations and maintenance activities. • Support reliable and efficient availability of critical facilities and capabilities for the growing demand of R&D mission needs. • Complete planned facility modifications identified in MFC DSAs. • Complete 1-3 shipments of NE-owned special nuclear material for off-site disposition. • Continue maintenance within the MFC nuclear facilities and infrastructure consistent with the approved safety bases. • Establish a Materials Condition Assessment program at MFC to improve understanding of facility conditions and long-term maintenance requirements.	60,734

INL Engineering and Support Facility Operations and Maintenance
Overview

This category funds all activities that support the effective management of the buildings, structures, and systems that support the non-nuclear facilities at the INL consistent with Departmental orders and regulations. This category includes activities to support Departmental sustainability goals to improve energy efficiency at the INL.

Additionally, support is provided for Federally-funded program activities and community regulatory support activities to meet obligations defined in crosscutting agreements and contracts such as: Shoshone-Bannock Tribes, Nevada Test Site waste disposal fees, Defense Contract Audit Agency, site environmental monitoring, Payment in Lieu of Taxes, and the National Oceanic and Atmospheric Administration.

Benefits

- Maintains Real Property through recapitalization and life-cycle management activities to keep existing facilities modern and relevant, consistent with DOE Order 430.1B *Real Property and Asset Management* requirements
- Reduces out-year costs by dispositioning surplus, non-nuclear facilities.
- Improves energy efficiency and compliance with Executive Order (EO) 13514 *Federal Leadership in Environmental, Energy, and Economic Performance* to increase efficiency and reduce energy costs.

Funding Schedule

Fiscal Year	Line Item	Funding (dollars in thousands)
FY 2012	• Continued management of non-nuclear facilities, real property management, sustainment, and community support activities. • Completed planned facility decontamination and disposal work. • Installed approximately 21,400 ft2 of roof replacement utilizing cool roof technology. • Managed the implementation of the new Energy Savings Performance Contract (ESPC) for ATR and several other INL complexes.	10,015
FY 2013	Planned activities in the FY 2013 Budget (final allocations have not yet been determined): • Manage non-nuclear facilities, real property management, sustainment, and community support activities. • Conduct performance-based real property life-cycle asset management activities. • Recapitalization activities structured to keep existing facilities modern and relevant in an environment of changing standards and missions, consistent with DOE Order 430.1B. • Continue life-cycle planning to identify essential capital alterations and additions; improvements to land, buildings, and utility systems necessary to maintain INL general purpose infrastructure; common/domestic services infrastructure; and multi-program infrastructure. • Continue implementation of a systematic real property asset building inspection program and operation and maintenance of the Department's Facility Information Management System and Condition Assessment Information System. • Complete of planned disposition work for non-nuclear excess buildings. • Continue to implement comprehensive planning activities to support EO 13514 and EO 13423, Strengthening Federal Environmental, Energy, and Transportation Management. • Continue oversight of the new ESPC for several complexes across the site. • Replace and repair approximately 20,000 ft2of roofs utilizing cool technology.	---
FY 2014	• Manage non-nuclear facilities, real property management, sustainment, and community support activities.	

Fiscal Year	Line Item	Funding (dollars in thousands)
	• Conduct performance-based real property life-cycle asset management activities. • Recapitalization activities structured to keep existing facilities modern and relevant in an environment of changing standards and missions, consistent with DOE Order 430.1B. • Continue facility and land use life-cycle planning to identify essential capital alterations and additions; improvements to land, buildings, and utility systems necessary to maintain INL general purpose infrastructure; common/domestic services infrastructure; and multi-program infrastructure. • Continue implementation of a systematic real property asset building inspection program and operation and maintenance of the Department's Facility Information Management System and Condition Assessment Information System. • Conduct planned disposition work for non-nuclear excess buildings.	10,653

INL Regulatory Compliance
Overview

This category supports compliance activities driven by state and Federal environmental and other regulations that are under the purview of NE owner responsibilities. Compliance activities focus on air, soil, and water monitoring and waste disposal consistent with Federal and State permit requirements. Regulatory activities also include work that supports the 1995 Settlement Agreement with the State of Idaho. This category also supports other project costs for the proposed RHLLW Disposal Project to meet long-term waste disposal needs for NE and Office of Naval Reactors, consistent with regulatory requirements.

Benefits

- Reduce environmental liabilities through waste treatment and disposal obligations with the State of Idaho
- Management of waste will result in steady or reduced life cycle costs and ensure operations are conducted in an environmentally safe manner

Funding Schedule

Fiscal Year	Line Item	Funding (dollars in thousands)
FY 2012	• Processed of 68 kilograms of EBR-II sodium-bonded fuel in support of the 1995 Settlement Agreement with the State of Idaho. • Treated approximately two cubic meters of sodium-contaminated low-level waste backlog. • Initiated documentation to support CD-2, Approve Performance Baseline, and CD-3, Approve Start of Construction/Execution, for the RHLLW Disposal Project.	14,673
FY 2013	Planned activities in the FY 2013 Budget (final allocations have not yet been determined): • Continue regulatory compliance program management. • Meet Site Treatment Plan milestones of two cubic meters of Mixed Low-Level Waste (MLLW) that will be treated in the Sodium Components and Maintenance Shop at MFC. • Treat approximately 170 kilograms of EBR-II spent nuclear fuel. • Treat remaining sodium-contaminated low-level waste backlog, approximately two cubic meters. • Retrieve MLLW from Radioactive Scrap and Waste Facility. • Continue Other Project Costs activities for the RHLLW Disposal Project.	---
FY 2014	• Continue regulatory compliance program management. • Meet Site Treatment Plan milestones for two cubic meters of MLLW. • Treat approximately 76 kilograms of EBR-II used nuclear fuel. • Complete 6transfers of UNF from wet storage in accordance with the Idaho Settlement Agreement (ISA). • Perform modifications to Material and Fuels Complex facilities to allow newly generated remote-handled transuranic waste to be packaged for disposal at the Waste Isolation Pilot Plant. • Support post CD-2/3 activities for RHLLW Disposal Project.	10,549

Advanced Post Irradiation Examination (PIE) Capabilities
Overview

This activity assesses the benefits and options for developing a possible future large-scale advanced post-irradiation examination (A-PIE) facility. The Department has not committed to constructing any facility that may be considered in this program element. In future years, the Department will decide whether to proceed with a project based on a variety of factors including project costs, research needs, budgetary constraints, and competing priorities. No funding for activities beyond CD-1 is requested.

NE is completing the Irradiated Materials Characterization Laboratory (IMCL), which will provide modern, flexible nano- and atomic-scale post-irradiation examination capabilities. IMCL is expected to be operational in 2013. IMCL will provide the ability to meet modern electrical, cleanliness, vibration isolation and radiological control requirements to support current PIE tools and equipment. This facility concept will provide a concept testing ground for A-PIE capabilities, including machine-to-sample and machine-to-building interfaces, and will inform future decisions on the A-PIE capabilities effort.

If a larger-scale, Advanced PIE Capabilities Project were ever executed, it would require equipment that would allow high hazard materials to be routinely examined in a safe and secure environment. Any such facility could serve as a center for advanced fuels and materials characterization, as well as development of new processes, tools and instruments to further research. The project requirements would specify that alternatives have a flexible footprint with a variety of laboratory capabilities in both fixed and reconfigurable space.

Benefits

- Understanding the irradiation-induced degradation behavior of existing nuclear plant material at a sub-atomic level provides added information for extending the life of the nation's nuclear power reactors;
- Provides added information for developing and qualifying fuels and materials that could improve the operational efficiency of current plants and enable the design and construction of less costly, more efficient future nuclear plants;
- Assists in developing new fuel technologies that enable the development of economical, sustainable, proliferation resistant advanced fuel cycles; and
- Increases fundamental scientific knowledge of the response of materials to irradiation that leads to development and validation of predictive models of fuel and material behavior.

Funding Schedule

Fiscal Year	Line Item	Funding (dollars in thousands)
FY 2012	• Initiated initial assessment of alternatives analysis, analysis maturation, environmental studies, and other documentation in support of obtaining Critical Decision 1, Approve Alternative Selection and Cost Range.	3,931
FY 2013	Planned activities in the FY 2013 Budget (final allocations have not yet been determined): • Complete alternatives analysis, conceptual design, preparation of the National Environmental Policy Act documentation, project execution plan activities and support design activities pending approval of CD-1, Approve Alternative Selection and Cost Range. • Continue project management and other work to support design activities up to CD-2, Approve Performance Baseline.	---
FY 2014	• Complete alternatives analysis, conceptual design, preparation of the National Environmental Policy Act documentation, project execution plan activities and support design activities pending approval of CD-1, Approve Alternative Selection and Cost Range.	2,000

Construction
Overview

Line-item capital projects are required at INL to maintain its infrastructure and its ability to support mission goals. These projects help achieve NE and DOE strategic objectives by maintaining site services or providing critical information for future decisions. This activity is focused on two primary objectives: (1) identification, planning, and prioritization of projects required to meet NE program objectives, and (2) development and execution of these projects within approved cost and schedule baselines as such projects are deemed necessary. While the Department's acquisition management process does not guarantee that a project will be completed once the initial information gathering and preliminary design phase are complete, it does provide an important decision-making framework that, when well executed, allows only the most critically necessary, cost-effective projects to proceed to construction.

Benefits

RHLLW Disposal Project (13-D-905)

- Design and construction of this replacement capability will provide the continued capability of remote-handled low-level waste storage at INL.
- This jointly funded replacement project will support long-term program needs for the Office of Naval Reactors and the Office of Nuclear Energy.

Funding Schedule

Fiscal Year	Line Item	Funding (dollars in thousands)
FY 2012	• None	0
FY 2013	Planned activities in the FY 2013 Budget (final allocations have not yet been determined): • Pursuant to Section 102(a), P.L. 112-175, Continuing Appropriations Resolution, 2013, new construction projects are not authorized while operating under the Continuing Resolution. • **Advanced PIE Capabilities**: Begin preliminary design activities to inform a future decision on whether to enhance NE's PIE capabilities ($1,500,000). • **RHLLW Disposal Project**: Initiate design and construction of the selected alternative to construct a new disposal facility at INL ($6,280,000).	---
FY 2014	• RHLLW Disposal Project: Initiate design and construction of the selected alternative to construct a new disposal facility at INL to meet NE and Office of Naval Reactor (NR) long-term program needs. This project is joint-funded with the Office of Naval Reactors.	16,398

Supporting Information

Capital Operating Expenses

Capital Operating Expenses Summary

(dollars in thousands)

	FY 2012 Current	FY 2013 Annualized CR	FY 2014 Request
Plant Projects (GPP and IGPP) (< $10M)	4,820	---	5,009
Total, Capital Operating Expenses	4,820	---	21,407

Note: The final FY 2013 allocations have not yet been determined.

Plant Projects (GPP and IGPP) (TEC < $10M)

(dollars in thousands)

	Total	Prior Years	FY 2012 Current	FY 2013 Annualized CR	FY 2014 Request
Total Plant Projects (GPP/IGPP) (TEC $5M)	n/a	n/a	4,820	---	5,009
Total, Plant Projects (GPP/IGPP) **(TEC < $10M)**			4,820	---	5,009

Construction Projects Summary

Construction Projects

(dollars in thousands)

	Total	Prior Years	FY 2012 Current	FY 2013 Annualized CR	FY 2014 Request
13-D-905, Remote Handled Low-Level Waste Disposal Project, Idaho National Laboratory					
TEC	31,767	0	0	---	16,398
OPC	19,770	8,190	3,800	---	415
TPC 13-D-905, Remote Handled Low-Level Waste Disposal Project, Idaho National Laboratory	51,537	8,190	3,800	---	16,813
Total All Construction Projects					
Total TEC			0	---	16,398
Total OPC			3,800	---	415
TPC All Construction Projects			3,800	---	16,813

Outyears Construction Projects

(dollars in thousands)

	FY 2015	FY 2016	FY 2017	FY 2018	Outyears to Completion
13-D-905, Remote Handled Low-Level Waste Disposal Project, Idaho National Laboratory					
TEC	9,499	5,870	0	0	0
OPC	1,030	4,170	1,735	0	0
TPC, 13-D-905, Remote Handled Low-Level Waste Disposal Project	10,529	10,040	1,735	0	0

13-D-905, Remote-Handled Low-Level Waste Disposal Project
Idaho National Laboratory
Project Data Sheet is for Design and Construction

1. Summary and Significant Changes

The most recent DOE O 413.3B approved Critical Decision (CD) is CD-1, Approve Alternative Selection and Cost Range, that was approved on July 13, 2011 with a Total Project Cost of $95 million based on the upper end of the range. CD-2, Approve Performance Baseline, and CD-3, Approve Start of Construction, is anticipated to be approved in the 2nd Quarter of FY 2014 in compliance with the DOE O 413.3B. The project data sheet (PDS) will be updated to reflect the performance baseline upon approval of CD-2. This is a non-major acquisition project with a cost range less than $100 million. Based on the conceptual design and estimate, the lower and upper bound of the cost range is between $75 million and $95 million respectively.

The project will be jointly funded in accordance with a Memorandum of Agreement between the Department of Energy (DOE) Office of Nuclear Energy (NE) and the Office of Naval Reactors (NR).

A Federal Project Director has been assigned to this project.

This PDS is a new start in the FY 2014 Request for Design and Construction. The FY 2013 Request included $6.28 million to initiate the Remote-Handled Low Level Waste Disposal project; however, no funding was appropriated pursuant to H.R. 933, Consolidated and Continuing Appropriations Act, 2013.

This project data sheet (PDS) reflects a design-build delivery method. The project will employ a combined CD-2/3 critical milestone approach regarding "Approval of the Performance Baseline and Approval to Start Construction", with hold points established by DOE-Idaho (DOE-ID) to verify readiness prior to actual Start of Construction. The funding presented in Sections 5 and 6 represent the upper end of the cost range. The funding will be updated to reflect the performance baseline point estimate upon approval of CD-2.

2. Design, Construction, and D&D Schedule

(fiscal quarter or date)

	CD-0	CD-1	CD-2/3[a]	CD-4[a,b]	D&D[a,b] Start	D&D[a,b] Complete
FY 2013	07/01/2009	07/13/2011	1Q FY 2013	4Q FY 2017	4Q FY 2037	4Q FY 2038
FY 2014	07/01/2009	07/13/2011	2Q FY 2014	4Q FY 2017	4Q FY 2058[c]	4Q FY 2059[c]

a. The Critical Decision (CDs) dates for CD-2/3, CD-4 and D&D are estimates and consistent with the high end of the schedule range.
b. Dates are based on plans for facility closure and emplacement of a cap at the existing RH LLW Disposal Facility located at the Radioactive Waste Management Complex by the Office of Environmental Management (EM) and the costs are not part of the project.
c. Date change based on H.R. 933, Consolidated and Continuing Appropriations Act, 2013, and design for a 50 year life-expectancy. Funding requested will provide up to 20 years of disposal capacity and infrastructure with a life expectancy of 50 years to allow for expansion.

CD-0 – Approve Mission Need
CD-1 – Approve Alternative Selection and Cost Range
CD-2/3– Approve Performance Baseline/Start of Execution
CD-4 – Approve Start of Operations or Project Closeout
D&D Start – Start of Demolition & Decontamination (D&D) work
D&D Complete –Completion of D&D work

3. Baseline and Validation Status

(dollars in thousands)

	TEC[a], Design	TEC[a], Construction	TEC, Total[a]	OPC Except D&D[a]	OPC, D&D[a, c]	OPC, Total[a]	TPC[a]
FY 2013[b]	3,820	63,440	67,260	27,740	0	27,740	95,000
FY-2014[b]	3,820	63,440	67,260	27,740	0	27,740	95,000

a. A design-build acquisition strategy is being implemented.
b. The baseline has been set at the high-end of the TPC range; the project baseline will be approved upon approval of CD-2. No construction will be performed until the project performance baseline has been validated and CD-3 conditions have been addressed and approved by the Acquisition Executive.
c. D&D of the existing RH LLW Disposal Facility located at RWMC is part of the Waste Area Group-7 CERCLA cleanup activity being performed by the Office of Environmental Management in response to the Idaho Settlement Agreement.

4. Project Description, Justification, and Scope

Mission Need

The continuing mission of the Idaho National Laboratory (INL), associated ongoing and planned operations, and Naval spent fuel activities at the Naval Reactors Facility (NRF) requires continued capability to appropriately dispose of remote-handled low level waste (LLW) in support of Office of Nuclear Energy and Office of Naval Reactors mission-critical operations. The new facility can accommodate disposal of up to twenty years of remote-handled LLW generated at the INL, and provide capability for further expansion.

Scope and Justification – 13-D-905 Remote-Handled Low-Level Waste Disposal Project

Scope
The project will provide on-site disposal capability for ten to twenty years of remote-handled LLW generated at the Idaho National Laboratory (INL); however, facilities are being designed to allow operation for 50 years to support future expansion, if needed. Replacement capability must be available when the current waste disposal site, which has been in operation since 1952, becomes unavailable for expansion with the closure of the Radioactive Waste Management Complex (RWMC). The subsurface vaults are envisioned to be constructed of precast concrete cylinders (pipe sections) stacked on end and placed in a honeycomb-type array. Based on waste projections, for a 20 year period, approximately 900 canisters of waste will be disposed of at the facility. The facility is projected to be a Hazard Category 2 nuclear facility, subject to the requirements of DOE-STD-1189, "Integration of Safety into the Design Process." The disposal facility will be located on a suitable site within the INL boundary. Performance of the site/facility will be analyzed in accordance with requirements of DOE Order 435.1, "Radioactive Waste Management."

Supporting infrastructure to the new facility will include a paved access road; electrical service; firewater and potable water; security fence and systems; a maintenance building; administration building; communications and emergency systems; and other operational capabilities. Transportation and handling equipment systems also will be developed for onsite shipments of activated metals and debris waste from the Advanced Test Reactor Complex and the Material and Fuels Complex.

Justification
As DOE's lead nuclear energy laboratory, INL is a multipurpose national laboratory delivering specialized science and engineering global solutions for the DOE. INL also hosts the National Nuclear Security Administration's (NNSA) Naval Reactors Facility (NRF). NRF supports the U.S. Navy's nuclear-powered fleet through research and development of materials

and equipment and management of naval spent nuclear fuel. In addition to the nuclear energy mission, Environmental Management (EM) is supporting a large-scale cleanup mission at the INL. These activities include closure of the RWMC under CERCLA (42 USC 9601 et seq. 1980). Remote-handled LLW generated by INL and NRF has been disposed of at RWMC since 1952. EM has notified NE and NR that disposal at RWMC should not be assumed beyond September 30, 2017.

The continuing nuclear energy mission of INL and NRF require continued capability to dispose of remote-handled LLW. Without established, viable remote-handled LLW disposal capability, ongoing and future operations at the INL and NRF would be adversely impacted. In addition to impacting INL operations at the Advanced Test Reactor and Material and Fuels Complex, remote-handled LLW disposal capability also is critical to the NNSA's mission to "provide the United States Navy with safe, militarily effective nuclear propulsion plants and to ensure the safe and reliable operation of those plants." Spent nuclear fuel from the Navy's nuclear-powered fleet is sent to NRF for examination, processing, dry storage, and ultimate disposition. A reliable disposal path for remote-handled LLW is essential to NRF's continued receipt and processing of naval spent nuclear fuel and, therefore, national security. Based on an evaluation of on-site and off-site alternatives and completion of an Environmental Assessment in accordance with the National Environmental Policy Act [NEPA], the highest-ranked alternative for providing continued, uninterrupted remote-handled LLW disposal capability is construction of a new onsite remote-handled LLW disposal facility. The life cycle cost to construct and operate a new onsite facility and the risk to the public have been determined to be significantly lower than the offsite disposal alternatives evaluated.

Project Status

On July 13, 2011, the Office of Nuclear Energy approved Critical Decision-1, selecting development of a new facility for disposal of remote-handled LLW generated at the Idaho site as the preferred alternative to meet the mission need. In accordance with NEPA (42 USC§ 4321 et seq.), a thorough analysis of a range of reasonable alternatives was subsequently performed and, after evaluating the results of the analysis, the DOE Idaho Operations Office Manager issued a Finding of No Significant Impact on December 21, 2011. A preliminary Disposal Authorization Statement, based on the Low-Level Waste Disposal Facility Federal Review Group's review of the facility's current Performance Assessment and related documentation, was received on April 2, 2012. A competitive procurement has been initiated to select a design-build contractor, and will be completed pending the approval of congressional appropriations in FY 2014.

Risks

A detailed evaluation of project risks and mitigations has been performed (INL PLN-2541). Contingency and management reserve adequate to address project risks has been identified and will be managed in accordance with the requirements of DOE O413.3b. The project is being conducted in accordance with the project management requirements in DOE O 413.3B, Program and Project Management for the Acquisition of Capital Assets, and all appropriate project management requirements have been met.

Funds appropriated under this data sheet may be used to provide independent assessments related to project planning and execution.

5. Financial Schedule[a]

(dollars in thousands) (Total Project Cost @ Upper Bound[c])

	Appropriations[b]			Obligations			Costs
	NE	NR	Total	NE	NR	Total	
Total Estimated Cost (TEC)							
Design[b]							
FY 2013	0	0	0	0	0	0	0
FY 2014	47	1,463	1,510	47	1,463	1,510	700
FY 2015	940	1,370	2,310	940	1,370	2,310	1,510
FY 2016	0	0	0	0	0	0	1,610
FY 2017	0	0	0	0	0	0	0
Total Design	987	2,833	3,820	987	2,833	3,820	3,820
Construction							
FY 2013	0	0	0	0	0	0	0
FY 2014	16,351	19,610	35,961	16,351	19,610	35,961	20,870
FY 2015	8,559	13,050	21,609	8,559	13,050	21,609	28,170
FY 2016	5,870	0	5,870	5,870	0	5,870	14,400
FY 2017	0	0	0	0	0	0	0
Total Construction	30,780	32,660	63,440	30,780	32,660	63,440	63,440
TEC							
FY 2013	0	0	0	0	0	0	0
FY 2014	16,398	21,073	37,471	16,398	21,073	37,471	21,570
FY 2015	9,499	14,420	23,919	9,499	14,420	23,919	29,680
FY 2016	5,870	0	5,870	5,870	0	5,870	16,010
FY 2017	0	0	0	0	0	0	0
Total TEC	**31,767**	**35,493**	**67,260**	**31,767**	**35,493**	**67,260**	**67,260**
OPC, except D&D							
FY 2009	184	0	184	184	0	184	184
FY 2010	3,706	0	3,706	3,706	0	3,706	3,706
FY 2011	4,300	0	4,300	4,300	0	4,300	3,774
FY 2012	3,800	0	3,800	3,800	0	3,800	4,326
FY 2013	430	1,310	1,740	430	1,310	1,740	1,740
FY 2014	415	1,075	1,490	415	1,075	1,490	1,490
FY 2015	1,030	570	1,600	1,030	570	1,600	1,600
FY 2016	4,170	3,640	7,810	4,170	3,640	7,810	7,810
FY 2017	1,735	1,375	3,110	1,735	1,375	3,110	3,110
Total OPC, except D&D	19,770	7,970	27,740	19,770	7,970	27,740	27,740
D&D							
Total D&D	0	0	0	0	0	0	0

(dollars in thousands) (Total Project Cost @ Upper Bound[c])

	Appropriations			Obligations			Costs
	NE	NR	Total	NE	NR	Total	
OPC							
FY 2009	184	0	184	184	0	184	184
FY 2010	3,706	0	3,706	3,706	0	3,706	3,706
FY 2011	4,300	0	4,300	4,300	0	4,300	3,774
FY 2012	3,800	0	3,800	3,800	0	3,800	4,326
FY 2013	430	1,310	1,740	430	1,310	1,740	1,740
FY 2014	415	1,075	1,490	415	1,075	1,490	1,490
FY 2015	1,030	570	1,600	1,030	570	1,600	1,600
FY 2016	4,170	3,640	7,810	4,170	3,640	7,810	7,810
FY 2017	1,735	1,375	3,110	1,735	1,375	3,110	3,110
Total OPC	**19,770**	**7,970**	**27,740**	**19,770**	**7,970**	**27,740**	**27,740**
Total Project Cost (TPC)							
FY 2009	184	0	184	184	0	184	184
FY 2010	3,706	0	3,706	3,706	0	3,706	3,706
FY 2011	4,300	0	4,300	4,300	0	4,300	3,774
FY 2012	3,800	0	3,800	3,800	0	3,800	4,326
FY 2013	430	1,310	1,740	430	1,310	1,740	1,740
FY 2014	16,813	22,148	38,961	16,813	22,148	38,961	23,060
FY 2015	10,529	14,990	25,519	10,529	14,990	25,519	31,280
FY 2016	10,040	3,640	13,680	10,040	3,640	13,680	23,820
FY 2017	1,735	1,375	3,110	1,735	1,375	3,110	3,110
Total TPC	**51,537**	**43,463**	**95,000**	**51,537**	**43,463**	**95,000**	**95,000**

a. Budget figures shown are only estimates and based on the high end of the cost range.

b. The FY 2013 annualized Continuing Resolution NR TEC amount is $0; however, $8,890,000 was originally requested for FY 2013. The FY 2013 annualized Continuing Resolution NE TEC amount is $0; however, $6,280,000 was originally requested for FY 2013.

c. Design costs are part of the design-build contract, which is funded with construction funds.

6. Details of Project Cost Estimate[a]

(dollars in thousands)

	CD-1 Upper Bound Estimate	Previous Total Estimate	Original Validated Baseline
Total Estimated Cost (TEC)			
Design			
Design	3,220	3,220	N/A
Contingency	600	600	N/A
Total, Design	3,820	3,820	N/A
Construction			
Site Preparation	NA	NA	N/A
Equipment	10,000	10,000	N/A
Construction	51,520	51,520	N/A
Contingency	1,920	1,920	N/A
Total, Construction	63,440	63,440	N/A
Total, TEC	67,260	67,260	N/A
Contingency, TEC	2,520	2,520	N/A
Other Project Cost (OPC)			
OPC except D&D			
Conceptual Planning	8,030	8,030	N/A
Conceptual Design	3,240	3,240	N/A
Other OPC Costs	8,490	8,490	N/A
Start-Up	3,430	3,430	N/A
Contingency	4,550	4,550	N/A
Total, OPC except D&D	27,740	27,740	N/A
D&D			
D&D	0	0	N/A
Contingency	0	0	N/A
Total, D&D	0	0	N/A
Total, OPC	27,740	27,740	N/A
Contingency, OPC	4,550	4,550	N/A
Total, TPC	95,000	95,000	N/A
Total, Contingency	7,070	7,070	N/A

a. CD-2 approval is expected during the 2Q FY 2014. All funding numbers are only estimates and based on the high end of the cost range approved at CD-1.

7. Schedule of Appropriation Requests

Request		Prior Years	FY 2013	FY 2014	FY 2015	FY 2016	FY 2017	Outyears	Total
FY 2013 (Initial Request)	TEC	0	15,570	39,490	12,600	0	0	0	67,260
	OPC	11,990	1,740	1,490	1,600	7,810	3,110	0	27,740
	TPC	11,990	16,910	40,980	14,200	7,810	3,110	0	95,000
FY 2014[a]	TEC	0	0	37,471	23,919	5,870	0		67,260
	OPC	11,990	1,740	1,490	1,600	7,810	3,110		27,740
	TPC	11,990	1,740	38,961	25,519	13,680	3,110	0	95,000

a. CD-2 approval is expected during the 2Q FY 2014. All funding numbers are only estimates and based on the high end of the cost range approved at CD-1.

8. Related Operations and Maintenance Funding Requirements

Start of Operation or Beneficial Occupancy (fiscal quarter or date)	3Q FY 2018
Expected Useful Life[a] (number of years)	50 years
Expected Future Start of D&D of this capital asset (fiscal quarter)	3Q FY 2058

a. Facility is designed for a 50 year life-expectancy. Funding requested will provide up to 20 years of disposal capacity and infrastructure with a life expectancy of 50 years to allow for expansion.

(Related Funding requirements)

(dollars in thousands)

	Annual Costs		Life Cycle Costs	
	Current Total Estimate	Previous Total Estimate	Current Total Estimate	Previous Total Estimate
Operations	$5,130	NA	$102,600	NA
Maintenance	$490	NA	$9,800	NA
Total, Operations & Maintenance	$5,620	NA	$112,400	NA

9. Required D&D Information

Area	Acres
Area of new construction	10 acres
Area of existing facility(s) being replaced	97 acres
Area of additional D&D space to meet the "one-for-one" requirement	0

Name(s) and site location(s) of existing facility(s) to be replaced:

- The existing Remote-handled LLW disposal vaults are located within the Subsurface Disposal Area of the Radioactive Waste Management Complex. The RWMC, including the existing remote-handled LLW disposal vaults is funded by DOE EM as part of CERCLA remediation of Waste Area Group 7, Operable Unit 13/14 and is not included in this PDS.

10. Acquisition Approach

The INL Management and Oversight (M&O) contractor will competitively procure the facility design and construction of the proposed onsite remote-handled LLW disposal facility utilizing a negotiated, design-build subcontract. A competitive procurement has been initiated to select a design-build contractor, and will be completed pending the approval of congressional appropriations in FY 2014. Responses to the request for proposal will be evaluated using a "best value" selection process that considers pricing, qualifications, and functionality; conformance with established requirements; safety record; and past performance.

Additional support subcontracts (e.g., monitoring well installation) are envisioned. Services will be solicited only from qualified firms via requests for proposal. Dependent on the action, selection will be based on technical merits and price considerations as provided for in the INL operating contractor's DOE-approved procurement procedures manual.

The types of contracts used for acquisition (e.g., fixed price or fixed labor rate) will vary, dependent on the specific scope of work. Financial incentives may be used, as appropriate, to motivate contractor performance, along with competition to select suppliers. To the extent feasible, procurements will be accomplished by fixed-price contracts awarded based on "best value."

Because this project is based on proven technology and a simplistic design, the design-build delivery method is considered the best acquisition method to complete the project. This method provides continuity between the designer and constructor, reducing project risks, conflicts, schedule, and cost.

The INL M&O contractor will provide project management, construction oversight, and Safety and Quality inspection during construction. In addition, the INL M&O contractor will also perform the following key project activities with subcontractor support and DOE-ID oversight: preparation of documents to support CDs; preparation of engineering design documentation; preparation of NEPA documentation, including a siting study and an environmental assessment; preparation and support to DOE Headquarters approval of a performance assessment and composite analysis; preparation of disposal facility waste acceptance criteria; preparation of nuclear safety documentation; preparation of requests for proposal and performance specifications; subcontractor selection and contract administration; facility design and construction management; and, operational readiness activities.

Idaho Sitewide Safeguards and Security
Funding Profile by Subprogram

(dollars in thousands)

	FY 2012 Current	FY 2013 Annualized CR*	FY 2014 Request
Idaho Sitewide Safeguards & Security			
Protective Forces	0	---	53,277
Security Systems	0	---	10,434
Information Systems	0	---	3,181
Personnel Security	0	---	6,634
Material Control & Accountability	0	---	4,130
Program Management	0	---	5,354
Cyber Security	0	---	10,990
Total, Idaho Sitewide Safeguards & Security	0[a]	0[a]	94,000

*FY 2013 amounts shown reflect the P.L. 112-175 continuing resolution level annualized to a full year. These amounts are shown only at the "congressional control" level and above; below that level a dash (—) is shown.

*Note: FY 2013 amounts shown reflect the P.L. 112-175 continuing resolution level annualized to a full year.

[a] Funding for Idaho Sitewide Safeguards and Security was appropriated in Other Defense Activities in FY 2012 and FY 2013.

Public Law Authorizations

P.L. 112-74, Consolidated Appropriations Act, 2012

Overview

The Idaho Sitewide Safeguards and Security (S&S) program supports the Idaho National Laboratory (INL) complex nuclear facility infrastructure and enables the Office of Nuclear Energy (NE) to conduct research and development in support of multiple program missions. In an effort to better align the S&S funding with INL infrastructure and R&D programs, the S&S program is requested under the Nuclear Energy appropriation in FY 2014.

The S&S program funds all physical and cyber security activities for the INL, providing protection of the Department of Energy's (DOE) nuclear materials, classified and unclassified matter, Government property, personnel and other vital assets from theft, diversion, sabotage, espionage, unauthorized access, compromise, and other hostile acts that may cause unacceptable adverse impacts on our national security; program continuity; or the health and safety of employees, the public, or the environment.

The S&S program at the INL benefits the site infrastructure and users by providing the safeguards and security functions required at DOE sites to enable research and development (R&D) utilizing nuclear materials and protected information. In addition to the Office of Nuclear Energy R&D activities, S&S enables a range of national security programs that support the National Nuclear Security Administration (NNSA) and other Federal agencies including the Department of Homeland Security in the areas of critical infrastructure protection and nuclear nonproliferation. Safeguards and security functions are also provided through the INL S&S program which enables the Department of the Army, the Department of the Navy and NNSA Naval Reactors mission activities.

