DOE/CF-0059
Volume 3

Department of Energy

FY 2012 Congressional Budget Request

Energy Efficiency and Renewable Energy
Electricity Delivery and Energy Reliability
Energy Transformation Acceleration Fund
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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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.

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

	FY 2010 Current Approp.	FY 2011 Cong. Request	FY 2011 Annualized CR	FY 2012 Congressional Request	FY 2012 vs. FY 2010 $	FY 2012 vs. FY 2010 %
Discretionary Summary By Appropriation						
Energy And Water Development, And Related Agencies						
Appropriation Summary:						
Energy Programs						
Energy efficiency and renewable energy	2,216,392	2,355,473	2,242,500	3,200,053	+983,661	+44.4%
Electricity delivery and energy reliability	168,484	185,930	171,982	237,717	+69,233	+41.1%
Nuclear energy	774,578	824,052	786,637	754,028	-20,546	-2.7%
Fossil energy programs						
Fossil energy research and development	659,770	586,583	672,383	452,975	-206,795	-31.3%
Naval petroleum and oil shale reserves	23,627	23,614	23,627	14,909	-8,718	-36.9%
Strategic petroleum reserve	243,823	138,861	243,823	121,704	-122,119	-50.1%
Northeast home heating oil reserve	11,300	11,300	11,300	10,119	-1,181	-10.5%
Northeast home heating oil reserve oil sale	0	0	0	-79,000	-79,000	N/A
Total, Fossil energy programs	938,520	760,358	951,133	520,707	-417,813	-44.5%
Uranium enrichment D&D fund	573,850	730,498	573,850	504,169	-69,681	-12.1%
Energy information administration	110,595	128,833	110,595	123,957	+13,362	+12.1%
Non-Defense environmental cleanup	254,673	225,163	244,673	219,121	-35,552	-14.0%
Science	4,963,887	5,121,437	4,903,710	5,416,114	+452,227	+9.1%
Energy transformation acceleration fund	0	299,966	0	550,011	+550,011	N/A
Nuclear waste disposal	98,400	----	98,400	0	-98,400	-100.0%
Departmental administration	168,944	169,132	168,944	128,740	-40,204	-23.8%
Inspector general	51,927	42,850	51,927	41,774	-10,153	-19.6%
Title 17 - Innovative technology loan guarantee program	0	500,000	-15,000	200,000	+200,000	N/A
Section 1705 temporary loan guarantee program	0	----	0	0	——	——
Advanced technology vehicles manufacturing loan	20,000	9,998	20,000	6,000	-14,000	-70.0%
Better building pilot loan guarantee initiative for Universities, Schools, and Hospitals	0	0	0	105,000	+105,000	N/A
Total, Energy Programs	10,340,250	11,353,690	10,309,351	12,007,391	+1,667,145	+16.1%
Atomic Energy Defense Activities						
National nuclear security administration:						
Weapons activities *	6,386,371	7,008,835	7,008,835	7,629,716	+620,881	+8.9%
Defense nuclear nonproliferation *	2,131,382	2,687,167	2,136,709	2,549,492	-137,675	-5.1%
Naval reactors *	945,133	1,070,486	945,133	1,153,662	+83,176	+7.8%
Office of the administrator *	410,754	448,267	410,754	450,060	+1,793	+0.4%
Total, National nuclear security administration	9,873,640	11,214,755	10,501,431	11,782,930	+568,175	+5.1%
Environmental and other defense activities:						
Defense environmental cleanup	5,640,371	5,588,039	5,642,331	5,406,781	-233,590	-4.1%
Other defense activities	847,468	878,209	847,468	859,952	+12,484	+1.5%
Defense nuclear waste disposal	98,400	0	98,400	0	-98,400	-100.0%
Total, Environmental & other defense activities	6,586,239	6,466,248	6,588,199	6,266,733	-319,506	-4.9%
Total, Atomic Energy Defense Activities	16,459,879	17,681,003	17,089,630	18,049,663	+248,669	+1.5%
Power marketing administrations:						
Southeastern power administration	0	0	0	0	——	——
Southwestern power administration	13,076	12,699	13,076	11,892	-1,184	-9.1%
Western area power administration	109,181	105,558	109,181	95,968	-13,213	-12.1%
Falcon & Amistad operating & maintenance fund	220	220	220	220	——	——
Colorado River Basins	-23,000	-23,000	-23,000	-23,000	——	——
Total, Power marketing administrations	99,477	95,477	99,477	85,080	-14,397	-14.5%
Federal energy regulatory commission	0	0	0	0	——	——
Subtotal, Energy And Water Development and Related Agencies	26,899,606	29,130,170	27,498,458	30,142,134	+1,901,417	+6.7%
Uranium enrichment D&D fund discretionary payments	-463,000	-696,700	-463,000	0	+463,000	+100.0%
Excess fees and recoveries, FERC	-10,933	-29,111	-28,886	-25,072	-14,139	-129.3%
Subtotal, Discretionary Funding	26,425,673	28,404,359	27,006,572	30,117,062	+2,350,278	+8.5%
Strategic petroleum reserve sale	0	0	0	-500,000	-500,000	N/A
Cancellation of prior year unobligated balances	0	0	0	-70,332	-70,332	N/A
Total, Discretionary Funding **	26,425,673	28,404,359	27,006,572	29,546,730	+3,121,057	+11.8%

NOTE: * FY12 is compared against the FY11 Request. This exception has been implemented for NNSA only.
** The Total, Discretionary Funding, FY12 vs FY10 "$" and "%" columns, reflects a comparison of FY12 Request vs. FY10 Current Approp for all programs including NNSA

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, $3,200,053,000, to remain available until expended . (Energy and Water Development and Related Agencies Appropriations Act, 2010.)

Note.—A full-year 2011 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. 111–242, as amended). The amounts included for 2011 reflect the annualized level provided by the continuing resolution.

Energy Efficiency and Renewable Energy
Office of Energy Efficiency and Renewable Energy
Overview
Appropriation Summary by Program

(dollars in thousands)

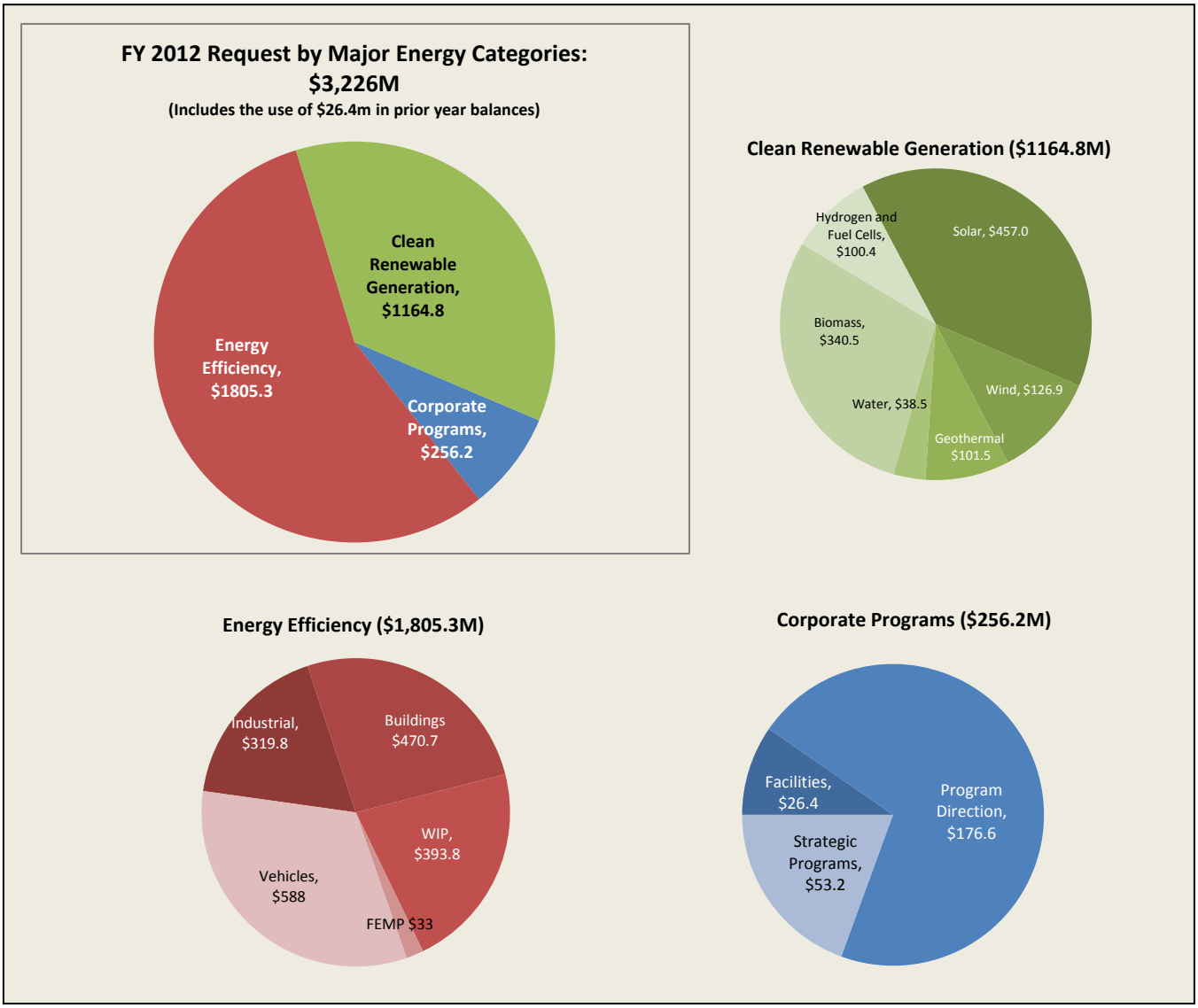
	FY 2010 Current Approp[a]	FY 2011 CR	FY 2012 Request
Energy Efficiency and Renewable Energy (EERE)			
Hydrogen & Fuel Cell Technologies	170,297	0	100,450
Biomass & Biorefinery Systems RD&D	216,225	0	340,500
Solar Energy	243,396	0	457,000
Wind Energy	79,011	0	126,859
Geothermal Technology	43,120	0	101,535
Water Power	48,669	0	38,500
Vehicle Technologies	304,223	0	588,003
Building Technologies	219,046	0	470,700
Industrial Technologies	94,270	0	319,784
Federal Energy Management Program	32,000	0	33,072
Facilities and Infrastructure	19,000	0	26,407
Weatherization and Intergovernmental Activities	270,000	0	393,798
Program Direction	140,000	0	176,605
Strategic Programs	45,000	0	53,204
Congressionally Directed	292,135	0	0
Subtotal, EERE	2,216,392	2,242,500	3,226,417
Use Of Prior Year Balances	0	0	-26,364
Total, EERE	2,216,392	2,242,500	3,200,053

[a] SBIR/STTR funding transferred in FY 2010 was $23,310,200 for the SBIR program and $2,797,220 for the STTR program.

Preface

The Office of Energy Efficiency and Renewable Energy (EERE) requests $3.2 billion in FY 2012 including the use of $26,364 in prior year balances. EERE's research, development, demonstration, and deployment (RDD&D) activities are critical to meeting the Nation's goals of growing our economy and keeping America competitive in the 21st century by developing cutting-edge technologies with real-world applications that dramatically reduce energy consumption, GHG emissions and oil consumption and diversify our electricity generation. EERE programs provide a vital link between advances in basic research and Administration efforts to commercially deploy clean energy technologies. EERE does this by supporting applied research, technology development, and demonstrations of clean energy technologies that have the potential to be cost competitive with conventional alternatives. EERE coordinates with the Office of Science on fundamental research, and with ARPA-E on the development of breakthrough technologies. These activities also help inform national policies that can create markets for widespread deployment of innovative technologies. EERE also works in close partnership with state and local organizations to achieve these objectives.

The FY2012 programs fall into three major categories:



First, EERE will achieve **rapid gains in the efficient use of energy** by supporting the development of cost-effective new building systems that can reduce commercial and residential energy use; enabling a vigorous building energy retrofit industry capable of providing comprehensive energy retrofits for the bulk of America's buildings over the next 15 years; and, supporting innovations in materials and manufacturing processes that will increase the energy productivity of US industry and make US firms more competitive in global markets. It does this both through research, development, and demonstration (RD&D) and working to encourage rapid adoption and use of new technology by encouraging innovative financing, codes and standards, improved consumer information, and other methods.

Second, it will ensure the continued availability of affordable transportation for people and freight that does not depend on petroleum by supporting RD&D on a portfolio that would make the United States the **world leader in new transportation technologies** based on electricity, renewable fuels, and other advanced technologies. It also works to ensure that the infrastructure needed to deliver new energy technologies and fuels will be available.

Third, EERE RD&D will achieve **rapid growth in renewable energy** supplies using biomass, wind, solar, geothermal, water power, fuel cells, and other energy technologies to produce competitive sources of fuels and electricity. EERE works with utilities and other partners to ensure rapid adoption of new renewable technologies providing technical information, technical analysis, and other resources.

Mission

Energy Efficiency and Renewable Energy (EERE) supports research, development, demonstration, and deployment activities on technologies essential for meeting national security goals by reducing dependence on oil, meeting environmental goals by minimizing the emissions associated with energy production and use, and stimulating economic growth and job creation by minimizing the cost of energy services and stimulating investment in US businesses.

RAPID GROWTH IN RENEWABLE ENERGY

One way the Recovery Act helped the U.S. move toward growth in the renewable energy sector by retooling manufacturing plants to make parts for technologies such as wind and solar.

Benefits

Benefits are estimated in terms of reduced cost of energy services, reduced greenhouse gas and other emissions resulting from energy production and use, and reduced use of oil. EERE will continue to refine its strategic planning methodology and analytical toolkit this year.

Strategic Plan, Implementation

The FY 2012 EERE budget planning process began with a detailed review of how energy is now used in the US, where the energy is obtained, and how federal research and other programs would support the Department's goals and achieve the greatest benefits.

The Department is in the process of updating its strategic plan, and has been actively engaging stakeholders including Congress. The draft strategic plan is being released for public comment concurrent with this budget submission, with the expectation of official publication this spring. The

draft plan and FY12 budget are consistent and aligned. Updated measures will be released at a later date and available at the following link http://www.mbe.doe.gov/budget/12budget/index.htm.

The achievement of RDD&D goals, objectives and strategies by EERE's programs will yield significant short- and long-term results in areas critical to reducing GHG emissions, deploying clean, secure energy, and enhancing economic prosperity.

High-Priority Performance Goals (HPPGs)

The FY 2012 EERE budget request and activities proposed contribute to several HPPGs to:

- Double renewable energy generation (excluding conventional hydropower and biomass) from 2008 to 2012.
- Assist in the development and deployment of advanced battery manufacturing capacity to support 500,000 plug-in hybrid electric vehicles a year by 2015.
- Work with HUD to enable the cost-effective energy retrofits of a total of 1.1 million housing units. Of this number, DOE programs will contribute to retrofits of an estimated one million housing units.

The performance measures for EERE programs are aligned with these goals as well as the goals previously cited, and tracking their progress toward this end in FY 2012. Additional information on the intermediate performance critical to the achievement of these goals is provided at www.performance.gov.