In order to maximize the benefits of nuclear security, the S&S program will work in FY 2014 to address the following challenges:

- Support the development of Department and program specific long-term nuclear materials management plans that address operational demand, on-site storage/consolidation and disposition.
- Develop implementation strategies for new or evolving Federal and DOE specific physical and cyber security requirements.
- Modernize and maintain physical and cyber security infrastructure, systems and equipment.

Subprogram Accomplishments and Milestones

In FY 2014, Idaho Sitewide S&S will work towards the following key milestones:

Milestones	Date
Complete implementation of Contractor Assurance System (CAS) operating procedures and supporting processes	Sep 2014
Purchase and install cyber security equipment and software life cycle replacements.	Sep 2014

Program Planning and Management

The goal of the INL Sitewide S&S program is to maintain, with high confidence, a robust, highly-effective, efficient, and cost-effective safeguards and security operational strategy aligned with site-specific characteristics and the DOE and NE missions. The S&S operations strategy, as outlined in INL Site-Specific Security Plan, is to limit adverse effects on INL operations, assets and personnel.

The FY 2014 budget request supports funding for the base S&S program maintaining stable manning levels and labor costs. To ensure a robust and cost effective program NE conducts periodic reviews of the S&S program and supports independent reviews and inspections.

The FY 2014 submission provides direct funding for the S&S base program for NE. Base program costs determined to be allocable, i.e., beneficial to Work for Others (WFO), will be paid by WFO via full cost recovery. The costs for WFO-specific security requirements beyond the S&S base program that are specifically requested or driven by the WFO project will be directly charged to those customers as appropriate.

Estimate of Security Cost Recovered by Nuclear Energy, Idaho Sitewide Safeguards and Security

(dollars in thousands)

	FY 2012	FY 2013	FY 2014
Idaho National Lab. (INL)	2,763	2,800	2,800
Total, INL	2763	2,800	2,800

Strategic Management

In meeting the identified challenges to nuclear security, the Department will implement three key strategies to more effectively manage the Idaho Sitewide S&S program, thus putting the taxpayers' dollar to more productive use.

1. Conduct peer reviews, self assessments, and benchmark studies to identify cost-effective opportunities to implement comprehensive risk-based approaches that address changing threats and requirements for both physical and cyber security.
2. Utilize the authority requested and granted in the FY 2012 request to charge Work for Other (WFO) customers and other users that drive base S&S costs.
3. Support the implementation nuclear material consolidation and disposition plans to reduce total material holds and storage locations over the next 5-7 years.

Three external factors present the strongest potential impacts on the overall achievement of the program's strategic goal:

- New and/or evolving DOE Orders impacting physical security requirements.
- New and/or evolving DOE Orders and Federal requirements impacting cyber security.
- Ability of external programs/organizations to meet commitments identified in the INL material consolidation and disposition plan.

Subprogram Goals and Funding

U.S. Department of Energy Strategic Plan/ Office of Nuclear Energy Research and Development Roadmap Goal: Energy Security.

The Idaho Sitewide S&S program supports Department's strategic goal of Energy Security by protecting INL facilities and infrastructure, enabling NE to conduct research and development (R&D) in support of multiple program missions.

U.S. Department of Energy Strategic Plan: Nuclear Security

The Idaho Sitewide S&S program supports the Department's strategic goal of Nuclear Security, to "*enhance nuclear security through defense, nonproliferation, and environmental efforts"* by securing the Idaho National Laboratory (INL) complex and enabling a safe and secure environment to conduct NE R&D as well as other Departmental R&D in the areas of defense and nonproliferation.

Explanation of Funding AND/OR Program Changes

(dollars in thousands)

	FY 2012 Current	FY 2014 Request	FY 2014 Request vs FY 2012 Current
Protective Forces The increase from $0 to $53,277,000 reflects the transfer of Idaho Sitewide S&S from Other Defense Activities to Nuclear Energy (a net increase of $1,793,000 from FY 2012) and provides funds to maintain protective force levels for key INL facilities consistent with the approved site protection plan and approved site labor wage agreement.	0	53,277	+53,277
▪ Security Systems The increase from $0 to 10,434,000 reflects the transfer of Idaho Sitewide S&S from Other Defense Activities to Nuclear Energy (a net decrease of $3,774,000 from FY 2012) and cost savings achieved through completing end of life cycle equipment replacements and maintaining security system reliability.	0	10,434	+10,434
▪ Information Security The increase from $0 to $3,181,000 reflects the transfer of Idaho Sitewide S&S from Other Defense Activities to Nuclear Energy (a net increase of $1,215,000 from FY 2012). Provides funds to maintain information security services for key INL facilities consistent with the site operational needs and reflects a realignment of like activities, personnel and streamlining of management functions from other areas of the program.	0	3,181	+3,181
▪ Personnel Security The increase from $0 to $6,634,000 reflects the transfer of Idaho Sitewide S&S from Other Defense Activities to Nuclear Energy (a net increase of $1,251,000 from FY 2012). Provides funds to maintain personnel security services for key INL facilities consistent with the site operational needs and reflects a realignment of like activities, personnel and streamlining of management functions from other areas of the program	0	6,634	+6,634
▪ Material Control & Accountability The increase from $0 to $4,130,000 reflects the transfer of Idaho Sitewide S&S from Other Defense Activities to Nuclear Energy. Provides steady-state funding to account for and control special nuclear material at key INL facilities consistent with the site operational needs.	0	4,130	+4,130
▪ Program Management The increase from $0 to $5,354,000 reflects the transfer of Idaho Sitewide S&S from Other Defense Activities to Nuclear Energy (a net decrease of $411,000 from FY 2012). Provides funds to maintain and update security program documentation, develop and implement plans to address new security requirements and supports performance assurance activities (table top exercise, simulations, self-assessments, limited scope performance tests and force-on-force exercises) required to ensure adequate protection of INL assets.	0	5,354	+5,354

	(dollars in thousands)		
	FY 2012 Current	FY 2014 Request	FY 2014 Request vs FY 2012 Current
▪ Cyber Security The increase from $0 to $10,990,000 reflects the transfer of Idaho Sitewide S&S from Other Defense Activities to Nuclear Energy (a net increase of $276,000 from FY 2012). Maintains cyber security systems consistent with the Department's measured risk management and vulnerability management strategies.	0	10,990	+10,990
▪ Total, Idaho Sitewide Safeguards and Security Program	0	94,000	+94,000

Protective Forces
Overview

Protective Force provides security police officers (SPO's) and other specialized personnel, equipment, training, and management needed during normal and security emergency conditions for adequate protection of Special Nuclear Material (SNM), classified and sensitive information, Government property and personnel. Protective force personnel are deployed 24 hours a day, 7 days a week, across the 890 square miles of the INL site to deter, detect, delay and respond to adversarial threats. Funding needs are based on protection strategies designed to ensure adequate protective force staffing levels, equipment, facilities, training, management and administrative support are available to respond to any security incident outlined in Site-Specific Security Plans.

Benefits

Idaho Sitewide S&S enables work with SNM and classified matter at the INL supporting NE R&D and other activities for a broad national security customer base including the Department of the Navy, Department of the Army, Department of Homeland Security, and the National Nuclear Security Administration.

- Fuel Cycle Development
- Reduced Enrichment Research & Test Reactors (RERTR)
- Space Defense and Power Systems
- Idaho Facilities Management Material Consolidation and Disposition Activities

Funding Schedule

Fiscal Year	Line Item	Funding (dollars in thousands)
FY 2012	• Funding for this activity was requested under Other Defense Activities.	0
FY 2013	Planned activities in the FY 2013 Budget (final allocations have not yet been determined): • Funding for this activity was requested within Nuclear Energy in the FY 2013 Congressional Budget Request; however, it is being executed within Other Defense Activities per the conditions of the current continuing resolution. • Provides funds to maintain a protective force consistent with the Site Specific Security Plan and approved site labor wage agreement, and associated training activities, including facilities, required to maintain protective force qualifications. Also provides funding to purchase replacement protective force equipment such as ammunition, weapons, and protective gear that is at the end of life cycle.	---
FY 2014	• Provides funds to maintain a protective force consistent with the Site Specific Security Plan and approved site labor wage agreement, and associated training activities, including facilities, required to maintain protective force qualifications. Also provides funding to purchase replacement protective force equipment such as ammunition, weapons, and protective gear that is at the end of life cycle.	53,277

Security Systems
Overview

Security Systems provides equipment to protect vital security interests and Government property, including performance testing, intrusion detection and assessment, entry and search control, barriers, secure storage, lighting, sensors, entry/access control devices, locks, explosives detection, and tamper-safe monitoring. Security Systems provides maintenance of approximately 4,600 security alarms and 6,100 security locks at multiple INL security areas ensuring 24 hour a day, 7 days a week operation of these systems. Maintaining a reliable physical security infrastructure allows the Idaho Sitewide S&S program to maintain consistent/lower staffing levels and lower labor costs.

Benefits

Idaho Sitewide S&S enables work with SNM and classified matter at the INL supporting NE R&D and other activities for a broad national security customer base including the Department of the Navy, Department of the Army, Department of Homeland Security, and the National Nuclear Security Administration.

- Fuel Cycle Development
- Reduced Enrichment Research & Test Reactors (RERTR)
- Space Defense and Power Systems
- Idaho Facilities Management Material Consolidation and Disposition Activities

Funding Schedule

Fiscal Year	Line Item	Funding (Dollars in Thousands)
FY 2012	• Funding for this activity was requested under Other Defense Activities.	0
FY 2013	Planned activities in the FY 2013 Budget (final allocations have not yet been determined): • Funding for this activity was requested within Nuclear Energy in the FY 2013 Congressional Budget Request; however, it is being executed within Other Defense Activities per the conditions of the current continuing resolution. • Provides funds to plan and conduct preventative and corrective maintenance on approximately 4,600 security alarms and 6,100 security locks at multiple INL security areas to ensure 24 hour operation of these systems. Funds also support the operation of INL central alarm stations which monitor security area access and development/modification of security alarm systems to maintain compliance with Departmental Requirements, including completion of replacement of the database required to maintain badge credentials.	---
FY 2014	• Provides funds to plan and conduct preventative and corrective maintenance on approximately 4,600 security alarms and 6,100 security locks at multiple INL security areas to ensure 24 hour operation of these systems. Funds also support the operation of INL central alarm stations which monitor security area access and development/modification of security alarm systems to maintain compliance with Departmental Requirements.	10,434

Information Security
Overview

Information Security provides for the protection and control of classified and sensitive matter that is generated, received, transmitted, used, stored, reproduced or destroyed at the INL. The Classified Matter Protection and Control Program and Operations Security Program ensure that classified and sensitive unclassified matter is appropriately managed and adequately protected and controlled to prevent access by unauthorized individuals and that those individuals that do have access are trained to handle classified matter. Information Security executes the Technical Security Countermeasures (TSCM) program and conducts TSCM surveys.

Benefits

Idaho Sitewide S&S enables work with SNM and classified matter at the INL supporting NE R&D and other activities for a broad national security customer base including the Department of the Navy, Department of the Army, Department of Homeland Security, and the National Nuclear Security Administration.

- Fuel Cycle Development
- Reduced Enrichment Research & Test Reactors (RERTR)
- Space Defense and Power Systems
- Idaho Facilities Management Material Consolidation and Disposition Activities

Funding Schedule

Fiscal Year	Line Item	Funding (Dollars in Thousands)
FY 2012	• Funding for this activity was requested under Other Defense Activities.	0
FY 2013	Planned activities in the FY 2013 Budget (final allocations have not yet been determined): • Funding for this activity was requested within Nuclear Energy in the FY 2013 Congressional Budget Request; however, it is being executed within Other Defense Activities per the conditions of the current continuing resolution. • Provides funds to implement INL information security activities to protect classified and sensitive unclassified matter, including programs for: Classified Matter and Control, Technical Surveillance Countermeasures, Classification/Declassification, and Operations Security. Funds also support coordination activities with INL R&D programs to develop project-specific security requirements within the context of the overall INL information security program.	---
FY 2014	• Provides funds to implement INL information security activities to protect classified and sensitive unclassified matter, including programs for: Classified Matter and Control, Technical Surveillance Countermeasures, Classification/ Declassification, and Operations Security. Funds also support coordination activities with INL R&D programs to develop project-specific security requirements within the context of the overall INL information security program and to support increased classification work scope.	3,181

Personnel Security
Overview

Personnel Security provides for access to classified and sensitive information and assignment of personnel in sensitive positions through the clearance program, adjudication, security awareness and education, U.S. citizen and foreign visitor control, Human Reliability Program, psychological/medical assessments, and administrative review costs. Personnel security also provides for the annual cost to support the database that maintains smart card credentials for INL personnel and badging requirements.

Benefits

Idaho Sitewide S&S enables work with SNM and classified matter at the INL supporting NE R&D and other activities for a broad national security customer base including the Department of the Navy, Department of the Army, Department of Homeland Security, and the National Nuclear Security Administration.

- Fuel Cycle Development
- Reduced Enrichment Research & Test Reactors (RERTR)
- Space Defense and Power Systems
- Idaho Facilities Management Material Consolidation and Disposition Activities

Funding Schedule

Fiscal Year	Line Item	Funding (Dollars in Thousands)
FY 2012	• Funding for this activity was requested under Other Defense Activities.	0
FY 2013	Planned activities in the FY 2013 Budget (final allocations have not yet been determined): • Funding for this activity was requested within Nuclear Energy in the FY 2013 Congressional Budget Request; however, it is being executed within Other Defense Activities per the conditions of the current continuing resolution. • Provides funds to conduct INL personnel security programs including security investigations to determine the suitability of INL personnel for classified work, assessing requests for U.S and foreign researchers to work in selected sensitive subject areas, and maintaining databases that hold clearance information. Funds also support federal activities related to processing, tracking, and adjudication of security investigations for federal and non-federal employees, including medical examinations.	---
FY 2014	• Provides funds to conduct INL personnel security programs including security investigations to determine the suitability of INL personnel for classified work, assessing requests for U.S and foreign researchers to work in selected sensitive subject areas, and maintaining databases that hold clearance information. Funds support federal activities related to processing, tracking, and adjudication of security investigations for federal and non-federal employees, including medical examinations.	6,634

Material Control & Accountability
Overview

Material Control & Accountability (MC&A) provides the personnel, equipment, and services required to account for and control all special nuclear material (SNM) at INL from diversion. MC&A is accomplished through the administration of a robust formal inventory process for all SNM on site that allows INL security personnel to locate and track specific quantities in real time, state of the art measurement equipment, non-destructive analysis and a robust tamper indicating device program.

Benefits

Idaho Sitewide S&S enables work with SNM and classified matter at the INL supporting NE R&D and other activities for a broad national security customer base including the Department of the Navy, Department of the Army, Department of Homeland Security, and the National Nuclear Security Administration.

- Fuel Cycle Development
- Reduced Enrichment Research & Test Reactors (RERTR)
- Space Defense and Power Systems
- Idaho Facilities Management Material Consolidation and Disposition Activities

Funding Schedule

Fiscal Year	Line Item	Funding (Dollars in Thousands)
FY 2012	• Funding for this activity was requested under Other Defense Activities.	0
FY 2013	Planned activities in the FY 2013 Budget (final allocations have not yet been determined): • Funding for this activity was requested within Nuclear Energy in the FY 2013 Congressional Budget Request; however, it is being executed within Other Defense Activities per the conditions of the current continuing resolution. • Provides funds to maintain the site's SNM database and tracking systems, coordinate on-and off-site material movements, and to conduct SNM inventories.	---
FY 2014	• Provides funds to maintain the site's SNM database and tracking systems, coordinate on-and off-site material movements, and to conduct SNM inventories.	4,130

Program Management
Overview

Program Management includes policy oversight, development and update of site security plans; vulnerability assessments and performance testing to ensure adequate protection of SNM; and investigations into incidents of security concern and issuance of security infractions. The activities completed within Program Management allow for risk-informed decision making, support a performance-based S&S program and directly test the efficacy of the INL protection methodology/posture.

Benefits

Idaho Sitewide S&S enables work with SNM and classified matter at the INL supporting NE R&D and other activities for a broad national security customer base including the Department of the Navy, Department of the Army, Department of Homeland Security, and the National Nuclear Security Administration.

- Fuel Cycle Development
- Reduced Enrichment Research & Test Reactors (RERTR)
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- Idaho Facilities Management Material Consolidation and Disposition Activities

Funding Schedule

Fiscal Year	Line Item	Funding (Dollars in Thousands)
FY 2012	• Funding for this activity was requested under Other Defense Activities.	0
FY 2013	Planned activities in the FY 2013 Budget (final allocations have not yet been determined): • Funding for this activity was requested within Nuclear Energy in the FY 2013 Congressional Budget Request; however, it is being executed within Other Defense Activities per the conditions of the current continuing resolution. • Provides funds to maintain and update security program documentation, develop and implement plans to address new security requirements through a combination of table-top exercises, simulations and force-on-force exercises to assure program effectiveness and efficiency.	---
FY 2014	• Provides funds to maintain and update security program documentation, develop and implement plans to address new security requirements through a combination of table-top exercises, simulations and force-on-force exercises to assure program effectiveness and efficiency.	5,354

Cyber Security
Overview

Cyber Security maintains the computing infrastructure and network security configuration necessary to support classified and unclassified information and electronic operations at the INL. The Cyber Security program uses a graduated risk approach based on data sensitivity and impact of loss/ compromise to ensure that electronic or computer information systems, are protected in a manner consistent with upholding key priorities, including importance to national security, support of DOE missions and programs, vulnerability to threats, and the magnitude of harm that would result from an information system compromise.

Benefits

Idaho Sitewide S&S enables work with SNM and classified matter at the INL supporting NE R&D and other activities for a broad national security customer base including the Department of the Navy, Department of the Army, Department of Homeland Security, and the National Nuclear Security Administration.

- Fuel Cycle Development
- Reduced Enrichment Research & Test Reactors (RERTR)
- Space Defense and Power Systems
- Idaho Facilities Management Material Consolidation and Disposition Activities

Funding Schedule

Fiscal Year	Line Item	Funding (Dollars in Thousands)
FY 2012	• Funding for this activity was requested under Other Defense Activities.	0
FY 2013	Planned activities in the FY 2013 Budget (final allocations have not yet been determined): • Funding for this activity was requested within Nuclear Energy in the FY 2013 Congressional Budget Request; however, it is being executed within Other Defense Activities per the conditions of the current continuing resolution. • Provides funds to operate, test, and maintain cyber security systems for 8 INL enclaves consistent with the Department's measured risk management and vulnerability management strategies. Funds also support certification and accreditation activities for classified cyber security systems and INL training programs to educate users on cyber security strategies.	---
FY 2014	• Provides funds to operate, test, and maintain cyber security systems for 7 INL enclaves consistent with the Department's measured risk management and vulnerability management strategies. Funds also support certification and accreditation activities for classified cyber security systems, INL training programs to educate users on cyber security strategies and implementation of optimized Contractor Assurance System (CAS) operating procedures and supporting processes (assessments, continuous monitoring, and performance metrics).	10,990

Supporting Information

Capital Operating Expenses

Capital Operating ExpensesSummary

(dollars in thousands)

	FY 2012 Current	FY 2013 Annualized CR	FY 2014 Request
Capital Equipment> $500K (including Major Items of Equipment (MIE))	0	-	500
Total, Capital Operating Expenses	0	-	500

International Nuclear Energy Cooperation
Funding Profile

(dollars in thousands)

	FY 2012 Current	FY 2013 Annualized CR*	FY 2014 Request
International Nuclear Energy Cooperation	2,983	3,001	2,500
Total, International Nuclear Energy Cooperation	2,983	3,001	2,500

*FY 2013 amounts shown reflect the P.L. 112-175 continuing resolution level annualized to a full year. These amounts are shown only at the "congressional control" level and above; below that level a dash (—) is shown.

Public Law Authorizations

P.L. 112-74, Consolidated Appropriations Act, 2012

Overview

International Nuclear Energy Cooperation's (INEC) mission is to serve as the Department's overall lead for all international activities related to civil nuclear energy, including analysis, development, and implementation of international civil nuclear energy policy and coordination and integration of the Office of Nuclear Energy's (NE) international nuclear technical activities. These activities support international bilateral and multilateral engagement and civil nuclear energy research and development (R&D) activities with countries with an established or planned civilian nuclear power sector. INEC may also employ workshops to engage industry and foreign governments on international civil nuclear issues such as financing, safety, or comprehensive nuclear fuel services.

INEC provides the Department the ability to meet growing demands for engagement with international partners on civil nuclear policy, R&D, and related activities. INEC engages both bilaterally and multilaterally to support broader U.S. policy and commercial goals related to nuclear energy globally and allow more effective integration of NE international R&D and policy interests. INEC also leverages nuclear energy efforts with Department of Energy's (DOE) National Nuclear Security Administration, Office of Environmental Management, and Office of Policy and International Affairs; the National Security Council; Department of State; Department of Commerce; and the Nuclear Regulatory Commission to facilitate U.S. nuclear energy R&D, policy, and commercial interests internationally.

INEC has identified the following challenges for FY 2014:

- Supporting unanticipated international engagement pursuant to new and emerging policy priorities and direction.
- Shaping NE's bilateral and multilateral international engagement to ensure expansion of the use of nuclear power internationally is done safely and securely.

Program Accomplishments and Milestones

In FY 2012, INEC achieved four significant accomplishments or milestones in program management and/or program development: 1) Integrated and coordinated bilateral R&D Action Plans with China, France, Russia and, to a lesser degree, Japan, as bilateral legal Agreements with Japan were being negotiated post-Fukushima; managed the International Nuclear Energy Research Initiative in support of NE's R&D objectives, where needed; advanced DOE's bilateral nuclear safety activities with China through the establishment of two new Working Groups on High-Temperature Gas Reactors and Light-Water Reactor Sustainability R&D activities and continued to engage with China through workshops in Probabilistic Safety Analysis and Assessment activities under the Peaceful Use of Nuclear Technology agreement; 2) Developed and implemented bilateral cooperation programs with the Czech Republic, Kazakhstan, Mongolia, Russia, and Ukraine; 3) Engaged in international collaborative activities advancing the commercially-based Comprehensive Fuel Services (CFS) approach to limit incentives for individual countries to acquire and/or develop sensitive nuclear technologies, and to support opportunities to increase U.S. commercial competitiveness in global markets; and 4) Facilitated workshops between the United States and Japan on nuclear safety-related issues concerning the Fukushima nuclear power plants.

In FY 2014, INEC is progressing towards the following key milestones:

Milestone	Date
Continue to engage multilaterally on the CFS concepts and continue needed analytical studies to support this engagement.	Sept.-2014
Effectively integrate and coordinate NE's international nuclear R&D activities.	Sept.-2014
Maintain the existing bilateral and multilateral cooperation commitments as appropriate and develop new cooperation commitments with advanced and developing nuclear energy countries to support both the Office of Nuclear Energy and U.S. Government strategic priorities and objectives.	Sept.-2014

Program Planning and Management

INEC conducts various internal and external reviews and audits to validate and verify program performance. Periodic program reviews evaluate progress against established plans. INEC holds periodic reviews, consistent with program management plans and project baselines, to ensure progress, cost, and schedule adherence, and responsiveness to program requirements. Internally, INEC provides continual management and oversight of its R&D coordination and other activities.

INEC has engaged its stakeholders to help define the appropriate scope of its program activities to support nuclear energy's role in meeting the nation's energy security and environmental goals. In addition, NE's international engagement activities are conducted in consultation and cooperation with a number of U.S. government organizations, including the National Nuclear Security Administration, National Security Council, and Department of State.

Strategic Management

In meeting the identified challenges to nuclear power, the Department will implement the following key strategies to more efficiently and effectively manage the program, thus putting the taxpayers' dollar to more productive use:

1. NE will leverage international resources and cooperate with other countries bilaterally and multilaterally to boost U.S. technical expertise in civil nuclear energy.
2. NE will partner with the private sector, national laboratories, universities, and international partners to support cooperative international R&D activities to support the safe and secure use of civilian nuclear power.

NE will work with DOE's Office of Policy and International Affairs, as well as other U.S. Government organizations, including the National Nuclear Security Administration, National Security Council, Department of State, and Department of Commerce to support the safe and secure international use of civilian nuclear power.

Program Goals and Funding

INEC contributes to the Department's strategic goal of maintaining a vibrant U.S. science and engineering enterprise by helping NE R&D programs leverage funding and facilities to advance nuclear power as a resource capable of making major contributions to meeting the Administration's energy, environment, security and economic objectives.

INEC supports NE R&D Roadmap Objective 4, which seeks to understand and minimize the risks of nuclear proliferation and terrorism.

Explanation of Funding AND/OR Program Changes

(dollars in thousands)

	FY 2012 Current	FY 2014 Request	FY 2014 Request vs FY 2012 Current
International Nuclear Energy Cooperation			
Decreased by $483,000. Program will leverage existing appropriations and maintain program levels.	2,983	2,500	-483
Total, International Nuclear Energy Cooperation	2,983	2,500	-483

International Nuclear Energy Cooperation
Overview

The requested funding will support INEC's role as overall lead for the Department's international activities regarding civil nuclear energy, including analysis, development, and implementation of international civil nuclear energy policy and coordination and integration of NE's international nuclear technical activities. These activities support international bilateral and multilateral engagement and civil nuclear energy R&D activities with countries with an established or planned civilian nuclear power sector. INEC may also employ workshops to engage industry and foreign governments on international civil nuclear issues such as financing, safety, or comprehensive nuclear fuel services.

Benefits

The potential benefits of INEC include:

- Improves integration and coordination of international cooperative R&D activities.
- Supports NE's and U.S. Government priorities including Administration initiatives for civil nuclear energy (e.g., Team USA) by integrating ongoing bilateral and multilateral engagement in various forums, such as the International Framework for Nuclear Energy Cooperation and the International Atomic Energy Agency (IAEA).
- Promotes nuclear safety through international dialogue and cooperation in the IAEA Joint Convention on the Safety of Spent Fuel Management and the Safety of Radioactive Waste Management and other fora.
- Helps ensure U.S. nonproliferation requirements are met through coordination of NE's international activities with the National Nuclear Security Administration, the Department of State, and the National Security Council.
- Encourages states to forego the indigenous development of sensitive technologies by advancing the international dialogue bilaterally and multilaterally, including through discussions on commercially-based comprehensive nuclear fuel services.

Funding Schedule

Fiscal Year	Line Item	Funding (dollars in Thousands)
FY 2012	• As part of U.S.-China Peaceful Uses of Nuclear Technology collaboration, initiated the Level 2 Probabilistic Safety Assessment (PSA) pilot project at China's Fuqing nuclear power plant, conducted a PSA Level 2 workshops on severe accident analysis, human reliability analysis and risk-informed in-service inspection in China. • Completed two workshops with Kazakhstan on nuclear safety practices. • Further engaged with international partners on comprehensive nuclear fuel services (CFS) concepts; continued analytical studies to support this engagement; contributed to development of the International Framework for Nuclear Energy Cooperation (IFNEC) CFS paper, conducted studies involving financing issues associated with back end solutions. • Provided country-specific policy and logistical support required to effectively implement NE's bilateral nuclear energy R&D activities with expert support from national laboratory lead country coordinators. • Provide expertise and technical assistance to the Export Import Bank in its efforts to support the U.S. nuclear industry abroad. • Increased attention to international nuclear safety collaboration; engaged with Japan on post-Fukushima nuclear safety workshops.	2,983
FY 2013	Planned activities in the FY 2013 budget (final allocations have not yet been determined): • Continue existing cooperation efforts with advanced and developing nuclear energy countries. • Implement R&D action plan with Argentina and Brazil. • Potential establishment of Joint Coordinating Committee with South Africa. • Expand expert exchanges and joint work with Kazakhstan. • Continue international collaboration on nuclear safety.	3,001

Fiscal Year	Line Item	Funding (dollars in Thousands)
	• Develop international agreement on comprehensive nuclear fuel services concepts.	
FY 2014	• Continue bilateral and multilateral collaboration on CFS concepts and continue analytical studies to support this engagement. • Provide country-specific policy and logistical support required to effectively implement NE's bilateral nuclear energy R&D activities with expert support from national laboratory lead country coordinators. Maintain the existing bilateral and multilateral cooperation commitments as appropriate and develop new cooperation commitments with advanced and developing nuclear energy countries to support both the Office of Nuclear Energy and U.S. Government strategic priorities and objectives. • Provide expertise and technical assistance to the Department of Commerce in its efforts to support the U.S. nuclear industry abroad.	2,500

Office of Nuclear Energy
Program Direction
Funding Profile

(dollars in thousands)

	FY 2012 Current	FY 2013 Annualized CR*	FY 2014 Request
Headquarters			
Salary & Benefits	64,451	---	64,000
Travel	2,000	---	1,850
Support Services	6,647	---	5,050
Other Related Expenses	17,902	---	16,600
Total, Headquarters	91,000	91,557	87,500
Full Time Equivalents	426	416	418

*FY 2013 amounts shown reflect the P.L. 112-175 continuing resolution level annualized to a full year. These amounts are shown only at the "congressional control" level and above; below that level a dash (—) is shown.

Public Law Authorizations

P.L. 112-74, Consolidated Appropriations Act, 2012

Overview

Program Direction provides the Federal staffing resources and associated costs required to provide overall direction and execution of the Office of Nuclear Energy (NE) programs. NE staff is located in Washington, DC, the Idaho Operations Office, Oak Ridge Operations Office and the Nevada Site Office.

In addition to NE federal personnel, Program Direction also supports the coordination of the Energy portfolio by the Office of the Under Secretary for Energy and select federal staff from the Office of the General Counsel and Energy Information Administration responsible for administrative and judicial litigation associated with the termination of the Yucca Mountain Nuclear Waste Repository project, legal issues related to the standard contract, and the Department's responsibilities regarding spent fuel and high level waste as specified by the Nuclear Waste Policy Act (NWPA).

Program Direction also includes travel funding for transportation of HQ and field NE personnel, per diem allowances while in authorized travel status, and other expenses incidental to travel. Support Services allows the Department to cost-effectively hire the best available industry experts to assist federal staff in managing the nuclear programs and complex activities. In addition to rapidly acquiring this expertise on an as needed basis, using support services provides unlimited flexibility in team composition as the needs of NE evolve. Finally, Other Related Expenses provides NE's contribution to the Department's Working Capital Fund (WCF) for common administrative services at HQ. DOE is working to achieve economies of scale through an enhanced WCF. The WCF covers certain shared, enterprise activities including enhanced cyber security architecture, employee health and testing services, and consolidated training and recruitment initiatives which were created in previous fiscal years and are being maintained in FY 2014.

In addition to appropriated funds, NE also manages approximately $140 million dollars annually in work for others and reimbursable funding from the National Aeronautics and Space Administration and the Department of Defense for the development of advanced radioisotope power systems for space exploration and national security missions. The Program Direction request reflects NE's continued attempts to optimize support for its Federal workforce, while continuing to improve efficiency and cost-effectiveness and ensure the expert Federal management and oversight of NE mission activities.

Explanation of Funding AND/OR Program Changes

	(dollars in thousands)		
	FY 2012 Current	FY 2014 Request	FY 2014 Request vs FY 2012 Current
Salaries and Benefits			
Salaries and Benefits remain effectively level from FY 2012 to FY 2014.	64,451	64,000	-451
Travel			
Travel funding is reduced consistent 30% below the FY 2010 baseline.	2,000	1,850	-150
Support Services			
Support Services reduction reflects NE's continuing efforts to improve management of support services contracts and the completion of the Administration's Strategy for the Management and Disposal of Used Nuclear Fuel and High-Level Radioactive Waste response to the Blue Ribbon Commission.	6,647	5,050	-1,597
Other Related Expenses			
Other Related Expenses reduction anticipated reductions to NE's physical footprint requirements as well as reduced procurements in support of the federal staff.	17,902	16,600	-1,302
Total Funding Change, Program Direction	91,000	87,500	-3,500

Support Services by Category

	(dollars in thousands)		
	FY 2012 Current	FY 2014 Request	FY 2014 Request vs FY 2012 Current
Support Services			
Technical Support Services	3,123	2,300	-823
Management Support Services	3,524	2,750	-774
Total, Support Services	6,647	5,050	-1,597

Other Related Expenses by Category

	(dollars in thousands)		
	FY 2012 Current	FY 2014 Request	FY 2014 Request vs FY 2012 Current
Other Related Expenses			
Other Services	4,269	3,930	-339
Federal IT Services	6,337	5,940	-397
Rent/Utilities/Maintenance	6,461	6,060	-401
Training	835	670	-165
Total, Other Related Expenses	17,902	16,600	-1,302

Race to the Top for Energy Efficiency and Grid Modernization

Race to the Top for Energy Efficiency and Grid Modernization

Race to the Top for Energy Efficiency and Grid Modernization

Proposed Appropriation Language

For Department of Energy expenses necessary to promote policies at the State, local, or tribal level or by electric cooperatives intended to increase energy efficiency, increase clean distributed generation, and modernize the grid in carrying out the purposes of the Department of Energy Organization Act (42 U.S.C. 7101 et seq.) $200,000,000, to remain available until September 30, 2018.

Race to the Top for Energy Efficiency and Grid Modernization
Overview
Appropriation Summary by Program

(Dollars in Thousands)

	FY 2012 Current	FY 2013 Annualized CR	FY 2014 Request
Race to the Top for Energy Efficiency and Grid Modernization	0	0	200,000

Public Law Authorizations

Public Law 95–91, "Department of Energy Organization Act", 1977
Public Law 102-486, "Energy Policy Act, 1992"
Public Law 109-58, "Energy Policy Act, 2005"
Public Law 110-140, "Energy Independence and Security Act, 2007

Program Overview

The President has established a new goal to double American energy productivity by 2030 relative to 2010 levels. America's energy productivity, which is the economic output per unit of energy consumed, can be improved by greater efficiency and a more resilient grid that can integrate more renewable energy technologies, help customers save energy, and defend against disruption.

States and tribal governments, along with local governments with public power utilities, and electric co-operatives, can advance these objectives by adopting laws, policies and/or regulations that align the incentives of their organizations, regulated utilities, and other investors with (1) customer/member interests in energy efficiency and clean distributed generation, and (2) the national interest in a more resilient and efficient grid. These entities can also advance these objectives through adopting policies that improve energy efficiency, such as adopting, implementing, and enforcing building codes. The Race to the Top is designed to challenge these entities to lead by implementing policies that improve conditions for investments that improve energy productivity and modernize the grid.

In support of the Secretary's goal of Transforming Our Energy Systems, DOE requests $200 million in one-time funding for Race to the Top awards, based on demonstrated performance, to State and tribal governments, local governments with public power utilities, and electric cooperatives that implement effective policies to cut waste and modernize the grid.

Modeled after a successful Administration approach in education reform designed to promote forward-leaning policies at the state level, DOE will offer informational resources and merit-based technical assistance grants to States and other eligible applicants that want to qualify for awards for the greatest demonstrated improvements in energy efficiency and energy productivity.

The Race to the Top is distinct and different from the existing DOE programs that engage States through formula grants with limited opportunities for competitive funding. The Race to the Top is designed to motivate as many eligible entities as possible to (a) adopt targeted policies that support investment in energy efficiency and grid modernization and then (b) compete to achieve new heights of performance in energy efficiency and energy productivity.

Program Planning and Management

The Race to the Top will be open to applications from State governors or their designees, as well as electric co-operatives, public power utilities, and tribes that apply independently based on their unique authorities for energy efficiency and grid modernization.

DOE will serve as an informational resource for all interested parties. The Race to the Top will be structured into two phases: 1) a qualifying phase that includes merit-based technical assistance grants and 2) a competition and selection phase. The challenge to States and other applicants will be presented as qualifying criteria in five categories: energy efficiency, including combined heat and power, and demand response; distributed generation; customer access to data;

resiliency and cybersecurity; and visibility in grid operations. All qualifying applicants can compete for awards in the selection (prize) phase based on demonstrated improvements in energy efficiency and energy productivity.

The purpose of a two phased approach is to offer all interested applicants an opportunity to take actions to qualify to compete in the Race to the Top. During the qualifying phase, DOE will serve as an informational resource for interested parties, and will provide competitive merit-based technical assistance grants, to support those actions. For this reason, the qualifying phase, which includes the technical assistance grants period, will extend approximately one year before the beginning of the competition and selection phase.

Program Direction ($15 million)
Program direction will be funded out of the total amount appropriated in order to oversee program execution.

Phase 1: Qualification and Technical Assistance Grants ($25 million total)
In the qualifying phase, eligible applicants will be able to use DOE assessment tools to evaluate their energy policies relevant to the qualifying areas. Thereafter, applicants will be able to draw on DOE information resources and seek merit-based technical assistance to meet the qualifying criteria for the competition.

Detailed qualifying criteria for the Race to the Top will be established by DOE, within the following criteria categories.

1. Modernize utility regulations and adopt innovative policies to encourage cost-effective investments in energy efficiency, including combined heat and power, and demand response
2. Create a level playing field for distributed generation
3. Enhance customer access to their energy data
4. Increase investments that improve the reliability, security and resilience of the grid
5. Enhance the sharing of information regarding grid conditions

To encourage broad participation, applicants may opt out of a single qualifying category of their choice, except energy efficiency.

Phase 2: Competition and Selection for Awards ($160 million total)
All applicants that achieve the qualifying criteria, whether or not they sought and received technical assistance in the qualifying phase, will be able to compete for an award in the competition and selection phase. Applicants that make the most progress toward improving energy efficiency and energy productivity will be rewarded with federal funds. Regional variations in weather and the composition of economic activity will be taken into consideration. Regional diversity may be a factor in selection. Because applicants vary widely in size, awards may be proportional to each applicant's size.

Milestone	**Proposed Date**
Announcement of program	Dec. 2013
Merit-based technical assistance grants available	2014
Selection for awards based on demonstrated performance	After 2015

Explanation of Funding Changes

	(Dollars in Thousands)		
	FY 2012 Current	FY 2014 Request	FY 2014 Request vs. FY 2012 Current
Race to the Top for Energy Efficiency and Grid Modernization	0	200,000	+200,000

Funding and Activity Schedule

Fiscal Year	Activity	Funding (Dollars in Thousands)
FY 2013	No existing program	
FY 2014	Establish program, provide informational resources to applicants including best practices and policy measurement and evaluation, award funds for technical assistance to accomplish qualifying objectives; funding also covers pay-for-performance awards.	200,000

Fossil Energy Research and Development

Fossil Energy Research and Development

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Fossil Energy Research and Development
Proposed Appropriation Language

For necessary expenses in carrying out fossil energy research and development activities, under the authority of the Department of Energy Organization Act (Public Law 95-91), including the acquisition of interest, including defeasible and equitable interests in any real property or any facility or for plant or facility acquisition or expansion, and for conducting inquiries, technological investigations and research concerning the extraction, processing, use, and disposal of mineral substances without objectionable social and environmental costs (30 U.S.C. 3, 1602, and 1603), $420,575,000, to remain available until expended: Provided, That $115,753,000 shall be available until September 30, 2015 for program direction: Provided further, That for all programs funded under Fossil Energy appropriations in this Act or any other Act, the Secretary may vest fee title or other property interests acquired under projects in any entity, including the United States

Explanation of Changes

No changes.

Fossil Energy
Office of Fossil Energy

Overview
Appropriation Summary by Program

(dollars in thousands)

	FY 2012 Current	FY 2013 Annualized CR*	FY 2014 Request
Fossil Energy Research and Development			
Coal	359,320	370,650	276,631
Natural Gas Technologies	14,575	15,083	17,000
Unconventional Fossil Energy Technologies	4,859	5,027	0
Program Direction	119,929	120,663	115,753
Plant & Capital Equipment	16,794	16,897	13,294
FE Environmental Restoration	7,897	7,945	5,897
Special Recruitment Programs	700	704	700
Subtotal, Fossil Energy Research and Development	524,074	536,969	429,275
Rescission of Prior Year Balances	-187,000	-42,000	0
Use of Prior Year Balances	0	0	-8,700
Total, Fossil Energy Research and Development	**337,074**	**494,969**	**420,575**
Strategic Petroleum Reserve	**192,704**	**193,883**	**189,400**
Northeast Home Heating Oil Reserve	**10,119**	**10,181**	**8,000**
Elk Hills School Land Fund	**0**	**0**	**0**
Naval Petroleum and Oil Shale Reserves	**14,909**	**15,000**	**20,000**
Total, Fossil Energy	**554,806**	**714,033**	**637,975**

*FY 2013 amounts shown reflect the P.L. 112 175 continuing resolution level annualized to a full year. These amounts are shown only at the "congressional control" level and above; below that level a dash (—) is shown.

*SBIR/STTR:

- FY 2012 Transferred: SBIR: $8,486; STTR: $1,142
- FY 2013 Annualized CR: SBIR $9,020: STTR: $1,161
- FY 2014 Request: SBIR $6,082: STTR: $869

Office Overview and Accomplishments

The Office of Fossil Energy (FE) advances technologies related to the reliable, efficient, affordable, and environmentally sound use of fossil fuels which are essential to our Nation's security and economic prosperity. FE leads Federal research, development, and demonstration efforts on advanced carbon capture, and storage (CCS) technologies to facilitate achievement of the President's climate goals. FE also develops technological solutions for the prudent and sustainable development of our unconventional domestic resources. These Fossil Energy Research and Development (FER&D) programs create public benefits by 1) performing and managing research that reduces market barriers to the environmentally sound use of fossil fuels, 2) partnering with industry and others to advance fossil energy technologies toward commercialization, and 3) supporting the development of information and policy options that benefit the public.

In addition to R&D, FE also manages the Strategic Petroleum Reserve (SPR), the SPR Petroleum Account, the Northeast Home Heating Oil Reserve (NEHHOR), and the Naval Petroleum and Oil Shale Reserves (NPOSR). The SPR provides strategic and economic security against foreign and domestic disruptions in U.S. oil supplies via an emergency stockpile of crude oil. The program fulfills U.S. obligations under the International Energy Program, which avails the U.S. of International Energy Agency (IEA) assistance through its coordinated energy emergency response plans, and provides a deterrent against energy supply disruptions. The SPR Petroleum Account funds all SPR petroleum inventory acquisitions, associated transportation costs, U.S. Customs duties, terminal throughput charges and other related miscellaneous costs. During an emergency drawdown and sale, the SPR Petroleum Account is the source of funding for the incremental costs of withdrawing oil from the storage caverns and transporting it to the point where purchasers take title. NEHHOR provides a short-term emergency supplement to the Northeast systems' commercial supply of heating oil in the event of a supply interruption. NPOSR continues to close out legal responsibilities of environmental remediation at Naval Petroleum Reserves No. 1 (NPR-1) and disposition activities, including environmental remediation, at Naval Petroleum Reserves No. 3 (NPR-3).

In FY 2012 FE achieved significant accomplishments in program management and program development.

Accomplishments include:

FER&D: Three CCS demonstration projects initiated or substantially advanced their construction efforts while five other projects either completed or progressed toward their front-end engineering design; which also included providing updated capital cost estimates and signing critical, project-related agreements. The Natural Gas Technology Program conducted research to understand and minimize the potential environmental, health, and safety impacts of shale gas development. The Program successfully completed a 30 day production test of an arctic well in 2012 providing large volumes of data available to the public for further evaluation.

SPR: The SPR maintained an emergency petroleum stockpile to protect the Nation's Energy Security.

Alignment to Strategic Plan

The Department's May 2011 Strategic Plan articulates DOE's first goal to catalyze the timely, material, and efficient transformation of the Nation's energy system and secure U.S. leadership in clean energy technologies.

FE's R&D mission supports achievement of this DOE goal, and FE is accountable for the following targeted outcome identified in the Strategic Plan:

- Bring at least five commercial-scale carbon capture and storage (CCS) demonstrations online by 2016.

These demonstrations focus on first generation CCS technologies and seek to demonstrate that CCS can be integrated at commercial scale while maintaining reliable, predictable and safe plant operations. However, in the case of electricity generation, first generation CCS technology cost is not expected to be low enough to achieve widespread deployment in the near term.

Current R&D on second generation technology indicates, through engineering and systems analyses studies, 90 percent CO_2 capture from Advanced Energy Systems equipped with pre-, post-, and oxycombustion technology with the potential for no more than \$40/tonne CO_2 captured. More advanced, transformational technology could achieve below \$10/tonne CO_2 captured. These figures are in constant dollars (USD2011).

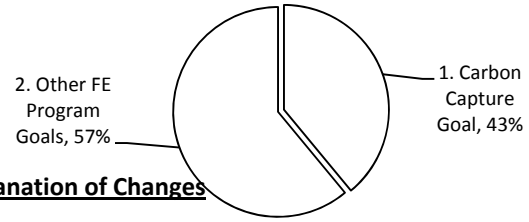
FER&D efforts are fully aligned with the DOE Strategic Plan to enable prudent development of our natural resources, accelerate energy innovation through precompetitive R&D, leverage domestic and international partnerships, and help to sustain a world-leading technical workforce.

Under the Department's Strategic Goal, *Transform Our Energy Systems*, the SPR provides an emergency stockpile of petroleum to protect the United States against petroleum supply disruptions by domestic and international events.

In order to achieve these targeted outcomes and support the overall DOE mission and goals, FE has established the following FE Programmatic Goals:

- Enable commercial baseload CCS deployment of 1st generation technologies in the 2020 timeframe, based on engineering scale-up and operational experience from the demonstration scale projects brought online in the 2016 time period.
- Conduct scientific assessments of shale gas exploration and production risk and develop mitigating technologies and sponsor research projects to evaluate the occurrence, nature, and behavior of naturally occurring gas hydrates and the resulting resource, hazard, and environmental implications.
- Project American leadership in Fossil Energy technologies through active participation and collaboration with the international community. Continue the momentum for CCS in multilateral organizations including IEA, United Nations, World Energy Council (WEC), and the Carbon Sequestration Leadership Forum and bilaterals with key countries such as China and India.

FY 2014 Request Aligned with Strategic Plan Goals



Explanation of Changes

The Department's Office of Fossil Energy requests $637.975 million in FY 2014, which is a 15% increase over the current FY 2012 level. However, the FY 2012 level reflects a one-time offset of $187,000 from rescission of prior year balances.

Alignment to the Quadrennial Technology Review (QTR)

DOE's 2011 QTR emphasizes several strategies for DOE-funded research, including:

- Focusing "on innovation relevant to today's technologies"
- Carrying out "analyses, modeling and simulation, or other highly relevant fundamental engineering research activities that could influence the private sector in the nearer term"
- Devoting a fraction of it its effort to pursuing "disruptive breakthroughs"

FE's CCS RD&D focuses on the fossil fuels that account for most of the domestic energy consumed by large stationary sources. Eight fully-funded, large-scale CCS projects are being pursued to demonstrate the commercial scale integration of existing technologies, while maintaining reliable, predictable and safe plant operations. Second generation CCS technologies -- the primary focus of currently-funded R&D activities -- could contribute materially to domestic carbon mitigation by 2030. The economic viability of 2nd generation technologies is likely to depend either on a moderate carbon price or inclusion of value-added strategies such as CO_2 enhanced oil recovery (EOR). Also included is investment in transformational technology focusing on breakthroughs that could reduce the cost of CCS so that it will be deployable on a global scale without the need for a significant carbon price or EOR. FE, in partnership with other National Laboratories and key energy companies, is carrying out analyses, modeling and simulation activities under its Carbon Capture Simulation Initiative and National Risk Assessment Partnership, which are expected to reduce RD&D and CCS cost, and accelerate the pace of technology development and innovation.

Goal Program Alignment Summary

	Focus on near term critical CCS for clean coal.	Conduct natural gas research with DOI and EPA to address potential environmental, and safety impacts of gas development including hydraulic fracturing (fracking) and conduct Gas Hydrate research.	Maintain an SPR with a readiness and capability to respond quickly and effectively to potential disruptions in U.S. petroleum supplies (foreign or domestic).	Maintain a NEHHOR with 1 million barrels of heating oil to protect the Northeast against high vulnerability of winter-related supply shortages.	Close out 45 Areas of Concern at NPR-1 (Elk Hills, California) and initiate disposition of NPR-3 in FY 2015.
Fossil Energy Appropriation					
Coal	100%	0%	0%	0%	0%
Natural Gas Technologies	0%	100%	0%	0%	0%
Strategic Petroleum	0%	0%	100%	0%	0%
Northeast Home Heating Oil Reserve	0%	0%	0%	100%	0%
Naval Petroleum & Oil Shale Reserves	0%	0%	0%	0%	100%
Subtotal, Fossil Energy Appropriation	43%	3%	30%	1%	3%

Performance Measures

Performance Goal (Measure)	**CCS Demonstrations** - Initiate construction of CCS demonstration projects		
Fiscal Year	**2012**	**2013***	**2014**
Target	3 CCS projects initiated	2 CCS projects initiated	1 CCS project initiated
Result	3 CCS projects initiated		
Endpoint Aim	Initiate operations of at least five commercial scale CCS demonstrations by 2016 including the Clean Coal Power Initiative (CCPI), FutureGen 2.0, and the Industrial CCS Demonstration projects (includes projects funded by both annual appropriations and the American Recovery and Reinvestment Act). At least two of the five demonstrations to initiate operations by 2016 will be CCPI projects.		

*2013 targets represent DOE's FY 2013 Budget Request to Congress. FY 2013 target updates can be found in the upcoming FY 2012-2014 Annual Performance Plan & Report.

Performance Goal (Measure)	**Carbon Storage** - Inject 3.0 million (cumulative since 2009) metric tons of CO_2 in large-volume field test sites to demonstrate the formations capacity to permanently, economically, and safely store carbon dioxide.		
Fiscal Year	**2012**	**2013***	**2014**
Target	3 MMTs injected (since 2009)	4 MMTs injected (since 2009)	5 MMTs injected (since 2009)
Result	3 MMTs injected (since 2009)		
Endpoint Target	Inject 9.0 million metric tons of CO2 in large-volume field test sites representing different storage classes, since January 2009, to demonstrate and monitor for the formations capacity to permanently, economically, and safely store carbon dioxide. A long-term goal is to ensure the cost effective ability to measure and account for 99 percent of injected CO2 in all storage types while minimizing the environmental footprint of carbon storage activities.		

*2013 targets represent DOE's FY 2013 Budget Request to Congress. FY 2013 target updates can be found in the upcoming FY 2012-2014 Annual Performance Plan & Report.

Performance Goal (Measure)	**Drawdown Readiness** - Ensure drawdown readiness by achieving greater than 95% of monthly maintenance and accessibility goals.		
Fiscal Year	**2012**	**2013***	**2014**
Target	95% of monthly maintenance achieved	95% of monthly maintenance achieved	95% of monthly maintenance achieved
Result	95% of monthly maintenance achieved		
Endpoint Target	Achieve 95% of monthly maintenance and accessibility goals in all years.		

*2013 targets represent DOE's FY 2013 Budget Request to Congress. FY 2013 target updates can be found in the upcoming FY 2012-2014 Annual Performance Plan & Report.

Performance Goal (Measure)	**SPR Operating Cost** - Ensure cost efficiency of SPR operations by achieving low operating cost per barrel of capacity		
Fiscal Year	**2012**	**2013***	**2014**
Target	≤ $0.25 operating cost per barrel	≤ $0.25 operating cost per barrel	≤ $0.25 operating cost per barrel
Result	$0.22 operating cost per barrel		
Endpoint Target	< $0.25 operating cost per barrel		

*2013 targets represent DOE's FY 2013 Budget Request to Congress. FY 2013 target updates can be found in the upcoming FY 2012-2014 Annual Performance Plan & Report.

Performance Goal (Measure)	**Sustained (90 day) Drawdown Rate** - Enable ready distribution of SPR oil by achieving maximum sustained (90 day) drawdown rate of 4.4 million barrels per day.		
Fiscal Year	**2012**	**2013***	**2014**
Target	4.4 million barrels per day (MMB/Day)	4.25 MMB/Day drawdown readiness rate	4.25 MMB/Day drawdown readiness rate
Result	4.25 million barrels per day (MMB/Day)		
Endpoint Target	Maintain a 90 day drawdown rate of 4.4 million barrels per day		

*2013 targets represent DOE's FY 2013 Budget Request to Congress. FY 2013 target updates can be found in the upcoming FY 2012-2014 Annual Performance Plan & Report.

Facilities Maintenance and Repair

The Department's Facilities Maintenance and Repair activities are tied to its programmatic missions, goals, and objectives. Facilities Maintenance and Repair activities funded by the Office of Fossil Energy budget are displayed below.

Costs for Direct-Funded Maintenance and Repair (including Deferred Maintenance)

(dollars in thousands)

	FY 2012 Actual Cost	FY 2013 Planned Cost	FY 2014 Planned Cost
National Energy Technology Laboratory	21,315	---	13,145
Strategic Petroleum Reserve	37,134	---	41,142
Naval Petroleum and Oil Shale Reserve	1,370	---	490
Total, Direct-Funded Maintenance and Repair	50,894	48,870	54,777

Report on FY 2012 Expenditures for Maintenance and Repair

This report responds to legislative language set forth in Conference Report (H.R. Conf. Rep. No. 108-10) accompanying the Consolidated Appropriations Resolution, 2003 (Public Law 108-7) (pages 886-887), which requests the Department of Energy provide an annual year-end report on maintenance expenditures to the Committees on Appropriations. This report compares the actual maintenance expenditures in FY 2012 to the amount planned for FY 2012, including directed changes.

Total Costs for Maintenance and Repair

(dollars in thousands)

	FY 2012 Actual Cost	FY 2012 Planned Cost
National Energy Technology Laboratory	21,315	21,345
Strategic Petroleum Reserve	37,134	33,133
Naval Petroleum and Oil Shale Reserve	1,370	1,370
Total, Direct-Funded Maintenance and Repair	59,819	55,848

The SPR exceeded the planned funding for maintenance and repair activities due to emergency repair of a Big Hill transformer, unplanned replacement of PIV 20 at Bryan Mound, and repair of firewater leak at Bryan Mound. Additionally, the rework of pipeline valves at Bryan Mound and Bayou Choctaw was accelerated from FY 2013 to FY 2012.

Small Business Innovation Research/Small Business Technology Transfer (SBIR/STTR)

(dollars in thousands)

	FY 2012 Current	FY 2013 Annualized CR	FY 2014 Request
Fossil Energy Research and Development			
Carbon Capture	1,912	1,988	2,618
Carbon Storage	3,202	3,331	1,838
Advanced Energy Systems	2,773	2,877	1,446
Cross-cutting Research	1,188	1,352	537
Natural Gas	415	488	512
Unconventional Fossil Energy Technologies	138	145	0
Total, SBIR/STTR	9,628	10,181	6,951

Fossil Energy Research and Development
Office of Fossil Energy
Funding by Site by Program

(dollars in thousands)

	FY 2012 Current	FY 2013 Annualized CR*	FY 2014 Request
Ames National Laboratory			
Coal	1,905	---	1,795
Total, Ames National Laboratory	1,905	---	1,795
Idaho National Engineering and Environmental Laboratory			
Natural Gas	30	---	436
Total, Idaho National Engineering and Environmental Laboratory	30	---	436
Lawrence Berkeley National Laboratory			
Coal	4,574	---	2,780
Natural Gas	375	---	150
Total, Lawrence Berkeley National Laboratory	4,949	---	2,930
Lawrence Livermore National Laboratory			
Coal	2,800	---	900
Total, Lawrence Livermore National Laboratory	2,800	---	900
Los Alamos National Laboratory			
Coal	4,578	---	2,205
Natural Gas	175	---	0
Total, Los Alamos National Laboratory	4,753	---	2,205
National Energy Technology Laboratory			
Coal	326,711	---	310,248
Program Direction	88,100	---	88,100
Fossil Energy Environmental Restoration	6,477	---	6,477
Unconventional Fossil Energy Technologies	4,688	---	0
Total, National Energy Technology Laboratory	443,111	---	365,296
Oak Ridge National Laboratory			
Coal	900	---	2,075
Total, Oak Ridge National Laboratory	900	---	2,075
Pacific Northwest Laboratory			
Coal	4,445	---	1,190
Total, Pacific Northwest Laboratory	4,445	---	1,190
Sandia National Laboratories			
Coal	788	---	291
Total, Sandia National Laboratories	788	---	291
Washington Headquarters			
Coal	8,054	---	4,624
Natural Gas	1,425	---	1,765
Program Direction	31,829	---	30,790

(dollars in thousands)

	FY 2012 Current	FY 2013 Annualized CR*	FY 2014 Request
Fossil Energy Environmental Restoration	1,420	---	1,420
Plant and Capital Equipment	16,794	---	13,294
Special Recruitment Programs	700	---	700
Unconventional Fossil Energy Technologies	171	---	0
Total, Washington Headquarters	60,393	---	52,593
Subtotal, Fossil Energy Research and Development	524,074	536,969	429,275

*FY 2013 amounts shown reflect the P.L. 112 175 continuing resolution level annualized to a full year. These amounts are shown only at the "congressional control" level and above; below that level a dash (—) is shown.

Coal
Funding Profile

(dollars in thousands)

	FY 2012 Current	FY 2013 Annualized CR*	FY 2014 Request
Coal			
CCS Demonstration Programs	0	0	0
Carbon Capture and Storage, and Power Systems, (CCS&PS)	359,320	370,650	276,631
Total, Coal	359,320	370,650	276,631

*FY 2013 amounts shown reflect the P.L. 112 175 continuing resolution level annualized to a full year. These amounts are shown only at the "congressional control" level and above; below that level a dash (—) is shown.

SBIR/STTR:

- FY 2012 Transferred: SBIR: $7,998; STTR: $1,077
- FY 2013 Annualized amount: SBIR: $8,460; STTR: $1,088
- FY 2014 Request: SBIR $6,564: STTR: $936

Public Law Authorizations

Public Law 95-91

Overview

The Department's September 2011 Quadrennial Technology Review (QTR) outlines three challenges, energy security, environmental protection, and economic competitiveness to which FE's Coal Program aligns its activities: 1) Deploy the Technologies that have significant technical headroom, yet could be demonstrated at commercial scale within a decade and 2) Discover the New Solutions We Need like technologies that could have a consequential impact on meeting national energy goals in two decades, and 3) technologies that could be expected to be adopted by the relevant markets, understanding that these markets are driven by economics shaped by public policy.

The mission of the Coal Program's CCS Demonstration Programs, and CCS and Power Systems R&D activities is to support secure, affordable, and environmentally acceptable near-zero emissions fossil energy technologies. This will be accomplished via research, development, and demonstration to improve the performance of advanced CCS technologies. Commercial availability of CCS technologies will provide an option to use fossil fuel resources to provide energy and meet the President's climate goals.

Program Accomplishments and Milestones

FY 2012 Program Accomplishments and Milestones can be found in the CCS and Power Systems and CCS Demonstration Programs justifications.

Program Planning and Management

The Office of Clean Coal performs real-time performance tracking utilizing various systems that rely on data from a single corporate source of record. These systems track progress of multiple programs and projects, including project progress toward ARRA and GPRA quarterly milestones, annual program performance targets, and earned value. Additionally, the Coal Program conducts independent, periodic peer reviews to provide guidance and critical feedback on its programs' direction and plans. Some of these tools include:

- FE Dashboard: A comprehensive system that tracks progress and risk toward program quarterly milestones and annual goals, project information, and reporting of information.

- Standard Accounting and Reporting System (STARS): STARS provides the Department with a modern, comprehensive, and responsive financial management system that is the foundation for linking budget formulation, budget execution, financial accounting, financial reporting, cost accounting, and performance measurement. The system processes Departmental accounting information, including General Ledger, Purchasing, Accounts Payable, Accounts Receivable, and Fixed Assets. The system also includes budget execution functionality associated with recording appropriations, apportionments, allotments, allocations, and provides funds control for commitments, obligations, costs, and payments.

- Strategic Integrated Procurement Enterprise System (STRIPES):

STRIPES encompasses activities required or directly associated with planning, awarding, and administering various unclassified acquisition and financial assistance instruments. In general terms, the required activities are comprised of the following functions: acquisition/financial assistance planning; pre-solicitation documentation generation; solicitation development; evaluation and award; administration, including approving payment requests; and instrument closeout. Additional functions provided, which are directly associated with the planning, awarding, and administering of the instruments, include: interfacing with internal and external systems, such as STARS, the iManage Data Warehouse, FedBizOpps, and the Central Contractor Registration; workload management; workflow capabilities; and appropriate reporting capabilities for both internal and external purposes.

- Primavera and MS Project:
  Software tools that track project progress toward goals and milestones.
- iPortal:
  The iPortal will provide personalized dashboards, messaging (thresholds/alerts), discussion boards, collaboration capabilities, news, reporting, graphing, and data exchange capabilities to DOE executives, managers and staff.

Strategic Management

In meeting the identified challenges to clean fossil energy, the Department will implement key strategies to more efficiently and effectively manage the program, thus putting the taxpayers' dollar to more productive use, including reducing greenhouse gas emission by 17% by 2020 and 83% by 2050, from a 2005 baseline.

Program Goals and Funding

In FY 2014, the Coal program will be working to achieve the following goals:

- Initiate construction of at least one Clean Coal Power Initiative demonstration project.
- Advanced Energy Systems with CO_2 capture at a 13% cost reduction per tonne of CO2 captured (2011 dollars).
- Inject 5.0 million metric tons of CO_2 in large-volume field test sites

Explanation of Funding AND/OR Program Changes

(dollars in thousands)

	FY 2012 Current	FY 2014 Request	FY 2014 Request vs FY 2012 Current
CCS Demonstration Programs			
This program currently manages projects that are fully funded with prior year appropriations.	0	0	0
CCS and Power Systems			
Increased level of funding for Carbon Capture ($45M), including transitioning and scaling-up multiple, advanced CO_2 capture technologies pursued by the ARPA-E and EFRC programs between 2009 and 2013 to the Fossil Energy Carbon Capture Program. $25M is allocated to fund (through a competitive inducement prize or other appropriate funding mechanism) a solicitation to demonstrate the first commercial natural gas combined cycle plant to capture and store 75% or more of the CO2 emissions.			
The requested decrease in funding for Carbon Storage (-$51M), maintains a minimum level of funding for current activities and focuses budgetary resources on advancements in carbon capture.			
The requested decrease in funding for Advanced Energy Systems (-$49M) will focus resources on activities related to pressurized oxy-boiler and chemical looping combustion. Of the eight projects that were selected in the FY2012 FOA, four will be down-selected according to their performance and potential merits and Gasification Systems will continue to support the construction of the 100 TPD ITM oxygen plant and R&D activities in coal dry feed systems and hydrogen membrane separation. The Hydrogen Turbines program will focus on the development of advances in 2nd generation hydrogen turbine component technologies.			
The requested decrease in funding levels for Cross-cutting Research (-$27M) reflects the shift in focus toward sensor technologies that have potential benefits to maximize plant efficencies and reduce emissions to both existing and new fossil-fueled power plants.			
	359,320	276,631	-82,689
Total, Coal	359,320	276,631	-82,689

CCS Demonstration Programs
Funding Profile by Subprogram

(dollars in thousands)

	FY 2012 Current	FY 2013 Annualized CR*	FY 2014 Request
Clean Coal Power Initiative (CCPI)*	0	0	0
FutureGen 2.0**	0	0	0
Industrial Carbon Capture and Storage**	0	0	0
Total, CCS Demonstration Programs	0	0	0

*Funded through Base Appropriations and the American Recovery and Reinvestment Act

**American Recovery and Reinvestment Act Program

*FY 2013 amounts shown reflect the P.L. 112 175 continuing resolution level annualized to a full year. These amounts are shown only at the "congressional control" level and above; below that level a dash (—) is shown.

Overview

The Clean Coal Power Initiative (CCPI) program has provided government co-financing for new coal technologies that have helped utilities cut sulfur, nitrogen and mercury pollutants from power plants and aims to reduce greenhouse gas emissions by boosting plant efficiencies and capturing and storing carbon dioxide. All projects from Round I have been completed, but projects from Rounds II and III are still ongoing and in various stages of development. In addition to the CCPI program, FER&D manages two American Recovery and Reinvestment Act CCS demonstration programs: FutureGen 2.0 and the Industrial Carbon Capture and Storage program. The ability to demonstrate advanced technologies at scale that have been developed in the FER&D or other R&D programs is an important benefit of the demonstration programs. In addition, successful completion of the existing projects will help in meeting the President's broad national energy goal for reducing greenhouse gas emissions by 17% by 2020 and 83% by 2050, from a 2005 baseline.

Program Accomplishments and Milestones

The CCS demonstration projects are at varying stages of project definition, design, construction, and operation. Overall, the projects are progressing satisfactorily.

1) There are currently eight active CCS demonstration projects at varying stages of project definition, design, construction, and operation:
   - Four under the Clean Coal Power Initiative (CCPI),
   - Three under Industrial Carbon Capture and Storage (ICCS),
   - FutureGen 2.0.
2) The Air Products ICCS project has completed major construction activities and begun commercial operation. The project has captured and stored over 100,000 tons of CO2.
3) One CCPI project (Kemper) and one ICCS project (Archer Daniels Midland (ADM)) are currently under construction.

Benefits

- Public Benefits
- Reduced cost of achieving carbon emissions reductions.
- Reduced environmental impacts of using domestic fossil resources.