FY 2012 Budget Highlights

Planning, Evaluation, and Transparency

EERE's budget will ensure robust, transparent, and accountable program management and support functions that will efficiently and effectively execute and inform EERE's critical mission. EERE programs will leverage their planning, analysis and deployment funds by collaborating with Strategic Programs (formerly Program Support) activities to maximize the effectiveness of program and corporate activities for EERE and DOE through integrated planning and resource utilization. Efforts include integrated strategic planning, collaboration and coordination initiatives and first-of-a-kind in-depth studies of the future of energy use in transportation, buildings, industry, and electric utilities. Collaborative efforts make EERE more productive as they reduce unnecessary overlap; coordinate and expand the possible scope of interdependent activities; and that EERE resources are optimized to meet National goals in energy security, environmental quality, and economic growth.

Energy Efficiency

EERE's FY 2012 portfolio will achieve rapid gains in the efficient use of energy through research that can dramatically increase energy efficiency for less than the cost of new energy resources, without sacrificing functionality or safety. EERE's energy efficiency programs have been rebalanced to create an effective portfolio of long-term research and development, market priming to speed the market acceptance of new technologies and practices, and efforts to achieve short term objectives such as appliance standards.

In buildings, the FY 2012 budget focuses the Administration's Better Buildings Initiative – that seeks to achieve a 20 percent improvement in commercial building energy efficiency by 2020. In addition, buildings activities will drive the deployment and integration of advanced building components (next generation lighting, heating and refrigeration devices, sensors and controls, windows, shell materials,

etc.) and methods to accelerate the adoption of new efficiency technologies (appliance standards, the development and adoption of new building codes, building rating programs, innovative financing, support for building retrofits, etc) . In industry, the budget focuses on research on new, inherently low embodied energy materials, radically improved manufacturing processes and specialized topics such as combined heat and power (CHP) and energy for computer centers. EERE teams work directly with industry to help audit their facilities, identify cost-effective upgrades and encourage rapid adoption of efficiency technology.

Buildings Technologies ($470.7M): FY 2012 funding will focus on large, untapped near term energy savings such as low cost retrofits for the large existing building stock. EERE Building Technology Program (BTP) is joining with industry partners to release a new design specification for 10-ton capacity commercial air conditioners. When built according to the criteria of the new specifications, the high-efficiency rooftop units are expected to reduce energy use by as much as 50 to 60 percent over equipment being replaced. Other component technology research fills identified gaps in technical performance and/or cost reduction needed to accelerate market penetration. Also in FY 2012, BTP will convene researchers and innovative thinkers from across disciplines at the building technology Energy Innovation Hub to reach breakthroughs in building efficiency, as well as continuously improve and replicate the results from the Recovery Act Better Buildings projects and expand the Home Energy Score Pilot into a national program. BTP will complete 8 energy efficiency standards while working on 42 product classes. Lastly, DOE is requesting $100 million for a new major competitive program to demonstrate innovative approaches to improve the efficiency of the commercial and industrial sector. The request also includes $60 million in FY12 to launch a major initiative for cost effective energy efficient retrofits in commercial buildings.

Federal Energy Management Program ($33.1M): FEMP will maintain or improve the level of service to Federal agencies through improved quality of assistance and leveraging other EERE resources. There will be increased emphasis on new technology deployment, support for development of agency GHG reduction initiatives, increased support for building-level assessments of cost-effective measures, oversight of alternative financing mechanisms, and support for sustainable design and building commissioning. FEMP is assisting Federal Agencies in reaching the Executive Order 13514 goal to reduce federal GHG emissions by 28 percent by FY 2020 from a FY 2008 baseline. DOE's new Sustainability Performance Office will facilitate DOE's progress with this Executive Order.

Industrial Technologies ($319.8M): The Industrial program will support advanced industrial technologies to help re-invigorate existing industries while supporting the growth and development of new industries here in the U.S. The program will provide a balanced portfolio of advanced R&D and complimentary near-term low cost deployment opportunities with the objectives of increasing U.S. competitiveness, enhancing clean energy manufacturing, and improving energy productivity. There will be a focus on next generation manufacturing processes and materials, activities for clean energy manufacturing, upgrade of existing facilities with energy efficient technologies, and refocused efforts for Industrial Technical Assistance to achieve greater results with less funding through more effective leveraging of funding for deployment partnerships. Included is a new critical materials energy innovation hub.

Weatherization & Intergovernmental Programs ($393.8M): The Weatherization and Intergovernmental Program will focus on lowering consumers energy bills by increasing the efficiency of their buildings. The program will transition from the high levels of Recovery Act funding to sustainable approaches using a combination of formula and competitive grants. For example, high impact competitive grants through Innovations in Weatherization ($97M) will demonstrate methods that reduce weatherization costs, increase leveraging of Federal investment, and improve savings.

Renewable Generation

Renewable Generation programs will position the United States as the global leader in developing and manufacturing cutting-edge clean energy technologies. The programs will drive rapid growth in renewable generation with technologies that produce competitive sources of electricity at full price parity with conventional alternatives by driving innovation and investment in our nation's energy infrastructure, thereby catalyzing economic growth and creating American jobs. The FY 2012 budget generally places increased emphasis on R&D at early and mid-stage Technology Readiness Levels (applied research and development), and less on deployment activities. Resources are focused on early-stage research where industry is unable to fully fund activities on their own. Cost-shared partnerships with industry, academia and other research institutions are established to make technologies more cost-competitive and reliable. Demonstrations will be used on a very selective basis to validate economic and performance data needed for commercial deployment. Priority research includes increasing the efficiency and lowering the manufacturing costs of solar devices to $1 per Watt installed when deployed at scale; increasing the cost-competitiveness of off-shore wind energy; support for both cost-effective low-temperature geothermal systems and high-risk/high-payoff work in enhanced geothermal systems; programs that can upgrade the efficiency and capacity of conventional hydroelectric systems without damaging the environment; and innovative marine hydrokinetic devices.

EERE also supports complementary programs designed to accelerate the introduction of these technologies including work to address the challenge of integrating intermittent electric resources into utility systems, and work in utility policy and building codes that can remove barriers to rapid introduction of renewables. Energy storage systems will also be an important part of this investment. Together, these shifts in R&D activities provide the necessary foundation to drive clean energy penetration into the market at the speed and scale envisioned by the Administration.

Solar ($457M): A major objective is to achieve a $1 per Watt installed price for solar electricity before the end of the decade, called the "SunShot Initiative". This would mean that solar energy would be competitive with conventional electric generation in most parts of the US and the world. The Program is pursuing this goal in collaboration with the Office of Science and the Advanced Research Projects Agency- Energy (ARPA-E). The program will drive transformative research looking at next-generation technologies as well as programs designed to improve the performance and drive down the cost of photovoltaic modules, power electronics, and balance of system costs. The program also encourages Systems Integration by developing radically new approaches to reduce the cost and improve reliability and functionality of power electronics and supporting industry development through test and evaluation standards, and tools for understanding grid integration issues. The Balance of Systems-Software (BOS-Software) subprogram will refocus on quantitatively non-hardware related Balance of Systems (BOS) costs including delays in permitting, streamlined permitting, inspection, and interconnection and perform key analyses of policy options that can accelerate the rapid deployment of solar technologies through the use of innovative Information Technology solutions. The Concentrating Solar Power subprogram invests heavily in thermal storage and supporting systems research and optimization to provide baseload power on demand. The Solar Demonstration Zone will enter its second year of funding with resources focused on achieving SunShot goals.

DOE 1.5MW research wind turbine installed at the National Wind Technology Center (NWTC) in Colorado

Wind ($126.9M): The Wind Program supports a broad R&D portfolio of land-based and offshore wind systems at small, medium, and utility-scale to achieve clean energy goals. EERE will continue to increase focus on offshore wind. In conjunction with the Department of the Interior approval of the first offshore wind farm in the U.S., the DOE has launched an initiative to accelerate the rapid and responsible development of America's vast offshore wind resources. EERE will also continue to develop a strong reliability program for land-based turbines. R&D activities focus on analysis, innovative marine platform designs, testing, and integration of advanced components and systems to reduce the cost of energy from wind power and to contribute to positioning the United States as a global leader in developing and manufacturing cutting-edge clean energy technologies. The Program also supports activities to enable wind energy interconnection with the transmission grid, assure power quality and accurately characterize the wind resource so as to spur innovation and investment in our nation's energy infrastructure, catalyzing economic growth and creating American jobs. R&D funding will also improve advanced manufacturing for materials technologies related to wind energy, development of codes and standards for domestic manufacturing and supply chains; and analysis, research, and technical support in collaboration with appropriate agencies to address radar issues, environmental concerns, and regulatory barriers. Funding also supports removing market barriers through efforts to improve the dissemination and use of objective, factual wind energy technology and economic data.

Conventional Hydropower Turbine

Water ($38.5M): The Water Power Program funds cost-shared R&D of innovative water power technologies in order to further develop renewable power generation from water resources in a cost-effective and environmentally responsible manner. This program also supports a wide range of water power resource assessments, environmental studies, advanced modeling, and cost assessments, and other activities aimed at demonstrating the viability, reducing market barriers and accelerating deployment of these innovative technologies. The program's goal is to (1) significantly increase generation from existing hydropower resources, and (2) demonstrate marine and hydrokinetic technologies as viable option within our nation's renewable energy portfolio. To maximize the speed and scale of clean energy implementation, funding is increased for low-cost efficiency, capacity upgrades and operational improvements of conventional hydropower. Funding for Marine and Hydrokinetic Technologies will be used to test devices with the aim of establishing baseline cost of energy and performance.

Geothermal ($101.5M): The Geothermal Technologies Program (GTP) is developing cost-effective ways to exploit the enormous and diverse geothermal energy resources. The program will expand its focus beyond high-risk, high-payoff Enhanced Geothermal Systems technologies to a more balanced portfolio that will include low-

temperature, coproduced, geopressured, and undiscovered hydrothermal resources that have near-term impacts. In FY 2012, in addition to EGS, the Program will pursue four other activities: (1) Low Temperature and Coproduced Resources will expand geothermal energy development to new areas in the United States, (2) Permeable Sedimentary Resources will investigate the opportunity for heat mining in permeable sedimentary reservoirs, (3) Innovative Exploration Technologies will develop new methods and explore undiscovered hydrothermal resources, and (4) Systems Analysis will continue development of analytical tools aimed at reducing geothermal development costs and risks.

Advanced Fuels and Vehicles

Advanced Fuels and Vehicles programs are shifting to a portfolio of new transportation technologies based on electricity, renewable fuels, and advanced technologies that can decouple the U.S. vehicle fleet from fossil fuels. These programs will also enable rapid growth in renewable fuels with technologies that produce cost competitive alternatives to petroleum-based fuels. For FY 2012, vehicle work will focus heavily on new generations of hybrid electric vehicles, plug-in hybrids, electric vehicles, and highly efficient trucks. Investments in infrastructure, and early deployment and field validation of advanced technologies will facilitate rapid introduction of these technologies by gathering critical performance and economic data needed for commercialization. In advanced fuels, priority work includes biomass conversion technologies that can produce bio-based hydrocarbon fuels that face no blend limits in aviation or diesel fuel, and are completely compatible with existing distribution infrastructure. Fuel cell research will continue to focus on cost reductions and durability while new cost competitive forms of renewable hydrogen will be developed. EERE will also support programs designed to accelerate the introduction of these technologies, including the testing of fuels and dispensing equipment so that they can move into the marketplace.

Accelerating the development of electric vehicle charging infrastructure and deployment. Pictured; a residential vehicle charger.

Vehicle Technologies ($588M): To accelerate the introduction and market acceptance of electric vehicles, the Program is greatly expanding its emphasis on the electrification of the vehicle (i.e., new generations of hybrid electric vehicles, plug-in hybrids, electric vehicles) through research and development of batteries and power electronics, systems R&D on the electric drive to improve performance and cost, development of EV supporting infrastructure (e.g., advanced chargers, streamlined codes and standards), and efforts to reward communities for leadership in reducing regulatory barriers and developing comprehensive electric vehicle-friendly infrastructure. In addition, the Program is focused on developing highly efficient trucks, the testing of non-petroleum fuels so that they can move seamlessly into the marketplace and other work that will facilitate rapid introduction of these technologies, accumulating 112 million miles of plug-in hybrid and electric vehicle testing by 2015.

Biomass & Biorefinery Systems RD&D ($340.5M): Increased emphasis is placed on basic and applied R&D with an initiative to enable biomanufacturing in collaboration with ARPA-e and the Office of Science. The program is developing thermochemical and biochemical conversion pathways for stable biofuel intermediates that can be used to make hydrocarbon biofuels and environmentally and economically sustainable algae and advanced feedstocks. Continued improvement and innovation will reduce the cost of feedstock logistics. The demonstration and commercial deployment of cutting-edge conversion technologies in integrated biorefineries will also continue, validating these new technologies at scale and reducing investor risk. To provide market surety for new cellulosic biorefineries coming on

line, the Biomass & Biorefinery Systems RD&D Program will rapidly infuse $150M into the industry through a Cellulosic Biofuels Reverse Auction. A biopower R&D initiative will provide a renewable electricity alternative for regions of the Nation that lack other renewable options, such as wind or solar. In 2012, the Biomass & Biorefinery Systems RD&D Program's major cost performance target for cellulosic ethanol will come due, with the program striving to achieve a modeled cost for mature technology of less than $3.00per GGE (less than $2.00per gallon of ethanol), based on the technical performance of its improved biofuels conversion technologies.

Hydrogen and Fuel Cell Technologies ($100.5M): The program will focus on critical R&D to reduce costs and improve the performance of hydrogen and fuel cell technologies primarily through activities in TRLs 2 and 3. The program continues to pursue a balanced portfolio for diverse applications in stationary, portable, and transportation sectors. The program also will include R&D to enable integrating intermittent renewables into the grid, through the use of hydrogen for energy distribution and storage. A key goal in 2012 will be to achieve a catalyst specific power of 6 kW per gram of platinum group metal compared to 2.8 kW per gram in 2008. These activities contribute to the development of a more diverse and efficient energy infrastructure and help to ensure the U.S. stays competitive in emerging clean energy technologies.

Corporate Programs

Program Direction ($176.6M): Program direction provides for Federal staff salaries and benefits, the DOE Working Capital Fund, office space, travel, training, and contractor support services. This funding allows EERE to strengthen program and project management, as well as improve monitoring and oversight functions.

Strategic Programs ($53.2M): Formerly Program Support, these activities support EERE corporate priority efforts, including: communications and outreach; legislative affairs; regulatory affairs; strategic priorities and analysis; innovation and deployment; education and training; and international.

Facilities and Infrastructure ($26.4M): Funding requested supports essential maintenance, repair, and equipment replacement requirements at the National Renewable Energy Laboratory (NREL). In addition, it supports Safeguards and security activities at NREL, which provides a safe work environment for the research and support staff and the protection of property, both physical and intellectual.

High-Priority FY 2012 investments include the following activities:

- **Buildings**: Additional funding is allocated to the Better Buildings Initiative to retrofit commercial buildings (>35 percent of U.S. electricity demand) critical to achieving Administration goals for improving energy efficiency and improving competitiveness. The initiative will:
    - Increase integrated commercial buildings technical research to develop and demonstrate new retrofit practices, technologies, and tools for the many types of commercial buildings across the country, and
    - Initiate a major competitive program to encourage states and municipalities to upgrade building codes, performance standards and regulations to increase commercial building energy efficiency.
- **Accelerated Cost Reduction for Photovoltaics (PV):** The SunShot initiative will reduce the total costs of photovoltaic energy systems by about 75 percent so that they are cost competitive at large scale with other forms of electricity without subsidies. Without an accelerated effort on

PV, the U.S. will lose its technical edge and solar energy manufacturing will not remain competitive with other countries. While the EERE effort primarily focuses on the module and balance of system, it will be closely coordinated with ARPA-E in power electronics and other areas. Collaborations with the Office of Science Energy Frontier Research Centers and other programs will enable basic research discoveries to be applied to fundamental questions related to PV devices.