Funding and Activity Schedule

Fiscal Year	Activity	Funding (dollars in thousands)
FY 2012	Continue activities under the CCS Demonstrations Programs using prior year appropriations	0
FY 2013	Planned activities in the FY 2013 Budget (final allocations have not yet been determined): Continue activities under the CCS Demonstrations Programs using prior year appropriations	

Fiscal Year	Activity	Funding (dollars in thousands)
FY 2014	Continue activities under the CCS Demonstrations Programs using prior-year appropriations	0

Carbon Capture and Storage and Power Systems
Funding Profile by Subprogram and Activities

(dollars in thousands)

	FY 2012 Current	FY 2013 Annualized CR*	FY 2014 Request
Carbon Capture			
Post-Combustion	53,955	---	75,000
Natural Gas Capture	0	---	25,000
Pre-Combustion	13,031	---	12,000
Total, Carbon Capture	**66,986**	**69,320**	**112,000**
Carbon Storage			
Regional Carbon Sequestration Partnerships	80,882	---	40,495
Geological Storage Technologies	14,563	---	5,474
Monitoring, Verification, Accounting and Assessment	6,551	---	4,900
Carbon Use and Reuse	756	---	500
Focus Area for Carbon Sequestration Science	9,456	---	9,726
Total, Carbon Storage	**112,208**	**116,116**	**61,095**
Advanced Energy Systems			
Advanced Combustion Systems	15,499	---	14,000
Gasification Systems	37,918	---	23,000
Hydrogen Turbines	14,583	---	11,000
Coal and Coal-Biomass to Liquids	4,862	---	0
Solid Oxide Fuel Cells	24,307	---	0
Total, Advanced Energy Systems	**97,169**	**100,554**	**48,000**
Cross-cutting Research			
Plant Optimization Technologies			
Sensors, Controls and Other Novel Concepts	12,447	---	4,275
Cross-cutting Materials R&D	837	---	2,500
Coal Utilization Science			
Computational System Dynamics	11,472	---	4,350
Computational Energy Science	13,000	---	4,350
Energy Analyses			
Environmental Activities	450	---	450
Technical and Economic Analyses	500	---	500
System Analysis/Product Integration	4,000	---	0
University Training and Research			
University Coal Research	2,917	---	2,000
Historical Black Colleges and Universities & Training	973	---	750
International Activities			
Coal Technology Export	650	---	650
International Program Support	700	---	700
Total, Cross-cutting Research	**47,946**	**49,435**	**20,525**
NETL Coal Research and Development	**35,011**	**35,225**	**35,011**
Total, CCS and Power Systems	359,320	370,650	276,631

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*SBIR/STTR:

- FY 2012 Transferred: SBIR: $7,998; STTR: $1,077

- FY 2013 Annualized: SBIR $8,763; STTR: $1,128
- FY 2014 Request: SBIR $6,082; STTR: $869

Public Law Authorizations

Public Law 95-91

Overview

The CCS and Power Systems program conducts research to reduce carbon emissions by improving the performance and efficiency of fossil energy systems and carbon capture and storage (CCS) technologies. The Department is developing advanced fossil energy technology that will facilitate the commercial deployment of highly efficient fossil power plants capable of achieving near-zero atmospheric emissions. FE's CCS and Power Systems program is leading efforts to make possible greater utilization of the nation's fossil energy resources in an environmentally sound and economically competitive way. The core R&D efforts of the CCS and Power Systems program focuses on a variety of technologies that can reduce the carbon footprint of existing and future fossil energy systems.

The NETL Direct Research and Development program funds in-house activities supporting CCS and Power Systems. This funding supports Federal researchers directly associated with conducting basic and applied research activities specific to CCS and Power Systems in Carbon Capture, Carbon Storage, Advanced Energy Systems and Cross-cutting Research.

Program Accomplishments and Milestones

In FY 2012, CCS and Power Systems achieved the following accomplishments:

1) Conducted over 2,000 hours of post-combustion capture pilot-scale testing;
2) Initiated large-scale projects to inject, monitor, and store carbon dioxide at two additional Regional Carbon Sequestration Partnerships (RCSP);
3) Received recognition from *R&D Magazine* for developing [Platinum / Chromium Alloy, APECS v2 with ANSYS Design Xployer™ ROM Builder, and Mn-Co Coating for Solid Oxide Fuel Cells] – three technologies listed as among the 100 most significant in the past year;
4) Completed initial prototype testing on piezoelectric and fiber optic based sensors for high temperature combustion conditions;
5) Completed 100 hours of combustion testing to assess second generation design concepts for oxy-fired boilers;
6) Completed construction, commissioning and testing of one Oxygen Transport Membrane (OTM) module;
7) Achieved 50% construction completion on a 30-100 ton per day Ion transport Membrane oxygen system; and
8) Commenced testing of a novel dry gasification feed system.

Milestone	**Date**
Complete evaluation of two CO_2 utilization technologies to convert CO_2 into useful products	2nd Qtr FY
Complete hydrogen turbine hot gas ingestion rig testing of optimized wheel space geometry	3rd Qtr FY 2013
Begin extensive monitoring of large-scale injection and storage of CO_2 at two RCSPs field projects	
Initiate construction of slipstream-scale (0.5-5 MWe) post-combustion carbon capture system/component pilot project	
Complete reduced order reservoir models to predict pressures and saturation over time to within 10% of prediction from detailed models for major storage formations types and demonstrated on at least 2 actual storage formations	
Complete high fidelity multi-scale kinetic/diffusion model for amine based solid sorbents	
Complete evaluation of advanced oxycombustion technologies through systems evaluation	4th Qtr FY 2013
Complete construction of 30-100 TPD ion transport membrane oxygen system	
Select and award projects from FOA's solicitation in the following topics: Oxy-combustion, sensors and controls, monitoring, verification, and accounting technologies, and University Grant Programs (UCR and HBCU/OMI)	

Program Planning and Management

The CCS and Power Systems program, included within FER&D, conducts R&D on technologies to significantly reduce coal power plant emissions and substantially improve efficiency to reduce carbon emissions, leading to viable near-zero atmospheric emissions coal energy systems and supporting carbon capture and storage.

Strategic Management

In meeting the identified challenges to clean fossil energy, the Department will implement five key strategies to more efficiently and effectively manage the program, thus ensuring the taxpayers' investment is put to productive use.

1. Coal's R&D program will partner with the private sector, national laboratories, university and international partners to develop advanced CCS and Power Systems technologies.
2. Natural Gas Capture, along with Carbon Capture and Storage (CCS) technologies will need to be broadly applied to meet long-term climate change goals. $25M is allocated to fund (through a competitive inducement prize or other appropriate funding mechanism) a solicitation to demonstrate the first commercial natural gas combined cycle plant to capture and store 75% or more of the CO_2 emissions.
3. Provide analysis of how improvements in CCS technologies impact the cost of achieving carbon emissions reductions goals.
4. Pursue advanced modeling and simulation to accelerate and reduce the risk of the development timeframe.
5. Nurture ties with countries and organizations pursuing state-of-the-art CCS RD&D to leverage resources.

Two external factors present the strongest impacts to the overall achievement of the program's strategic goal:

1. Power demand and environmental factors beyond the scope of DOE R&D programs; and
2. Industry's inclination to focus on near-term deployment using proven technologies.

Program Goals and Funding

In FY 2014, CCS and Power Systems will be working to achieve the following goals:

- Advanced Energy Systems with CO_2 capture at a 13% cost reduction per tonne of CO2 captured.
- Inject 5.0 million metric tons of CO_2 in large-volume field test sites.

Explanation of Funding AND/OR Program Changes

(dollars in thousands)

	FY 2012 Current	FY 2014 Request	FY 2014 Request vs FY 2012 Current
Carbon Capture			
Post-combustion			
The requested funding level includes transitioning and scaling-up multiple, advanced CO_2 capture technologies including those pursued by the ARPA-E and EFRC programs between 2009 and 2013 to the Fossil Energy Carbon Capture Program through a competitive solicitation.	53,955	75,000	+21,045
Natural Gas Capture			
Carbon Capture and Storage (CCS) technologies will need to be broadly applied to meet long-term climate change goals. $25M is allocated to fund (through a competitive inducement prize or other appropriate funding mechanism) a solicitation to demonstrate the first commercial natural gas combined cycle plant to capture and store 75% or more of the CO_2 emissions.	0	25,000	+25,000
Pre-combustion			
The requested funding level is sufficient to maintain focus on current scope of activities.	13,031	12,000	-1,031
Total, Carbon Capture	**66,986**	**112,000**	**+45,014**

(dollars in thousands)

	FY 2012 Current	FY 2014 Request	FY 2014 Request vs FY 2012 Current
Carbon Storage			
Regional Carbon Sequestration Partnerships			
The requested FY2014 funding level focuses resources on large volume development tests of sequestration technologies, injection techniques and monitoring at selected geologic site locations.	80,882	40,495	-40,387
Geologic Storage Technologies			
The requested FY2014 funding level focuses resources on current activities that are conducting initial development of the most promising tools and technologies to deliver safe and permanent storage options for CO2.	14,563	5,474	-9,089
Monitoring, Verification, Accounting and Assessment			
The requested FY2014 funding level focuses resources on the most promising technology areas.	6,551	4,900	-1,651
Carbon Use and Reuse			
This area of research is a low priority relative to other activities which are expected to yield greater public benefits.	756	500	-256
Focus Area for Carbon Sequestration Science			
The requested funding level is sufficient to maintain focus on the current scope of activities.	9,456	9,726	+270
Total, Carbon Storage	**112,208**	**61,095**	**-51,113**
Advanced Energy Systems			
Advanced Combustion Systems			
The requested FY2014 funding level focuses resources on activities related to pressurized oxy-boiler and chemical looping combustion. Eight projects were selected in the FY2012 FOA. They will be downselected to the four most promising projects according to performance and other project merits.	15,499	14,000	-1,499
Gasification Systems			
The requested FY2014 funding level continues to support the construction of the 100 TPD ITM oxygen plant and R&D activities in coal dry feed systems and hydrogen membrane separation.	37,918	23,000	-14,918
Hydrogen Turbines			
The requested FY2014 funding level focuses resources on the development of advances in 2nd generation hydrogen turbine component technologies.	14,583	11,000	-3,583
Coal and Coal Biomass to Liquids			
This area of research is a low priority relative to other activities which are expected to yield greater public benefits.	4,862	0	-4,862
Solid Oxide Fuel Cells			
The program has prioritized near-term CCS technologies. SECA Core Technology R&D will continue and then complete existing work with prior year funding – no new Core Technology effort will be initiated in FY 2014.	24,307	0	-24,307
Subtotal, Advanced Energy Systems	**97,169**	**48,000**	**-49,169**

(dollars in thousands)

	FY 2012 Current	FY 2014 Request	FY 2014 Request vs FY 2012 Current
Cross-cutting Research			
Plant Optimization Technology			
Sensors & Controls			
The requested FY2014 funding level represent the shift in focus toward sensor technologies that have potential benefits to maximize plant efficiencies and reduce emissions to both existing and new fossil-fueled power plants.	12,447	4,275	-8,172
Crosscutting Materials R&D			
The requested FY2014 funding level is sufficient to maintain focus on the current scope of activities and initiate critical ASME code testing for the next class of ultra supercritical materials.	837	2,500	1,663
Coal Utilization Science			
Computational System Dynamics			
The requested FY2014 funding level represents a shift in focus to technologies that have potential benefits to both existing and new fossil fueled power plants. Funding will rescope the efforts on critical NRAP modeling development and de-emphasized the efforts on modeling next generation power plans.	11,472	4,350	-7,122
Focus Area for Computational Energy Science			
The requested FY2014 funding level represents a shift in focus to technologies that have potential benefits to both existing and new fossil fueled power plants. Funding will rescope the effort on critical CCSI modeling development and de-emphasized the efforts on modeling of physical phenomenon.	13,000	4,350	-8,650
Energy Analyses			
The requested FY2014 funding level will maintain focus on technical outreach support for advanced technologies commercialization efforts.	4,950	950	-4,000
University Training and Research			
University Coal Research			
The requested FY2014 funding level will continue to support grants to Universities under the University Coal Research program.	2,917	2,000	-917
HBCU's Education and Training			
The requested FY2014 funding level will continue to support grants to Historically Black Colleges and University.	973	750	-223
International Activities			
The requested FY2014 funding level maintains focus on the current scope of activities.	1,350	1,350	0
Subtotal, Cross-cutting Research	**47,946**	**20,525**	**-27,421**
NETL Coal Research and Development			
No change in funding.	35,011	35,011	0
Subtotal, NETL Coal Research and Development	**35,011**	**35,011**	**0**
Total, CCS and Power Systems	**359,320**	**276,631**	**-82,689**

Carbon Capture

Overview

The Carbon Capture activity is focused on the development of post-combustion and pre-combustion CO_2 capture and compression technologies for new and existing power plants. Post-combustion CO_2 capture technology R&D is focused on pulverized coal (PC) power plants, which is the current standard industry technology for coal-fueled electricity generation. The Natural Gas Capture subactivity is focused on facilitating the demonstration of the first commercial natural gas combined cycle (NGCC) power plant to capture and store 75% or more of the CO_2 emissions. Pre-combustion CO_2 capture is applicable to gasification-based systems such as Integrated Gasificiation Combine Cycle (IGCC), a potential technology for future generation of electricity from coal-fueled plants.

Post-Combustion

The Post-Combustion subactivity focuses specifically on developments related to 2nd generation technologies that can achieve CO_2 capture at $40/tonne CO_2 capture cost for new and existing conventional coal-fired power plants. 2nd generation technologies are those that are not currently in commercial application at any scale or level of integration, but have potential to improve the efficiency or reliability of carbon capture processes. Significant improvements in both cost and efficiency of CO_2 separation and compression will be required to achieve this goal. Critical R&D milestones have been achieved by laboratory- through pilot-scale testing of a broad spectrum of CO_2 capture approaches including advanced solvents, sorbents, and membranes since 2008; and initiation of multiple, small-scale (0.5-5 MWe) slipstream tests of the most promising of these CO_2 capture technologies that began in 2010..

This subactivity also coordinates its efforts with ARPA-E and EFRC and will pursue the development, scale-up and field testing of multiple advanced and transformational capture technologies including those pursued under these programs between 2009 and 2013, through a competitive solicitation. Continued technology development is necessary to integrate these technologies into “real world” flue gas conditions.

Natural Gas Capture

The Natural Gas Capture subactivity will focus on carbon capture technologies that are critically important to natural gas application. This effort will support (through a competitive inducement prize or other appropriate funding mechanism) demonstration of the first commercial natural gas combined cycle (NGCC) power plant to capture and store 75% or more of the CO_2 emissions

Pre-Combustion

The Pre-Combustion subactivity focuses on development of 2nd generation technologies for pre-combustion capture (e.g., IGCC) that achieve CO_2 capture at $40/tonne removed CO_2 capture cost. Significant improvements are required to reduce parasitic energy load and cost, and many technologies that are available in the near-term have not been scaled up or applied to fossil fuel-powered generation systems. Critical R&D milestones have been achieved through laboratory-scale testing of novel solvent, sorbent, and membrane technologies.

Benefits

Public Benefits

- Reduced cost of achieving carbon emissions reductions.
- Reduced environmental impacts of using domestic fossil resources.
- Increased spillover benefits from technological innovations as a result of R&D.

Funding Schedule

Fiscal Year	Activity	Funding (dollars in thousands)
FY 2012	Completed laboratory-scale test runs of solvent technologies for post-combustion carbon capture, performed initial stability tests of a membrane contactor, performed slipstream testing of several post-combustion capture technologies (baseline amine solvent, advanced amine solvent, membrane, enzyme) at NCCC on a real flue gas stream, and	66,986

Fiscal Year	Activity	Funding (dollars in thousands)
	tested advanced, pre-combustion capture membrane technologies at laboratory-scale and also at NCCC.	
FY 2013	Planned activities in the FY 2013 Budget (final allocations have not yet been determined): Continue advanced laboratory scale and small pilot scale slipstream R&D for pre-IGCC and post-combustion (Pulverized Coal) CO_2 capture technologies.	
FY 2014	Continue advanced laboratory scale and small pilot scale slipstream R&D for pre- (IGCC) and post-combustion (Pulverized Coal) CO_2 capture technologies. Continue R&D of the most promising ARPA-E and EFRC capture technologies under the FE Capture Program. Initiate an effort that incentivizes a demonstration of the first commercial NGCC facility that captures and stores 75% or more of its CO_2 emissions.	112,000

Carbon Storage

Overview

The overall goal of the Carbon Storage Program is to develop and validate technologies to ensure safe and permanent geologic storage of captured CO_2. Development and validation of these technologies is critical to ensure industry and regulatory agencies have the capability to monitor and account for CO_2 and ensure the viability of carbon storage as an effective technology solution that can be implemented on a large-scale to mitigate carbon emissions. Applied R&D and field projects are being conducted in five primary storage types (saline formations, oil and gas reservoirs, unmineable coal seams, basalts, and organic shales) across eleven different geologic storage formation classes. Technologies developed and validated through the Carbon Storage Program will improve storage efficiency and reduce the overall cost of CCS with a goal of ensuring the cost effective ability to measure and account for 99 percent of injected CO_2 in all storage types while minimizing the environmental footprint of carbon storage activities.

Regional Carbon Sequestration Partnerships

The Regional Carbon Sequestration Partnerships (RCSP) subactivity focuses on development and validation of technologies, infrastructure, and human capital through the RCSPs and other small- and large-scale field projects. These field projects conduct regional and site-specific characterization and validation; simulation and risk assessment; and application of monitoring, verification and accounting technologies in various depositional environments. They provide the needed understanding of CO_2 injection, fluid flow and pressure migration, geomechanical and geochemical impacts to CO_2 injection, and developing a "commercial toolbox" for cost-effective monitoring in all storage types. These field projects are critical to deployment of safe and permanent storage and monitoring.

Field projects conducted under this technology area are implemented in three phases: (i) Regional and Site Characterization; (ii) Site and Injection Operations; and (iii) Post-Injection Monitoring Operations. Regional characterization activities are focused on identifying regional opportunities for CCS, CO_2 sources, and priority opportunities for field sites. Site characterization evaluation builds on previous characterization with greater detail to ensure a field project site has suitable geologic characteristics for safe injection and post-injection operations. Both small- and large-scale field projects integrate CO_2 capture, transportation, injection, and storage such that it can be achieved safely and permanently. As part of the field projects, project developers and regulatory agencies are addressing regulatory and public outreach and education issues associated with carbon storage. Resource assessment is also a critical component of this effort, regional understanding of storage types and estimated storage potential aids in the development of carbon mitigation plans and provides the foundation for first-mover projects. All of this information is made available to the public through the DOE's NATCARB geographic information system.

Geologic Storage Technologies

The Geologic Storage Technologies subactivity is focused on developing and validating storage simulation and risk assessment technologies that have the potential to safely, permanently, and cost effectively store CO_2 in geologic formations. This area involves developing technologies to improve construction material resistance to CO_2 and reservoir minerals, fluids and by-products; mitigate CO_2 leakage pathways; manage fluid flow, pressure and water; and minimize negative geochemical and geomechanical impacts. The simulation and risk assessment models integrate storage technologies with field operations for CO_2 flow and trapping mechanisms, geochemical changes, and geomechanical impacts within the geologic formations in all storage types. These technologies help maintain the integrity of the storage operations to ensure 99 percent storage permanence and optimize storage capacity.

Monitoring, Verification, Accounting and Assessment

The Monitoring, Verification, Accounting, and Assessment (MVAA) subactivity focuses on the critical components of geologic storage operations that track the transport and fate of injected CO_2. Technologies being developed and validated in field projects monitor CO_2 at atmospheric, near-surface and subsurface levels for integration into an intelligent monitoring system. MVAA of geologic storage sites addresses safety and environmental concerns; verifies inventory; and accounts for greenhouse gas (GHG) emissions mitigation to help achieve GHG reduction goals. Research focuses on technologies such as open path detection of CO_2 anomalies in the atmosphere with remote sensing and improved geophysical data acquisition tools, analysis, and tracking of CO_2 in the subsurface. These technological advances improve our ability to ensure 99 percent storage permanence and optimize storage capacity.

Carbon Use and Reuse

The Carbon Use and Reuse subactivity focuses on technologies, other than enhanced hydrocarbon recovery, that have the potential to reduce CO_2 emissions by developing beneficial uses for the CO_2. These beneficial uses include the conversion of CO_2 to chemicals, plastics, building materials, and curing for cement.

Focus Area for Carbon Sequestration Science

The Focus Area for Carbon Sequestration Science supports the Carbon Storage Program through complementary research support and validation of technologies applied in Regional Carbon Sequestration Partnerships field projects. Some R&D activities that this subactivity focuses on include (1) multiphase flow and CO_2 reactions in injection (reservoirs) and confining (seals) zones; (2) fundamental processes and properties of geologic storage necessary to optimize simulations and operations; (3) development and refinement of modeling methodologies for estimates of storage capacity in all storage types; (4) modeling and development of tools to investigate coupled effects and predict location of leakage and verify storage permanence, as well as enhance integration and interpretation of MVAA data; (5) geospatial data resources and management of the NATCARB system and energy data exchange (EDX) to archive data from the R&D field projects to ensure access and consistency by other researchers and (6) fundamental science and engineering support of novel CO_2 use, re-use and conversion.

Benefits

Public Benefits

- Increased certainty of carbon emissions reductions.
- Minimized the environmental impacts of using carbon storage.
- Increased spillover benefits from technological innovations as a result of R&D.

Funding Schedule

Fiscal Year	Activity	Funding (dollars in thousands)
FY 2012	Injected 3.6 million metric tons of CO_2 cumulatively at large-volume field tests since 2009 to validate geologic storage technologies. Two additional RCSPs began large-scale projects that inject carbon dioxide for utilization and geologic storage. Continued characterization efforts at other RCSPs to support CO_2 injection and storage/utilization efforts. Continued core R&D activities to improve understanding of science behind CO_2 and co-contaminants flow and reactions in formation rocks and seals, evaluate advanced geophysical tools to monitor CO_2 plume, and continue evaluation of CO_2 for beneficial use.	112,208
FY 2013	Planned activities in the FY 2013 Budget (final allocations have not yet been determined): Continue carbon storage activities through Core R&D and Regional Carbon Sequestration Partnership efforts.	
FY 2014	Inject 5.0 million metric tons of CO_2 cumulatively at large-volume field projects since 2009. RCSP Technology Area will continue regional characterization and field (injection) projects to validate geologic storage of CO_2 as a viable technology option. Core R&D Technology Areas will continue to develop and validate technologies to increase understanding of geologic formations appropriate for CO_2 storage; monitor and account for CO_2; mitigate potential risks; improve storage efficiency; develop tools to reduce uncertainty associated with long-term storage operations; and develop technologies for use and reuse of CO_2 to commercial products.	61,095

Advanced Energy Systems

Overview

The Advanced Energy Systems (AES) are integral parts of the CCS and Power Systems R&D Program. The AES mission is to increase the availability and efficiency of fossil energy systems integrated with CO_2 capture, while maintaining the highest environmental standards. The program elements focus on gasification, oxy-combustion, advanced turbines, and other energy systems. While the primary focus is on coal-based power systems, improvements to many of these technologies will result in positive spillover benefits that also reduce the cost of converting other carbon-based materials, such as biomass, petcoke or natural gas, into power and value-added products in an environmentally-acceptable manner.

Advanced Combustion Systems

This subactivity focuses on development of advanced combustion technologies, such as pressurized oxy-combustion and chemical looping processes, which have the potential to achieve $40/tonne CO_2. These advanced technologies are applicable to new and existing power plants. The application of these technologies today would result in a capture cost of more than $60/tonne CO_2 captured, compared with the current state of the art for a pulverized coal-fired plant. A critical R&D milestone is to initiate bench scale testing of the most promising advanced oxy-combustion and chemical looping technologies in 2014.

Advanced Combustion Systems also focuses on high performance materials R&D activities to validate the performance of the alloys developed in the Cross-Cutting Materials R&D through application in ultrasupercritical and oxy-combustion power plant environments which operate at significantly higher temperatures and pressures relative to current technologies.

Gasification Systems

This subactivity focuses on technology developments to increase gasification efficiency and availability to improve the performance of systems that convert fossil fuels to electricity and marketable bi-products. Research activities aim to increase, through design and plant integration, the efficiency of fuel and oxygen feed to IGCC power systems with CO_2 capture; improve high-pressure solid feed systems to enable use of low-rank coals in high-pressure gasifiers, facilitate co-feeding of coal with biomass or waste, and encourage more efficient high-pressure operation of dry feed gasifiers; and, further develop Ion Transport Membrane (ITM) technology to lower the capital requirements of oxygen production resulting in more efficient IGCC plants. In addition, this subactivity supports development of durable refractory materials, creates models to better understand the kinetics and particulate behavior of fuel inside a gasifier, and develops solutions to mitigate the plugging and fouling of syngas coolers.

A major cost element in gasification plants is converting raw syngas into a pure and specific gas used to create the plant's output of electricity and other byproducts. High hydrogen, low methane, ultra-clean syngas is versatile and can be used for power production with CO_2 capture, fuels or chemicals production, and for many polygeneration applications. The technologies being developed are focused on high-efficiency processes that operate at moderate to high temperatures and clean syngas of all contaminants.

Hydrogen Turbines

The Hydrogen Turbines subactivity focuses on the development of turbine component technologies capable of withstanding the high temperatures and aggressive environments that are predicted for high-hydrogen content syngas combustion. Current activities support development of key turbine system components capable of achieving a 4 percentage point efficiency increase relative to existing combined cycle turbines. Specifically, research focuses on rig testing of materials and components to be used in commercial scale machines, including combustor components, rotating parts, and cooling systems. These technologies will reduce interstage leakage via improved sealing designs, optimize airfoil heat flux with reduced cooling flows, improve material architectures for higher temperature operation, and result in superior airfoils for more efficient expansion with higher throughput.

Hydrogen from Coal

No funding is requested in the FY 2014 appropriation for this activity.

Coal and Coal-Biomass to Liquids

No funding is requested in the FY 2014 appropriation for this activity.

Solid Oxide Fuel Cells

No funding is requested in the FY 2014 appropriation for this activity.

Benefits

Public Benefits

- Reduced cost of achieving carbon emissions reductions.
- Increased efficiency and reliability of power generation advanced fossil fuel systems.
- Minimized the environmental impacts of using domestic fossil resources.
- Increased spillover benefits from technological innovations as a result of R&D.

Funding Schedule

Fiscal Year	Activity	Funding (dollars in thousands)
FY 2012	Advanced Combustion Program, A) completed construction and initiate operation of 1) a 1 MWe pilot-scale, calcium-based chemical looping combustion technology capable of 100 percent CO_2 capture, 2) 1 oxygen transport membrane (OTM) module, and B) Complete 110 hours of oxy-combustion testing at the 3 MWe pilot scale using West Virginia bituminous coal. Gasification Program, complete construction and testing of a warm gas H2/CO_2 separation membrane at 12 lb/hr, operate on real coal derived synthesis gas and complete systems analysis based on results. Hydrogen & Fuels Program, completed over 1,200 hours of membrane tests on actual syngas. Fuel Cell Program, completed testing of the non-repeat hardware for the proof-of-concept SOFC module. Hydrogen Turbine program, conduct full-scale, full-can tests of the "pre-production" high-hydrogen combustion nozzle technology to demonstrate the ability to meet relative efficiency targets with low NOx emissions at required gas turbine firing temperatures	97,169
FY 2013	Planned activities in the FY 2013 Budget (final allocations have not yet been determined): Continue Advanced Energy Systems core R&D activities which include the completion of detail design and construction of the Warm Gas Cleanup slipstream system that will reduce parasitic load, start the operation of the 100 T/D ITM pilot plant, continue to create advanced technology and subsystems for turbines that will permit the design of IGCC plants to achieve or surpass goals for carbon capture with less than 10% increase in COE over baseline IGCC without CCS, and implement advanced combustion projects selected in the FY2012 FOA.	
FY 2014	Combustion R&D will finalize design of pressurized oxycombustion and chemical looping pilot test facility and initiate construction of pilot-scale pressurized oxy-combustion and chemical looping testing. Gasification R&D focused on operating the Warm Gas Cleanup test system, the 100 TPD ITM oxygen system, and will develop advanced technologies that enable IGCC to achieve	48,000

Fiscal Year	Activity	Funding (dollars in thousands)
	or surpass goals for cost and carbon capture. It will also continue to develop transformational technologies that benefit IGCC. Hydrogen Turbine Program R&D activities include leading to down selections of key turbine components including the combustion system at 2012 or H-class conditions. The down selected technologies, with system level specifications, will position the program for a detailed design phase of the 2015 hydrogen turbine.	

Cross-cutting Research

Overview

The Cross-cutting Research activity serves as a bridge between basic and applied research by fostering the development of innovative systems for improving availability, efficiency, and environmental performance of fossil energy systems with carbon capture and storage. This crosscutting effort is implemented through the research and development of sensors, controls, and advanced materials. This program area also develops computation, simulation, and modeling tools focused on optimizing plant design and shortening developmental timelines. In addition, the Cross-cutting Research program area supports science and engineering education in minority colleges and universities.

Plant Optimization Technologies

Sensors, Controls and Other Novel Concepts

The Instrumentation, Sensors & Control element focuses on the development of sensors critical to the implementation and optimization of advanced fossil fuel-based power generation systems, including sensors capable of monitoring key parameters (temperature, pressure, and gas composition) and operating in high temperature, high pressure, and corrosive environments. This involves development of innovative analytical techniques for on-line industrial use, along with technologies that meet the immediate high-priority measurement need. The controls research effort centers around self-organizing information networks and distributed intelligence for process control and decision making. For example, research examines fundamental combustion and gasification chemistry to discern rates and mechanisms affecting emissions behavior under combustion/gasification conditions.

Cross-cutting Material R&D

Cross-cutting Materials R&D focuses on developing fundamental materials applicable to the full range of fossil fuel power generation technologies. Computational techniques to design and develop optimal materials for use in advanced combustion and gasification systems are being developed. Continue development of alloys based on refractory metal elements such as Nb, Mo, Cr and W to withstand the high temperatures and aggressive environments that are predicted for oxy-fuel turbines, hydrogen turbines and syngas turbines. This computational work will decrease the time to develop the new materials that will enable the next generation of fossil energy power systems.

Coal Utilization Science

Computational Systems Dynamics

The Computational System Dynamics element develops the capability to utilize immersive, interactive, and distributed visualization technology in the design of advanced fossil power systems under development in the Advanced Energy Systems activity. These will also implement the use of distributed, computer-aided design tools, as well as developing system tools that will allow the integrated use of information technology in advanced fossil power systems design including carbon capture. This program will also fund a multi-laboratory carbon storage modeling effort defined as the National Risk Assessment Partnership (NRAP). NRAP harnesses the breadth of capabilities across the DOE national lab system to develop a defensible, science-based quantitative methodology for determining risk profiles at carbon dioxide (CO_2) storage sites. These collaborative efforts will accelerate CCS development and support the goal to enable commercial deployment of CCS technologies by 2020.

Computational Energy Science

Computational Energy Science element develops models of physical phenomenon occurring in fossil fuel conversion processes as well as carbon capture systems. Activities in this element include multi-scale, multi-physics simulation capabilities that couple fluid flow, heat and mass transfer, and complex chemical reactions for optimizing the design and operation of fuel cells, heat engines, combustors, gasifiers, chemical reactors, and other important unit processes in advanced power generation systems. The Carbon Capture Simulation Initiative (CCSI) focuses on capture technologies, risk assessment, and integrated multi-scale physics-based simulations designed to support the applied research conducted in the Carbon Capture activity. These activities will accelerate CCS development and support the goal to enable commercial deployment of CCS technologies by 2020.

Energy Analyses

Environmental Activities

Analyses include potential environmental impacts (e.g., on water quality, air emissions, solid waste disposal, climate change) of fossil fuel use and large-scale deployment of different generations of CCS. Of particular interest are the life cycle environmental emissions for existing and advanced fossil fuel technologies

Technical and Economic Analyses

The Technical and Economic Analyses element supports program strategic planning by identifying major challenges, technologies, and advanced concepts that have the potential to improve the efficiency, cost, and/or environmental performance of fossil energy systems. These analyses include technical and economic studies such as benefit cost analysis and CCS deployment projections.

System Analysis/ Product Integration

No funding is requested in the FY 2014 appropriation for this element.

University Training and Research

University Coal Research

The University Coal Research (UCR) Program provides grants to colleges and universities to support research consistent with the CCS and Power Systems program. Through research grants, the UCR program supports the education of students in the area of fossil energy systems. Key research areas that will be supported include, but are not limited to, advanced power systems including near-zero emission power plants; CCS; development of advanced high performance materials; harsh environment sensors and controls; and the development of advanced fossil based power generation systems.

HBCU's Education and Training

The Historical Black Colleges and Universities (HBCU) and Other Minority Institutions (OMI) education and training program awards research grants to HBCUs and OMIs which emphasize longer-term research consistent with the CCS and power Systems program. Key research areas that will be supported include, but are not limited to, advanced power systems including near-zero emission power plants; CCS; development of advanced high performance materials; harsh environment sensors and controls; and the development of advanced fossil based power generation systems. Funding will be used to conduct Fossil Energy research activities at these institutions and to support an HBCU/OMI annual technology transfer symposium. Grants awarded under this program are intended to maintain and upgrade educational, training and research capabilities of HBCUs/OMIs in the fields of science and technology related to fossil energy resources, with project results being used to further DOE's commitment to Fossil Energy research.

International Activities

Coal Technology Export

The Coal Technology Export element works with international organizations to facilitate export of U.S. climate technology and energy services to the developing world. The element engages multilateral organizations including the IEA, United Nations, WEC, and the Carbon Sequestration Leadership Forum while managing bilateral agreements with key countries such as China and India.

International Program Support

The International Program Support element supports FE's commitment to the International Energy Agency Clean Coal Center (IEACCC) to enhance the competitiveness and adoption of U.S. Clean Coal Technologies in targeted countries that will help protect the local and global environment. It will also preserve and enhance active relationships with national and international organizations by focusing on expanding cleaner energy technology power systems activities globally.

Benefits

Public Benefits

- Reduced cost of achieving carbon emissions reductions.
- Reduced time and cost of developing carbon capture and advanced power system technologies.
- Increased efficiency and reliability of power generation advanced fossil fuel systems through improved sensors and controls.

- Increased spillover benefits from technological innovations as a result of R&D.

Funding Schedule

Fiscal Year	Activity	Funding (dollars in thousands)
FY 2012	Pursued the development of new classes of sensors that are capable of monitoring key parameters in harsh environment conditions of fossil energy systems and expanded the utilization of sensors through the development of artificially intelligent sensor networks and advanced process control for near zero emission power plants, established a multi-laboratory NRAP focused on developing a science-based quantitative methodology for determining risk profiles (i.e., residual risk) at CO_2 storage sites, provided high-performance computational modeling and simulation research into advanced energy plants and CCS technology, and continued to support grants at U.S. colleges and universities by emphasizing longer-term research for achieving FE's strategic objectives.	47,946
FY 2013	Planned activities in the FY 2013 Budget (final allocations have not yet been determined): Continue the development of 1st and 2nd generations of novel sensors, controls, advanced modeling and simulation, and high performance modeling technologies that contribute to a power systems' safe, efficient and environmentally benign operation. Work has started on new classes of transformational sensors. Existing sensors will be integrated into artificially intelligent sensor networks with self-organizing capabilities and increasingly used for advanced process control of near-zero emissions power plants. Model based process control for gasification and chemical looping processes will be demonstrated virtually.	
FY 2014	Continue development of 2nd generation and transformational sensors, controls and models with the deployment of developmentally ready temperature, and stress sensors to the turbines and gasification programs. NRAP will deploy the next generation of reservoir, groundwater, induced seismicity and atmosphere risk models.	20,525

NETL Coal Research and Development

Overview

The NETL staff is directly associated with conducting in-house research activities for the Coal Research and Development. This research supports NETL program specific activities in Carbon Capture, Carbon Storage, Advanced Energy Systems, and Cross Cutting Research. The in-house research and development activities are conducted by a staff of scientists, engineers, technicians and administrative personnel.

	FY 2012 Current	FY 2013 Annualized CR*	FY 2014 Request
NETL Coal R&D Direct Program			
Salaries and Benefits	29,260	---	26,800
Travel	1,172	---	1,000
Support Services	4,579	---	7,211
Total, NETL Coal R&D Direct Program	35,011	35,225	35,011
Full Time Equivalents	213	---	195

Benefits

NETL in-house research supports program specific activities in Carbon Capture, Carbon Storage, Advanced Energy Systems, and Cross-cutting Research.

Funding Schedule

Fiscal Year	Activity	Funding (dollars in thousands)
FY 2012	NETL in-house research activities for Coal Research and Development. This research supports program specific activities in Carbon Capture, Carbon Storage, Advanced Energy Systems, and Cross-cutting Research.	35,011
FY 2013	Planned activities in the FY 2013 Budget (final allocations have not yet been determined): NETL in-house research activities for Coal Research and Development. This research supports program specific activities in Carbon Capture, Carbon Storage, Advanced Energy Systems, and Cross-cutting Research.	35,225
FY 2014	NETL in-house research activities for Coal Research and Development. This research supports program specific activities in Carbon Capture, Carbon Storage, Advanced Energy Systems, and Cross-cutting Research.	35,011

Natural Gas Technologies
Funding Profile by Subprogram

(dollars in thousands)

	FY 2012 Current	FY 2013 Annualized CR	FY 2014 Request
Natural Gas Technologies			
Effective Environmental Protection	4,859	---	12,000
Gas Hydrates	9,716	---	5,000
Total, Natural Gas Technologies	14,575	15,083	17,000

*FY 2013 amounts shown reflect the P.L. 112 175 continuing resolution level annualized to a full year. These amounts are shown only at the "congressional control" level and above; below that level a dash (—) is shown.

*SBIR/STTR:

- FY 2012 Transferred: SBIR: $366; STTR: $49
- FY 2013 Annualized CR: SBIR $432: STTR: $56
- FY 2014 Request: SBIR $448: STTR: $64

Public Law Authorizations

Public Law 95–91, "Department of Energy Organization Act", 1977
Public Law 109–58, "Energy Policy Act of 2005"

Overview

The mission of the Natural Gas program is to support DOE missions in energy, environment, and national security.

The Natural Gas Technologies program was reprioritized to launch a collaborative research and development initiative together with the Environmental Protection Agency (EPA) and the Department of the Interior's U.S. Geological Survey (USGS) to understand and minimize the potential environmental, health, and safety impacts of natural gas development through hydraulic fracturing (fracking), consistent with the recommendations of the Secretary of Energy Advisory Board's (SEAB) August 2011 "Shale Gas Production Subcommittee Ninety-Day Report."

Subprogram Accomplishments and Milestones

In FY 2013, the budget invests in research and development to understand and minimize the potential environmental, health, and safety impacts of shale gas development.

The Program successfully completed a 30-day production test of an arctic well in 2012 providing large volumes of data available to the public for further evaluation.

In FY 2014, The Natural Gas program will focus on continued implementation of collaborative research plan in such areas as water quality, water availability, air quality, induced seismicity, and mitigating the impacts of development.

In FY 2014 the Natural Gas program intends to conduct lab- and/or field-based research focused on increasing public understanding of methane dynamics in gas-hydrate bearing areas. These public sector-led efforts will be designed to evaluate the occurrence, nature and behavior of naturally occurring gas hydrates and the resulting resource, hazard, and environmental implications.

Program Planning and Management

The Department Of Energy, Department of the Interior, and Environmental Protection Agency developed a focused, collaborative research effort to address high-priority challenges to safe and prudent development of unconventional resources. The primary goal of this multiagency research effort is to provide timely science and tools that support sound policy, allow for informed unconventional resource development decisions at many levels –federal, state, tribal, and local; industry; and the public, and to advance technologies that will maximize benefits to the Nation.

Major Outyear Priorities and Assumptions

The Natural Gas program will focus on continued implementation of a priority collaborative research and development initiative together with the EPA and DOI to ensure that hydraulic fracturing for natural gas development is conducted in a manner that is environmentally sound and protective of human health and safety.

Subprogram Goals and Funding

The Natural Gas Program goal is to conduct scientific assessments of shale gas exploration and production risk and develop mitigating technologies, and conduct lab- and/or field-based research to evaluate the occurrence, nature, and behavior of naturally occurring gas hydrates and the resulting resource, hazard, and environmental implications.

Explanation of Funding AND/OR Program Changes

(dollars in thousands)

	FY 2012 Current	FY 2014 Request	FY 2014 Request vs FY 2012 Current
Effective Environmental Protection			
The increase in funding for Effective Environmental Protection (+$7M) is necessary to continue implementation of collaborative research including research on water quality and availability, air quality, induced seismicity, and mitigating the impacts of shale gas development.	4,859	12,000	+7,141
Gas Hydrates			
The decrease in funding for Gas Hydrates (-$4.7M) is a result of the program focusing on increasing public understanding of methane dynamics in gas-hydrate bearing areas. These public sector-led efforts will be designed to evaluate the occurrence, nature and behavior of naturally occurring gas hydrates and the resulting resource, hazard, and environmental implications.	9,716	5,000	-4,716
Total, Natural Gas	14,575	17,000	+2,425

Unconventional FE Technologies
Funding Profile

(dollars in thousands)

	FY 2012 Current	FY 2013 Annualized CR*	FY 2014 Request
Unconventional FE Technologies	4,859	5,027	0

*FY 2013 amounts shown reflect the P.L. 112 175 continuing resolution level annualized to a full year. These amounts are shown only at the "congressional control" level and above; below that level a dash (—) is shown.

*SBIR/STTR:

- FY 2012 Transferred: SBIR: $122; STTR: $16
- FY 2013 Annualized CR: SBIR: $128; STTR:$17

Public Law Authorizations

Public Law 95–91, "Department of Energy Organization Act", 1977
Public Law 109–58, "Energy Policy Act of 2005"

Overview

The mission of the Unconventional Fossil Energy Resource Program is to provide information and technologies that will assure sustainable, reliable, affordable, and environmentally sound supplies of domestic unconventional fossil energy resources.

Program Accomplishments and Milestones

No activity is proposed in FY 2014.

Program Planning and Management

No activity in FY 2014.

Program Goals and Funding

No activity in FY 2014.

Explanation of Funding AND/OR Program Changes

(Dollars in Thousands)

	FY 2012 Current	FY 2014 Request	FY 2014 Request vs FY 2012 Current
Unconventional FE Technologies			
No activity is proposed in FY 2014.	4,859	0	-4,859
Total, Unconventional FE Technologies	4,859	0	-4,859

Program Direction
Funding Profile by Category

(dollars in thousands)

	FY 2012 Current	FY 2013 Annualized CR*	FY 2014 Request
Indirect Program Direction – Headquarters			
Salaries and Benefits	17,084	---	16,371
Travel	1,000	---	900
Support Services	85	---	85
Other Related Expenses	11,544	---	11,351
Total, Indirect Program Direction – Headquarters	29,713	---	28,707
Full Time Equivalents	110	---	104
NETL Indirect			
Salaries and Benefits	45,500	---	44,350
Travel	1,800	---	1,600
Support Services	21,751	---	20,528
Other Related Expenses	19,049	---	18,485
Total, NETL Indirect	88,100	---	84,963
Full Time Equivalents	360	---	346
Total Indirect Program Direction			
Salaries and Benefits	62,584	---	60,721
Travel	2,800	---	2,500
Support Services	21,836	---	20,613
Other Related Expenses	30,593	---	29,836
Total, Total Indirect Program Direction	117,813	---	113,670
Full Time Equivalents	470	---	450
Import/Export Authorization			
Salaries and Benefits	1,437	---	1,437
Travel	22	---	22
Other Related Expenses	657	---	624
Total, Import/Export Authorization	2,116	---	2,083
Full Time Equivalents	13	---	13
Total Program Direction			
Salaries and Benefits	64,021	---	62,158
Travel	2,822	---	2,522
Support Services	21,836	---	20,613
Other Related Expenses	31,250	---	30,460
Total, Total Program Direction	119,929	120,663	115,753
Total, Full Time Equivalents*	483	476	463

* Excludes FTEs under the NETL Direct R&D program

*FY 2013 amounts shown reflect the P.L. 112 175 continuing resolution level annualized to a full year. These amounts are shown only at the "congressional control" level and above; below that level a dash (—) is shown.

Overview

Program Direction provides for the Headquarters and field Federal workforce responsible for the overall direction and administrative support of the FE program. To carry out FE's mission a federal staff is needed to provide program management and guidance, contract administration, and budget formulation and execution, etc. FE's primary mission is to ensure that the nation can continue to rely on traditional resources for clean, affordable energy while enhancing economic, environmental, and energy security. The mission of the program is to create technology and technology-based policy options for the public benefit. The program is also responsible for projects and reporting requirements related to American Recovery and Reinvestment Act (ARRA) activities. It also includes funding for the coordination of the Energy portfolio by the Office of the Under Secretary for Energy.

The Office of Import/Export Authorization manages the regulatory review of natural gas imports and exports. This program exercises regulatory oversight of the conversion of existing oil and gas-fired power plants, processes exemptions from the statutory provisions of the Power Plant and Industrial Fuel Use Act of 1978 (FUA), as amended, and processes certifications of alternate fuel capability.

Accomplishments and Strategic Inititatives

FE has been undergoing an effort on work force restructuring and optimization. Management optimization efforts have been put in place to meet government objectives of reducing costs for support service activities.

Major Program Shifts or Changes

Beginning in FY 2012, the NETL Coal R&D Direct Program Direction was moved out of Program Direction and is now a line titled NETL Coal R&D under the CCS and Power System area. Beginning in FY 2013, FTEs associated with ARRA activities are included under NETL Indirect.

Explanation of Funding AND/OR Program Changes

(dollars in thousands)

	FY 2012 Current	FY 2014 Request	FY 2014 Request vs FY 2012 Current
Headquarters			
Salaries and Benefits			
The decrease reflects a change in FTE from (110) FY 2012 Current to (104) in FY 2014 Request.	17,084	16,371	-713
Travel			
The decrease in travel is due to the mandated travel reductions.	1,000	900	-100
Support Services			
No funding changes.	85	85	+0
Other Related Expenses			
The decrease reflects administrative cost savings to support the Accountable Government Initiative.	11,544	11,351	-193
Total, Indirect Program Direction – Headquarters	29,713	28,707	-1,006
NETL Indirect			
Salaries and Benefits			
The decrease reflects a change in FTEs from FY 2012 Current (360 FTEs) to FY 2014 Request (346 FTEs).	45,500	44,350	-1,150
Travel			
The decrease in travel is the result of mandated travel reductions.	1,800	1,600	-200
Support Services			
The decrease is the result of cost savings and monitoring of requested increases for the contractors.	21,751	20,528	-1,223

(dollars in thousands)

	FY 2012 Current	FY 2014 Request	FY 2014 Request vs FY 2012 Current
Other Related Expenses			
The decrease is the result of decreases in facility services/operations and infrastructure.	19,049	18,485	-564
Total, NETL Indirect	88,100	84,963	-3,137

Support Services by Category

(dollars in thousands)

	FY 2012 Current	FY 2014 Request	FY 2014 Request vs FY 2012 Current
Technical Support Services			
Feasibility of Design Considerations	0	0	+0
Development of Specifications	0	0	+0
System Definition	0	0	+0
System Review and Reliability Analysis	350	400	+50
Trade-Off Analysis	0	0	+0
Economic and Environmental Analysis	875	950	+75
Test and Environmental Studies	2,600	2,700	+100
Surveys or Reviews of Technical Operations	400	425	+25
Total, Technical Support Services	4,225	4,475	+250
Management Support Services			
Analysis of Workload and Workflow	0	0	+0
Directive Management Studies	650	650	+0
Automatic Data Processing	6,500	6,500	+0
Manpower Systems Analysis	0	0	+0
Preparation of Program Plans	0	0	+0
Training and Education	0	0	+0
Analysis of DOE Management Processes	0	0	+0
Reports and Analyses Management and General Administrative Support	10,461	8,988	-1,473
Total, Management Support Services	17,611	16,138	-1,473
Total, Support Services	21,836	20,613	-1,223

Other Related Expenses by Category

(dollars in thousands)

	FY 2012 Current	FY 2014 Request	FY 2014 Request vs FY 2012 Current
Other Related Expenses			
Rent to GSA	0	0	+0
Rent to Others	1,700	1,800	+100
Communication, Utilities, Misc.	5,900	5,500	-400
Printing and Reproduction	30	30	+0
Other Services (Facility Operations, Technology	5,870	4,280	-1,590

(dollars in thousands)

	FY 2012 Current	FY 2014 Request	FY 2014 Request vs FY 2012 Current
Infrastructure Support, etc.)			
Training	750	750	+0
Purchases from Gov. Accounts	1,800	1,800	+0
Operation and Maintenance of Equipment	3,200	2,800	-400
Supplies and Materials	2,200	2,200	+0
Equipment	2,400	2,000	-400
Working Capital Fund	7,400	9,300	+1,900
Total, Other Related Expenses	31,250	30,460	-790

Plant and Capital Equipment
Funding Profile by Subprogram and Activities

(dollars in thousands)

	FY 2012 Current	FY 2013 Annualized CR	FY 2014 Request
Plant and Capital Equipment			
General Plant Projects	16,794	---	13,294
Total, Plant and Capital Equipment	16,794	16,897	13,294

*FY 2013 amounts shown reflect the P.L. 112 175 continuing resolution level annualized to a full year. These amounts are shown only at the "congressional control" level and above; below that level a dash (—) is shown.

Public Law Authorizations

Public Law 95–91, "Department of Energy Organization Act", 1977
Public Law 108–153, "21st Century Nanotechnology Research and Development Act 2003"
Public Law 109–58, "Energy Policy Act of 2005"
Public Law 110–69, "America COMPETES Act of 2007"
Public Law 110-140, "Energy Independence and Security Act 2007"
Public Law 111–358, "America COMPETES Act of 2010"

Overview

The Plant and Capital Equipment program creates, improves, and maintains the 118 facilities and infrastructure making up the National Energy Technology laboratory (NETL). NETL has 118 facilities and related infrastructure located in Morgantown, West Virginia; Pittsburgh, Pennsylvania; and Albany, Oregon. These facilities directly support the development of clean technologies for fossil energy and are critical for supporting the R&D necessary to meet DOE program goals for cost effective and efficient CO_2 capture and sequestration technologies.

Program Accomplishments and Milestones

In FY 2014, execution of this program's mission will support the Secretary's climate change technology goals and energy usage reduction goals. Additionally, these funds will contribute to the Secretary's priority for clean energy and GPRA Unit Program Goals by maintaining and improving facilities and related infrastructure supporting performance of research to develop and deploy clean, safe, low-CO_2 emissions energy sources.

Milestone

- Conducting projects which will reduce energy, environmental, safety/health risks and liabilities posed by an aging infrastructure, to comply with building standards, and to meet the energy conservation and research requirements of Public Law 110-140, The Energy Independence and Security Act of 2007.

- Meet or exceed the energy conservation milestones for FY 2013 through energy efficiency improvements.

- Department Strategic Goal 5.3 – Infrastructure: Build, modernize, and maintain facilities and infrastructure to achieve mission goals and ensure a safe and secure workplace.

Program Planning and Management

The funding for the Plant and Capital Equipment subprogram in FY 2014 will be used to maintain and improve facilities and related infrastructure supporting performance to develop and deploy clean, safe, low-CO_2 emissions energy sources. In addition to supporting a safe infrastructure, FE sites are working to achieve a reduction in its energy consumption by up to 30 percent total reduction by the end of FY 2015.

Program Goals and Funding

- Provide an infrastructure that is compliant with safety, health and environmental regulations.
- Meet milestones established to comply with the 2015 energy savings requirements of P.L. 110-140.
- Meet the High Performance Sustainable Buildings goals established by the Secretary.

Specific goals include making substantial progress in the areas of:

- Energy saving
- Demonstrating new technologies
- Efficiency

Explanation of Funding AND/OR Program Changes

(Dollars in Thousands)

	FY 2012 Current	FY 2014 Request	FY 2014 Request vs FY 2012 Current
General Plant Projects			
The program has prioritized funding of projects that support compliance with all safety, health and environmental regulations.	16,794	13,294	-3,500
Total, General Plant Projects	16,794	13,294	-3,500

Environmental Restoration
Funding Profile by Subprogram and Activities

(dollars in thousands)

	FY 2012 Current	FY 2013 Annualized CR*	FY 2014 Request
Environmental Restoration			
CERCLA[a] Remedial Actions	200	---	200
RCRA[b] Remedial Action	1,697	---	1,697
Other ES&H[c] Actions	6,000	---	4,000
Total, Environmental Restoration	7,897	7,945	5,897

*FY 2013 amounts shown reflect the P.L. 112 175 continuing resolution level annualized to a full year. These amounts are shown only at the "congressional control" level and above; below that level a dash (—) is shown.

Public Law Authorizations

Public Law 95–91, "Department of Energy Organization Act", 1977
Public Law 108–153, "21st Century Nanotechnology Research and Development Act 2003"
Public Law 109–58, "Energy Policy Act of 2005"
Public Law 110–69, "America COMPETES Act of 2007"
Public Law 111–358, "America COMPETES Act of 2010"

Overview

FE Environmental Restoration activities ensure protection of workers, the public, and the environment in performing the FE mission of the NETL at the Morgantown, West Virginia; Pittsburgh, Pennsylvania; Houston, Texas; Fairbanks, Alaska; and Albany, Oregon sites.

Program Accomplishments and Milestones

In FY 2012, FE's CERCLA subprogram operated and maintained the air sparge remediation system at the Rock Springs Site to remove organic contaminants from the Tipton aquifer ground water, as required by the Wyoming Department of Environmental Quality (WDEQ). Periodic ground water sampling events at Sites 4, 6, 7, 9, and 12 were conducted to evaluate contaminant removal and to assess progress toward meeting regulatory requirements set forth by the WDEQ. A project review report, as required by the WDEQ, was prepared and submitted. Participants include: U.S. Army Corps of Engineers, HydroGeoLogic Consultants and URS (NETL site support contractor). The 2-year ground water stability period at the Hoe Creek III Site was successfully completed and the WDEQ determined that the aquifer was restored. A surface reclamation plan was successfully negotiated with the WDEQ. The wells and equipment have been decommissioned. Participants include: U.S. Army Corps of Engineers and Cape Environmental Associates.

In FY 2012, the RCRA subprogram implemented chemical- and pollutant-related environmental management plans under NETL's ISO-14001 program. It continued NETL RCRA-related on-site regulatory, corrective, preventive, and improvement activities, such as asbestos and lead abatement and waste minimization and pollution prevention activities; performed activities to ensure compliant wastewater treatment plant operations in order to address past notices of violations; and funded RCRA-related risk management and maintenance activities.

The NETL Albany site continued its RCRA cleanup actions, including: abating lead and asbestos exposures; resolving chemical storage issues; monitoring soil and ground water; upgrading ventilation and air pollution control systems; and improving air emission management, materials handling, facility equipment disposal, and waste disposal activities. Regulatory ground water monitoring activities continued in conjunction with the Oregon Department of Environmental Quality (ODEQ) as did the investigation and risk assessment activities for the specific trichloroethylene (TCE) ground water contamination issue.

The Other ES&H subprogram implemented and improved baseline regulatory compliance, integrated safety management, and ISO 14001 programs (i.e., emergency management, occupational medicine and health, industrial hygiene, safety, environmental management, ergonomics, training, security, and fire protection). It included; actions in support of correcting ES&H deficiencies associated with infrastructure (e.g., ventilation systems, waste pads, and gas cylinder storage areas); actions in support of achieving DOE's pollution prevention and energy management goals; maintaining indoor air quality and ventilations systems,

walking/working surfaces, personal protective equipment, and alarm infrastructure systems. The subprogram also included actions in support of personnel security, operational security, export/import controls, and the foreign national visitor and assignment programs.

Milestones

- The CERCLA subprogram plans to continue active operation and maintenance of the air sparge remediation system at the Rock Springs Sites 4, 6, 7, 9, and 12 in order to remove organic contaminants from the Tipton aquifer ground water. Upon conclusion of active groundwater water remediation, a groundwater stabilization period will be required. Periodic ground water sampling events will be conducted to evaluate contaminant removal and to assess progress toward meeting regulatory requirements set forth by the WDEQ. Regulatory agreements, as requested by the WDEQ, will be negotiated and the closure process will be completed. Disturbed areas will be contoured and seeded with seed mixtures approved by WDEQ. Participants include: U.S. Army Corps of Engineers, HydroGeoLogic Consultants and URS (NETL site support contractor).

- The RCRA subprogram plans to continue RCRA-related on-site regulatory, corrective, preventive, and improvement activities, such as asbestos and lead abatement and waste minimization and pollution prevention activities. It also will continue NETL Albany site RCRA cleanup actions, including; abating lead and asbestos exposures; resolving chemical storage issues; monitoring soil and ground water; upgrading ventilation and air pollution control systems; improving air emission management, materials handling, facility equipment disposal, and waste disposal activities. Regulatory ground water monitoring activities will continue in conjunction with the ODEQ and will include ongoing investigation and risk assessment activities for the specific trichloroethylene (TCE) ground water contamination issue.

- The Other ES&H subprogram will implement and improve baseline regulatory compliance, integrated safety management, and ISO 14001 programs (i.e., emergency management, occupational medicine and health, industrial hygiene, safety, environmental management, ergonomics, training, security, and fire protection). Actions will include; support for correcting ES&H deficiencies associated with infrastructure (e.g., ventilation systems, waste pads, and gas cylinder storage areas); support for achieving DOE's pollution prevention and energy management goals; maintaining indoor air quality and ventilations systems, walking/working surfaces, personal protective equipment, and alarm infrastructure systems; implementation of ergonomics corrective actions; and conducting site-specific ES&H training and emergency drills. It will also implement actions in support of personnel security, operational security, export/import controls, and the foreign national visitor and assignment programs.

Program Planning and Management

The funding for the CERCLA subprogram in FY 2014 will be used to continue active operation and maintenance of the air sparge remediation system at Rock Springs Sites 4, 6, 7, 9, and 12 as well as continue a 10-year surface revegetation at the Hoe Creek Site.

In FY 2014, The RCRA subprogram will continue RCRA-related on-site regulatory, corrective, preventive, and improvement activities, such as asbestos and lead abatement, waste minimization, and pollution prevention activities along with the NETL Albany site RCRA clean-up which includes: abating lead and asbestos exposures; resolving chemical storage issues; monitoring soil and ground water; upgrading ventilation and air pollution systems; improving air emission management, materials handling, facility equipment disposal, and waste disposal activities; regulatory ground water monitoring activities in conjunction with the Oregon Department of Environmental Quality (ODEQ) involving investigation; and risk assessment activities for the specific trichloroethylene (TCE) ground water contamination issue.

The Other ES&H subprogram will continue to implement and improve baseline regulatory compliance, integrated safety management, and ISO 14001 programs (i.e., emergency management, occupational medicine and health, industrial hygiene, safety, environmental management, ergonomics, training, security, and fire protection). This will include: actions in support of correcting ES&H deficiencies associated with infrastructure (e.g., ventilation systems, waste pads, and gas cylinder storage areas); actions in support of

achieving DOE's pollution prevention and energy management goals; and maintaining indoor air quality, ventilations systems, walking/working surfaces, personal protective equipment, and alarm infrastructure systems. It will also implement actions in support of personnel security, operational security, export/import controls, and the foreign national visitor and assignment programs.

Program Goals and Funding

Support actions and projects to correct or mitigate various ES&H deficiencies associated with the various infrastructure systems and processes across all NETL sites. Support actions and projects to realize DOE's pollution prevention and energy management goals. Meet NETL's RCRA obligations at all NETL sites.

Specific Goals:
Continuing upgrades of fire detection and alarm system and asbestos and lead paint abatement at NETL.
Investigation and assessment of risks associated with ground water contamination at NETL-Albany.
Operate and maintain remediation efforts at Rock Springs, WY site in accordance with Wyoming Department of Environmental Quality.

Explanation of Funding AND/OR Program Changes

(dollars in thousands)

	FY 2012 Current	FY 2014 Request	FY 2014 Request vs FY 2012 Current
CERCLA			
Continuing activities include groundwater remediation at Rock Springs and a 10-year revegetation effort at Hoe Creek. These activities will continue through the FY 2012-2014 timeframe. Increases in funding requirements are directly related to manpower support requirements for variable work involving air sparging activities at the Rock Springs sites.	200	200	0
RCRA			
Asbestos, lead abatement activities, and pollution prevention work at NETL continues to diminish. The only significant driver of costs in this activity remains the remediation of the groundwater contamination at the Albany site.	1,697	1,697	0
Other ES&H			
Concentrate on core ES&H activities while maintaining regulatory work with CERCLA and RCRA.	6,000	4,000	-2,000
TOTAL Funding Change, Environmental Restoration	7,897	5,897	-2,000

Special Recruitment Programs
Funding Profile by Subprogram and Activities

(dollars in thousands)

	FY 2012 Current	FY 2013 Annualized CR*	FY 2014 Request
Special Recruitment Programs			
Special Recruitment Programs	700	---	700
Total, Special Recruitment Programs	700	704	700

*FY 2013 amounts shown reflect the P.L. 112 175 continuing resolution level annualized to a full year. These amounts are shown only at the "congressional control" level and above; below that level a dash (—) is shown.

Public Law Authorizations

Public Law 95–91, "Department of Energy Organization Act", 1977
Public Law 108–153, "21st Century Nanotechnology Research and Development Act 2003"
Public Law 109–58, "Energy Policy Act of 2005"
Public Law 110–69, "America COMPETES Act of 2007"
Public Law 111–358, "America COMPETES Act of 2010"

Overview

The Office of Fossil Energy (FE) developed the Mickey Leland Energy Fellowship (MLEF) Program to provide students majoring in science, technology, engineering and mathematics disciplines the opportunity to enhance their education and knowledge of fossil fuels. The goal of the program is to support an increase in the number of females and under-represented minorities entering the scientific and engineering career fields within the U.S. workforce.

The MLEF program is a ten-week summer internship program that offers students in science, technology, engineering and mathematic disciplines the opportunity to learn about the programs and initiatives within the Office of Fossil Energy and the challenges in providing clean, affordable energy for future generations.

Program Accomplishments and Milestones

The Special Recruitment Program supports the Secretary's Priority of developing and nurturing science and engineering talent in order to provide a succession of scientists and engineers.

In FY 2014, a diverse group of undergraduate, graduate, and Ph.D. students in science, technology, engineering and mathematic majors will be recruited and selected to participate in the MLEF program.

Program Planning and Management

The funding for the Special Recruitment Programs subprogram in FY 2014 will be used to recruit applicants from colleges and universities to participate in the MLEF program.

Program Goals and Funding

In FY 2014, a diverse group of undergraduate, graduate, and Ph.D. students in science, technology, engineering and mathematic majors will be recruited and selected to participate in the MLEF program.

Explanation of Funding AND/OR Program Changes

(dollars in thousands)

	FY 2012 Current	FY 2014 Request	FY 2014 Request vs FY 2012 Current
Special Recruitment Programs			
No change.	700	700	0
Total, Special Recruitment Programs	700	700	0

Naval Petroleum and Oil Shale Reserves

Naval Petroleum and Oil Shale Reserves

Naval Petroleum and Oil Shale Reserves
Proposed Appropriation Language

For expenses necessary to carry out naval petroleum reserve and oil shale reserve activities, $20,000,000 to remain available until expended: Provided, That, notwithstanding any other provision of law, unobligated funds remaining from prior years shall be available for all naval petroleum and oil shale reserve activities.

Explanation of Change

No changes.

Naval Petroleum and Oil Shale Reserves
Fossil Energy

Overview
Appropriation Summary by Program

(dollars in thousands)

	FY 2012 Current	FY 2013 Annualized CR*	FY 2014 Request
Naval Petroleum and Oil Shale Reserves			
Naval Petroleum and Oil Shale Reserves	14,909	15,000	20,000
Total, Naval Petroleum and Oil Shale Reserves	14,909	15,000	20,000

*FY 2013 amounts shown reflect the P.L. 112 175 continuing resolution level annualized to a full year. These amounts are shown only at the "congressional control" level and above; below that level a dash (—) is shown.

Office Overview and Accomplishments

NPR-1—Environmental remediation and cultural resource activities are required by legal agreements between DOE, Occidental, Chevron, and the California Department of Toxic Substances Control (DTSC) that were executed to fulfill the requirement in P.L. 104-106 to sell the government's interests in NPR-1. Current activities encompass execution of a technical baseline, interim measures, environmental sampling and analysis, corrective measures, waste removal and disposal, confirmatory sampling, and requests for release from further corrective action.

NPR-2—Disposal of eight 2-acre parcels of unused land on NPR-2 (the "Ford City Drill Sites") was authorized by the Energy Security Act of 2005. In FY 2012 the last of the eight sites was transferred to GSA for disposal.

NPR-3 will begin implementing the disposition plan with final disposition of the property estimated to occur in FY 2015. NPR-3 will be utilized for production and testing operations in order to retain asset value during preparation to transfer to new ownership. Production facilities will remain operational per the *Authorization of Continued Production of the Naval Petroleum Reserves beyond April 5, 2012 ,* submitted to Congress by the President in November 2011. The program will continue RMOTC testing for 100 percent funds-in projects. Environmental remediation of NPR-3 facilities will continue to facilitate the sale/disposition of the property in a manner consistent with an approved property sale/disposition plan.

Alignment to Strategic Plan

Under the Department's Strategic Goal, Transform Our Energy Systems, NPOSR Program provides for meeting the legal agreements involving NPR-1 environmental cleanup including payment for post-employment medical and dental benefits to former NPR-1 M&O contractor employees, and for NPR-3 Oil Field Operation & Divestiture.

Explanation of Changes

An increase of $5 million over the enacted FY 2012 is associated with accelerating environmental remediation responsibilities of NPR-1 to be responsive to the landowner development plan and meet compliance requirements of the California Department of Toxic Substances Control (DTSC).

Facilities Maintenance and Repair

The Department's Facilities Maintenance and Repair activities are tied to its programmatic missions, goals, and objectives. Facilities Maintenance and Repair activities funded by this budget are displayed below.

Costs for Direct-Funded Maintenance and Repair (including Deferred Maintenance)

(dollars in thousands)

	FY 2012 Current	FY 2013 Annualized CR	FY 2014 Request
Naval Petroleum and Oil Shale Reserves	1,370	---	490
Total, Direct-Funded Maintenance and Repair	1,370	---	490

Naval Petroleum and Oil Shale Reserves
Fossil Energy
Funding by Site by Program

(dollars in thousands)

	FY 2012 Current	FY 2013 Annualized CR*	FY 2014 Request
Naval Petroleum and Oil Shale Reserves			
NPR Wyoming	9,179	---	9,200
Washington Headquarters	5,730	---	10,800
Total, Naval Petroleum and Oil Shale Reserves	14,909	15,000	20,000

*FY 2013 amounts shown reflect the P.L. 112 175 continuing resolution level annualized to a full year. These amounts are shown only at the "congressional control" level and above; below that level a dash (—) is shown.