- **Competitive Offshore Wind:** Efforts to develop cost-competitive offshore wind energy by 2020 continue to expand. Funding will be used to start a new cost-shared, public-private demonstration project to more clearly pinpoint research areas of focus for cost reduction and to provide performance and economic data necessary for initial commercial deployment.
- **Innovation in Manufacturing & Materials:** Funding for the Industrial program is increased to help drive a U.S. manufacturing renaissance based on next generation processes and materials. R&D efforts will advance transformational manufacturing technologies and next generation materials; and help enable major cost reductions in manufacturing energy ef**ficiency devices (lighting**, windows, and batteries) and renewable energy technologies (wind blades, power conversion, and PV arrays).
- **Innovations in Weatherization:** The expansion of this activity will support high impact competitive grants to demonstrate methods which reduce weatherization costs, increase leveraging of Federal investment, and improve savings. The Innovations in Weatherization network will conduct 50 pilot projects and result in an additional 15,000 energy retrofits for low income families.

Basic and Applied R&D Coordination

Coordination between the Department's basic research and applied technology programs is a high priority for EERE, the Office of Science and other program offices. The Department has a responsibility to coordinate its basic and applied research programs to effectively integrate R&D by the science and technology communities (e.g., National Laboratories, universities, and private companies) that support the DOE mission. Efforts have focused on improving communication and collaboration between Federal program managers and increasing opportunities for collaborative efforts targeted at the interface of scientific research and technology development to accelerate DOE mission and national goals.

Coordination between the basic and applied programs is also enhanced through joint programs, jointly-funded scientific facilities, and the program management activities of the DOE Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) programs. Additionally, co-funding research activities and facilities at the DOE laboratories and funding mechanisms that encourage broad partnerships (e.g., Funding Opportunity Announcements) are means by which the Department facilitates greater communication and research integration within the basic and applied programs. EERE will work closely with DOE's Office of Science and the Advanced Research Projects Agency – Energy (ARPA-E) to ensure that cutting edge technology innovations are accelerated into the commercial marketplace research communities. EERE also utilizes the DOE Hubs to focus on problems that are ripe for the close integration of discovery-oriented science with translational engineering research so that they can quickly seize opportunities for commercialization.

Power Electronics: Our future electric systems will need cost-effective, high-capability power electronic components and devices—that can only be enabled by research in advanced materials and manufacturing processes—to control and link complex HVDC networks, measure and control flow, and reduce energy losses in long-distance transmission. Advanced materials need to be demonstrated in

devices and applications that can handle appropriate power and voltage requirements that are needed to reliably control and connect the varying forms of electric generation and consumption (and intermediate components) into an integrated system. The urgency to advance cost-effective power electronics systems is already growing. A targeted effort by the Department, integrated with efforts from materials and device manufacturers (e.g., semiconductor industry), can lead to US manufacturers capturing the lead in the global market for devices and systems. Goals include significant advancements in the cost, reliability, and performance of power electronic devices and systems. This will be a collaborative initiative with the Office of Science, ARPA-E and the Office of Electricity Delivery and Energy Reliability.

Key FY 2010 Accomplishments

In FY 2010, the **Hydrogen and Fuel Cell Technologies** program reduced the modeled high-volume production cost of fuel cells to $51kW, a 16 percent cost reduction from FY 2009 and more than an 80 percent cost reduction compared to the baseline cost of $275/kW in 2002. Also in fuel cells, the non-platinum group metal catalyst performance improved by more than 100X since 2008, exceeding the 2010 target of 130 A/cm^3 at 0.80V. The program reduced the water electrolyzer cost by over 20 percent via a 55 percent reduction in catalyst loading using new processing techniques. The program exceeded the 2010 Recovery Act fuel cell installation target by more than 90 percent with 230 fuel cells installed.

Biomass and Biorefinery Systems RD&D has validated sustained operations at one of its cellulosic ethanol biorefinery projects having 1.4 MGY (million gallons per year) capacity, and has brought another plant with 2.5 MGY biofuel capacity online. Additionally, the NEPA compliance process was completed for over 75 percent of the program's integrated biorefinery projects. In partnership with the Vehicle Technologies Program, the program also completed ethanol blends testing for vehicles 2007 and newer, supporting an EPA waiver decision on E15. Conversion technology efficiency was also improved measurably. For biochemical conversion, the program has demonstrated >85 percent intermediate sugars production from the conversion of oligomers to simple sugars (xylan to xylose). For thermochemical conversion, >90 percent CH_4 conversion to syngas has been achieved. In addition, feedstock logistics costs were also significantly reduced from $46.15 per dry ton to $37.80 per dry ton.

Solar Energy, in collaboration with SunPower, developed and is commercially producing 20 percent efficient crystalline silicon PV modules after a multi-year development effort. Abengoa Solar built a 4 MW demonstration CSP plant demonstrating that the heat produced by a solar facility can increase the efficiency and decrease the carbon footprint of a conventional plant.

Geothermal Technologies dramatically expanded its portfolio under the Recovery Act, awarding 151 projects - totaling up to $368.2 million - including EGS R&D and demonstrations, low temperature, coproduced fluids, ground source heat pumps and innovative exploration technologies. With GTP support, GE Global developed a high temperature circuit chip for down hole sensing up to 300 degrees C, a notable milestone in the field of high temperature electronics.

Wind Power Several significant initiatives were launched to access the 4,150 GW offshore wind resource, including the publication of a draft Strategic Plan for public comment and a Memorandum of Understanding (MOU) between the Department of Energy and the Department of Interior to ensure resources and expertise from both agencies to support commercial-scale projects on the Outer Continental Shelf. The DOE Wind program hosted several major workshops and published nationally significant studies that addressed the highest priorities for wind energy deployment such as new cost of energy analysis, transmission planning studies, radar interference mitigation, turbine reliability, and wind resource forecasting. Major R&D milestones included installation of two utility-scale, research

turbines at the National Wind Technology Center, finalization of Non-Destructive Inspection standards, and testing of highly instrumented innovative rotor designs.

Water Power completed the initial model of a radically redesigned Francis hydropower turbine with improved environmental performance, and competitively awarded Recovery Act funds to increase generation between 7 percent and 30 percent at seven existing hydropower projects The program also executed a Memorandum of Understanding (MOU) between the Department of Energy, the Department of Interior, and the Army Corps of Engineers This MOU will focus on increasing energy generation at federally-owned facilities and explore opportunities for new development of low-impact hydropower The Program also awarded funding to 27 innovative marine and hydrokinetic (MHK) technologies across a range of technology readiness levels, in order to advance the commercial readiness of this innovative suite of new renewable energy technologies, and released the MHK Siting and Regulatory Handbook to assist stakeholders in the state and federal licensing process.

Vehicle Technologies lowered the cost of plug-in hybrid electric vehicles (PHEV) batteries to $800 per kWh in Energy Storage; demonstrated efficiency improvements for gasoline engines that can potentially double the fuel economy of passenger vehicles on real-world driving cycles; completed a Magnesium front end design with a 45 percent weight reduction compared to a conventional steel design; developed a cost-neutral, advanced high strength steel chassis component with a 28 percent weight reduction compared to a standard component; and Clean Cities coalitions and VTP deployment initiatives contributed to the reduction of over 500 million gallons of petroleum use during 2010 and helped to open over 400 new electric & alternative fuel fueling stations.

Building Technologies (BTP) established new energy conservation standards for five products; completed two test procedure final rules and more than doubled the pace of rulemaking publications in preparation for a ramp-up in future conservation standards; and provided key research for the successful commercialization of the solid state lighting (SSL) lamp, which has an energy savings of 81 percent over traditional lamps. Also in SSL, the Program developed and facilitated the scale adoption of technology and performance specifications for light-emitting diode (LED) refrigerated case lighting, LED parking lot lighting, and high efficiency lighting for parking structures, with projected savings of about 50 percent. In other areas of research, BTP successfully commercialized dynamic insulation, a new Energy Star Hybrid Heat Pump Water Heater with an Energy Factor (EF) of 2.35, and a low-cost solar water heating system.

Industrial Technologies has awarded 47 industrial energy efficiency grand challenge concept grants that support the development of transformational industrial processes, technologies, and materials. The program initiated 14 projects that support the development of new technologies to improve energy efficiency in the information and communication technology sectors, funded by the Recovery Act. The program also launched a new industry partnership program in which companies commit to reduce their energy intensity by 25 percent or more in 10 years; as of December 2010, 104 companies had signed this pledge.

The **Federal Energy Management Program** awarded an unprecedented $589 million in Energy Savings Performance Contract (ESPC) projects. FEMP also trained over 1,000 people in Utility Energy Service Contracts, Power Purchase Agreements, and ESPCs. FEMP awarded and completed 120 agency energy and efficiency projects funded by the Recovery Act.

Weatherization and Intergovernmental Activities utilized annual appropriations and approximately $11.5 billion in Recovery Act funds to support over 2,500 innovative State, Tribal, and local energy projects including: clean energy project planning and deployment; energy savings performance contracting; sustainable energy efficiency finance mechanisms; renewable energy certificate trading

programs; energy efficiency-based utility incentives; green workforce training in residential energy retrofit; and the weatherization of additional homes.

Facilities and Infrastructure completed two major EERS projects at the National Renewable Energy Laboratory. The Integrated Biorefinery Project, completed in July, provides the Nation a unique continuous process research and development capability to accelerate the production of ethanol from cellulose. The Research Support Facility, completed in June, consolidates the majority of NREL operations into a building that demonstrates EERE's leadership in energy modeling, efficient design, and renewable technologies. Both projects were completed at cost, in scope, and on time, and serve as examples of how to create ultra-energy efficient projects today. The Research Support Facility ($80M) and Integrated Biorefinery Facility ($20M) were both completed at cost, scope, and schedule and commissioned for use.

Indirect Costs and Other Items of Interest

Institutional General Plant Projects (IGPPs)

Institutional General Plant Projects (IGPPs) are miscellaneous construction projects that are less than $10 million and are of a general nature (cannot be allocated to a specific program). IGPPs support multi-programmatic and/or inter-disciplinary programs and are funded through site overhead.

Current projects include: safety and security improvements; replacement of building systems and components; replacement, and upgrades to building and site utilities; site wide energy efficiency improvements; reconfigurations of existing buildings to accommodate changes or growth in RDD&D programs or research support needs; upgrades to the primary site access point; and other site improvements to maintain the viability of EERE's capital investments at NREL. The following table displays IGPP funding by site.

(dollars in thousands)

	FY 2010 Current Approp	FY 2012 Request
Institutional General Plant Projects (IGPP)		
National Renewable Energy Laboratory	10,000	11,515
Total, IGPP	10,000	11,515

Facilities Maintenance and Repair

DOE'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.

Indirect-Funded Maintenance and Repair

(dollars in thousands)

	FY 2010 Current Approp	FY 2012 Request
National Renewable Energy Laboratory	2,504	4,261
Total, Indirect-Funded Maintenance and Repair	2,504	4,261

Direct-Funded Maintenance and Repair

(dollars in thousands)

	FY 2010 Current Approp	FY 2012 Request
National Renewable Energy Laboratory	0	3,300
Total, Direct-Funded Maintenance and Repair	0	3,300

Office of Energy Efficiency and Renewable Energy

Funding by Site by Program

(dollars in thousands)

	FY 2010 Current Approp	FY 2012 Request
Ames Laboratory		
Wind Energy	11	0
Vehicle Technologies	2,000	2,000
Industrial Technologies	699	0
Strategic Programs	0	100
Total, Ames Laboratory	2,710	2,100
Argonne National Laboratory (East)		
Hydrogen and Fuel Cell Technologies	16,917	10,100
Biomass and Biorefinery Systems R&D	2,500	3,550
Solar Energy	850	0
Wind Energy	1,096	274
Geothermal Technology	400	1,000
Water Power	1,046	1,355
Vehicle Technologies	35,424	35,000
Building Technologies	0	2,697
Industrial Technologies	5,853	0
Federal Energy Management Program	150	0
Strategic Programs	610	460
Total, Argonne National Laboratory	64,846	54,436
Brookhaven National Laboratory		
Hydrogen and Fuel Cell Technologies	2,393	1,400
Solar Energy	470	490
Vehicle Technologies	1,250	1,200
Strategic Programs	740	845
Total, Brookhaven National Laboratory	4,853	3,935
Chicago Operations Office		
Solar Energy	21,446	0
Wind Energy	95	0

(dollars in thousands)

	FY 2010 Current Approp	FY 2012 Request
Total, Chicago Operations Office	21,541	0
Golden Field Office		
Biomass and Biorefinery Systems R&D	2,044	2,500
Solar Energy	92,955	339,677
Wind Energy	12,233	67,600
Geothermal Technology	22,800	55,000
Water Power	24,530	24,888
Federal Energy Management Program	1,100	1,283
Weatherization and Intergovernmental Activities	8,000	8,000
Strategic Programs	350	8,250
Program Direction	29,073	43,051
Congressionally Directed Projects	292,135	0
Total, Golden Field Office	485,220	550,249
Idaho National Laboratory		
Biomass and Biorefinery Systems R&D	11,896	9,600
Wind Energy	1,351	1,004
Geothermal Technology	410	1,000
Water Power	940	0
Vehicle Technologies	9,000	9,000
Industrial Technologies	578	0
Federal Energy Management Program	800	241
Strategic Programs	0	100
Total, Idaho National Laboratory	24,975	20,945
Lawrence Berkeley National Laboratory		
Hydrogen and Fuel Cell Technologies	4,491	4,200
Biomass and Biorefinery Systems R&D	0	3,000
Solar Energy	400	0
Wind Energy	590	457
Geothermal Technology	3,665	5,000
Vehicle Technologies	14,317	14,000

(dollars in thousands)

	FY 2010 Current Approp	FY 2012 Request
Building Technologies	19,980	54,688
Industrial Technologies	2,876	2,562
Federal Energy Management Program	3,597	4,161
Weatherization and Intergovernmental Activities	500	500
Strategic Programs	2,105	2,520
Total, Lawrence Berkeley National Laboratory	52,521	91,088
Lawrence Livermore National Laboratory		
Hydrogen and Fuel Cell Technologies	2,105	1,800
Wind Energy	1,292	352
Geothermal Technology	0	1,400
Vehicle Technologies	3,700	3,700
Strategic Programs	0	100
Total, Lawrence Livermore National Laboratory	7,097	7,352
Los Alamos National Laboratory		
Hydrogen and Fuel Cell Technologies	16,798	8,800
Wind Energy	464	0
Vehicle Technologies	580	590
Industrial Technologies	1,450	0
Total, Los Alamos National Laboratory	19,292	9,390
National Energy Technology Laboratory		
Hydrogen and Fuel Cell Technologies	70	0
Biomass and Biorefinery Systems R&D	100	0
Federal Energy Management Program	3,251	370
Building Technologies	0	45,534
Program Direction	15,534	15,155
Strategic Programs	35	100
Total, National Energy Technology Laboratory	18,990	61,159
National Renewable Energy Laboratory		
Hydrogen and Fuel Cell Technologies	16,372	13,200

(dollars in thousands)

	FY 2010 Current Approp	FY 2012 Request
Biomass and Biorefinery Systems R&D	38,316	42,330
Solar Energy	79,694	72,967
Wind Energy	38,841	27,449
Geothermal Technology	4,800	5,000
Water Power	4,191	2,951
Vehicle Technologies	19,970	19,000
Building Technologies	18,161	46,220
Industrial Technologies	475	0
Federal Energy Management Program	5,893	7,291
Facilities and Infrastructure	19,000	26,407
Weatherization and Intergovernmental Activities	2,200	2,300
Strategic Programs	20,986	18,225
Total, National Renewable Energy Laboratory	268,899	283,340
Oak Ridge Operations Office		
Wind Energy	500	0
Strategic Programs	2,090	2,500
Total, Oak Ridge Operations Office	2,590	2,500
Oak Ridge National Laboratory		
Hydrogen and Fuel Cell Technologies	6,967	4,200
Biomass and Biorefinery Systems R&D	5,745	6,239
Solar Energy	213	1,000
Wind Energy	1,660	274
Water Power	7,340	1,749
Geothermal Technology	700	1,400
Vehicle Technologies	49,446	44,000
Building Technologies	16,731	21,796
Industrial Technologies	24,458	5,725
Federal Energy Management Program	4,013	2,679
Weatherization and Intergovernmental Activities	1,025	4,500
Strategic Programs	647	990
Total, Oak Ridge National Laboratory	118,945	94,552

(dollars in thousands)

	FY 2010 Current Approp	FY 2012 Request
Pacific Northwest National Laboratory		
Hydrogen and Fuel Cell Technologies	6,979	3,400
Biomass and Biorefinery Systems R&D	10,822	20,825
Wind Energy	1,675	1,431
Water Power	2,708	2,515
Vehicle Technologies	8,433	8,400
Building Technologies	28,166	30,434
Industrial Technologies	1,794	0
Federal Energy Management Program	2,248	1,818
Strategic Programs	1,492	1,410
Total, Pacific Northwest National Laboratory	64,317	70,233
Sandia National Laboratories		
Hydrogen and Fuel Cell Technologies	9,308	4,900
Biomass and Biorefinery Systems R&D	0	1,980
Solar Energy	28,839	19,430
Wind Energy	10,928	8,644
Geothermal Technology	5,400	5,000
Water Power	3,861	3,466
Vehicle Technologies	11,461	11,000
Building Technologies	0	320
Federal Energy Management Program	100	453
Weatherization and Intergovernmental Activities	450	450
Strategic Programs	1,500	1,600
Total, Sandia National Laboratories	71,847	57,243
Savannah River National Laboratory		
Hydrogen and Fuel Cell Technologies	3,590	2,900
Wind Energy	15	0
Strategic Programs	0	100
Total, Savannah River National Laboratories	3,605	3,000

(dollars in thousands)

	FY 2010 Current Approp	FY 2012 Request
Washington Headquarters		
Hydrogen and Fuel Cell Technologies	84,307	45,550
Biomass and Biorefinery Systems R&D	144,802	250,476
Solar Energy	18,529	23,436
Wind Energy	8,260	19,374
Geothermal Technology	4,945	26,735
Water Power	4,053	1,576
Vehicle Technologies	148,642	440,113
Building Technologies	136,008	269,011
Industrial Technologies	56,087	311,497
Federal Energy Management Program	10,848	14,776
Weatherization and Intergovernmental Activities	257,825	378,048
RE-ENERGYSE	0	0
Program Direction	95,393	118,399
Strategic Programs	14,445	15,904
Total, Washington Headquarters	984,144	1,914,895
Subtotal, Energy Efficiency and Renewable Energy	2,216,392	3,226,417
Use of Prior Year Balances	0	-26,364
Total, Energy Efficiency and Renewable Energy	2,216,392	3,200,053

Major Changes or Shifts by Site

Lawrence Berkeley National Laboratory

Building Technologies will design cost-effective integrated building systems. LBNL will manage activities relating to the Global Superior Energy Performance partnership and provide technical assistance for the Home Energy Score Program.

National Renewable Energy Laboratory

Building Technologies

- NREL will begin to manage the Building America Consortia, which was previously managed by NETL. NREL will also co-run the Home Energy Score Program along with LBNL.

Oak Ridge National Laboratory

Building Technologies

- ORNL will increase its activity under the Commercial Building Integration subprogram, in addition to new researc**h** into advanced working fluids.

Pacific Northwest National Laboratory

Building Technologies

- PNNL has been tasked to take on additional Commercial Building Integration activities in addition to increases in Appliance Standards activities.

Washington Headquarters

Building Technologies

- Some of the funds requested for the development of appliance standards, test procedures, and verifying and certifying ENERGY STAR appliances, will now be managed through HQ. A major competitive grant program for State and local governments will be run out of HQ.

Site Descriptions

Ames Laboratory

Ames Laboratory is a multi-discipline laboratory located in Ames, Iowa, providing support to Vehicle Technologies, and Strategic Programs.

Vehicle Technologies

Ames Laboratory is conducting research on new materials with unique properties. It also is working on improving magnetic powders for bonded permanent magnets and alternative permanent magnet materials for motors.

Strategic Programs

Ames provides support to the Strategic Programs', Innovation and Deployment activities including developing CRADAs, securing contracts with industry partners, and accelerating EERE technology into the marketplace.

Argonne National Laboratory East (ANL)

Argonne National Laboratory (ANL) is located in Argonne, Illinois, and is a multi-discipline laboratory providing support to Hydrogen and Fuel Cell Technologies, Biomass and Biorefinery Systems R&D, Wind Energy, Geothermal Technology, Water Power, Vehicle Technologies, Building Technologies, and Strategic Programs.

Hydrogen and Fuel Cell Technologies

ANL is the lead laboratory in fuel cell system analysis, life cycle analysis, and hydrogen delivery analysis, as well as in fuel cell testing and benchmarking. ANL provides key analysis of greenhouse gas emissions and petroleum use with the ANL GREET model and provides support for the Systems Analysis element of the Program. In addition, ANL is developing cathode electrocatalysts (Pt and non-Pt) based on particles with a base metal core and a noble metal shell to reduce the cost of fuel cell systems. ANL works to understand the role of electrocatalyst degradation in the long-term loss of fuel cell performance and is developing coated aluminum bipolar plates that are thinner and more durable than machined graphite plates. ANL is also an important contributor to quantifying the impact of fuel impurities on fuel cost and fuel cell performance, and it is the lead laboratory in the development of a commercially viable process for hydrogen production using the copper-chloride thermochemical cycle.

Biomass and Biorefinery Systems R&D

ANL provides modeling and performs a diverse range of quantitative analysis and technical support for the Biomass Program, including benefits, technology status, and environmental sustainability.

Wind Energy

ANL will provide statistical analysis support for improved short term wind forecasting and team with NREL to support Midwest/Great Plains renewables integration/grid system operation studies. Laboratories are eligible for additional funding based on results from competitive solicitations. Wind Program funding will be competed to enable all labs expertise to be leveraged in cooperation with industry to solve the most critical challenges related to wind energy.

Geothermal Technology

ANL will work on a life cycle analysis for geothermal technologies program.

Water Power

ANL leads a team of National Laboratories to study water-use optimization for hydropower, including developing and demonstrating a suite of integrated modeling approaches. These approaches optimize the operational efficiency and environmental performance of hydroelectric power plants to enhance currently available approaches through the integration of water forecasting, reservoir and power system models, stream flow routing, and ecological simulation algorithms.

Vehicle Technologies

ANL provides VTP with expertise in materials, combustion chemistry, electrochemistry, systems simulation, computational fluid dynamics, and techno-economic analysis. ANL performs research on non-destructive testing, R&D for advanced capacitors for power electronics, novel bonding techniques for dissimilar materials, and lubrication and friction reduction. Many of these efforts take advantage of ANL's unique Advanced Photon Source to characterize materials and sprays. ANL's combustion research includes development of in-cylinder emission-control methods for high efficiency engines, as well as post-combustion emissions control. The lab's expertise in materials and combustion comes together in development of catalysts and sensors to improve engine efficiency and reduce emissions.

ANL's capabilities in system simulation and fluid dynamics support VTP efforts to improve under-hood thermal management (including nanofluid technology and novel heavy-vehicle cooling systems) and to reduce aerodynamic drag on heavy vehicles. ANL develops the system simulation software necessary for "hardware-in-the-loop" testing and validation of component and subsystem performance, and develops test procedures for advanced vehicles. Systems simulation supports development of optimal control strategies for both combustion and hybrid-vehicle propulsion and battery systems. ANL uses its expertise in electrochemistry to perform both R&D and standardized testing of advanced batteries and ultra capacitors. The lab uses both its system simulation and techno-economic analysis capabilities to support VTP planning and program evaluation with energy, economic, and environmental analyses. This includes providing analytical and technical assistance related to the deployment of VTP supported technologies and petroleum reduction practices. ANL provides general technical and analytical support to VTP battery R&D, the Graduate Automotive Technology Education (GATE) activity, and VTP's student vehicle competitions.

Building Technologies

ANL will work with DOE on achieving a 30 percent reduction in energy consumption in existing commercial buildings by 2015.

Strategic Programs

ANL will provide analytical support for major crosscutting issues, such as market and benefit analyses. Strategic Priorities and Impact Analysis (SPIA) works with ANL to conduct technical and analytical work for a variety of technology areas with special expertise in transportation analysis, including vehicle electrification systems. Analytical support from ANL also includes life cycle analysis on advanced vehicle materials and support for crosscutting behavioral analysis for energy efficiency. Innovation and Deployment activities include developing CRADAs, securing contracts with industry partners, and accelerating EERE technology into the marketplace. International activities include technical and analytical support for partner countries related to vehicle technologies, advanced fuel testing, and biofuels.

Brookhaven National Laboratory (BNL)

Located in Upton, New York, BNL is a multi-disciplinary research laboratory dedicated to basic, non-defense scientific research. BNL provides support to Hydrogen and Fuel Cell Technologies, Solar Energy, Vehicle Technologies Program, and Strategic Programs.

Hydrogen and Fuel Cell Technologies

BNL conducts R&D of electrocatalysts with ultra-low platinum loading, focusing on synthesis and characterization of the materials. Additionally, BNL is investigating the potential of aluminum hydride as a hydrogen storage material in automotive applications. BNL also conducts analysis of the CO_2 emissions reductions and petroleum savings benefits of for the program.

Solar Energy

BNL performs R&D for the Photovoltaic (PV) Energy Systems efforts. BNL has the responsibility for environmental, health, and safety (ES&H) impacts associated with PV energy production, delivery, and use. BNL also conducts ES&H audits, safety reviews, and incident investigations, and assists industry to identify and examine potential ES&H barriers and hazard control strategies for new PV materials, processes, and application options before their large-scale commercialization. BNL will also use these funds to support Solar Grid integration projects.

Vehicle Technologies

BNL performs analysis, studies and conducts research in advanced materials to improve the performance and abuse tolerance of lithium-ion battery systems, and provides research support for analysis of internal combustion engine emissions for program. BNL also provides analytical and technical assistance in support of VTP deployment and Clean Cities activities related to the recovery and use of renewable natural gas (biogas) as a transportation fuel.

Strategic Programs

Provides analytical support for crosscutting issues such as market and benefit analyses. SPIA works with BNL to conduct technical and analytical work for a variety of technology areas, including life cycle sustainability analysis in particular for PV technology applications. Innovation and Deployment activities include developing CRADAs, securing contracts with industry partners, and accelerating EERE technology into the marketplace. International activities at BNL include technical and analytical support for partner countries related to building efficiency technology applications.

Golden Field Office

The Golden Field Office (GO) is located in Golden, Colorado, and manages funding opportunity announcements to compete work for analytical, deployment, and training activities, and provides project management and procurement support for Biomass and Biorefinery Systems R&D, Solar Energy, Wind Energy, Geothermal Technology, Water Power, FEMP, Weatherization and Intergovernmental Activities, Strategic Programs and Program Direction.

Biomass and Biorefinery Systems R&D

GO will continue to provide ongoing project management, contracting, and legal support for biomass related projects. GO will also continue to conduct a number of Funding Opportunity Announcements (FOAs) across program areas and negotiate and manage a large number of biomass related Congressionally Directed Projects (CDPs).

Solar Energy

GO will implement substantial increases in procurement actions for the program, primarily related to the PV Manufacturing Initiative and the CSP Demonstration/Solar Zone Projects.

Wind Energy

GO administers, monitors, and helps manage competitive solicitations, state projects, and CDPs. FY12 will include multiple funding opportunities in offshore wind R&D, advanced components, and wind resource assessment to enable more efficient and reliable turbine designs and siting to reduce the cost of energy from wind power.

Geothermal Technology

GO will also continue to conduct a number of FOAs across program areas and negotiate and monitor number of geothermal related CDPs.

Water Power

GO administers cost-shared activities with universities and private sector interests and manages resulting grants and projects to advance water power technologies and resource assessments.

FEMP

The Golden Field Office support FEMP by managing the Energy Savings Performance Contract and provides facilitation services for the ESPC contract to Federal Agencies.

Weatherization and Intergovernmental Activities

GO provides project management and procurement support for Weatherization and Intergovernmental Activities. Specific GO support includes: management (in coordination with NETL) of financial assistance awarded to State Energy Program and Weatherization Assistance grantees, and management of all of the financial assistance and some of the technical assistance for Tribal Energy Activities.

Strategic Programs

GO administers a number of small contracts on behalf of Technology Advancement and Outreach, including work with the Ad Council on a National Energy Efficiency Public Information Campaign. GO also provides analytical support for major crosscutting issues, such as market and benefit analyses.

Program Direction

Administrative, management, and oversight functions will be performed from the Washington Headquarters, GO, and NETL. These functions include program and project management, coordination and liaison with other Federal government organizations, with State and local governments, and stakeholders.

Program Direction funds the salary, benefits, and travel costs for FTEs of the GO in order to support: (1) promotion of EERE renewable energy and energy efficiency programs at the local and regional levels; (2) administration of grants to, and cooperative agreements with, States and local governments, particularly State Energy Program grants; and (3) administration and implementation of locally- and regionally-focused deployment activities, such as Wind Powering America, Clean Cities, and FEMP.

Idaho National Laboratory (INL)

INL is located in Idaho Falls, Idaho, and is a multi-discipline laboratory providing support to Biomass and Biorefinery Systems R&D, Wind Energy, Geothermal Technology, Vehicle Technologies, FEMP and Strategic Programs.

Biomass and Biorefinery Systems R&D

INL provides support for biomass feedstock logistics activities, including maintaining and operating the deployable Process Demonstration Unit (PDU). This work is performed in close collaboration with ORNL and NREL, when appropriate. INL also supports the program's Biopower activities.

Wind Energy

INL supports transmission integration of wind energy, using its technical expertise for electrical system modeling and transient response analysis, load flow and complex power system assessment, and policy and ordinance evaluation. INL also supports work addressing wind radar issues. Activities include developing and demonstrating mitigation tools, public outreach, and case study analysis.

Geothermal Technology

INL will work on a Geothermal Electricity Technology Evaluation Model (GETEM) for geothermal technologies program.