Naval Petroleum and Oil Shale Reserves
Funding Profile by Subprogram

(dollars in thousands)

	FY 2012 Current	FY 2013 Annualized CR*	FY 2014 Request
Naval Petroleum and Oil Shale Reserves			
Production Operations	5,480	---	13,000
Management	9,429	---	7,000
Total, Naval Petroleum and Oil Shale Reserves	14,909	15,000	20,000

*FY 2013 amounts shown reflect the P.L. 112 175 continuing resolution level annualized to a full year. These amounts are shown only at the "congressional control" level and above; below that level a dash (—) is shown.

Public Law Authorizations

Public Law 94–258, "Naval Petroleum Reserves Production Act", 1976
Public Law 95–91, "Department of Energy Organization Act", 1977
Public Law 109–58, "Energy Policy Act of 2005"
Public Law 104–106, "The National Defense Authorization Act For Fiscal Year 1996"
Public Law 105–261, "The Strom Thurmond National Defense Authorization Act for Fiscal Year 1999"

Overview

The NPOSR program manages a number of legal agreements that were executed as part of the 1998 sale of NPR-1 in California. These agreements direct post-sale work including environmental restoration and remediation, equity finalization, contract closeout, and records disposition. Legal agreements include payment for post-employment medical and dental benefits to former Management & Operating (M&O) contractor employees. The NPR-1 program continues to work towards closing out the remaining environmental findings, as required by the 2008 agreement between DOE and the California DTSC.

DOE also operates NPR-3 and RMOTC, co-located near Casper, Wyoming. NPR-3/RMOTC will begin implementing a disposition plan with final disposition of the property estimated to occur in FY 2015. The site facilities will be utilized by production and testing operations in order to maintain asset value during preparation to transfer to new ownership. Production facilities will remain operational per the *Authorization of Continued Production of the Naval Petroleum Reserves beyond April 5, 2012 ,* submitted to Congress by the President in November 2011.. Operating the NPR-3 site will be done in a safe manner in accordance with environmental regulations. Production of 137 barrels of oil per day is forecast generating $4.2M deposited into the U.S. Treasury. Wells will be maintained to support continued production, but major breakdown of equipment will not be repaired or replaced. Infrastructure will not be removed for facilities that could be utilized to attract new owners.

RMOTC will provide opportunities through 100 percent funds-in agreements to academia, industry, and small inventors for field testing of oilfield technologies and demonstration of renewable energy technologies having oilfield application in order to assist in bringing them to the market place.

Environmental remediation of NPR-3 facilities will continue to facilitate the sale/disposition of the property in a manner consistent with an approved property sale/disposition plan. Remediation activities will continue for facilities that are not environmentally in compliance with the State of Wyoming Oil and Gas Commission (WOGCC) regulations, have mechanical issues, or no longer hold value for production operations, testing operations, or for new owners.

Subprogram Accomplishments and Milestones

On April 22, 2011, DOE settled its Equity Finalization process with Chevron. Under the settlement agreement Chevron has paid $108,000,000 to the Department. Significant progress was made in FY 2012 on the identification and remediation of environmental contamination at the former NPR-1. Disposal of the last of the eight Ford City Drill Sites on NPR-2 was also completed.

Milestone	Date
Current conditions and proposed paths to closure for 100 AOCs at NPR-1 submitted to DTSC.	FY 2012
DTSC completed review of proposed paths to closure for 72 AOCs at NPR-1	FY 2012
DTSC approved No Further Action for 9 AOCs at NPR-1	July 2012
Complete environmental remediation of Ford City Drill Site 26 at NPR-2	June 2012
Acceptance by GSA of Drill Site (NPR-2) 26 as surplus property for disposal	July 2012

NPR-3 outyear milestones will be dependent upon agreed to options of an approved disposition plan to be completed with implementation beginning in FY 2013. Complete environmental cleanup obligations that are required from the sale/transfer agreement(s) by the end of FY 2014. Completed transfer of property will occur in FY 2015 along with the closeout of the DOE RMOTC office and records disposition.

Program Planning and Management

NPOSR manages operational measures that are implemented by support service contractors. Action plans are reviewed and analyzed at Program Reviews held at NPR-1 and NPR-3. These reviews provide an opportunity to discuss performance, cost, schedule, and scope to ensure activities are on-track and within budget. Budget formulation/execution assessments are regularly conducted throughout the year to ensure that budget execution is on target.

Strategic Management

NPOSR activities directly support the Department's strategy for the development of fossil energy resources in an environmentally responsible manner through the continuation of environmental remediation projects at the former NPR-1.

Restructuring activities at NPR-3 will include implementing a disposition plan for possible sale or transfer of the site. Two external factors present the strongest impacts to the overall achievement of the program's strategic goal:

- Identifying new ownership for the property; and
- Having the required environmental remediation completed for disposition and/or sale that would be in the best interest of the government.

Subprogram Goals and Funding

The FY 2014 request provides an increase in funding for the acceleration of NPR-1 environmental remediation.

NPR-3 funding will be used for maintenance of wells and infrastructure required to maintain the value of the field for disposition. Complete mechanical integrity tests of all idle wells and plug and abandon any wells that pose a risk to the environment and/or have no potential value to a new owner. Conduct a rigorous Oil and Gas Reserves Evaluation including preparing an oil reserve upside report that provides information on potential untapped oil reserves to potential buyers to maximize sales price. Obtain regulatory oversight and/or approval from the State of Wyoming on any activities or facilities under their jurisdiction that may require further remediation, including closeout permits as needed. Dispose of U.S. Government personal property.

Explanation of Funding AND/OR Program Changes

(dollars in thousands)

	FY 2012 Current	FY 2014 Request	FY 2014 Request vs FY 2012 Current
Production and Operations			
The increase is due to accelerating the cleanup of NPR-1 remediation responsibilities.	5,480	13,000	+7,520
Management			
The decrease is due to reduction in federal staffing due to attrition and management directed reassignments for the RMOTC office.	9,429	7,000	-2,429
Total, Naval Petroleum and Oil Shale Reserves	14,909	20,000	+5,091

Benefits

- Reduced environmental liabilities from the legacy of Federal oil resrve production.

Operations and Production
Funding Profile by Subprogram and Activities

(dollars in thousands)

	FY 2012 Current	FY 2013 Annualized CR*	FY 2014 Request
NPOSR - Operations and Production			
NPR-1 Closeout	2,480	---	8,827
NPR-3 Disposition	0	---	4,173
NPR-3 Environmental Remediation	3,000	---	0
Total, NPOSR – Operations and Production	5,480	---	13,000

*FY 2013 amounts shown reflect the P.L. 112 175 continuing resolution level annualized to a full year. These amounts are shown only at the "congressional control" level and above; below that level a dash (—) is shown.

Public Law Authorizations

Public Law 94–258, "Naval Petroleum Reserves Production Act", 1976
Public Law 95–91, "Department of Energy Organization Act", 1977
Public Law 109–58, "Energy Policy Act of 2005"
Public Law 104–106, "The National Defense Authorization Act For Fiscal Year 1996"
Public Law 105–261, "The Strom Thurmond National Defense Authorization Act for Fiscal Year 1999"

Overview

NPR-1 environmental remediation and cultural resource activities are required as a result of the former NPR-1 sales agreement of 1998. The commitments were formalized in legal agreements between DOE, Occidental, Chevron, and the State of California.

NPR-3 program operates as a stripper field that produces oil and deposits revenue into the U.S. Treasury. It also utilizes the site as a testing facility for RMOTC that allows field testing of oilfield technologies, as well as renewable energy applications as related to oilfield application.

In maximizing the benefits of disposition and remediation of NPR-3, work must be done to address the following challenges:

- Ability to maintain facilities to optimal level of usage and conditioning to attract new owners
- Providing a site to assist bringing innovations to market
- Generate net-revenue for the U.S. Treasury

Program Accomplishments and Milestones

On April 22, 2011, DOE settled its Equity Finalization process with Chevron. Under the settlement agreement Chevron has paid $108 million to the Department. Significant progress was made in FY 2012 on the identification and remediation of environmental contamination at the former NPR-1. Disposal of the last of the eight Ford City Drill Sites on NPR-2 was also completed.

NPR-3 continued profitable production operations providing revenue to the U.S. Treasury. NPR-3 outyear milestones will be dependent upon agreed to options of approved disposition plan. Complete environmental cleanup obligations will be required from the sale/transfer agreement(s) by the end of FY 2014. Completion of the transfer of the property will occur by the end of FY 2015. And finally, the closeout of DOE RMOTC office and records disposition will be completed in FY 2016. NPR-3/RMOTC will begin implementing the disposition plan, with final disposition of the property estimated to occur in FY 2015.

Program Planning and Management

(Refer to applicable sections shown previously)

Strategic Management

(Refer to applicable sections shown previously)

Subprogram Goals and Funding

(Refer to applicable sections shown previously)

Explanation of Funding AND/OR Program Changes

(dollars in thousands)

	FY 2012 Current	FY 2014 Request	FY 2014 Request vs FY 2012 Current
NPR-1 Closeout			
The increase is due to an accelarated focus on environmental remediation at NPR-1.	2,480	8,827	+6,347
Disposition			
The increase is due to transitioning from production, testing, and environmental remediation to disposition of the field. NPR-3 will implement the approved disposition plan that will transfer or sell the site while maintaining and operating assets that provide value to new ownership.	0	4,173	+4,173
NPR-3 Environmental Remediation			
The Environmental Remediation activities will be done under disposition.	3,000	0	-3,000
Total, NPOSR – Operations and Production	5,480	13,000	+7,520

Naval Petroleum and Oil Shale Reserves

Program Direction
Funding Profile by Category

(dollars in thousands)

	FY 2012 Current	FY 2013 Annualized CR	FY 2014 Request
NPR - Wyoming			
Salary & Benefits	2,315	---	1,285
Travel	100	---	70
Support Services	0	---	0
Other Related Expenses	780	---	552
Business Management & Support	2,984	---	3,120
Total, NPR - Wyoming	6,179	---	5,027
Full Time Equivalents	14		8
Washington, Headquarters			
Salary & Benefits	1,080	---	700
Travel	50	---	50
Support Services	75	---	275
Other Related Expenses	45	---	45
Equity	1,000	---	0
Bechtel Medical/Dental	1,000	---	903
Total, Washington, Headquarters	3,250	---	1,973
Full Time Equivalents	6		4
Total Program Direction			
Salaries & Benefits	3,395	---	1,985
Travel	150	---	120
Support Services	75	---	275
Other Related Expenses	825	---	597
Equity	1,000	---	0
Bechtel Medical/Dental	1,000	---	903
Business Management & Support	2,984	---	3,120
Total, Total Program Direction	9,429	---	7,000
Full Time Equivalents	20		12

Overview

Program Direction provides the Federal staffing resources and associated costs required to provide overall direction and execution of the NPOSR. There are a variety of functions that are inherently governmental (e.g., program management, contract administration, budget formulation and execution that require a dedicated Federal workforce.

Explanation of Funding AND/OR Program Changes

(dollars in thousands)

	FY 2012 Current	FY 2014 Request	FY 2014 Request vs FY 2012 Current
Salaries and Benefits			
Decrease is due to attrition, management directed reassignments at NPR-3 implemented in FY 2012, and relocation of key position to the RMOTC site in FY 2012.	3,395	1,985	-1,410
Travel			
Decrease is due to implementation of disposition plan for NPR-3 and the increase of televideo conferencing.	150	120	-30
Support Services	75	275	+200
Increase is due to the increase in Records Management			
Other Related Expenses			
Decrease is due to decrease in Other Services.	825	597	-228
Business Management & Support			
Increase is due to support in disposition of site.	2,984	3,120	+136
Bechtel Medical/Dental			
Decrease is due to lower number of participants in the insurance program.	1,000	903	-97
Equity			
DOE settled its Equity Finalization process with Chevron on April 22, 2011	1,000	0	-1000
Total Funding Change, Program Direction	9,429	7,000	-2429

Support Services by Category

(dollars in thousands)

	FY 2012 Current	FY 2014 Request	FY 2014 Request vs FY 2012 Current
Support Services	75	275	+200
Total, Support Services	75	275	+200

Other Related Expenses by Category

(dollars in thousands)

	FY 2012 Current	FY 2014 Request	FY 2014 Request vs FY 2012 Current
Other Related Expenses			
Rent to Others	450	206	-244
Communication, Utilities, Misc	100	160	+60
Other Services	205	169	-36
Operations and Maintenance of Equipment	5	15	+10
Supplies and Materials	65	47	-18
Total, Other Related Expenses	825	597	-228

Strategic Petroleum Reserve

Strategic Petroleum Reserve

Strategic Petroleum Reserve
Proposed Appropriation Language

For necessary expenses for Strategic Petroleum Reserve facility development and operations and program management activities pursuant to the Energy Policy and Conservation Act of 1975, as amended (42 U.S.C. 6201 et seq.), $189,400,000, to remain available until expended.

Explanation of Changes

No changes.

Strategic Petroleum Reserve
Fossil Energy

Overview
Appropriation Summary by Program

(dollars in thousands)

	FY 2012 Current	FY 2013 Annualized CR*	FY 2014 Request
Strategic Petroleum Reserve			
Strategic Petroleum Reserve	192,704	193,883	189,400
Total, Strategic Petroleum Reserve	192,704	193,883	189,400

*FY 2013 amounts shown reflect the P.L. 112 175 continuing resolution level annualized to a full year. These amounts are shown only at the "congressional control" level and above; below that level a dash (—) is shown.

Office Overview and Accomplishments

The Strategic Petroleum Reserve (SPR) protects the U.S. from disruptions in critical petroleum supplies and meets the U.S. obligations under the International Energy Program (Energy Policy and Conservation Act, P.L. 94-163, as amended, Section 151). The mission of the SPR achieves the Secretary's Goal of Security: Protecting the Nation against interruptions in its critical petroleum supplies.

Within the SPR Appropriation, the SPR program funds Facilities Development, Operations (Security, Power, Operations and Maintenance, and Support Services), and Management of the SPR.

In FY 2011, the SPR executed a presidentially ordered SPR drawdown of 30 million barrels as the U.S. obligation under the International Energy Agency Libya Collective Action, which reduced the crude oil inventory from 727 million barrels to 696 million barrels. In FY 2012, the SPR maintained an emergency petroleum stockpile with the readiness and capability to respond to U.S. oil supply emergencies. SPR also completed the replacement of an existing storage cavern at its Bayou Choctaw site that posed a major environmental risk.

The SPR's oil inventory of 696 million barrels in FY 2012 provides approximately 93 days of net oil import protection. The unavailability of 60 million barrels for emergency use due to termination of SPR's oil degasification project in FY 2011 has resulted in an 8 day reduction in SPR's import protection level. The degasification plant was scheduled to be moved in 2011 to commence crude degasification activities at West Hackberry site in FY 2012. The FY 2011 rescission ($15.3M) took funding needed to move the plant, which terminated SPR crude degasification activities, thereby reducing availability of SPR stocks for drawdown. The crude inventory stored in the SPR must be periodically processed through a degasification plant in order to maintain a safe crude oil vapor pressure compliant with federal and state regulations. If the 2013 Budget request is enacted by Congress funding to move the degasification plant from Bryan Mound to West Hackberry site will be provided. The planned FY 2014 restart of degasification operations at West Hackberry site will begin processing SPR stocks, requiring approximately 2 years for the entire inventory to be available for emergency use.

Alignment to Strategic Plan

Under the Department's Strategic Goal, *Transform Our Energy Systems*, the SPR provides an emergency stockpile of petroleum to protect the United States against petroleum supply disruptions by domestic and international events.

Explanation of Changes

The Request is $189.4 million for the SPR in FY 2014, which is a 2 percent decrease from the FY 2012 Current Request of $192.7 million.

The FY 2014 request provides continuation of the Casing Inspection and Remediation Program to address cavern integrity at all sites and prevent potential environmental contamination. This request also supports degasification of crude oil using one degas plant. The plant begins processing oil at West Hackberry in February 2014 and continues through December 2018. The base program for SPR operation, maintenance and security includes annual System Test and Recovery Program Exercises, as well as preventive, predictive and corrective maintenance and major maintenance activities to ensure efficient operating conditions of all sites.

The FY 2014 request decreases funding in Security (-$1.0M) due to 10 fewer rover positions and reduces the Power budget (-$1.9M) to reflect efficiencies realized in contract renewals. Decreased funding from completion of the new Bayou Choctaw Cavern 102 development is offset by increased cavern remediation activities (-$3.6M). Requirements for Support Services have increased slightly (+$0.4M) for additional technical support and Management (+$2.9M) requires increased funding for federal staffing, evacuation planning and updates to intra-site communication services.

Facilities Maintenance and Repair

The Department's Facilities Maintenance and Repair activities are tied to its programmatic missions, goals, and objectives. Facilities Maintenance and Repair activities funded by this budget are displayed below.

Costs for Direct-Funded Maintenance and Repair (including Deferred Maintenance)

(dollars in thousands)

	FY 2012 Actual Cost	FY 2012 Planned Cost	FY 2013 Planned Cost	FY 2014 Planned Cost
Strategic Petroleum Reserve	37,134	33,133	35,208	41,142
Total, Direct-Funded Maintenance and Repair	37,134	33,133	35,208	41,142

Total Costs for Maintenance and Repair

(dollars in thousands)

	FY 2012 Actual Cost	FY 2012 Planned Cost
Strategic Petroleum Reserve	37,134	33,133
Total, Costs for Maintenance and Repair	37,134	33,133

The SPR exceeded the planned funding for maintenance and repair activities due to emergency repair of a Big Hill transformer, unplanned replacement of PIV 20 at Bryan Mound, and emergency repair of firewater pipe leak at Bryan Mound. Additionally, the rework of pipeline valves at Bryan Mound and Bayou Choctaw was accelerated from FY 2013 to FY 2012.

Strategic Petroleum Reserve
Fossil Energy
Funding by Site by Program

(dollars in thousands)

	FY 2012 Current	FY 2013 Annualized CR*	FY 2014 Request
Strategic Petroleum Reserve			
Bayou Choctaw Site, LA	11,425	---	16,940
Big Hill Site, TX	20,968	---	17,651
Bryan Mound Site, TX	16,925	---	16,091
National Energy Technology Laboratory	1,415	---	243
Oak Ridge National Laboratory	390	---	400
Sandia National laboratory	3,342	---	3,260
SPR Program Management Office, DC	5,987	---	6,942
SPR Project Management Office, LA	111,183	---	101,584
West Hackberry Site, LA	21,069	---	26,289
Total, Strategic Petroleum Reserve	192,704	193,883	189,400

*FY 2013 amounts shown reflect the P.L. 112 175 continuing resolution level annualized to a full year. These amounts are shown only at the "congressional control" level and above; below that level a dash (—) is shown.

Strategic Petroleum Reserve
Funding Profile by Subprogram

(dollars in thousands)

	FY 2012 Current	FY 2013 Annualized CR*	FY 2014 Request
Strategic Petroleum Reserve			
Facilities Development and Operations	170,914	---	164,741
Management	21,790	---	24,659
Total, Program Name	192,704	193,883	189,400

*FY 2013 amounts shown reflect the P.L. 112 175 continuing resolution level annualized to a full year. These amounts are shown only at the "congressional control" level and above; below that level a dash (—) is shown.

Public Law Authorizations

Public Law 109–58, "Energy Policy Act of 2005"

Overview

The SPR protects the U.S. from disruptions in critical petroleum supplies and meets the U.S. obligations under the International Energy Program (Energy Policy and Conservation Act, Section 151). SPR also includes Defense Department crude oil, stored for national defense purposes.

The SPR benefits the Nation by providing an insurance policy against potential interruptions in U.S. petroleum supplies whether originating from international supply problems, hurricanes, accidents or terrorist activities.

In FY 2011, the SPR completed sale of 30.6 million barrels of crude oil its obligation under the International Energy Agency (IEA) Libya Collective Action. The FY 2011 sale reduced the crude oil inventory from 727 million barrels to 696 million barrels. The U.S. imports close to 50% of its petroleum supplies; the impact of a disruption in these supplies could be significant on the Nation and the national economy without an emergency response capability. The SPR serves as a deterrent to hostile threats of cutoffs of petroleum supplies. The SPR, with currently available crude oil stocks equal to approximately 93 days of imports in underground storage, provides a strong deterrent to hostile efforts. A release of petroleum from the SPR can mitigate the potential economic damage of an actual disruption in international or domestic petroleum supplies and the accompanying severe price increases. The SPR avails the United States of worldwide emergency assistance through its IEA participation. IEA members are required to maintain 90 days of strategic stocks and participate with other stockholding nations in a coordinated release of stocks in the event of a major supply disruption.

To accomplish its mission and address the challenges outlined above, the SPR program is organized into two subprograms: Facilities Development and Operations and Management. The Facilities Development and Operations subprogram funds all requirements associated with developing and maintaining facilities for the storage of petroleum, operations activities associated with placing petroleum into storage, and operational readiness initiatives associated with drawing down and distributing the inventory within 11-15 day's notice in the event of an emergency. The Management subprogram funds personnel and administrative expenses related to maintaining the Project Management Office (New Orleans, LA) and the Program Office (Washington, DC), as well as contract services required to support management and the technical analysis of program initiatives and issues.

Subprogram Accomplishments and Milestones

In FY 2012, the SPR maintained an emergency petroleum stockpile of 696 million barrels (with an unavailable inventory of 60 million barrels) and a drawdown capability of 4.25 million barrels per day to respond to U.S. oil supply emergencies. In October 2012, the SPR completed its cavern replacement project to provide a new cavern to replace an existing problem cavern at its Bayou Choctaw site.

In FY 2013, the Program is planning to monitor petroleum markets prior to any decision to refill SPR oil sold during the IEA coordinated release. Market monitoring is planned to continue during FY 2014. Also in 2013, the SPR plans to initiate the relocation of the degasification plant to the West Hackberry site and continue critical activities for its cavern casing inspection and remediation programs.

In FY 2014, the SPR is working towards the following key milestones:

Milestone	Date
Begin degasification operations at the West Hackberry site	February 2014

Program Planning and Management

There is a hierarchy of performance information for the SPR. The Department collects and tracks the executive-level "corporate" measures. The SPR Program Office monitors the "critical few," specific short- and long-term measures. The SPR Project Management Office manages the detailed, operational measures that are implemented by the contractors. Organizational and action plans are reviewed and analyzed at quarterly Program Reviews. Project Reviews/Assessments, including dashboard updates, are conducted monthly to analyze performance against all milestones and contracts. These reviews provide an opportunity to discuss performance and provide direction to contractors. These same measures are reviewed daily during the site managers' site status meetings.

Budget formulation/execution assessments are regularly conducted throughout the year, including periodic financial performance reviews and annual budget validations. Other evaluations include: semi-annual Management & Operating (M&O) contractor award fee performance assessments against Work Authorization Directives; on-site reviews to verify operational, maintenance and management performance data; and drawdown readiness quarterly reviews.

Strategic Management

The SPR will use various means and strategies to continue its mission and achieve program goals. Assurance of a readiness posture will be accomplished through internal readiness reviews, assessments, exercises, and tests. Effectiveness of the SPR to mitigate severe oil supply disruptions will be influenced by the SPR's size (inventory and capacity) and ability to deliver into the marketplace. In FY 2009, DOE used available balances for the purchase of additional SPR oil, and continued to fill using Federal royalty oil until a 727 million barrel inventory was achieved in December 2009. In FY 2011, the SPR completed a sale of 30.6 million barrels of crude oil as part of the International Energy Agency (IEA) emergency release. The program continues to monitor market conditions prior to future refill of the SPR oil sold during 2011 IEA coordinated release.

The SPR utilizes a transportable degas plant to ensure availability of crude oil inventories at SPR sites within environmental and safety constraints. This process prevents the off-gassing of volatile organic compounds (VOCs) above safe levels during oil movements through commercial distribution points. Inventory processing at Big Hill was completed in FY 2006, and the self-contained degas plant was relocated to Bryan Mound in FY 2007. When Bryan Mound degas operations were completed in FY 2011, the plant was scheduled to move to the West Hackberry site. Due to an FY 2011 Continuing Resolution Rescission, the SPR did not have sufficient funding for the required relocation and operations of its crude degasification plant. During FY 2013 the degasification plant will be moved from the Bryan Mound to West Hackberry site. Planned FY 2014 resumption of degasification operations at West Hackberry site will begin process of treating oil to safe vapor pressure levels so it is once again available for emergency use.

SPR's underground storage caverns require maintenance to assure their storage capability and integrity. SPR maintains a cavern casing inspection and remediation program to comply with the state of Texas' regulations and mitigate the risk of potential casing leaks and environmental damage.

In FY 2014, the continuation of a damaged internal floating roof on a tank at Bryan Mound site leaves the maximum site drawdown rate at a reduced 150,000 barrels per day. This reduction also diminishes the overall maximum SPR drawdown rate to 4.2 million barrels per day versus 4.4 million barrels per day.

Program performance can be affected by several external factors including:

- Changing U.S. petroleum consumption and import dependence levels
- Petroleum market conditions, and
- Developments in the commercial distribution system (i.e., pipelines, and terminals)

Subprogram Goals and Funding

Maintain an SPR with a readiness and capability to respond quickly and effectively to potential disruptions in U.S. petroleum supplies (foreign or domestic). The FY 2014 request provides for the management, operations, maintenance, and security of the Government's four SPR storage sites and maintains SPR readiness and capability to respond to U.S. oil supply emergencies. SPR will:

Continue a cavern casing Inspection and remediation program to address corrosion, cracks and deformations in wellhead components and casing per state regulations; resume degas operations to bring SPR oil inventory to a safe vapor pressure available for emergency use; and fund a major maintenance program that includes rework of crude oil pipeline valves at West Hackberry.

Explanation of Funding AND/OR Program Changes

(dollars in thousands)

	FY 2012 Current	FY 2014 Request	FY 2014 Request vs FY 2012 Current
Facilities Development and Operations.			
Fewer rover positions in the Protective Force contract and decreased funding due to the completion of the new Bayou Choctaw Cavern 102 development and increased cavern remediation activities.	170,914	164,741	-6,173
Management			
Increased staffing requirements (re-federalization), contingency for hurricane evacuation expenses, and updating teleconferencing capabilities between the field Project Management Office and the four storage sites.	21,790	24,659	+2,869
Total, Strategic Petroleum Reserve	192,704	189,400	-3,304

Strategic Petroleum Reserve
Funding Profile by Subprogram and Activities

(dollars in thousands)

	FY 2012 Current	FY 2013 Annualized CR*	FY 2014 Request
Facilities Development and Operations			
Security	20,895	---	19,889
Power	4,516	---	2,947
Operations and Maintenance	142,125	---	138,125
Support Services	3,378	---	3,780
Total, Facilities Development and Operations	170,914	---	164,741

*FY 2013 amounts shown reflect the P.L. 112 175 continuing resolution level annualized to a full year. These amounts are shown only at the "congressional control" level and above; below that level a dash (—) is shown.

Public Law Authorizations

Public Law 109-58, "Energy Policy Act of 2005"

Overview

In supporting the Secretary's Goal of *Security*, the SPR provides an emergency stockpile of petroleum to protect the United States against petroleum supply disruptions by domestic and international events.

The Facilities Development and Operations subprogram provides funding for protection from supply disruptions. The U.S. reliance on petroleum combined with location of significant global reserves in regions of the world subject to political unrest have made the U.S. vulnerable to supply disruptions.

Explanation of Funding AND/OR Program Changes

(dollars in thousands)

	FY 2012 Current	FY 2014 Request	FY 2014 Request vs FY 2012 Current
Facilities Development and Operations			
Security	20,895	19,889	-1,006
Reduction in follow-on Protective Force contract with reduction of 10 rover positions.			
Power	4,516	2,947	-1,569
Efficiencies in the Bryan Mound storage site follow-on power contract renewal.			
Operations and Maintenance	142,125	138,125	-4,000
Reduction reflects completion of BC 102 in FY 2012 and increased cavern remediation activities in FY 2014.			
Support Services	3,378	3,780	+402
Inflation plus new requirements-based contract.			
Total, Facilities Development and Operations	170,914	164,741	-6,173

Strategic Petroleum Reserve
Program Direction
Funding Profile by Category

	FY 2012 Current	FY 2013 Annualized CR*	FY 2014 Request
Washington Headquarters			
Salary & Benefits	3,913	---	4,370
Travel	194	---	160
Support Services	1,430	---	2,020
Other Related Expenses	840	---	792
Total, Headquarters	6,377	---	7,342
Full Time Equivalents	27	---	28
Strategic Petroleum Reserve Project Management Office			
Salary & Benefits	13,184	---	13,538
Travel	668	---	485
Support Services	0	---	0
Other Related Expenses	1,561	---	3,294
Total, Strategic Petroleum Reserve Project Management Office	15,413	---	17,317
Full Time Equivalents	95	---	95
Total Program Direction			
Salary & Benefits	17,097	---	17,908
Travel	862	---	645
Support Services	1,430	---	2,020
Other Related Expenses	2,401	---	4,086
Total, Headquarters	21,790	---	24,659
Full Time Equivalents	122	---	123

*FY 2013 amounts shown reflect the P.L. 112 175 continuing resolution level annualized to a full year. These amounts are shown only at the "congressional control" level and above; below that level a dash (—) is shown.

Public Law Authorizations

Public Law 109–58, "Energy Policy Act of 2005"

Overview

Program Direction provides Federal staffing and associated costs required to provide overall direction and execution of the SPR. The SPR mission is carried out by a workforce composed largely of M&O contractors, although there are a variety of functions that are inherently governmental (e.g., program management, contract administration, budget formulation and execution, and interagency and international coordination) that require a dedicated Federal workforce.

Accomplishments and Strategic Initiatives

In FY 2012, the SPR maintained an emergency petroleum stockpile of 696 million barrels (with an unavailable inventory of 60 million barrels) and a drawdown capability of 4.25 million barrels per day to respond to U.S. oil supply emergencies. In October 2012, the SPR completed its cavern replacement project to provide a new cavern to replace an existing problem cavern at its Bayou Choctaw site.

In FY 2013, the Program is planning to monitor petroleum markets prior to any decision to refill SPR oil sold during the IEA coordinated release. Market monitoring is planned to be continued during FY 2014. Also in 2013, the SPR plans to initiate the relocation of the degasification plant to the West Hackberry site and continue critical activities for its cavern casing inspection and remediation programs.

Explanation of Funding AND/OR Program Changes

(dollars in thousands)

	FY 2012 Current	FY 2014 Request	FY 2014 Request vs FY 2012 Current
Salaries and Benefits			
The increase in Salaries and Benefits is attributable to escalation of salaries, step increases, and training for critical new hires (re-federalization) and relocation expenses.	17,097	17,908	+811
Travel			
The decrease in travel is part of the DOE initiative to increase Intra-site teleconferencing.	862	645	-217
Support Services			
The increase is attributable to project-planning efforts and escalation associated with service support contracts to maintain technical, mission essential support capabilities.	1,430	2,020	+590
Other Related Expenses			
The increase is due to the contingency for DOE employee evacuation expenses in the event of a hurricane and updating teleconferencing capabilities between the Project Management Office and the four sites (supports the initiative to decrease travel).	2,401	4,086	+1,685
Total Funding Change, Program Direction	21,790	24,659	2,869

Support Services by Category

(dollars in thousands)

	FY 2013 Current	FY 2014 Request	FY 2014 Request vs FY 2012 Current
Support Services			
Technical Support Services Economic and Environmental Analysis	1,430	2,020	+590
Total, Support Services	1,430	2,020	+590

Other Related Expenses by Category

(dollars in thousands)

	FY 2012 Current	FY 2014 Request	FY 2014 Request vs FY 2012 Current
Other Related Expenses			
Rent to Others	522	566	+44
Communications, Utilities, Misc	100	100	0
Other Services	1,367	2,262	+895
Supplies and Materials	137	626	+489
Equipment	145	392	+247
DOE/COE	130	140	+10
Total, Other Related Expenses	2,401	4,086	+1,685

Supporting Information

Capital Operating Expenses

Capital Operating Expenses Summary

(dollars in thousands)

	FY 2012 Current	FY 2013 Annualized CR*	FY 2014 Request
Capital Equipment > $500K (including Major Items of Equipment (MIE))	12,451	---	13,366
Total, Capital Operating Expenses	12,451	---	13,366

*FY 2013 amounts shown reflect the P.L. 112 175 continuing resolution level annualized to a full year. These amounts are shown only at the "congressional control" level and above; below that level a dash (—) is shown.