Vehicle Technologies

INL benchmarks and assesses the performance of new ultra capacitors for hybrid vehicles. The laboratory also conducts tests of high-power batteries, develops battery test procedures, tests and simulates hybrid vehicle performance, and develops energy storage models for electric and hybrid vehicles. INL conducts field testing and evaluations, and collects performance data from electric, plug-in hybrid and fuel cell light duty vehicles and infrastructure. INL also supports Federal Fleet acquisition reporting as required. INL also provides analytical and technical assistance in support of VTP deployment and Clean Cities activities associated with alternative fuels and hybrid and electric drive vehicle technologies.

Federal Energy Management Program

INL supports FEMP by maintaining the Federal Automotive Statistical Tool (FAST) database which collects fuel usage data on vehicle fleets reported by Federal agencies.

Strategic Programs

INL assists in developing CRADAs, securing contracts with industry partners, accelerating EERE technology into the marketplace and providing analytical support for major crosscutting issues, such as market and benefit analyses for the Innovation and Deployment subprogram.

Lawrence Berkeley National Laboratory (LBNL)

LBNL is located in Berkeley, California, and is a multi-discipline laboratory providing support to Hydrogen and Fuel Cell Technologies, Biomass and Biorefinery Systems R&D, Wind Energy, Geothermal Technology, Vehicle Technologies, Building Technologies, Industrial Technologies, FEMP, Weatherization and Intergovernmental Activities, and Strategic Programs.

Hydrogen and Fuel Cell Technologies

LBNL develops fuel cell membranes that do not require water for proton conduction, thus easing water and thermal management, and to reduce fuel cell cost, LBNL is developing novel catalyst that do not contain precious metals. LBNL also conducts modeling studies of fuel cell behavior at low and sub-zero temperatures.

Biomass and Biorefinery Systems R&D

LBNL currently operates the advanced biofuels user facility where biofuels R&D projects are conducted.

Wind Energy

LBNL provides targeted analysis that is specifically conducted to inform R&D planning and investment activities of the Wind Program, as well as providing stakeholders with unbiased data and analysis to better understand the potential, markets, benefits, costs, and barriers of wind energy.

Geothermal Technology

LBNL will support RD&D on exploration of geothermal reservoirs, reservoir dynamics and seismic monitoring and analysis.

Vehicle Technologies

LBNL conducts exploratory research in advanced battery technology, including development of new electrode and electrolyte materials, and understanding of fundamental electrochemical phenomena. LBNL develops devices to measure particulate matter from engines. LBNL also studies statistics in crash data evaluating relationships between size, mass and safety of vehicles.

Building Technologies

LBNL conducts R&D activities for windows, appliance standards, analysis tools and design strategies and commercial buildings integration.

Industrial Technologies

LBNL supports the Save Energy Now Leaders Partnership efforts in ITP's Industrial Technical Assistance area, particularly in support of plant certification standards, protocol, and certified practitioner development.

Federal Energy Management Program

LBNL facilitates projects, develops guidelines and provides expert advice on the monitoring and verification protocols for energy projects savings, laboratory sustainable design principles, public benefit funds, and lighting.

Weatherization and Intergovernmental Activities

LBNL develops information and methods on incentives and other utility policies and strategies to expand State Energy Office capabilities in implementing energy efficiency and demand reduction programs.

Strategic Programs

LBNL provides analytical support for major crosscutting issues, such as market and benefit analyses. Innovation and Deployment activities include developing CRADAs, securing contracts with industry partners, and accelerating EERE technology into the marketplace.

Lawrence Livermore National Laboratory (LLNL)

LLNL is located in Livermore, California, and is a multi-discipline laboratory providing support to Hydrogen and Fuel Cell Technologies, Wind Energy, Vehicle Technologies, and Strategic Programs.

Hydrogen and Fuel Cell Technologies

LLNL provides support for the Program's Systems Analysis activities, such as analyzing the impact of hydrogen production on water use and demand, and it serves as the lead laboratory for RD&D of hydrogen gas cryo-compression and cryo-pump technologies. LLNL provides an online and in-person course on hydrogen safety for other labs and researchers and works closely with other national laboratories and industry to develop hydrogen sensor technologies.

Wind Energy

LLNL will continue studies focused on characterizing turbine inflow conditions using multi-scale atmospheric modeling and provide complex terrain analysis for the improvement of short term (zero to 6 hour) wind forecasting. Laboratories are eligible for funding based on results from competitive solicitations. Wind Program funding will be competed to enable all labs expertise to be leveraged in cooperation with industry to solve the most critical challenges related to wind energy.

Geothermal Technology

Lawrence Livermore National Laboratory supports Geothermal Technologies Program to conduct research and development in computational and experimental geochemistry; reactive flow and transport and coupled thermal-hydraulic-mechanical-chemical modeling; and geophysical exploration and seismology.

Vehicle Technologies

LLNL applies advanced methods of computational fluid dynamics to the aerodynamics drag of heavy vehicles for increased energy efficiency. It also performs studies of combustion under diesel and homogeneous charge compression ignition (HCCI) conditions (including natural gas engines) using chemical kinetic modeling and other methods to determine means for increasing fuel efficiency, reducing emissions, and increasing peak output power of advanced internal combustion engines. LLNL develops specialized materials such as high-voltage ultra capacitors based on nanostructure multilayer oxide materials. The lab's expertise in materials science is also applied to advanced automotive manufacturing concepts such as metal treatment using Plasma Surface Ion Implantation (PSII). LLNL's sensor expertise is applied to development of advanced NO_x sensors for diesel engines.

Strategic Programs

LLNL assists in developing CRADAs, securing contracts with industry partners, accelerating EERE technology into the marketplace and providing analytical support for major crosscutting issues, such as market and benefit analyses for the Innovation and Deployment subprogram.

Los Alamos National Laboratory (LANL)

LANL is located in Los Alamos, New Mexico, and is a multi-discipline laboratory providing support to Hydrogen and Fuel Cell Technologies, and Vehicle Technologies.

Hydrogen and Fuel Cell Technologies

LANL develops anion exchange polymer electrolytes that have high conductivity and stability under alkaline conditions. LANL identifies and delineates fuel cell component degradation mechanisms and develops ceramic alternatives to carbon material supports for polymer electrolyte fuel cell cathodes. LANL investigates the effects of fuel impurities on fuel cell performance, and the results from the impurities analysis feed into an ISO (International Standardization Organization) standard for hydrogen fuel specification. Other fuel cell-related work at LANL includes evaluation of structural and surface properties of materials affecting water transport and performance, as well as modeling of water transport in the fuel cell. LANL also develops ammonia borane derivatives as hydrogen storage materials.

Vehicle Technologies

LANL performs research on combustion in internal combustion engines using simulation and modeling to increase efficiency and reduce NO_x in lean-burn engines.

National Energy Technology Laboratory (NETL)

NETL is located in Morgantown, West Virginia. NETL provides project management and procurement support to FEMP, Building Technologies, Program Direction, and Strategic Programs.

Federal Energy Management Program

NETL provides technical and financial analyses support for Biomass Alternate Methane Fuels Technology Specific Super Energy Savings Performance Contract activities.

Building Technologies

NETL funds analysis for the development of appliance standards and test procedures and verifies and certifies ENERGY STAR appliances.

Program Direction

Administrative, management, and oversight functions will be performed from the Washington Headquarters, GFO, and NETL. These functions include program and project management, coordination and liaison with other Federal government organizations, with State and local governments, and stakeholders.

Strategic Programs

NETL will provide analytical support for crosscutting issues, such as market and benefit analyses.

National Renewable Energy Laboratory (NREL)

NREL is located in Golden, Colorado. NREL is the principal research laboratory for EERE and also provides research expertise for the DOE Offices of Science and Electricity Delivery and Energy Reliability. NREL develops renewable energy and energy efficiency technologies and practices, advances related science and engineering, and transfers knowledge and innovations to address the Nation's energy and environmental goals. It is a multi-discipline laboratory providing support to Hydrogen and Fuel Cell Technologies, Biomass and Biorefinery Systems R&D, Solar Energy, Wind Energy, Geothermal Technology, Water Power, Vehicle Technologies, Building Technologies, FEMP, Facilities and Infrastructure, Weatherization and Intergovernmental Activities, and Strategic Programs.

Hydrogen and Fuel Cell Technologies

NREL provides key analytical support for the Systems Analysis element of the program. NREL develops models of the technical, economic, and integration aspects of the hydrogen infrastructure and fuel cell systems, such as the H2A Hydrogen Production Model and the Fuel Cell Power Model, and provides guidance for the development of hydrogen fuel cell components and materials. NREL develops in-line measurement processes for high volume component and stack manufacturing, serves as the lead laboratory for the biological, photoelectrochemical, and wind-to-hydrogen water electrolysis pathways for renewable hydrogen production, and investigates adsorbent materials for hydrogen storage. NREL has new activities in producing high surface area catalyst supports and novel catalysts based on extended platinum surfaces with increased activity and durability. NREL also coordinates domestic codes and standards harmonization efforts. Finally, NREL collaborates with automobile manufacturers and stationary fuel cell and hydrogen infrastructure developers and applies its analysis methodology and software to create composite data products on state-of-the-art performance that can be publically disseminated.

Biomass and Biorefinery Systems R&D

NREL is the lead R&D laboratory for Biomass and provides a broad range of analysis support across the program, including: 1) Biomass Scenario Model for feedstock production; 2) R&D state of technology for cellulosic ethanol, which provides guidance for the program's R&D targets; 3) models of biochemical and thermo chemical processes to produce other advanced biofuels; 4) analytical models used to estimate the future (nth plant) biofuel production costs; and 5) systems integration for portfolio analysis. The program utilizes NREL capabilities to benchmark and validate industry-led R&D in the area of enzyme and ethanologen development. NREL operates two user facilities that support commercialization efforts: the Thermochemical Users Facility (TCUF) for syngas technologies; and the Alternative Fuels Users Facility (AFUF) for bioconversion technologies. NREL also actively supports

the initial analysis and assessment activities for conversion of advanced feedstocks such as algae to biofuels. In coordination with ORNL, NREL will continue to support biofuels infrastructure development through intermediate ethanol blend testing on legacy vehicles, small engines, and materials.

Solar Energy

NREL serves as the lead laboratory for the Solar Energy Program. NREL conducts fundamental and applied materials research on PV devices, PV module reliability and systems development, data collection and evaluation on solar radiation, and implementation of cost-shared government/industry partnerships. Basic research teams investigate a variety of PV materials, such as amorphous silicon, polycrystalline thin films, high-efficiency materials and concepts, and high-purity silicon and compound semiconductors. NREL conducts simulated and actual outdoor tests on PV cells, modules, and arrays. The test results are used in developing standards and performance criteria for industry and to improve reliability.

Wind Energy

NREL produces wind integration studies, develops and validates wind generator models, performs resource assessment studies, and provides economic analysis and wind plant power curves to support improved short term forecasting. Infrastructure at the National Wind Technology Center (NWTC) includes upgrades and maintenance to existing NWTC buildings, test pads, and capital equipment such as cranes, lifts, trucks, safety equipment, and other heavy machinery. Test facilities include a MW size dynamometer for drivetrain testing, blade testing facilities, grid simulator facilities, and test turbines. NREL helps to address the barriers to large-scale wind energy deployment through stakeholder engagement and outreach on environmental and siting issues. Laboratories are eligible for funding based on results from competitive solicitations. Wind Program funding will be competed to enable all labs expertise to be leveraged in cooperation with industry to solve the most critical challenges related to wind energy.

Geothermal Technology

NREL will support geothermal risk assessment, multi-year program planning, techno-economic analysis and system integration.

Water Power

NREL provides expertise in marine and hydrokinetic (MHK) technology development and characterization activities, and development of international standards for comparison and evaluation of these technologies. NREL research focuses in the areas of mechanical engineering and machine performance, testing of hydrodynamics and sediments, development and testing of new materials, and modeling of water power systems and environmental interactions. NREL is also adapting its Regional Energy Deployment System (ReEDS) and Jobs and Economic Development Impact (JEDI) models for water power technologies.

Vehicle Technologies

NREL develops system models and provides analysis and simulation of advanced hybrid and fuel cell configurations using analytical software developed at the lab, as well as other tools; provides computer-generated design and engineering (CAD/CAE) for optimized vehicle system solutions in support of industry partnership goals; and conducts general engineering assessments of advanced vehicle technologies. The laboratory investigates and develops advanced battery thermal management for hybrid and fuel cell vehicles. For power electronics and electric motors, the lab investigates and

develops advanced cooling technologies, and performs modeling and analysis for increased reliability. For heavy duty vehicles, NREL provides analysis, modeling, and technical support for power electronics and electric machines; conducts engine/vehicle integration and platform studies; and leads an effort to identify the effects of sulfur levels in diesel fuels on emissions control devices.

NREL also leads an effort to determine the lube oil effects on exhaust after treatment devices, and conducts tests of bio-based diesel fuel blending agents to determine their ability to act as reductants in the exhaust stream of diesel engines. Additionally, NREL supports EPAct 1992 regulatory programs including Federal Fleet, State and Fuel Provider, Private and Local, and Fuel petitions; supports the Clean Cities deployment program with technical assistance to regional coalitions and fleet partners; and conducts program analysis and evaluation.

Building Technologies

NREL provides technical leadership, conducts research, and provides technical management support in a number of Building Technologies (BT) activities, primarily Building America (Residential Building Integration). NREL has integrated the BT Stage Gate process into the Building America and Commercial Buildings technical management processes. NREL also provides technical support to the implementation of Building America by conducting research, providing technical assistance to the teams and coordinating research among the partners, including the development and updating of tools such as Building Energy Optimization for the management of the project. For Commercial Buildings Integration, NREL provides technical support to the commercial building partners and energy alliances in three commercial building segments: retail, commercial real estate, and hospitals. Other NREL activities in support of BT include technical support for Energy Smart Schools and Hospitals, as well as development and implementation of new models and features that expand the capabilities of EnergyPlus. NREL also helps implement the Home Energy Score program.

Federal Energy Management Program

NREL facilitates projects, develops guidelines and provides expert advice on sustainable and renewable facility designs, green power procurement, and alternative financing.

Facilities and Infrastructure

The Facilities and Infrastructure program provides funding for capital investments to support a world-class R&D program at NREL to advance U.S. energy policy. General Plant Project (GPP) investments support the safe and efficient operation of NREL and EERE programs, and provide for a minimum two percent recapitalization of real property assets in support of changing mission needs. General Purpose Equipment (GPE) investments acquire shared science and support capabilities and maintain EERE's current equipment portfolio at NREL at a level of 50 percent (average) remaining portfolio value to ensure viability and readiness. Capital line item projects that include acquisition of new science and support capabilities, modification of existing capabilities, and improvements to NREL site infrastructure accommodate accelerated growth consistent with the EERE approved Ten Year Site Plan. Facilities and Infrastructure also supports Safeguards and Security investments which provide for a safe work environment for the research and support staff and the protection of property; both physical and intellectual.

Weatherization and Intergovernmental Activities

NREL assists with the development of communication strategies for the Weatherization and Intergovernmental Program; improves program and subprogram webpages; and provides technical assistance on energy efficiency and renewable energy technologies, practices, and opportunities for States, Tribes and international partners.

Strategic Programs

Provides analytical support for crosscutting issues, such as market and benefit analyses. NREL is SPIA's lead group for support analysis and acts as the primary partner in many analyses, including supply chain and lifecycle studies, behavioral modeling, and legislative and policy analysis. NREL provides analysis of deployment and incentives through the Database of State Incentives for Renewables and Efficiency (DSIRE) project and the market data resource center. NREL also handles much of the quick response analysis, develops CRADAs, funds industry partners, and accelerates EERE technology into the marketplace. International activities at NREL include support for core staff that assist in broad ranging projects. NREL staff assists in developing the specific activities and scope of international partnerships and also provide subsequent technical assistance to partner countries.

Oak Ridge Operations Office

Oak Ridge Operations Office is located in Oak Ridge, Tennessee, and will provide project management and procurement support for Strategic Programs.

Strategic Programs

Oak Ridge Operations Office will provide support for Strategic Program related projects including developing CRADAs, securing contracts with industry partners, and accelerating EERE technology into the marketplace.

Oak Ridge National Laboratory (ORNL)

ORNL is located in Oak Ridge, Tennessee, and is a multi-discipline laboratory providing support to Hydrogen and Fuel Cell Technologies, Biomass and Biorefinery Systems R&D, Solar Energy, Wind Energy, Water Power, Geothermal Technology, Vehicle Technologies, Building Technologies, Industrial Technologies, FEMP, Weatherization and Intergovernmental Activities, and Strategic Programs.

Hydrogen and Fuel Cell Technologies

ORNL conducts R&D on metal bipolar plates by nitriding the surface to mitigate plate corrosion and characterizes the properties of membrane electrode assemblies to understand degradation mechanisms during fuel cell operation. ORNL investigates the hydrogen permeability and integrity of hydrogen transfer pipelines and is developing a design for an integrated alloy/concrete hydrogen storage vessel. ORNL leads the analysis of the impact of key program targets on fuel cell and alternative vehicle penetration and market barriers. Finally, ORNL carries out R&D on hydrogen storage materials including hydrogen sorbents and metal hydrides, and investigates methods for producing lower-cost carbon fibers for high-pressure composite cylinders.

Biomass and Biorefinery Systems R&D

ORNL is integral to the program's feedstocks resource assessment efforts. ORNL will continue to lead updates for the Billion Ton Vision, a report that explores the feasibility of building a billion tons of feedstocks to convert to biofuels; the maintenance of the biomass GIS-based assessment tool; and will continue to support joint feedstocks production related activities with the USDA. These efforts are

closely coordinated with INL and NREL. Additionally, ORNL supports biofuels infrastructure development through intermediate ethanol blend testing on legacy vehicles, small engines, and materials in coordination with NREL. ORNL also provides assistance on biomass technology assessment and information transfer for the Integrated Biorefinery Platform.

Solar Energy

ORNL provides support in applied PV research, as well as technical assistance for the Solar America Cities project. ORNL will also use these funds for DOE's Solar Fellowship Program.

Wind Energy

ORNL will provide support on grid system operational protection schemes. Laboratories are eligible for funding based on results from competitive solicitations Wind Program funding will be competed to enable all labs expertise to be leveraged in cooperation with industry to solve the most critical challenges related to wind energy.

Water Power

ORNL provides engineering support and systems analysis for hydropower and MHK technologies. They lead the National Hydropower Asset Assessment Project (NHAAP), which collects and synthesizes data on existing hydropower facilities, as well as the Hydropower Advancement Project (HAP) to facilitate the development of cost-effective hydropower facility upgrades. ORNL participates in water power resource and technology characterization activities, and will provide environmental studies for hydropower including research on fish passage, in-stream flow, and GHG emissions. ORNL will also provide research into water-use optimization for hydropower and support the quantification of hydropower's ancillary benefits to the U.S. transmission grid.

Geothermal Technology

Oak Ridge National Laboratory conducts R&D to improve cold neutron imaging methods for rock fractures detection and develops techniques to reduce erosion of casing materials under extreme conditions.

Vehicle Technologies

ORNL provides VTP with expertise in materials, combustion, electrical engineering, systems analysis, vehicle testing and data collection, and techno-economic analysis. ORNL uses its materials expertise to develop and test a wide range of lightweight materials for vehicle applications, including carbon-fiber, lightweight alloys, and novel materials such as thermally-conducting carbon foams for high-performance engine radiators. ORNL also operates the High-Temperature Materials Lab for materials characterization, funded by VTP. ORNL supports VTP's combustion R&D with the development of in-cylinder diagnostics, development and testing of catalytic converters, measuring and modeling the chemical kinetics of emissions-treatment devices including NOx absorbers and selective catalytic reduction, and toxicity analysis of unregulated emissions from engines operating on advanced fuels. This work also supports VTP's Fuels R&D activity by analyzing and modeling the fuel characteristics that affect emissions control and efficiency in diesel engines. ORNL uses its electrical engineering expertise to research, develop, and test power electronics (inverters and converters) and electric motor/generators for hybrid and electric vehicles. The lab performs system cost analyses and techno-economic trade-off studies for advanced combustion, emissions-control, materials, and power-electronic components. ORNL backs up its modeling of engine and emissions-control processes with the collection of real-world, on-road heavy truck performance data. ORNL also provides technical and analytical assistance in support of VTP deployment (Clean Cities) initiatives and manages the

legislatively-mandated automobile *Fuel Economy Guide* and website, and related consumer education and outreach activities.

Building Technologies

ORNL is part of a National Laboratory/industry/university consortium conducting R&D for: Building America; space heating and cooling; and envelope and emerging technologies.

Industrial Technologies

ORNL conducts research and provides support in several ITP program areas including Nano-Manufacturing, Industrial Materials, Industrial Distributed Energy, Energy-Intensive Process R&D, and Industrial Technical Assistance. In Nano-Manufacturing prior year work included nano catalysts for diesel engine emission remediation and nanostructured superhydrophobic coatings for breakthrough energy savings. In Industrial Materials prior research included advanced conversion technologies for low-cost carbon fibers. In Industrial Distributed Energy, work has been conducted in advanced reciprocating engine R&D and combined heat and power implementation. In Energy Intensive Processes, prior year work has included flexible hybrid friction stir joining technology, magnetic field processing, and near net shape manufacturing for low cost titanium powders. All on-going activities will be completed using prior year funds. Promising technologies from existing work will be encouraged to apply for new awards in the new subprograms, where appropriate. In addition to R&D activities, ORNL supports multiple activities for ITP's Industrial Technical Assistance Save Energy Now Leaders Partnerships.

Federal Energy Management Program

ORNL facilitates projects, develops guidelines, and provides expert advice on combined heat and power (CHP) systems, biomass opportunities, whole building design, and alterative financing.

Weatherization and Intergovernmental Activities

ORNL assists in the implementation of the national evaluation of the State Energy Program and stakeholder outreach for DOE energy efficiency initiatives.

Strategic Programs

ORNL provides support analysis for supply chain analysis and also partner in analyzing state policies. Technology commercialization funds at ORNL assist in developing CRADAs, funding industry partners, and accelerating EERE technology into the marketplace. International activities at ORNL include technical and analytical support for partner countries related to a wide variety of technology applications, including biofuels sustainability analysis, industrial efficiency, and advanced geothermal technologies.

Pacific Northwest National Laboratory (PNNL)

PNNL is located in Richland, Washington, and is a multi-discipline laboratory providing support to Hydrogen and Fuel Cell Technologies, Biomass and Biorefinery Systems R&D, Wind Energy, Water Power, Vehicle Technologies, Building Technologies, FEMP, and Strategic Programs.

Hydrogen and Fuel Cell Technologies

PNNL is developing novel catalyst supports to mitigate support degradation during start/stop operation of fuel cells. In Hydrogen Fuel R&D, PNNL investigates reaction pathway mechanisms for hydrogen production from bio-derived liquids and leads the efforts on the use of solid ammonia borane derivatives as hydrogen storage materials. PNNL is the lead laboratory in the development of safety materials and

systems for various applications. PNNL manages the Hydrogen Safety Panel to promote and ensure safe practices in all DOE HFCT-funded projects and develops key safety information tools. PNNL is the lead laboratory in maintaining and updating the Hydrogen Analysis Resource Center (HyARC) which contains an online data book of critical analysis data for the Program.

Biomass and Biorefinery Systems R&D

PNNL conducts R&D on thermochemical conversion technologies for syngas and bio-oil, also providing support for the technical and economic assessment of thermochemical R&D and sustainable biofuels production. Major program components include thermocatalysts for fuels and chemicals. Additionally, PNNL performs research on the use of filamentous fungi in biorefineries. PNNL also supports initial analysis and assessment activities for conversion of advanced feedstocks such as algae to biofuels and life cycle assessments of alternative fuels.

Wind Energy

PNNL provides meteorological analysis and supports improved short term wind forecasting, evaluates turbulence models, and provides support on grid system operations to the Western Electricity Coordination Council's Variable Generation Committee. PNNL also supports stakeholder engagement and outreach activities to address the environmental and siting issues related to wind energy deployment. Laboratories are eligible for funding based on results from competitive solicitations. Wind Program funding will be competed to enable all labs expertise to be leveraged in cooperation with industry to solve the most critical challenges related to wind energy.

Water Power

PNNL is leading the development of the Environmental Risk Evaluation Systems (ERES). PNNL provides identification, analysis, and prediction of environmental impacts from MHK energy production. They also provide support for research and testing for MHK technologies, hydropower water-use optimization, and studies of environmental hurdles for conventional hydropower, including fish passage, in-stream flow, and GHG emissions.

Vehicle Technologies

PNNL supports VTP primarily through their expertise in a variety of materials technologies. PNNL evaluates advanced energy storage materials for battery R&D. PNNL supports VTP materials R&D effort by developing energy-efficient production and processing techniques for magnesium, titanium, aluminum, polymer, and glass composite components for advanced automotive and heavy vehicle designs. The laboratory also develops environmentally friendly processes for the manufacture of planar thin film ceramic sensors. To improve combustion efficiency and reduce emissions, PNNL develops tools and analytic techniques for developing new catalytic materials for engines using computational methods and materials-by-design approaches. PNNL supports development of thermoelectric devices for recovering waste heat in diesel engines (thus improving fuel efficiency) by working on the scale-up process for depositing Si/SiGe super-lattice materials.

Building Technologies

PNNL conducts R&D activities for building codes, appliance standards and lighting, and cross cutting economic and technical analyses. For Commercial Buildings Integration, PNNL provides technical support to the commercial building partners and energy alliances in three commercial building segments: retail, commercial real estate, and hospitals.

Federal Energy Management Program

PNNL develops guidelines and provides expert advice on energy efficient buildings maintenance and operations, utility load management, utility restructuring, building commissioning, building diagnostic systems, resource energy management, and analytical support for benefits modeling.

Strategic Programs

PNNL provides analytical support for crosscutting issues such as market and benefit analyses. SPIA works with PNNL to partner in supply chain analysis studies with particular expertise in the built environment. International activities include technical and analytical support for partner countries primarily related to biofuels and advanced fuels. Technology commercialization funds at PNNL assist in developing CRADAs, funding industry partners, and accelerating EERE technology into the marketplace.

Sandia National Laboratories (SNL)

SNL is located in Albuquerque, New Mexico and in Livermore, California. It is a multi-discipline laboratory providing support to Hydrogen and Fuel Cell Technologies, Biomass and Biorefinery Systems R&D, Solar Energy, Wind Energy, Geothermal Technology, Water Power, Vehicle Technologies, Building Technologies, FEMP, Weatherization and Intergovernmental Activities, and Strategic Programs.

Hydrogen and Fuel Cell Technologies

SNL characterizes fluid flow within fuel cells and conducts material property characterization and safety analysis of fuel cells. SNL plays a key role in conducting and promulgating the domestic international coordination of quantitative risk assessment approach for the development of key codes and standards for hydrogen and fuel cell technologies. SNL supports the Systems Analysis effort with development of the Macro-System Model for multi-functional analysis of cost, infrastructure and program benefits of GHG emissions and petroleum reduction. Also, SNL leads the effort to develop a thermochemical hydrogen production process using non-volatile metal oxides and investigates hydrogen storage system performance in potential accident scenarios and develops risk mitigation strategies.

Biomass and Biorefinery Systems R&D

SNL provides support on the initial analysis, research, and assessment activities for conversion of algae to biofuels.

Solar Energy

SNL supports the PV Energy Systems efforts with the principal responsibility for systems and balance-of-systems technology development and reliability. Indoor and outdoor measurement and evaluation facilities provide support to industry for cell, module, and systems measurement, evaluation, and analysis. Systems-level work concentrates on application engineering reliability, database development, and technology transfer. SNL is the lead laboratory for the CSP activity; technical responsibilities include power tower R&D, dish R&D, and the management of technical tasks and subcontracts to industry and universities.

Wind Energy

SNL provides the Wind Program and the U.S. wind industry with engineering expertise focused on wind turbine blade R&D, and wind generator model development and validation. Infrastructure funding at SNL covers the facilities at the Bushland, TX test site, which SNL has access to via an MOU with the USDA. Part of the funding is a mortgage to USDA, while the remaining funds cover the buildings, test

pads, test turbines, and capital equipment that make up the Bushland test site. SNL also supports work addressing wind radar issues. Activities include developing and demonstrating technologies to mitigate wind turbine effects on radar and supporting collaborative R&D efforts with other federal agencies. Laboratories are eligible for funding based on results from competitive solicitations. Wind Program funding will be competed to enable all labs expertise to be leveraged in cooperation with industry to solve the most critical challenges related to wind energy.

Geothermal Technology

SNL will support filed project monitoring activities, conduct R&D on high temperature components and drilling systems, and act as the technical lead for international activities.

Water Power

SNL provides expertise on research and testing for MHK technologies, and studies performance and loads for a variety of MHK devices, machine array and environmental interactions, as well as study advanced materials to improve device components. SNL develops tools and methods to measure and predict the environmental impacts of water power technologies in coastal environments and inland. For conventional hydropower, SNL provides research on water-use optimization and quantifying the value of hydropower's ancillary benefits to the U.S. transmission grid.

Vehicle Technologies

SNL supports VTP with its capabilities in aerodynamics and fluid dynamics, combustion chemistry and kinetics (especially using the laser diagnostic tools at SNL's Combustion Research Facility), materials R&D, and advanced manufacturing technologies. SNL performs modeling and simulation to reduce aerodynamic drag on heavy vehicles. The lab's expertise in fluid dynamics, combustion kinetics, and laser diagnostics are combined for research on the formation of pollutants in piston combustion and the effects of fuel-borne oxygen using optically and non-optically instrumented engines. SNL also uses laser diagnostics to characterize diesel engine particulate emissions to improve exhaust treatments. SNL develops and evaluates abuse-tolerant electrode materials for lithium-based batteries and rugged high-temperature film capacitors for power electronics. The lab's experience in advanced manufacturing supports VTP propulsion and lightweight materials efforts by developing techniques and instrumentation for forging, heat-treatment, coating, welding, and other factory processes.

Building Technologies

SNL will conduct work on a project, Rotary Air Bearing Heat Exchanger (RAHBE), which is a new approach to air-cooled heat exchangers for air conditioners, heat pumps, and refrigeration equipment.

Federal Energy Management Program

SNL develops guidelines and provides expert advice on renewable technologies for military applications and on distributed generation.

Weatherization and Intergovernmental Activities

SNL provides technical assistance on energy efficiency and renewable energy options available to Tribal governments.