Capital Equipment > $500K (including MIE)

(dollars in thousands)

	Total	Prior Years	FY 2012 Current	FY 2013 Annualized CR*	FY 2014 Request
Total Non-MIE Capital Equipment (>$500K)	n/a	n/a	11,451	---	8,366
Anhydrite Pond Liner Replacement (BH-MM-746)	0,000	0,000	1,000	---	0,000
Crude Oil Pipeline Mainline Valves (WH-MM-659	0,000	0,000	0,000	---	5,000
Total, Capital Equipment (including MIE)			12,451	---	13,366

*FY 2013 amounts shown reflect the P.L. 112 175 continuing resolution level annualized to a full year. These amounts are shown only at the "congressional control" level and above; below that level a dash (—) is shown.

Construction Projects Summary

Construction Projects

(dollars in thousands)

	Total	Prior Years	FY 2012 Current	FY 2013 Annualized CR*	FY 2014 Request
Site Building Upgrades (BC-MM-673)					
TEC	n/a	n/a	630	---	0,000
OPC*	n/a	n/a	630	---	0,000
TPC Project Number BC-MM-673	n/a	n/a	630	---	0,000
Site Building Upgrades Phase 2 (BH-MM-670)					
TEC	n/a	n/a	0,000	---	0,000
OPC	n/a	n/a	0,000	---	0,000
TPC Project Number BH-MM-670	n/a	n/a	0,000	---	0,000
Total All Construction Projects					
Total TEC			630	---	0,000
Total OPC			630	---	0,000
TPC All Construction Projects			630	---	0,000

*Indicates a project where the cost of the Conceptual Design Report is estimated to exceed $3M.

*FY 2013 amounts shown reflect the P.L. 112 175 continuing resolution level annualized to a full year. These amounts are shown only at the "congressional control" level and above; below that level a dash (—) is shown.

SPR Petroleum Account
Fossil Energy

Overview
Appropriation Summary by Program

(dollars in thousands)

	FY 2012 Current	FY 2013 Annualized CR[1*]	FY 2014 Request
SPR Petroleum Account			
Rescission of Prior-Year Balances	0	0	0
Total, SPR Petroleum Account	0	0	0

[1.] FY 2013 Congressional Budget request included a rescission of $291 million in mandatory balances from the emergency sale of SPR oil conducted in FY 2011.
*FY 2013 amounts shown reflect the P.L. 112 175 continuing resolution level annualized to a full year. These amounts are shown only at the "congressional control" level and above; below that level a dash (—) is shown.

Office Overview and Accomplishments

The SPR Petroleum Account was established in the Treasury pursuant to the provisions of the Omnibus Budget Reconciliation Act of 1981 (P.L. 97-35). This account funds all Strategic Petroleum Reserve petroleum inventory acquisitions, associated transportation costs, U.S. Customs duties, terminal throughput charges and other related miscellaneous costs. During an emergency drawdown and sale, the SPR Petroleum Account is the source of funding for the incremental costs of withdrawing oil from the storage caverns and transporting it to the point where purchasers take title.

The U.S. reliance on oil and U.S. net oil import levels, combined with the location of significant global oil reserves in regions of the world subject to political unrest, have made the U.S. vulnerable to supply disruptions. The presence of the SPR provides protection from supply disruptions.

In 2011, DOE executed an SPR Drawdown of roughly 31 million barrels in response to the IEA Libya Collective Action, reducing the SPR petroleum stockpile from 727 million to 696 million barrels and SPR import protection to approximately 80 days of U.S. net petroleum imports. About $9 million was spent from the SPR Petroleum Account in the execution of the SPR Drawdown in 2011, and Congress rescinded $500 million from the SPR Petroleum Account in the Consolidated Appropriations Act, 2012. The sales receipts from the FY 2011 drawdown created mandatory budget authority in the SPR Petroleum Account.

In FY 2013, FE is planning through market assessment to commence refill of the SPR oil sold during the IEA coordinated release once markets are at an acceptable level. Refill activities and market assessment are to continue during FY 2014.

Explanation of Changes

A rescission of $291 million was proposed in FY 2013. No rescission is proposed for FY 2014.

Northeast Home Heating Oil Reserve

Northeast Home Heating Oil Reserve

Northeast Home Heating Oil Reserve

Proposed Appropriation Language

For necessary expenses for Northeast Home Heating Oil Reserve storage, operation, and management activities pursuant to the Energy Policy and Conservation Act, $8,000,000, to remain available until expended.

Explanation of Change

No changes.

Northeast Home Heating Oil Reserve
Fossil Energy

Overview
Appropriation Summary by Program

(dollars in thousands)

	FY 2012 Current	FY 2013 Annualized CR*	FY 2014 Request
Northeast Home Heating Oil			
Northeast Home Heating Oil	10,119	10,181	8,000
Total, Northeast Home Heating Oil Reserve	10,119	10,181	8,000

*FY 2013 amounts shown reflect the P.L. 112 175 continuing resolution level annualized to a full year. These amounts are shown only at the "congressional control" level and above; below that level a dash (—) is shown.

Office Overview and Accomplishments

The Northeast Home Heating Oil Reserve (NEHHOR) provides a short-term supplement to the Northeast systems' commercial supply of heating oil in the event of a supply interruption.

Within the NEHHOR Appropriation, the NEHHOR Program funds Commercial Storage Leases, Information Technology Support, Quality Control, and Analyses.

In FY 2011, the NEHHOR Program completed the sale of all 2 million barrels of its high sulfur heating oil inventory located in commercial storage. Through FY 2012, NEHHOR converted to a 1 million barrel configuration of Ultra Low Sulfur Diesel (ULSD) stored in Northeast terminals, to meet new Northeast states' emission standards being instituted in FY 2011 and FY 2012. FY 2013 program will continue operation of 1 million barrel Reserve of ULSD.

Alignment to Strategic Plan

Under the Department's Strategic Goal, Transform Our Energy Systems, the Northeast Home Heating Oil Reserve (NEHHOR) provides a short-term supplement to the Northeast systems' private supply of heating oil in the event of a supply interruption.

Explanation of Changes

The decrease of $2.1 million is due to the reduction in NEHHOR from a two million barrel heating oil Reserve to a one million barrel higher cost ULSD Reserve and an increase in storage costs.

FY 2014 request continues operation of I million-barrel Reserve of ULSD to protect the Northeast against high vulnerability of winter-related supply shortages.

Northeast Home Heating Oil Reserve
Fossil Energy
Funding by Site by Program

(dollars in thousands)

	FY 2012 Current	FY 2013 Annualized CR*	FY 2014 Request
Northeast Home Heating Oil Reserve			
Hess (Groton, CT)	2,135	---	2,315
Global Companies LLC (Revere, MA)	4,290	---	4,410
Washington Headquarters	3,694	---	1,275
Total, Northeast Home Heating Oil Reserve	10,119	10,181	8,000

*FY 2013 amounts shown reflect the P.L. 112 175 continuing resolution level annualized to a full year. These amounts are shown only at the "congressional control" level and above; below that level a dash (—) is shown.

Northeast Home Heating Oil
Funding Profile by Subprogram and Activity

(dollars in thousands)

	FY 2012 Current	FY 2013 Annualized CR*	FY 2014 Request
Northeast Home Heating Oil Reserve			
Commercial Storage Leases	9,619	---	7,500
Information Technology Support	300	---	400
Quality Control and Analysis	200	---	100
Total Northeast Home Heating Oil Reserve	10,119	10,181	8,000

*FY 2013 amounts shown reflect the P.L. 112 175 continuing resolution level annualized to a full year. These amounts are shown only at the "congressional control" level and above; below that level a dash (—) is shown.

Public Law Authorizations

Public Law 107-63, Department of Interior and Related Agencies (2001)

Overview

In supporting the Secretary's Goal of Security: Protecting the nation against interruptions in its critical heating oil supplies, the Northeast Home Heating Oil Reserve (NEHHOR) provides protection from severe heating oil supply disruptions throughout the Northeast. The NEHHOR provides a short-term supplement to the Northeast systems' commercial supply of heating oil in the event of a supply interruption. The heating oil reserve has been designed to augment commercial supplies during an emergency. The Reserve is not designed to displace the private market. It provides a buffer to assist the heating oil industry in mitigating short-term supply interruptions. The reserve is a valuable component of America's energy readiness effort, separate from the Strategic Petroleum Reserve.

Subprogram Accomplishments and Milestones

In FY 2011, NEHHOR completed the sale of all 2 million barrels of its high sulfur heating oil in commercial storage in order to make the transition to a 1 million barrel Reserve of ULSD. By February 2012, delivery was completed for the 1 million barrels of ULSD to new commercial storage locations. The purchase of ULSD was made to comply with the requirement to convert heating oil to ULSD to meet new Northeast states' emission standards beginning in FY 2011 and FY 2012. In FY2013 the program will continue operation of the 1 million barrel ULSD Reserve.

Program Planning and Management

There is a hierarchy of performance information for Petroleum Reserves. The Department collects and tracks the "critical few" measures. The Office of Petroleum Reserves monitors limited, specific, short and long-term measures. Monthly inventory certifications are submitted by storage contractors and Department of Defense quality surveillance personnel make periodic random inspections at each contracted storage site. A comprehensive annual review of each contract is conducted prior to exercise of contract option years. The on-line sales system, always available to the public in a "demo" mode, is also tested annually through a simulated sale with industry participation. Budget formulation/execution assessments are regularly conducted throughout the year, including monthly Dashboard-level Reviews and annual budget validations. Other evaluations include an annual independent inventory audit and the use of a base year contract with one-year options to assure competitive storage service rates.

Strategic Management

NEHHOR will use various means and strategies to continue its mission and achieve program goals. Assurance of a readiness posture will be accomplished through internal readiness reviews and assessments, independent audits, quantity and quality surveillance, exercises, and tests. Effectiveness of the Reserve to mitigate the economic damage of severe heating oil supply disruptions will be influenced by the Reserve's ability to quickly deliver into the market.

Subprogram Goals and Funding

In FY 2014, NEHHOR will focus on the following:

- Management of NEHHOR storage contracts and Government inventories
- Monitor all New England states' conversion to ULSD and trending biofuel requirements.
- Winter Season NEHHOR response readiness.

Explanation of Funding AND/OR Program Changes

(dollars in thousands)

	FY 2012 Current	FY 2014 Request	FY 2014 Request vs FY 2012 Current
Commercial Storage Leases			
The decrease from $9,619 to $7,500 is due to a reduction in the commercial storage costs for the 1 million barrel ULSD Reserve.	9,619	7,500	-2,119
Information Technology Support			
The increase is due to increasing technical support and analysis for modernization and maintenance of heating oil sales system including cyber security requirements.	300	400	+100
Quality Control and Analysis			
The decrease is due to reduction of sites	200	100	-100
Total Funding Change, Northeast Home Heating Oil Reserve	10,119	8,000	-2,119

Ultra-Deepwater Unconventional Natural Gas

Ultra-Deepwater Unconventional Natural Gas

Ultra-Deepwater and Unconventional Natural Gas and Other Petroleum Research
Funding Profile by Subprogram

(dollars in thousands)

	FY 2012 Current	FY 2013 Annualized CR*	FY 2014 Request
Ultra-Deepwater and Unconventional Natural Gas and Other Petroleum Research Fund	50,000	N/A	50,000
Receipts Ultra-Deepwater and Unconventional Natural Gas and Other Petroleum Research Fund	-50,000	N/A	-50,000
Repeal Ultra-Deepwater and Unconventional Natural Gas and Other Petroleum Research Fund	0	N/A	-50,000
Repeal Receipts Ultra-Deepwater and Unconventional Natural Gas and Other Petroleum Research Fund	0	N/A	50,000
Total, Ultra-Deepwater and Unconventional Natural Gas and Other Petroleum Research Fund	0	N/A	0

Public Law Authorizations

Public Law 109–58, "Energy Policy Act of 2005"

Overview

The Ultra-Deepwater and Unconventional Natural Gas and Other Petroleum Research Fund was established in Subtitle J of the Energy Policy Act of 2005 (EPAct) and is funded by royalties paid by industry producers.

Prudent development of domestic oil and natural gas resources will continue to be part of our Nation's overall strategy for energy security for decades to come. These operations have to be conducted responsibly, ensuring that communities are safe and that the environment is protected.

Mandatory R&D funding from EPAct Sec. 999 is too inflexible a mechanism to adequately address environmental and safety concerns in the dynamic and rapidly evolving hydraulic fracturing space. Absent Congressional action to repeal the program, the Administration has refocused this program to support R&D with significant potential public benefits, including activities consistent with the Secretary's Energy Advisory Board SEAB recommendations.

Subprogram Accomplishments and Milestones

In FY 2013, the Ultra-Deepwater and Unconventional Natural Gas and Other Petroleum Research was refocused on quantifying potential safety and environmental risks and on developing technologies focused on risk mitigation.

Program Planning and Management

Recommendations, analyses, and ongoing initiatives underpinning this program are:

- The *2013 Draft Annual Plan*, prepared by the Program Consortium, Research Partnership to Secure Energy for America (RPSEA),
- Final report of findings and recommendations prepared by the Department of Energy Unconventional Resources Technology Advisory Committee (URTAC)
- *Deepwater: The Gulf Oil Disaster and the Future of Offshore Drilling*, Report to the President, National Commission on the BP Deepwater Horizon Oil Spill and Offshore Drilling, January 2011,
- *Blueprint for a Secure Energy Future*, The White House, Washington, March 30, 2011,
- Final report of findings and recommendations prepared by the Department of Energy Ultra-Deepwater Advisory Committee, April 2011,
- Department of the Interior Ocean Energy Safety Committee, Meeting summary, April 2011, and
- Department of Energy *Strategic Plan*, May 2011.

Absent enacted repeal, the Ultra-Deepwater and Unconventional Natural Gas and Other Petroleum Research program will be managed to comply with the statutory sunset date of September 30, 2014.

Subprogram Goals and Funding

The goals of the Ultra-Deepwater and Uncoventional Natural Gas and Other Petroleum Research per the 2013 Draft Annual Plan:

Unconventional Resources Program (UCR)
The goal of UCR is to unlock the vast resources of natural gas trapped within shale deposits across the nation while addressing safety and protection of the environment.

Ultra-Deepwater Program:
The goal of UDW is to ensure that the understanding of the risks associated with ultra-deepwater operations and associated mitigation methods keep pace with the technologies that industry has developed to tap reserves in increasingly challenging conditions.

Small Producer Program:
The goal of Small Producers Program is to carry out research, development, and demonstration efforts that will assist small producers in reducing the cost and increasing the efficiency of exploration and production while operating safely and in a manner which does not harm the environment.

Elk Hills School Lands Fund

Elk Hills School Lands Fund

Elk Hills School Lands Fund
Fossil Energy

Overview
Appropriation Summary by Program

(dollars in thousands)

	FY 2012 Current	FY 2013 Annualized CR[1*]	FY 2014 Request
Elk Hills School Lands Fund			
Elk Hills – California Teachers' Pension Fund Settlement	0	0	0
Total, Elk Hills School Lands Fund	0	0	0

[1] A request of $15,579,815 was submitted in the FY 2013 Budget Request for the final payment under the Settlement Agreement entered into by the United States and the State of California on October 11, 1996, as authorized by section 3415 of Public Law 104-106 for final payment.

*FY 2013 amounts shown reflect the P.L. 112 75 continuing resolution level annualized to a full year. These amounts are shown only at the "congressional control" level and above; below that level a dash (—) is shown.

Office Overview and Accomplishments

The Elk Hills School Lands Fund, subject to appropriation, provides a source of compensation for the California State Teachers' Retirement System as a result of a settlement with the State of California with respect to its longstanding claim to title of two sections of land within NPR-1.

DOE and the State of California entered into a "Settlement Agreement" on October 11, 1996, in which DOE agreed, subject to appropriation, to compensate the State of California for its claim to title to two sections of land within NPR-1. The "Settlement Agreement" stipulates installments totaling nine percent of the net proceeds from the sale will be paid to the State of California.

Installments totaling $299,520,000 have been paid to date. On April 22, 2011, the Department settled NPR-1 final equity with Chevron. Under the terms of the settlement, Chevron paid $108,000,000 to the United States. That, in turn, increased the net proceeds of the sale. On August 3, 2011, the Department and the State of California agreed on the final payment of $15,579,815 with respect to the longstanding claim on the two sections of land.

Explanation of Changes

The most recent installment payment was made to the State of California in FY 2006. It was necessary for DOE to settle NPR-1 final equity with Chevron before the final net proceeds from the sale of DOE's share of NPR-1 could be determined, and that has now been accomplished. The final installment payment of $15,579,815 was requested in the FY2013 Congressional Budget, but not appropriated.

Advanced Technology Vehicles Manufacturing Program

Advanced Technology Vehicles Manufacturing Program

Advanced Technology Vehicles Manufacturing Loan Program

Proposed Appropriation Language

For administrative expenses in carrying out the Advanced Technology Vehicles Manufacturing Loan Program, $6,000,000, to remain available until expended.

Explanation of Change

$6,000,000 is requested for administrative expenses in FY 2014 versus $6,000,000 appropriated in FY 2012 Current.

Advanced Technology Vehicles Manufacturing Loan Program

Overview
Appropriation Summary by Program

(dollars in thousands)

	FY 2012 Current	FY 2013 Annualized CR	FY 2014 Request
Advanced Technology Vehicles Manufacturing Loan Program			
Direct Loan Subsidy Costs	0	0	0
Administrative Expenses	6,000	6,037	6,000
Total, ATVM Loan Program	6,000	6,037	6,000

Overview

Section 136 of the Energy Independence and Security Act of 2007 established the Advanced Technology Vehicles Manufacturing (ATVM) Loan Program, consisting of direct loans of up to $25 billion in total loan authority to support the manufacturing of advanced technology vehicles and associated components in the United States. The ATVM Loan Program evaluates the technical merit of the proposed advanced technology vehicles or qualifying components. Technical program factors such as economic development and diversity in technology, company, risk, and geographic location are also considered.

Program Accomplishments and Milestones

The ATVM Loan Program has closed over $8 billion in loans for five projects. These projects are projected to fund over 30,000 jobs in the United States and save approximately 260 million gallons of gasoline annually.

Major Programmatic Shifts or Changes

The Department requests $6 million, which is no change from the FY 2012 levels, to cover administrative operations for the ATVM program, recognizing the need to meet demand by maintaining existing loan due diligence and monitoring capacity. The Department requests $0 in Fiscal Year 2014 for ATVM Loan Program direct loan credit subsidy costs, which is no change from FY 2012.

Program Planning and Management

In FY 2013-FY 2014, the ATVM Loan Program will focus on portfolio management and monitoring activities on the existing portfolio as well as originating new loans to utilize existing loan authority and appropriated credit subsidy.

Strategic Management

In FY 2013-FY 2014, the ATVM Loan Program will achieve its mission and performance targets by adhering to clear policies, rules, and procedures for the submission, review, and negotiation of loan applications and for follow-on project review. The ATVM Loan Program will undertake a rigorous underwriting process to evaluate the legal, technical, financial, market and environmental attributes of each project. This includes a detailed risk analysis supported by quantitative financial modeling that forecasts project cash flows through the full tenor of the debt instrument. The investigative due diligence process includes technical merit reviews performed by DOE laboratories, market analyses provided by independent marketing consultants, and independent financial advisor services to augment the Federal staff of the ATVM Loan Program. The ATVM Loan Program's underwriting and ongoing credit analysis may identify a number of areas where credit risk may be mitigated. Accordingly, an essential part of the process will be working with applicants/recipients in identifying risk mitigation strategies that will enhance the prospect for timely payment of principal and interest.

The ATVM loan program will actively monitor loans post financial close through the entire life-cycle of the transactions from execution of the loan agreement through the final payment of the debt obligation. The program's overarching goal for its project oversight and credit monitoring approach is to protect the interest of the Federal government by proactively managing risks associated with projects receiving loans.

Alignment to Strategic Plan

The mission of the ATVM Loan Program is to accelerate the domestic commercial deployment of innovative and advanced clean energy technologies at a scale sufficient to meaningfully contribute to the achievement of our national clean energy objectives—including job creation; reduced dependence on oil; mitigation of greenhouse gas emissions; and enhancement of American competitiveness in the global economy of the 21st century.

The Department's May 2011 Strategic Plan outlines one primary objective to which the ATVM Loan Program aligns its activities: Deploy the Technologies We Have. The Strategic Plan also identifies eight targeted outcomes to achieve this objective, of which the ATVM Loan Program supports one:

Support battery manufacturing capacity for 500,000 plug-in hybrid electric vehicles a year by 2015.

Strategic Plan and Performance Measures

Program	Loan Program Office		
Performance Goal (Measure)	**Loss Rate of ATVM Loans** - Loss Rate of ATVM Loans		
Fiscal Year	**2012**	**2013**	**2014**
Target	≤ 4 percent	≤ 4 percent	≤ 4 percent
Result	**Met** - 0		
Endpoint Target	Achieve a loan loss rate less than or equal to 4 percent for the life of the portfolio		

2013 targets reflect DOE's FY 2013 Budget Request to Congress. FY 2013 target updates, as well as a complete list of performance measures, can be found in the upcoming FY 2012–2014 Annual Performance Plan and Report.

Administrative Expenses
Funding Profile by Category

(dollars in thousands)

	FY 2012 Current	FY 2013 Annualized CR*	FY 2014 Request
Administrative Expenses			
Salary & Benefits	2,400	---	2,468
Travel	100	---	50
Support Services	3,200	---	3,082
Other Related Expenses	300	---	400
Total, Administrative Expenses	6,000	6,037	6,000
Full Time Equivalents**	15	15	15

*FY 2013 amounts shown reflect the P.L. 112 175 continuing resolution level annualized to a full year. These amounts are shown only at the "congressional control" level and above; below that level a dash (---) is shown.
**FTE levels differ between the Budget Appendix and this Budget Request. The levels listed in this Request are the correct levels consistent with the FY 2014 President's Budget Request.

Overview

Administrative Expenses provides the Federal staffing and contractor resources and associated costs required to provide overall direction and execution of the ATVM Loan Program, including portfolio management, legal, technical, and other operational activities.

Explanation of Funding AND/OR Program Changes

(dollars in thousands)

	FY 2012 Current	FY 2014 Request	FY 2014 Request vs FY 2012 Current
Salaries and Benefits			
Provides small inflationary factor for salaries and benefits for 15 full-time equivalent employees (FTEs) for loan monitoring activities and portfolio management of closed loans.	2,400	2,468	+68
Travel			
Supports the travel of staff members for site visits, training, and attending meetings and presentations.	100	50	-50
Support Services			
Provides funding for contractor support for legal, financial, and technical consultants supporting origination and portfolio management activities.	3,200	3,082	-118
Other Related Expenses			
Small increase in Working Capital Fund costs.	300	400	+100
Total Funding Change, Administrative Expenses	6,000	6,000	+0

Support Services by Category

(dollars in thousands)

	FY 2012 Current	FY 2014 Request	FY 2014 Request vs FY 2012 Current
Support Services			
Management/Professional Support Services	3,200	3,082	-118
Total, Support Services	3,200	3,082	-118

Other Related Expenses by Category

(dollars in thousands)

	FY 2012 Current	FY 2014 Request	FY 2014 Request vs FY 2012 Current
Other Related Expenses			
Other Services	100	50	-50
Working Capital Fund	300	400	+100
Total, Other Related Expenses	400	450	+50

Loan Guarantee Program

Loan Guarantee Program

Innovative Technology Loan Guarantee Program

Proposed Appropriation Language

Such sums as are derived from amounts received from borrowers pursuant to section 1702(b)(2) of the Energy Policy Act of 2005 under this heading in prior Acts, shall be collected in accordance with section 502(7) of the Congressional Budget Act of 1974: Provided, That for necessary administrative expenses to carry out this Loan Guarantee program, $48,000,000, is appropriated, to remain available until expended: Provided further, That $48,000,000 of the fees collected pursuant to section 1702(h) of the Energy Policy Act of 2005 shall be credited as offsetting collections to this account to cover administrative expenses and shall remain available until expended, so as to result in a final fiscal year 2014 appropriation from the general fund estimated at $0: Provided further, That fees collected under section 1702(h) in excess of the amount appropriated for administrative expenses shall not be available until appropriated.

Explanation of Change

$48,000,000 is requested for administrative expenses in FY 2014. These administrative expenses are expected to be offset by an estimated $48,000,000 in collections from borrowers for a net appropriation of $0. This represents an increase in gross funding of $10,000,000 and an increase in net authority of $0 from the FY 2012 current budget.

Innovative Technology Loan Guarantee Program
Loan Programs Office

Overview
Appropriation Summary by Program

(dollars in thousands)

	FY 2012 Current	FY 2013 Annualized CR*	FY 2014 Request
Title 17 Innovative Technology Loan Guarantee Program			
Administrative Operations, LGP	38,000	---	48,000
Offsetting Receipts	-38,000	---	-48,000
Total, Title 17 Innovative Technology Loan Guarantee Program	0	---	0

*FY 2013 amounts shown reflect the P.L. 112 175 continuing resolution level annualized to a full year. These amounts are shown only at the "congressional control" level and above; below that level a dash (---) is shown.

Overview

The Loan Guarantee Program (LGP), as authorized under Title XVII of the Energy Policy Act of 2005, encourages early commercial use of new or significantly improved technologies in energy projects. Projects supported by DOE loan guarantees must avoid, reduce, or sequester air pollutants or anthropogenic emissions of greenhouse gases; employ new or significantly improved technologies compared to commercial technologies in service in the United States at the time the guarantee is issued; and offer a reasonable prospect of repayment of the principal and interest on the guaranteed obligation.

Section 1703 of the Act authorizes DOE to provide loan guarantees for innovative clean energy projects in categories including renewable energy systems, advanced nuclear facilities, coal gasification, carbon sequestration, energy efficiency, and various other types of projects. Section 406 of the American Recovery and Reinvestment Act of 2009, Pub. L. No. 111-5 (Recovery Act) amended the Loan Guarantee Program's authorizing legislation, by establishing Section 1705 as a temporary program for the rapid deployment of renewable energy and electric power transmission projects, as well as leading edge biofuels projects. The authority to enter into loan guarantees under Section 1705 expired on September 30, 2011.

Program Accomplishments and Milestones

The Loan Guarantee Program has closed over $16 billion in loan guarantees for 26 renewable energy projects. The portfolio also includes over $10 billion in conditional commitments that have not yet closed, including loan guarantees for the first new commercial nuclear power plant to be licensed and built in the U.S. in three decades

Major Programmatic Shifts or Changes

The Department requests $48 million for administrative operations for the LGP to cover portfolio management and loan origination activities. The FY 2014 Budget request for the LGP represents a $10 million increase in gross funding from the FY 2012 current levels, reflecting lower carryover from previous years and continued monitoring required during the construction phase of Section 1705 projects. The request will be fully offset with fee collections for a net appropriation request of $0.

Program Planning and Management

In FY 2013-2014, the LGP will focus on portfolio management and monitoring activities on the existing portfolio as well as originating new loan guarantees to utilize existing loan authority in the Section 1703 program.

Strategic Management

The LGP undertakes a rigorous underwriting process to evaluate the legal, technical, financial, market and environmental attributes of each project. This includes a detailed risk analysis supported by quantitative financial modeling that forecasts project cash flows through the full tenor of the debt instrument. The investigative due diligence process includes rigorous engineering and technology reviews conducted by major independent engineering firms, market analyses provided by independent marketing consultants, and independent financial advisor services to augment the Federal staff of the LGP. The LGP's loan underwriting and credit analysis may identify a number of areas where credit risk may be mitigated. Accordingly, an essential part of the process involves working with the applicant to identify risk mitigation strategies that will enhance the prospect for timely payment of principal and interest.

The LGP loan program will actively monitor loans post financial close through the entire life-cycle of the transactions from execution of the loan agreement through the final payment of the debt obligation. The program's overarching goal for its project oversight and credit monitoring approach is to protect the interest of the taxpayer by proactively managing risks associated with projects receiving loans.

Alignment to Strategic Plan

The mission of LGP is to accelerate the domestic commercial deployment of innovative and advanced clean energy technologies at a scale sufficient to meaningfully contribute to the achievement of our national clean energy objectives—including job creation; reduced dependence on oil; mitigation of greenhouse gases; and enhancement of American competitiveness in the global economy of the 21st century.

The Department's May 2011 Strategic Plan outlines one primary objective to which the LGP aligns its activities: Deploy the Technologies We Have. The Strategic Plan also identifies eight targeted outcomes to achieve this objective, of which the LGP supports one:

Double renewable energy generation (excluding conventional hydropower and biopower) by 2012.

Strategic Plan and Performance Measures

Program	Loan Program Office		
Performance Goal (Measure)	**CO2 Reductions of Projects Receiving Loan Guarantees** - Estimated annual CO2 emissions reductions of projects receiving loan guarantees that have achieved commercial operations compared to "business as usual" energy generation. (metric tons, mt)		
Fiscal Year	**2012**	**2013**	**2014**
Target	≥ 2,000,000 mt CO2	≥ 5,000,000 mt CO2	≥ 6,500,000 mt CO2
Result	**Met** - 2,050,000		
Endpoint Target	Achieve 7,250,000 mt of avoided CO2 emissions per year by the end of FY 2015.		

Program	Loan Program Office		
Performance Goal (Measure)	**Generation Capacity of Projects Receiving Loan Guarantees** - Annual generation capacity from projects receiving DOE loan guarantees that have achieved commercial operations. (Gigawatts, GW)		
Fiscal Year	**2012**	**2013**	**2014**
Target	≥ 1.3 GW	≥ 2.8 GW	≥ 3.8 GW
Result	**Met** - 1.5		
Endpoint Target	Achieve 4.3 GW of annual electricity generation capacity by FY16		

2013 targets reflect DOE's FY 2013 Budget Request to Congress. FY 2013 target updates, as well as a complete list of performance measures, can be found in the upcoming FY 2012–2014 Annual Performance Plan and Report.

Administrative Operations
Funding Profile by Category

(dollars in thousands)

	FY 2012 Current	FY 2013 AnnualizedCR*	FY 2014 Request
Administrative Operations			
Salary & Benefits	11,800	---	14,400
Travel	400	---	500
Support Services	22,154	---	29,061
Other Related Expenses	3,646	---	4,039
Total, Administrative Operations	38,000	---	48,000
Full Time Equivalents**	80	80	95

*FY 2013 amounts shown reflect the P.L. 112 175 continuing resolution level annualized to a full year. These amounts are shown only at the "congressional control" level and above; below that level a dash (---) is shown.
**FTE levels differ between the Budget Appendix and this Congressional Justification. The levels listed in this CJ are the correct levels consistent with the FY2014 President's Budget.

Overview

Administrative Operations (Program Direction) provides the Federal staffing and contractor resources and associated costs required to provide overall direction and execution of the Loan Guarantee Program including loan origination, portfolio management, legal, technical, and other operational activities. Administrative Operations are estimated to be fully offset with fee collections for a net budget of $0.

Explanation of Funding AND/OR Program Changes

(dollars in thousands)

	FY 2012 Current	FY 2014 Request	FY 2014 Request vs FY 2012 Current
Salaries and Benefits			
Provides salaries and benefits for 95 full time equivalent employees (FTEs) to administer the following functions of the office: Director, NEPA Compliance, Legal, Technical and Project Management, Management Operations, Portfolio Management, Loan Origination, and Risk Management.	11,800	14,400	+2,600
Travel			
Supports the travel of staff members for site visits, training, and attending meetings and presentations.	400	500	+100
Support Services			
Funds outside expertise in finance, legal, engineering, technology, credit analysis, and market assessments. The increase in funding is due to the continued use of advisory services needed for underwriting and monitoring activities, which have been funded out of prior-year balances in previous fiscal years.	22,154	29,061	+6,907

Other Related Expenses			
Small increase in Working Capital Fund bill.	3,646	4,039	+393
Total Funding Change, Administrative Operations	38,000	48,000	+10,000

Support Services by Category

(dollars in thousands)

	FY 2012 Current	FY 2014 Request	FY 2014 Request vs FY 2012 Current
Support Services			
Management/Professional Support Services	22,154	29,061	+6,907
Total, Support Services	22,154	29,061	+6,907

Other Related Expenses by Category

(dollars in thousands)

	FY 2012 Current	FY 2014 Request	FY 2014 Request vs FY 2012 Current
Other Related Expenses			
Other Services	400	500	+100
Working Capital Fund	3,246	3,539	+293
Total, Other Related Expenses	3,646	4,039	+393

Energy Information Administration

Energy Information Administration

U.S. Energy Information Administration

Proposed Appropriation Language

For necessary expenses in carrying out the activities of the U.S. Energy Information Administration, $117,000,000, to remain available until expended.

Explanation of Change

No changes.

U.S. Energy Information Administration

Overview
Appropriation Summary by Program

(dollars in thousands)

	FY 2012 Current	FY 2013 Annualized CR	FY 2014 Request
Energy Information Administration	105,000	105,643	117,000
Total, Energy Information Administration	105,000	105,643	117,000

Overview

The U.S. Energy Information Administration (EIA) is a statistical and analytical agency within the U.S. Department of Energy. EIA collects, analyzes, and disseminates independent and impartial energy information to promote sound policymaking, efficient markets, and public understanding of energy and its interaction with the economy and the environment. EIA is the Nation's premier source of energy information and, by law, its data, analyses, and forecasts are independent of approval by any other officer or employee of the U.S. Government.