Strategic Programs

SNL provides analytical support for crosscutting issues such as market and benefit analyses. SPIA works with SNL to conduct technical and analytical work for a variety of technology areas, including analysis of carbon abatement through renewable portfolios and life cycle analysis. Innovation and

Deployment activities include developing CRADAs, securing contracts with industry partners, and accelerating EERE technology into the marketplace.

Savannah River National Laboratory (SRNL)

SRNL is located in Aiken, South Carolina, and is a multidisciplinary research laboratory that provides support to Hydrogen and Fuel Cell Technologies and Strategic Programs.

Hydrogen and Fuel Cell Technologies

SRNL develops and characterizes hydrogen storage materials for potential use in system prototypes, and works with other laboratories to characterize the hydrogen permeation characteristics of pipeline materials.

Strategic Programs

SRNL provides support to the Strategic Programs', Innovation and Deployment activities including developing CRADAs, securing contracts with industry partners, and accelerating EERE technology into the marketplace.

Washington Headquarters

Washington, D.C. is the headquarters for the EERE operations. The Headquarters operation provides specialized, technical expertise in program planning, formulation, execution, evaluation and communication and outreach in order to support the responsible guidance and management of the budget. In addition, competitive program announcements and solicitations are planned and implemented through Headquarters. It provides support to all EERE programs and activities.

Hydrogen and Fuel Cell Technologies

Funding Profile by Subprogram

(dollars in thousands)

	FY 2010 Current Approp[a]	FY 2012 Request
Hydrogen and Fuel Cell Technologies		
Fuel Cell Systems R&D	75,609	45,450
Hydrogen Fuel R&D	45,750	35,000
Systems Analysis	5,408	3,000
Market Transformation	15,005	0
Manufacturing R&D	4,867	2,000
Technology Validation	13,005	8,000
Safety, Codes & Standards	8,653	7,000
Education	2,000	0
Total, Hydrogen and Fuel Cell Technologies	170,297	100,450

Public Law Authorizations:

P.L. 93-275, "Federal Energy Administration 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. 94-413, "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. 96-512, "Methane Transportation Research, Development and Demonstration Act" (1980)
P.L. 96-294, "Energy Security Act" (1980)
P.L. 100-494, "Alternative Motor Fuels Act" (1988)
P.L. 101-566, "Spark M. Matsunaga Hydrogen Research, Development, and Demonstration Act of 1990"
P.L. 102-486, "Energy Policy Act of 1992"
P.L. 104-271, "Hydrogen Future Act of 1996"
P.L. 109-58, "Energy Policy Act of 2005"
P.L. 110-140, "Energy Independence and Security Act of 2007

Mission

The mission of the Hydrogen and Fuel Cell Technologies (HFCT) Program is to reduce petroleum use, greenhouse gas (GHG) emissions, and criteria air pollutants, and to contribute to a more diverse energy supply and more efficient energy use by enabling the widespread commercialization of hydrogen and fuel cell technologies. The program pursues this mission through research, development, demonstration, and deployment (RDD&D) activities, with the key 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.

[a] In FY 2010, $3,307,170 and $396,000 were transferred to the SBIR and STTR programs respectively.

Benefits

Fuel cells generate electricity with high efficiency and low or zero emissions, and can also be used to provide heating, cooling, and hot water. Fuel cells can be designed to use various fuels, including hydrogen, natural gas, propane, petroleum, and bio-derived renewable fuels such as methanol and bio-diesel. When using hydrogen as its fuel, the only "exhaust" from a fuel cell is water, with no CO_2 emissions. Achieving the program's mission would provide significant environmental, economic and energy-security benefits to the nation.

The HFCT Program develops technologies for several types of fuel cells (including solid oxide, alkaline, and polymer electrolyte), designed for a variety of fuel sources and diverse applications. HFCT also develops technologies for producing hydrogen from various forms of renewable energy, which will allow hydrogen to serve as a clean renewable energy "carrier."

The program's efforts include Fuel Cell Systems R&D (higher-performance and lower-cost fuel cells); Safety, Codes & Standards: Hydrogen Fuel R&D (diverse ways to cost-effectively produce hydrogen from renewable energy); Systems Analysis; Technology Validation; and Manufacturing R&D.

The program encourages technology and business model innovation through competitively awarded industry, university and federal laboratory partnerships and support for innovative deployment mechanisms. Fuel cell applications open new avenues for fuel diversity and distributed generation. With improvements in materials and components resulting in increases in performance and cost decreases, fuel cell technology has the potential to gain significant market traction. Fuel cells use energy that can be created from a diverse range of energy sources, including coal, natural gas and biological sources by gasification and reforming technologies; nuclear and solar energy through thermo-chemical reactions; and wind, hydroelectric and geothermal energy sources by use of electrolysis. Furthermore, fuels for fuel cells can be created from agricultural, food processing and industrial waste streams, and biogas from landfills and wastewater treatment plants.

HFCT coordinates with DOE's Office of Science in fields such as nanoscience, biological mechanisms of hydrogen production, and understanding hydrogen interactions with material surfaces. Fundamental understanding of hydrogen interaction mechanisms feeds into EERE applied R&D activities to enable breakthroughs in areas such as hydrogen storage, catalysis, and membranes. The program conducts monthly coordination group meetings between the DOE Offices of EERE, Science, Fossil Energy, and Nuclear Energy.

The program partners with 16 countries and the European Commission through the International Partnership for Hydrogen and Fuel Cells in the Economy (IPHE) and with 25 countries through the European Commission, the International Energy Agency (IEA), and with other international organizations. The program builds research networks by coordinating with other DOE offices involved in hydrogen and fuel cell research and through cooperation with industry associations: the Fuel Cells and Hydrogen Energy Association; Codes & Standards development organizations; the Hydrogen and Fuel Cell Technical Advisory Committee (HTAC); the Hydrogen and Fuel Cell Interagency Task Force and the Hydrogen and Fuel Cell Interagency Working Group.

Due to their high efficiency and their ability to use zero- or near zero-emission fuels, fuel cells have the potential to achieve significant reductions in GHG emissions in many applications, including:

- Combined heat and power (CHP) systems;
- Light-duty highway vehicles;
- Distributed stationary power systems; and

- Lift trucks

Fuel cell vehicles using hydrogen produced from zero-carbon sources have among the lowest CO_2 emissions of all alternative-fuel vehicles. This includes emissions associated with the production, delivery, and storage of hydrogen—"well-to-wheels" emissions. In addition, fuel cells emit negligible criteria air pollutants, regardless of the fuel they use. When fuel cells use hydrogen, only water is emitted. Hydrogen can be used as a zero-emissions energy storage medium to facilitate the expansion of renewable power generation. Hydrogen can "store" electrical energy when it is produced through electrolysis, and later it can be converted back into electricity (for "peak-power," when demand exceeds generation), using fuel cells or turbines. Producing hydrogen from surplus renewable power can also greatly improve the economics of renewable energy generation, as it can provide additional revenue when previously curtailed energy is sold for use in fuel cell vehicles, stationary fuel cells, and other applications. As a renewable energy "carrier," hydrogen can contribute to reductions in GHG emissions achieved by other technologies, and can reduce the need for natural gas consumption for peak-power generation.

Annual Performance Results and Targets

The Department is in the process of updating its strategic plan, and has been actively engaging stakeholders including Congress. The draft strategic plan is being released for public comment concurrent with this budget submission, with the expectation of official publication this spring. The draft plan and FY 2012 budget are consistent and aligned. Updated measures will be released at a later date and available at the following link http://www.mbe.doe.gov/budget/12budget/index.htm.

Fuel Cell Systems R&D

Funding Schedule by Activity

(dollars in thousands)

	FY 2010 Current Approp[a]	FY 2012 Request
Fuel Cell Systems R&D	75,609	44,182
SBIR/STTR	0	1,268
Total, Fuel Cell Systems R&D	75,609	45,450

Benefits

The core of the Fuel Cell Systems R&D sub-program is R&D for fuel cell stack and system balance of plant (BOP) components. These efforts target cost reduction and an increase in fuel cell stack and system durability. As recommended in the 2008 National Research Council (NRC) report,[b] HFCT reallocated funding over the past four years to prioritize and emphasize R&D that addresses the most critical barriers, such as membranes, catalysts, electrodes, and modes of operation.

In FY 2012, the program continues the emphasis on BOP component R&D (such as humidification, sensors, and air compression) that can lead to lower cost and lower parasitic losses. In addition, fuel-flexible fuel processors 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 fuel cells.

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 includes the effect of impurities and evaluating water and thermal management strategies as well as cost analysis for multiple applications. System control optimizations for efficiency and mitigation of degradation will improve performance and durability, while lowering cost. Analytical tools and partnerships continue to expand research capabilities. For example, neutron imaging using facilities at the National Institute of Standards and Technology (NIST) has enabled the visualization of water transport within fuel cells while they are operating, providing validation for models used to optimize future designs.

As the industry matures through success of near-term applications, continuing technological progress will allow fuel cells to expand into applications and markets that have more stringent requirements in terms of cost, durability, and performance, such as light-duty vehicles.

[a] In FY 2010, $1,673,000 was transferred to the SBIR program and $200,000 was transferred to the STTR program from comparable funding.

[b] *Review of the Research Program of the FreedomCAR and Fuel Partnership: Second Report.* National Research Council of the National Academies; Committee on Review of the FreedomCAR and Fuel Research Program, Phase 2; Board on Energy and Environmental Systems, Division on Engineering and Physical Sciences. Washington, DC: National Academies Press, 2008. http://www.nap.edu/catalog.php?record_id=12113#toc.

Fuel Cell Systems R&D reduces the cost and increases the durability, reliability, and efficiency of stationary fuel cell systems. For example, the table below shows that R&D has led to significant improvement in electrical efficiency of primary power stationary fuel cell systems.

Primary Fuel Cell Power System Performance Metrics: Electrical Efficiency

Fiscal Year	Target %	Actual %
2002	Baseline: 29	
2003	30	30
2004	31	31
2005	32	32
2006	32	32
2007	34	34
2008	35	35
2009	36	36
2010	38	38
2011	40	N/A
2012	40	N/A
2013	40	N/A

Distributed Stationary Prime-Power (including CHP)

Fuel cells offer a highly efficient and fuel-flexible technology for distributed power generation and CHP systems. Key applications include primary power for critical load facilities and remote power applications and CHP for residential and commercial buildings. Using fuel cells for power at locations where inexpensive, compatible fuels are available (such as landfill and wastewater-treatment gases and industrial byproducts) not only offsets demand for conventional fuels, but also prevents the release of methane, a potent GHG. Fuel cells are uniquely suitable for many commercial and residential applications due to: quiet and vibration-free operation, ability to use existing natural gas fuel supply, low operation and maintenance requirements, and ability to maintain high efficiency over a wide range of loads.

Backup Power

Fuel cells have emerged as 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 to generators, fuel cells are quieter and have low to zero emissions (depending on the fuel source). In addition, they require less maintenance than both generators and batteries. The potential U.S. market for emergency

backup fuel cells just for communication towers is approximately 40,000 units per year for existing towers and 50,000 units per year for new towers.[a]

Specialty Vehicles

Fuel cells powered by hydrogen have become a cost-competitive option for powering specialty vehicles such as forklifts. Many specialty vehicles operate in indoor facilities and locations where air quality is important and internal combustion engines cannot be used. Forklifts powered by fuel cells can provide significant potential savings in lifecycle costs and productivity over battery-powered forklifts used continuously in 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 power diminishes as they are used, while fuel cell power remains constant.

Auxiliary Power Units (APUs)

Fuel cells can provide auxiliary power for tractor trailers, recreational vehicles, yachts, commercial ships, locomotives, aircraft, and similar applications that frequently use power while stationary, which is very inefficient for large primary motive-power engines to provide. Every year, locomotive and truck engine idling emits 11 million tons of CO_2, 200,000 tons of NOx, and 5,000 tons of particulate matter.[b] For these reasons, idling restrictions have been placed on trucks. Fuel cells are quieter and more efficient than idling an engine, and produce no NOx, SOx, or particulate emissions.

Portable Power

Portable fuel cells are being developed by manufacturers for use in cell phones, cameras, PDAs, MP3 players, and laptop computers, and as portable generators and battery chargers. Benefits over current technologies include smaller packaging, lower weight, elimination of recharge time, and longer run-time. The military also has a strong interest in portable power for field electronics.

Transportation Applications

In transportation applications, fuel cell vehicles could substantially reduce the Nation's dependence on petroleum and emissions of CO_2 and criteria pollutants. In the near term, a fuel cell vehicle fueled with hydrogen produced from natural gas can reduce GHG emissions by at least 40 percent relative to a gasoline ICE vehicle, on a total life-cycle basis. In 15 to 20 years, when hydrogen from low-carbon sources (e.g., wind electrolysis, direct solar conversion, nuclear thermal processes, or biomass) is cost competitive, a fuel cell vehicle's GHG emissions would be 90 percent less relative to a gasoline ICE vehicle; 80 percent less than a plug-in hybrid electric vehicle (PHEV) fueled with gasoline and electricity; and 60 percent to 70 percent less than a PHEV fueled with cellulosic ethanol and electricity.[c]

[a] "Fuel Cells in Distributed Telecomm Backup, Citigroup Global Markets." Citigroup. New York: August 24, 2005; http://www.fuelcells.org/info/library/CitiGroupStationary-backup.pdf. "Identification and Characterization of Near Term Fuel Cell Markets." Battelle Memorial Institute. April 2007; http://www1.eere.energy.gov/hydrogenandfuelcells/pdfs/pemfc_econ_2006_report_final_0407.pdf.

[b] Blake, Gary D., "Solid Oxide Fuel Cell System Development for Auxiliary Power in Heavy Duty Vehicle Applications," Delphi Corporation. May 2009; http://www.hydrogen.energy.gov/pdfs/review09/fc_44_blake.pdf.

[c] DOE Hydrogen and Fuel Cells Program Record #9002, http://www.hydrogen.energy.gov/pdfs/9002_well-to-wheels_greenhouse_gas_emissions_petroleum_use.pdf

Detailed Justification

(dollars in thousands)

	FY 2010 Current Approp	FY 2012 Request
Fuel Cell Systems R&D	**75,609**	**44,182**

A key to meeting the goals of fuel cell systems R&D will be improving performance and durability, and reducing the cost of stack components and BOP components in fuel cell systems. This sub-program will also include innovative system designs and configurations as well as system integration and optimization. For consumer acceptance, the fuel cell system must be cost-competitive with today's incumbent technologies and with expected advances in incumbent technologies.

In FY 2012, Fuel Cell Systems catalyst R&D continues its focus on Platinum Group Metal (PGM) catalyst approaches that increase activity and utilization of current PGM and PGM alloy catalysts, through development of innovative nanostructured PGM-containing materials that can lead to reduced PGM content. Also, PGM-free catalyst approaches for long-term applications will continue, including the development of viable electrode structures that allow an increase in loading and thickness for these catalysts. Activities will also include investigation of durable catalysts to enhance stability under various conditions, including start-stop conditions. *In situ* studies will examine the effects of catalyst-support interactions, catalyst particle size, and catalyst structure. Innovative fuel cell component structures will also be investigated. Continuation of novel catalyst structure R&D will develop materials with superior corrosion resistance and with electrical and structural properties that exceed the properties of conventional carbon supported catalysts.