EIA conducts a wide range of data collection, analysis, forecasting, and dissemination activities to ensure that Congress, Federal and State Government, the private sector, the broader public, and the media have ready access to timely, reliable, and relevant energy information. This information is essential to inform a wide range of energy-related decisions, including utilization strategies; availability of energy sources; business and personal investment decisions; policy development; and responses to disruptions and other shocks affecting the energy sector. As the energy industry becomes increasingly more complex and interrelated, EIA must evolve its program to present a comprehensive picture of the energy marketplace to an expanding customer base.

To achieve this, EIA will rigorously monitor and evaluate its program so that resource-related decisions are informed by sound, evidence-based analysis and that business processes and technologies are leveraged to maximize operational efficiency.

Within the Energy Information Administration appropriation, EIA has one program and no subprograms.

Alignment to Strategic Plan

EIA's program supports the Departmental Goal to *Transform our Energy Systems: Catalyze the timely, material, and efficient transformation of the Nation's energy system and secure U.S. leadership in clean energy technologies*. Specifically, EIA supports the objective to *Lead the National Conversation on Energy*.

In doing so, the agency recently fielded a brief online survey to gauge the effectiveness of its energy education product line, and over 80% of respondents spanning EIA's broad stakeholder spectrum provided favorable ratings when asked to assess EIA's online information.

Further, EIA has established two annual performance measures to help the agency assess its mission effectiveness:

1. Timeliness of EIA information products
2. Quality of EIA information products

Strategic Plan and Performance Measures

Performance Goal (Measure)	**Quality of EIA Information Products** - Percentage of customers who are satisfied or very satisfied with the quality of EIA information.		
Fiscal Year	**2012**	**2013**	**2014**
Target	90 % customer satisfaction rating	90 % customer satisfaction rating	90 % customer satisfaction rating
Result	**Exceeded-** 91 % customer satisfaction rating		
Endpoint Target	This is an ongoing annual performance measure, as information quality is central to EIA's mission.		

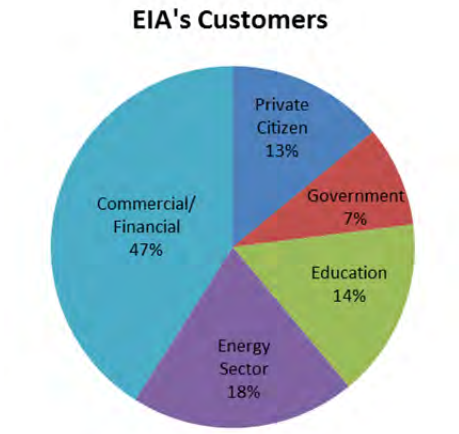
Performance Goal (Measure)	**Timeliness of EIA Information Products** - Percentage of selected EIA recurring products meet their release date targets (all product types).		
Fiscal Year	**2012**	**2013**	**2014**
Target	95 % of products released on schedule	95 % of products released on schedule	95 % of products released on schedule
Result	**Exceeded-** 97 % of products released on schedule		
Endpoint Target	This is an ongoing annual performance measure, as timely delivery of energy information is central to EIA's mission.		

2013 targets reflect DOE's FY 2013 Budget Request to Congress. FY 2013 target updates, as well as a complete list of performance measures, can be found in the upcoming FY 2012–2014 Annual Performance Plan and Report.

Benefits

EIA serves a broad range of stakeholders who require relevant energy information to bring meaning and context to a rapidly changing energy landscape. To this end, EIA's priority is to maintain a high-quality core program of energy statistics, analyses, and forecasting capabilities to lead and inform the national conversation on energy, a key component of DOE's overarching strategic vision. While much of EIA's work is done directly with policymakers through testimony, presentations, papers, analyses, and responses to questions, EIA ensures broad access to information to all of its stakeholders by disseminating data and analysis products through its website (see Figure 1).

Figure 1: EIA's Web Stakeholders and Customers



Source: 2012 EIA Web Customer Survey

Energy Information Benefits:

- Policymakers at the Federal, State, and local levels have access to statistics and analyses that help inform the public debate in many critical areas such as energy and associated environmental policy, changes in complex and evolving energy markets, and geopolitical dynamics that affect energy supply, demand and, ultimately, prices.
- Producers, consumers, investors, traders, and analysts can use a wealth of energy information in their day-to-day activities in the global energy marketplace. For example, Figure 2 shows two typical examples of the immediate effects of EIA's weekly releases of natural gas storage and petroleum product inventory reports on price formation in important energy markets.
- The general public, researchers, educators, and students have access to a wide range of factual materials that enables a well-informed citizenry regarding energy and its growing importance in today's world.

Figure 2: The energy industry and markets rely heavily on EIA's statistics

Data Represent NYMEX Henry Hub Natural Gas Near-Month Futures Contract November 8, 2012 - Source: Bloomberg Finance LP (December 3, 2012)

Data Represent NYMEX Light, Sweet Crude Oil (WTI) Near-Month Futures Contract October 24, 2012 - Source: Bloomberg Finance LP (December 3, 2012)

Strategic Management

EIA has identified and is investing in three areas of strategic focus that will enable meaningful contributions towards the Department's objective of leading the national conversation on energy while adhering to the principles of exemplary public stewardship:

1. Apply innovation and creativity to develop new ways to provide better information, both faster and cheaper, to meet stakeholder needs for timely, accurate, and relevant data, analysis and other information that accurately reflect changing energy markets.
2. Expand availability of EIA data, analysis, and forecasting to stakeholders by capitalizing on state-of-the-art web-based data management and communication strategies.
3. Optimize organizational efficiency by using innovative tools, methods, and management practices to support the mission.

Program Accomplishments and Milestones

EIA constantly reviews and, as appropriate, modifies its informational products and underlying business processes to meet evolving customer needs. Significant recent accomplishments include:

- Resumed collection of important energy data including fuel oil and kerosene sales, and data on domestic oil and natural gas proven reserves. This information contributes to a more comprehensive understanding of domestic energy markets and provides key inputs to EIA's forecasting models.
- Restarted work on the 2012 Commercial Buildings Energy Consumption Survey (CBECS), a multi-year effort that provides the only statistically reliable source of energy consumption, expenditures, and end uses in U.S. commercial buildings and provides an energy baseline crucial to understanding building characteristics, performance, efficiency, and user behavior.
- Provided key analyses, including time-sensitive information to Congress and the public on the availability and price of petroleum and petroleum products produced in countries other than Iran as required by the *National Defense Authorization Act* (NDAA) for Fiscal Year 2012.
- Enhanced the agency's forecasting capabilities through the ongoing modernization of the National Energy Modeling System (NEMS), which underpins the *Annual Energy Outlook* (AEO), a flagship agency publication that provides long-term projections of energy production, consumption, technology, and market trends.
- Improved customer access and usability of EIA's statistics through enhanced web-based delivery of energy information, including custom data tables for state as well as national data, dynamic state energy maps and profiles, and a wide range of other interactive features.
- Provided critical energy statistics to customers within stated deadlines. These statistics cover all aspects of the energy industry from production and trade to transformation, distribution, and storage--information critical to understanding domestic energy markets.

Milestone	Date
Release the AEO 2013, which will examine the future direction of the U.S. energy system, including long-term projections and analyses that take into account a range of trends, technologies, policies, and uncertainties impacting the U.S. energy economy.	Quarter 2, 2013
Release the International Energy Outlook 2013, which will restore EIA's ability to provide long-term projections of world trends in energy supply and demand along with related uncertainties in the rapidly changing global energy market.	Quarter 3, 2013
Launch data collection for the 2012 CBECS, which will enable release of important data in FY 2014 on energy-related building characteristics and types and amounts of energy consumed in U.S. commercial buildings.	Quarter 3, 2013

Major Program Shifts or Changes

The Department requests $117.0 million in FY 2014 for EIA, which is a $12.0 million increase over the FY 2012 appropriation. In addition to maintaining its core energy information program, the FY 2014 request enables EIA to complete the 2012 CBECS, including release of data that provide U.S. benchmarks used to inform investments in new technologies, performance labeling, and energy management practices; launch the 2014 Residential Energy Consumption Survey (RECS), which collects information from a nationally representative sample of housing units, including data on energy characteristics of homes, usage patterns, and household demographics;

and implement National Academy of Sciences (NAS) recommendations to improve the processes that underlie these complex, multi-year surveys.

The request also enables EIA to upgrade its critical weekly statistical products, the Weekly Petroleum Status Report (WPSR) and the Weekly Natural Gas Storage Report (WNGSR); continue modernizing and streamlining data collection processes across its energy supply surveys to yield significant efficiencies in the agency's largest operational area; enhance EIA's ability to monitor, forecast, and report on international energy developments; continue upgrades to EIA's forecasting capabilities through the modernization of NEMS; and improve and expand customer access to EIA data and information on its website.

Program Direction
Funding Profile by Category

(dollars in thousands)

	FY 2012 Current	FY 2013 Annualized CR*	FY 2014 Request
Headquarters Operations			
Salaries and Benefits	50,403	---	54,106
Travel	310	---	279
Support Services	38,777	---	47,360
Other Related Expenses	15,510	---	15,255
Total, Headquarters Operations	105,000	105,643	117,000
Full Time Equivalents	354	365	370

*FY 2013 amounts shown reflect the P.L. 112 175 continuing resolution level annualized to a full year. These amounts are shown only at the "congressional control" level and above; below that level a dash (---) is shown.

Public Law (P.L.) Authorizations

P.L. 83-703, Atomic Energy Act (1954)
P.L. 93-275, 15 U.S.C. 761, Federal Energy Administration Act (1974)
P.L. 93-319, Energy Supply and Environmental Coordination Act (1974)
P.L. 94-163, Energy Policy and Conservation Act (1975)
P.L. 94-385, 15 U.S.C. 790, Energy Conservation and Production Act (1976)
P.L. 95-91, 42 U.S.C. 7135, Department of Energy Organization Act, 1977
P.L. 95-621, Natural Gas Policy Act (1978)
P.L. 95-620, 42 U.S.C. 8301, Powerplant and Industrial Fuel Use Act (1978)
P.L. 96-294, Energy Security Act (1980)
P.L. 97-229, 42 U.S.C. 6245, Energy Emergency Preparedness Act (1982)
P.L. 99-58, National Coal Imports Reporting Act (1985)
P.L. 99-58, 42 U.S.C. 6201, Energy Policy and Conservation Act Amendments of 1985
P.L. 100-42, 42 U.S.C. 8312, Powerplant and Industrial Fuel Use Act Amendments of 1987
P.L. 102-486, 42 U.S.C. 13385, Energy Policy Act (1992)
P.L. 107-347: Title V of E-Government Act of 2002, Confidential Information Protection and Statistical Efficiency Act of 2002
P.L. 109-58, 42 U.S.C. 15801, Energy Policy Act of 2005
P.L. 110-140, Energy Independence and Security Act (2007)
P.L. 112-81, National Defense Authorization Act for Fiscal Year 2012
P.L. 112-158, Iran Threat Reduction and Syria Human Rights Act of 2012

Explanation of Funding AND/OR Program Changes

(dollars in thousands)

	FY 2012 Current	FY 2014 Request	FY 2014 Request vs FY 2012 Current
Salaries and Benefits – The increase in salaries and benefits supports 16 additional Federal full time equivalents and a 4.2% cost-of-living adjustment (COLA).	50,403	54,106	+3,703
Travel – The decrease in travel reflects the increased use of video conferencing, and reflects a 30 percent Departmental reduction from the FY 2010 adjusted baseline.	310	279	-31
Support Services – The net increase improves the ability of EIA to provide comprehensive, relevant energy information to its stakeholders by the most efficient and effective means.	38,777	47,360	+8,583

(dollars in thousands)

	FY 2012 Current	FY 2014 Request	FY 2014 Request vs FY 2012 Current
Energy Data Collection, Processing, and Integration (+$5,190)	25,645	30,835	+5,190

- Operates the Energy Supply Surveys (+$2,570) – Upgrade EIA's critical weekly statistical products, the WPSR and the WNGSR, by performing a complete system overhaul to facilitate more efficient data management; implement a robust, standardized toolset for evaluating the underlying statistical methods that inform the estimation process; upgrade security procedures to mitigate vulnerabilities; and enhance data delivery methods (+$1,271). Modernize data collection and processing systems and methods, the agency's largest operational, area by improving operational efficiencies, reducing costs, shortening time to publication, and improving data quality (+$815). Building on EIA's successful collection of monthly natural gas production data, collect monthly oil production information directly from operators, provide timely data regarding rapidly changing production trends, enable reporting of more accurate production information, and increase market confidence by reducing the need for significant retroactive adjustments (+$484).
- Conducts the Energy Consumption Data Program (+$2,620) – The net increase reflects the launch of the multi-year 2014 RECS effort (+4,333) and the completion of the 2012 CBECS (-$2,713). The RECS activities in FY 2014 include sample design and partial funding of field data collection that continues in FY 2015. RECS collects information from a nationally representative sample of housing units, including data on energy characteristics of homes, usage patterns, and household demographics. This information is combined with data from energy suppliers to estimate energy costs and usage for heating, cooling, appliances, and other end uses, and is critical to meeting future energy demand and improving efficiency and building design. CBECS provides the only statistically reliable source of energy consumption, expenditures, and end uses in U.S. commercial buildings. This energy baseline is critical to understanding building characteristics, performance, efficiency, and user behavior, and also provides U.S. benchmarks used to inform investments in new technologies, performance labeling, and energy management practices. Field collection of survey data, which requires the bulk of CBECS' cyclical funding, will be conducted in 2013, while final processing and initial release of the data will occur in 2014.
- Streamlines CBECS/RECS (+$1,000) – Improve the energy consumption data program by testing and implementing recommendations from the National Academies' February 2012 study on *Effective Tracking of Building Energy Use: Improving the Commercial Buildings and Residential Energy Consumption Surveys*. Initially focus on recommendations concerning timeliness and frequency of data by exploring such recommendations as evaluating the usefulness of implementing a rotating sample design to improve the timeliness of the data; developing procedures for a multimode approach and moving some of the data collection to the web; and investigating strategies for releasing the data faster.

(dollars in thousands)

	FY 2012 Current	FY 2014 Request	FY 2014 Request vs FY 2012 Current
Energy Analysis and Forecasting (+$1,836)	6,091	7,927	+1,836
• Enhances Energy Modeling and Analysis Capabilities (+$1,892) – Enhance international analysis capabilities: assess international crude qualities and price differentials, analyze liquid fuels and natural gas markets, and produce reports summarizing results on each topic and incorporate findings into EIA analysis tools. As part of this process, support the International Natural Gas Model to provide analytic capabilities to address questions regarding the impact of U.S. exports on international natural gas markets.			
• Upgrades NEMS (-$620) – Decrease reflects completion of portions of the multi-year NEMS upgrades, including the Liquid Fuels Market Module. NEMS is the Nation's preeminent tool for developing long-term projections of U.S. energy production, consumption, prices, and technologies so that Federal, State, and local policymakers have access to more reliable forecasts and analyses.			
• Strengthens Energy and Financial Markets Program (+$564) – Conduct analysis and report on refining and gasoline markets and expand efforts to better understand linkages between physical energy markets and financial market activity.			
Energy Information Dissemination and Communications (+$1,129) – Improves customer access and usability of EIA's statistics and analyses through enhanced web-based delivery of energy information. EIA's dissemination platform will provide a more flexible foundation to incorporate evolving and expanding content and data services; utilize web application programming interfaces, taxonomy and metadata to design for interoperability and openness; and enable data and information assets to be freely available for use within agencies, between agencies, in the private sector, or by citizens. Further, this initiative will expand EIA's reach to its stakeholders through the use of live streaming data and information updates, multimedia and social media content, and interactive, online tools such as dynamic mapping, animation, and data visualization. As a result, EIA's content will be more broadly available and accessible to its full spectrum of stakeholders providing improved public understanding of complex aspects of energy data and analysis.	1,494	2,623	+1,129
Resource and Technology Management (+$428) –The increase supports enhanced cybersecurity, continuity of operations, and disaster recovery requirements.	5,547	5,975	+428
Other Related Expenses – The net decrease in Other Related Expenses is due to reduced purchases of supplies and materials (-$309), savings from closing the Dallas Field Office (-$229), lower purchases of IT equipment for survey modernization (-$55), and reduced contributions to promote economic diversity (-$50), offset by an increase in DOE Working Capital Fund (WCF) costs (+$388).	15,510	15,255	-255
Total, Energy Information Administration	105,000	117,000	+12, 000

Program Activities

	(dollars in thousands)		
	FY 2012 Current	FY 2013 Annualized CR	FY 2014 Request
Salaries and Benefits	50,403	---	54,106

Provide salaries and benefits for 370 FTEs. The 370 FTEs support the following functions: Administrator's Office (7 FTEs), energy data collection, processing and integration (161 FTEs), energy analysis and forecasting (122 FTEs), energy information dissemination and communications (32 FTEs), and resource and technology management (48 FTEs).

Travel	310	---	279

Fund travel for EIA personnel to attend training, professional development programs, industry and state conferences; meet with national and international government and energy industry officials; and provide expertise in support of the EIA mission.

Support Services	38,777	---	47,360

Fund contractual support for EIA energy information collection and data management, analysis and forecasting activities, and energy information dissemination. The support services include development, operation, and processing of surveys and the automated tools and equipment required to collect, store, maintain, protect, and disseminate energy information.

- Energy Data Collection, Processing and Integration Activities 25,645 --- 30,835

  EIA's comprehensive energy data program conducts surveys of energy suppliers and consumers and then processes and integrates survey responses to produce a full range of publicly available data and reports containing relevant, reliable, and timely energy information. EIA strives to make data available in a format and structure to minimize additional effort on the part of users. The energy data program also provides the basis for EIA's energy analysis and forecasting activities, including key inputs for the Regional Short-Term Energy Model (RSTEM)and the NEMS.

  - Energy Supply Surveys 16,523 --- 19,093

    In FY 2014, continue to conduct EIA's core energy supply surveys that span the energy sector and perform several major upgrades and enhancements.

    As part of its data quality efforts, EIA will continue to modernize the systems and methods it uses in data collection and processing, the agency's largest operational area. Current processes are challenged with antiquated, dissimilar, and inefficient collection and processing mechanisms that are at increased risk of major failure and rely heavily on manual intervention, increasing costs and adversely impacting both quality and timeliness. EIA will continue improvements in the management of energy data; strengthen quality assurance and update statistical techniques; protect the integrity of data; assure system documentation of data processes; and reduce lifecycle development and operating costs for EIA's statistical programs.

    Petroleum and Biofuels Surveys – Operate petroleum and liquid fuel surveys on weekly, monthly, annual, and quadrennial cycles, as well as the monthly biodiesel survey mandated by Section 1508 of the Energy Policy Act of 2005. Collect and disseminate monthly state-level data on wholesale petroleum product prices, including gasoline, diesel, heating oil, propane, residual fuel oil, and kerosene, and prepare and publish the annual petroleum marketing data report and the fuel oil and kerosene sales report. Continue data collection grants to states through the State Heating Oil and Propane Program to collect winter fuels prices at the state level on a weekly basis.

    Monthly Oil Production Survey – Collect monthly oil production information directly from operators, providing timely data regarding rapidly changing production trends. This enables reporting of more accurate production information, increasing market confidence by reducing the need for significant retroactive adjustments.

    Natural Gas and Reserves Surveys – Operate natural gas production, storage, and consumption surveys on weekly, monthly, and annual cycles as well as an annual survey of proved reserves of both oil and natural gas.

Collect data from natural gas marketing companies.

Electricity, Coal, Renewables, and Uranium Surveys – Operate weekly, monthly, quarterly, and annual surveys for electric power. Operate weekly, monthly, quarterly, and annual surveys on reserves, supply, disposition, and prices for coal. Process selected renewable and alternative fuel surveys including annual surveys of photovoltaic cells and alternate fueled vehicles. Process uranium production and marketing surveys, including annual surveys of the uranium producers, marketers, and nuclear plant operators and a quarterly survey of uranium producers.

- Energy Consumption and Efficiency Surveys 8,039 --- 10,659

Collect and publish definitive, national end-use consumption data for commercial buildings, residential buildings, and manufacturing. The end-use consumption surveys contribute to EIA's integrated energy statistics and provide key inputs to short- and longer-term forecasting activities, provide baseline information critical to understanding energy use, and are the basis for benchmarking and performance measurement for energy efficiency programs. EIA will explore and, as appropriate, implement methodological improvements across its energy consumption data program based on NAS recommendations to increase data reliability and operational efficiency.

Release initial data from the 2012 CBECS in FY 2014. The multi-year CBECS provides the only national data regarding characteristics of the U.S. commercial building stock and its energy use, and provides baseline information critical to understanding energy end-use, establishing equipment standards, and developing performance measurements for energy efficiency programs. This data is essential in the context of the efficiency programs focused on commercial buildings – including Energy Star and Leadership in Energy and Environmental Design (LEED) certification program – as well as state-level initiatives.

Operate the RECS on a four-year cycle beginning with 2014 with a sample size sufficient to maintain state-level reporting of energy end-use estimates for 16 states. RECS provides information on structural, equipment, and operational characteristics of housing units, along with household energy consumption and expenditures. RECS provides baseline information crucial to understanding demand for and use of goods and services in U.S. households. Preliminary data from the 2014 RECS will be released in FY 2016.

Continue the 2014 Manufacturing Energy Consumption Survey (MECS) on a four-year cycle. MECS provides information on energy throughput and economic and operational characteristics of U.S. manufacturers. Linked with production and employment data from Census Bureau economic surveys, the MECS provides consumption information for policy development, market assessment, computation of gross national product, and public understanding.

- Integrated Data Program 1,083 --- 1,083

Produce the *Annual Energy Review*, *Monthly Energy Review*, and *State Energy Profiles*, each of which provides essential comprehensive national and state-level data that support EIA analysis and forecasting, more efficient energy markets, and state-level decision making.

- Energy Analysis and Forecasting 6,091 --- 7,927

Conduct energy analysis and forecasting activities, including the analysis of energy supply, demand, conversion, and prices. Update, operate, and document EIA's energy models. The models, which are in the public domain, are used by EIA and other DOE program offices, National Laboratories, non-governmental organizations, academic researchers, and others for a variety of energy analysis purposes. Assess the impact of proposed energy policies on projected energy trends. Prepare the AEO and the monthly *Short-Term Energy Outlook* (STEO) to provide comprehensive projections of domestic energy markets. Provide timely information to Congress and the public on the availability and price of petroleum and petroleum products produced in countries other than Iran as required by

the NDAA for Fiscal Year 2012. Address international data and analysis issues that are having a growing impact on U.S. natural gas and oil production and trade, and U.S. refining activity. Prepare special modeling analyses requested by the Congress or the Executive Branch.

- Energy Modeling and Analysis 2,671 --- 4,563

  Operate the NEMS, a mid-to-long term energy-economy modeling system. Using the output from NEMS, prepare the AEO, which presents a 25- to 30-year projection and analysis of U.S. energy supply, demand, and prices.

  In FY 2014, enhance international, short-term, end-use efficiency, and refinery analytic capabilities:

  International – Assess international crude, liquid fuel, and natural gas markets and produce reports summarizing results. Use these analyses to develop models with linkages to NEMS to address the global nature of these markets and include the results in the restored *International Energy Outlook*. As part of this process, support the International Natural Gas Model and perform analyses of alternative natural gas market conditions on international supply, consumption, imports and exports.

  Short-term – Update and operate the RSTEM, an integrated information system that forecasts U.S. supplies, demands, imports, stocks, and prices of energy with a horizon of 12 to 24 months. In FY 2014, add structured detail to its short-term modeling to better incorporate the impact of policies and programs and traditional data-driven forecasts. Using the output from RSTEM, prepare the monthly STEO, a *Summer Motor Gasoline Outlook* (in April), and a *Winter Fuels Outlook* (in October).

  End Use Efficiency – To better understand the impact of energy efficiency programs, evaluate the programmatic results of state and utility energy efficiency programs, producing an analytic report and incorporating results in models and short-term and long-term domestic and international energy projections and analyses.

  Refinery and Refined Products – Perform quantitative assessments of alternative refinery market conditions on product supply. Expand analysis of international crude and product trade and the impact this trade has on domestic fuel markets.

- Energy Model Development 2,487 --- 1,867

  Continue overhauling NEMS, which was developed in 1992. While the model has evolved substantially over the years, some fundamental aspects of the NEMS structure have limitations that threaten EIA's ability to provide accurate baseline energy projections, analyze proposed energy policies, and support energy technologies studies by DOE program offices. The new modules will help meet the needs of the Congress, the Administration, and other customers for more relevant, reliable, and timely assessments and forecasts of emerging policy and technology issues using a modern modeling platform that is more efficient to develop and maintain.
  FY 2014 activities include: Perform an assessment of liquid fuels markets taking into consideration the regional nature of the markets, the Renewable Fuels Standard, the likely sales and use of alternatively fueled vehicles, and revealed consumer preferences; enhance the treatment of enhanced oil recovery opportunities using captured CO2 in the new lower-48 oil and gas supply module; begin developing the regional transportation module that is critical for vehicle efficiency standards and biofuels demand analysis; evaluate and revise the decision-making algorithms in the end-use sector modules to better represent producer and consumer behavior, a multiyear effort; initiate multiyear technology-specific industrial demand module effort; initiate multiyear land and water competition effort that is critical for biofuels supply analysis; design, develop, and deploy ongoing alternative solution methods, simulation evaluation tools, output databases, and software; analyze expanded residential energy consumption information and incorporate additional regional information where practicable.

- Energy and Financial Markets Initiative 933 --- 1,497

  Continue efforts to increase public understanding of linkages between energy markets and those for other

commodities and assets. Specifically, EIA will expand its processing and analysis of proprietary and public data to yield a better understanding of the behaviors, strategies, risks, and profitability of different classes of oil futures market participants. EIA will purchase market data and procure analysis of investment flows in over-the-counter financial oil and gas markets to close existing information gaps. Additionally, EIA will analyze the relationship between inventory behavior and forward curves using EIA data on crude oil and petroleum product storage capacity and utilization. Results of this work will be used to inform policy makers and will be publicly available on EIA's Energy and Financial Markets website. This effort will yield improved understanding and explanation of the relationships of financial market activity and fundamentals to price formation, stronger theories and analytic techniques to explain market behavior, and a more comprehensive tracking of data regarding key physical and non-physical factors that influence energy prices.

EIA will continue to provide information to the Congress requested in the NDAA for Fiscal Year 2012 concerning the availability and price of crude oil and petroleum products produced in countries other than Iran. These reports will be provided at 60-day intervals.

▪ Energy Information Dissemination and Communications	1,494	---	2,623

Conduct EIA's comprehensive communications program for diverse external customer groups and agency employees including EIA's communications policies and standards, the public website (www.eia.gov), press and media relations, marketing and outreach services, energy education and literacy efforts, and employee intranet.

In FY 2014, expand EIA's reach to its stakeholders through the use of live streaming data and information updates, multimedia and social media content, and interactive, online tools. Support increased energy literacy by leveraging EIA's energy education product line: *Energy-in-Brief*, *Frequently Asked Energy Questions*, *Energy Explained*, *Energy Kids*, and *Today in Energy*. Operate the EIA Information Center, the agency's primary point of contact for customer inquiries and publication fulfillment, and conduct customer engagement activities.

▪ Resource and Technology Management	5,547	---	5,975

Provide overall business management, analysis, and administrative support to the rest of EIA and in response to requests from other components of DOE. Activities include strategic planning and program evaluation, financial and budget management, contracts management, human resource management, resource and workforce analysis, administrative services, and logistical support services.

Operate and maintain the EIA corporate infrastructure, local area network, communication equipment, and cyber-security requirements. Provide hardware, software, database, network, and other IT support to EIA offices. This support is consistent with EIA's mission requirements as a national statistical agency charged with statutory data confidentiality requirements.

Other Related Expenses	15,510	---	15,255

Other related expenses include goods and services provided through the DOE Working Capital Fund for operations. DOE is working to achieve economies of scale through an enhanced WCF. The WCF increase from FY 2012 covers certain shared, enterprise activities including enhanced cybersecurity architecture, employee health and testing services, and consolidated training and recruitment initiatives. This activity also covers employee training; other overhead expenses such as communications equipment; personal computers; and supplies, materials, and services purchased directly by EIA.

Total, Program Direction	105,000	105,643	117,000

Support Services by Category

(dollars in thousands)

	FY 2012 Current	FY 2014 Request	FY 2014 Request vs FY 2012 Current
Technical Support Services			
Data Acquisition	1,601	1,720	+119
Energy Analysis Support for Fuel Types, Supply, End Use and Energy Conversion Sectors	1,400	2,400	+1,000
Survey Development, Methodology, Sampling, & Quality Assurance	175	659	+484
Statistical Analysis	450	450	0
Forecasting and Modeling	5,545	7,336	+1,791
Survey Management	412	2,498	+2,086
Survey Operations	22,153	23,699	+1,546
System Integration and Maintenance	4,767	5,080	+313
Developing, Producing, and Disseminating Energy Products & Services	1,494	2,623	+1,129
Total, Technical Support Services	37,997	46,465	+8,468
Management Support Services			
Reports and Analyses	780	895	+115
Total, Management Support Services	780	895	+115
Total, Support Services	38,777	47,360	+8,583

Other Related Expenses by Category

(dollars in thousands)

	FY 2012 Current	FY 2014 Request	FY 2014 Request vs FY 2012 Current
Other Related Expenses			
Rent to GSA	84	0	-84
Communication, Utilities, Misc.	10	10	0
Training	390	390	0
Working Capital Fund	9,336	9,724	+388
O&M of Facilities	145	0	-145
Supplies and Materials	752	443	-309
Equipment	4,538	4,483	-55
Grants, Subsidies, Contributions	255	205	-50
Total, Other Related Expenses	15,510	15,255	-255

GENERAL PROVISIONS

(including cancellation and transfer of funds)

Sec. 301. The unexpended balances of prior appropriations provided for activities in this Act may be available to the same appropriation accounts for such activities established pursuant to this title. Available balances may be merged with funds in the applicable established accounts and thereafter may be accounted for as one fund for the same time period as originally enacted.

Sec. 302. Funds appropriated by this or any other Act, or made available by the transfer of funds in this Act, for intelligence activities are deemed to be specifically authorized by the Congress for purposes of section 504 of the National Security Act of 1947 (50 U.S.C. 414) during fiscal year 2014 until the enactment of the Intelligence Authorization Act for fiscal year 2014.

Sec. 303. Not to exceed 5 percent, or $100,000,000, of any appropriation, whichever is less, made available for Department of Energy activities funded in this Act or subsequent Energy and Water Development and Related Agencies Appropriations Acts may be transferred between such appropriations, but no such appropriation, except as otherwise provided, shall be increased or decreased by more than 5 percent by any such transfers, and any such proposed transfers shall be submitted promptly to the Committees on Appropriations of the House and Senate.

Sec. 304. None of the funds made available in this title shall be used for the construction of facilities classified as high-hazard nuclear facilities under 10 CFR Part 830 unless independent oversight is conducted by the Office of Health, Safety, and Security to ensure the project is in compliance with nuclear safety requirements.

Sec. 305. None of the funds made available in this title may be used to approve critical decision-2 or critical decision-3 under Department of Energy Order 413.3B, or any successive departmental guidance, for construction projects where the total project cost exceeds $100,000,000, until a separate independent cost estimate has been developed for the project for that critical decision.

Sec. 306. (a) The set-asides included in Division C of Public Law 111-8 for projects specified in the explanatory statement accompanying that Act in the following accounts shall not apply to such funds: "Defense Environmental Cleanup", "Electricity Delivery and Energy Reliability", "Energy Efficiency and Renewable Energy", "Fossil Energy Research and Development", "Non-Defense Environmental Cleanup", "Nuclear Energy", "Other Defense Activities", and "Science". (b) The set-asides included in Public Law 111-85 for projects specified in the explanatory statement accompanying that Act in the following accounts shall not apply to such funds: "Electricity Delivery and Energy Reliability", "Energy Efficiency and Renewable Energy", "Fossil Energy Research and Development", "Nuclear Energy", and "Science".

Sec. 307. [Of the unobligated balances from prior year appropriations available under the heading "Energy Efficiency and Renewable Energy", $69,667,000 are hereby permanently cancelled: Provided, That no amounts may be cancelled from amounts that were designated by the Congress as an emergency requirement pursuant to the Concurrent Resolution on the Budget or the Balanced Budget and Emergency Deficit Control Act of 1985, as amended]The Secretary of Energy may transfer up to $48,000,000 from any appropriation or combination of appropriations made available to the Department of Energy in this or prior Acts to any other appropriation, for the purpose of carrying out domestic uranium enrichment research, development, and demonstration activities: Provided, That any transfer pursuant to this section does not transfer funds from the national defense (050) budget function to any other budget function, or from any other budget function to the national defense (050) budget function.Note.--A full-year 2013 appropriation for this account was not enacted at the time the budget was prepared; therefore, this account is operating under a continuing resolution (P.L. 112-175). The amounts included for 2013 reflect the annualized level provided by the continuing resolution.