The Fuel Cell Systems R&D sub-program will continue development of high temperature membranes that allow better catalyst specific power, reduce the negative effects of impurities, and decrease the size of the cooling system. R&D to improve polymer electrolyte membrane electrode assemblies (MEAs) for stationary (including CHP) and transportation applications through integration of MEA components will continue in FY 2012. In particular, efforts will focus on integration of state-of-the-art electrodes (including catalysts) with state-of-the-art membranes and gas-diffusion layers into MEAs to meet 2015 performance targets for their respective applications.

In addition, R&D will continue to improve mass transport within the MEA and the stack to enhance fuel cell performance. The development of transport models and *in situ* and *ex situ* experiments provides data for model validation. This effort will include measurement and modeling of mass and electronic/protonic transport in each layer and interface in an MEA.

In FY 2012, Fuel Cell Systems degradation R&D will include studies of fuel cell materials and components to identify the degradation mechanisms, as well as approaches for mitigating the effects. Studies will include the development of integrated degradation models at the component, interface, and cell levels. The performance of MEAs in a single cell and short stacks will be evaluated and compared to FY 2015 targets. Impurities present in both the fuel stream and the air intake have a negative impact on fuel cell performance and durability. In FY 2012, investigation and quantification of the effects of impurities on fuel cell performance will continue, including: parametric studies of the effect of poisons on cell and system component performance and durability; identification of poisoning mechanisms and recommendations for mitigation; and modeling of impurity effects on cell performance and durability. Impurity effects R&D will aid the development of fuel quality standards.

(dollars in thousands)

FY 2010 Current Approp	FY 2012 Request

In cooperation with the DOT's Hydrogen and Fuel Cell Bus Initiative, R&D will also focus on fuel cell system performance related to the bus duty cycle.

BOP component development will focus on sensors, air compression, and humidification. Water management continues to be a challenge due to extremes in ambient temperature, humidity, and pressures at which fuel cells must operate, to ensure that the residual water in the system does not cause damage after shut-down if the water freezes. Projects will examine concepts for novel water management devices and fuel cell system configurations that facilitate water management. Fuel cell system performance modeling will optimize water management device concepts and configurations, and ensure development of robust solutions. Third-party evaluation of fuel cell stacks and systems will increase as these technologies mature.

In FY 2012, portable power R&D will focus on materials such as the anode, cathode, and membrane improvements for fuel cells that convert liquid fuels, in particular methanol or ethanol, to electrical power. Anode and cathode catalyst loading for portable power fuel cells will be reduced, while improving catalytic activity and durability. Membrane R&D will be directed to reduce fuel and water crossover and increase proton conductivity.

R&D to improve performance and durability and to reduce cost of high temperature fuel cells (including PEM-PBI-type and solid-oxide fuel cells) for stationary applications will continue in FY 2012. High operating temperature is amenable to CHP applications, although the response time to transient loads and start-up time for high-temp systems are performance challenges. The systems are relatively tolerant to fuel impurities and depending on the fuel source and the technology, may not require precious metals and may not need a separate fuel processor.

Fuel processors are developed for applications that have preference for a particular type or source of fuel at the point-of-use. DOD for instance, has a very strong preference for diesel or JP8 (jet fuel). There is also preference to supply APUs with the same fuel as the primary/propulsion system for logistical reasons, and because multiple fuel types are not presently available at all refueling locations. In some cases, such as wastewater treatment plants, specific sources of energy are co-located with electric loads. Fuel processing at point-of-use can reduce the delivery costs of fuel in dollars, energy, and emissions.

Processing conventional fuels (such as natural gas, propane, methanol, ethanol, biomass derived liquids, or diesel) and waste gases allows direct hydrogen fuel cells to be used in locations where hydrogen is not yet available and with renewable energy resources. The option of using a variety of fuels to power fuel cells contributes to energy independence. R&D efforts will concentrate on component integration, fuel flexibility, and purification and clean-up of deleterious components found in the raw fuels.

Activities may include promoting early adoption of fuel cell systems to validate performance, durability, and reliability through field testing.

Portions of this funding may be used to support efforts such as EPAct 2005 and EISA requirements; peer reviews; data collection and dissemination; and technical, market, economic, and other analyses.

(dollars in thousands)

	FY 2010 Current Approp	FY 2012 Request
SBIR/STTR	**0**	**1,268**

No funds were transferred from this budget line to the SBIR and STTR programs in FY 2010 because this was a new sub-program. However, in FY 2010, $1,678,000 was transferred to the SBIR program and $202,000 was transferred to the STTR program from comparable funding. The FY 2012 amounts shown are the estimated requirement for the continuation of the SBIR and STTR programs.

Total, Fuel Cell Systems R&D	**75,609**	**45,450**

Explanation of Funding Changes

	FY 2012 vs. FY 2010 Current Approp ($000)
Fuel Cell Systems R&D	
Funding is reallocated to higher priority programs. Most existing fuel cell system and component R&D commitments will be maintained, but technical targets are extended to later years. Funding for portable power and auxiliary power unit (APU) applications will be reduced or deferred.	-31,427
SBIR/STTR	
Changes in the SBIR/STTR funding are a direct result of changes in the funding of program activities and projected allocation among activities.	+1,268
Total Funding Change, Fuel Cell Systems R&D	**-30,159**

Hydrogen Fuel R&D

Funding Schedule by Activity

(dollars in thousands)

	FY 2010 Current Approp[a]	FY 2012 Request
Hydrogen Fuel R&D	45,750	33,969
SBIR/STTR	0	1,031
Total, Hydrogen Fuel R&D	45,750	35,000

Benefits

Hydrogen Fuel R&D focuses on materials research and technology to address key challenges to hydrogen production, delivery, and storage, and to enable low cost, carbon-free hydrogen fuels from diverse renewable pathways. The effort encompasses small-scale hydrogen production through renewable liquids reforming and electrolysis, and large-scale centralized production through biomass gasification, wind and solar-powered electrolysis, solar driven high temperature thermochemical cycles, as well as biological and direct photoelectrochemical pathways. This sub-program also includes technologies for hydrogen transportation and distribution to the end user and the end user operations of compression, storage, and dispensing.

The hydrogen storage component of this key activity focuses on the R&D of technologies to lower the cost of near-term physical storage options and materials approaches that can enable widespread commercialization of fuel cell systems for diverse applications across stationary, portable and transportation sectors. R&D is conducted on low-pressure, materials-based technologies, and will also explore low-cost advanced conformable and cryogenic-capable tank technologies for hydrogen storage systems to meet performance targets.

Hydrogen Fuel R&D supports the mission of HFCT by addressing critical challenges and developing new and advanced technologies to produce, deliver, and store hydrogen from diverse domestic renewable resources. Benefits of the R&D will impact diverse applications such as stationary, portable and transportation systems, and include lowering hydrogen cost on a cents/mile basis to a level equivalent to gasoline used in hybrid vehicles.[b] Research in hydrogen production will reduce the projected costs of hydrogen, contributing to security, economic, and environmental benefits. In addition, benefits include the ability to produce hydrogen using advanced technologies such as low temperature, energy efficient reforming of bio-derived liquids, microbial assisted electrolysis to surpass conventional electrolysis approaches, and *direct* conversion of solar energy to hydrogen such as using photoelectrochemical approaches, thereby completely eliminating conventional electrolysis.

Fuel storage is a key enabling technology for the advancement of hydrogen and fuel cell technologies

[a] In FY 2010, $1,116,000 was transferred to the SBIR program, and $134,000 was transferred to the STTR program from comparable funding.

[b] The hydrogen cost threshold range of $2.00 to $4.00 per gasoline gallon equivalent (gge) is independent of the production pathway and makes hydrogen fuel equivalent to gasoline on a cents-per-mile basis for hydrogen fuel cell vehicles and gasoline hybrid electric vehicles in 2020. http://www.hydrogen.energy.gov/pdfs/htac_oct1410_costanalysis.pdf

for stationary power, portable power, and transportation applications. Hydrogen storage can also be used to store energy created by intermittent renewable power sources (wind and solar) during periods of high availability and low demand, increasing the utilization and benefits of these large capital investments. The stored hydrogen can be used during peak hours or as system backup, or for portable, transportation, or industrial applications. The FY 2012 focus will be on storage engineering R&D, materials R&D activities, and reducing the cost of storage technologies. The storage materials activities will continue to focus on materials discovery R&D of novel materials with the potential to store hydrogen at close to room temperature and low to moderate pressure at greater energy densities than either liquid or compressed hydrogen. Key activities will be directed at improving the energetics, temperature, and rates of hydrogen release. For near-term applications, R&D is conducted on physical storage technologies: high pressure tanks, and cryogenic-capable tanks.

The program has established 2015 storage density goals of 1.8 kWh/kg (5.5 percent by weight) and 1.3 kWh/liter, and "ultimate" light-duty vehicle targets of 2.5 kWh/kg (7.5 percent by weight) and 2.3 kWh/liter.

Detailed Justification

(dollars in thousands)

	FY 2010 Current Approp	FY 2012 Request
Hydrogen Fuel R&D	**45,750**	**33,969**

The Hydrogen Fuel R&D sub-program focuses on breakthrough technologies and materials R&D to enable hydrogen production, delivery, and storage for diverse fuel cell applications. It includes materials research for hydrogen production from renewables (e.g., photoelectrochemical and biological), materials development for pipelines and tanks, and materials for low pressure, high pressure, and cryogenic hydrogen storage.

Fuel Production and Delivery

The focus of production R&D will be on materials and process development to enable hydrogen production from diverse renewable resources. This effort will include reforming of biomass-derived renewable liquids for hydrogen production and further development of aqueous phase reforming (APR) which has the potential to produce hydrogen in a one step, low temperature (~250°C) process. The program will also focus on electrolysis capital cost reduction through novel approaches and improvements in both PEM and alkaline electrolyzers. Wind and solar-powered electrolysis research will include advanced power electronics interface components and independent testing of new electrolyzer technology under renewable power scenarios.

Existing projects in the other renewable production pathways will be funded to develop breakthrough technologies and materials for large-scale centralized hydrogen production. In solar high-temperature water splitting, the program will continue development of three chemical cycles in the laboratory and then select one cycle for a small-scale, on-sun test by 2015. The program will collaborate closely on this effort with EERE's Solar Energy Technologies Program.

In photoelectrochemical water splitting hydrogen production, HFCT, in collaboration with DOE's Office of Science, will continue to develop and evaluate materials and systems and identify functional requirements for auxiliary devices. The program evaluates device configurations that are projected to

achieve 2015 and 2020 program targets. Also in collaboration with the Office of Science, research will continue on biological micro-organism systems to achieve breakthroughs in hydrogen production efficiency using photolytic, photosynthetic, fermentation, and microbial electrolysis pathways.

In the hydrogen delivery area, the program will conduct research to reduce capital costs and increase energy efficiency of hydrogen delivery systems. The focus in FY 2012 will be on development and testing of small scale compression and liquefaction projects. The integration of advanced compression technologies will be assessed across delivery program areas: pipelines, refueling stations, and liquefaction cycles. Testing and assessment will be coordinated with industry and will incorporate early market experience.

Fuel Storage

To address the critical challenge of hydrogen storage for stationary, portable, transportation applications, and energy storage for intermittent renewables, the program will continue with its overarching strategy to conduct R&D through the framework of competitively awarded projects, which includes teams of university, industry and Federal and National Laboratory partners. These efforts will focus on applied, target-oriented research of advanced concepts, innovative chemistries, and novel materials, with the potential to meet storage density technical goals of 1.8 kWh/kg (5.5 percent hydrogen by weight) and 1.3 kWh/L or 40 g/L by 2015. These goals represent usable specific energy from hydrogen and energy density, respectively, from an entire storage system (including all hardware and materials), and are comparable to a greater than 300 mile driving range for light duty vehicles. Advanced concepts include high-capacity metal hydrides, chemical hydrogen storage materials including solid and liquid chemical hydrogen carriers and boron-based materials, sorbents including novel metal-carbon hybrids, metal-organic framework materials, polymers, and other nanostructured high surface area materials, as well as novel material synthesis and treatment processes. Building on the research conducted, R&D will focus on the most promising material technologies down-selected from the overall portfolio that have the potential to meet the DOE 2015 system target. Research on material concepts with the potential to meet the ultimate DOE targets of 7.5 percent hydrogen by weight will also continue.

The applied R&D will be closely coordinated with the DOE Office of Science basic research efforts.

Metal hydride research focuses on developing novel high-capacity materials that have the potential to meet the 2015 system targets. The R&D investment will focus on improving the volumetric and gravimetric capacities, reaction thermodynamics, and the transient performance of a fraction of the potential material candidates. Long-term cycling effects will also be investigated.

Chemical hydrogen storage research focuses on developing high-capacity materials that have the potential to meet the 2015 system targets. The applied R&D investment focuses on improving volumetric and gravimetric capacity, transient performance, other system performance requirements and the efficient regeneration of the spent storage material.

Research on sorbents focuses on innovative ways to store hydrogen with lower binding energies (as compared to metal hydrides and chemical hydrides) to enable close to room temperature storage at

(dollars in thousands)

	FY 2010 Current Approp	FY 2012 Request

nominal pressure to meet the 2015 system targets. Following the FY 2009 materials down-select decision, the sorbent portfolio focuses on improving the volumetric capacity, reaction thermodynamics, and the transient performance of materials.

Physical energy storage as either compressed hydrogen or cryogenic hydrogen are energy storage options for near-term commercialization of vehicles and other early market applications. Research activities will be conducted to address near-term hydrogen storage options, including cost reduction of high-pressure composite tanks, and increasing the dormancy of cryogenic-capable tanks. Engineering research focuses on utilizing the storage system requirements for light-duty vehicles to design innovative components and systems with the potential to meet DOE performance and cost targets. Efforts will continue to develop engineering and system models that address both subsystems and the fuel cycle.

All of the material studies include a diverse set of material reactivity properties that generate critical information for a safe, commercially viable technology. Independent testing to validate materials performance for selected materials will also be continued. The program will rigorously assess the emerging technologies based on performance, cost, life-cycle energy efficiencies, and environmental impact through storage systems analysis and engineering activities.

Portions of this funding may be used to support efforts such as such as EPAct 2005 and EISA requirements, peer reviews; data collection and dissemination; and technical, market, economic, and other analyses.

SBIR/STTR	**0**	**1,031**

No funds were transferred from this budget line to the SBIR and STTR programs in FY 2010 because this was a new key activity.. However, in FY 2010, $1,116,000 was transferred to the SBIR program and $134,000 was transferred to the STTR program from comparable funding. The FY 2012 amounts shown are the estimated requirement for the continuation of the SBIR and STTR programs.

Total, Hydrogen Fuel R&D	**45,750**	**35,000**

Explanation of Funding Changes

	FY 2012 vs. FY 2010 Current Approp ($000)
Hydrogen Fuel R&D	
The decrease reflects consolidation of the R&D portfolio and fulfillment of current obligations, with limited new starts for hydrogen storage R&D and production R&D for intermittent renewable energy sources.	-11,781
SBIR/STTR	
Changes in the SBIR/STTR funding are a direct result of changes in the funding of program activities and projected allocation among activities.	+1,031
Total Funding Change, Hydrogen Fuel R&D	**-10,750**

Systems Analysis

Funding Schedule by Activity

(dollars in thousands)

	FY 2010 Current Approp[a]	FY 2012 Request
Systems Analysis	5,408	2,912
SBIR/STTR	0	88
Total, Systems Analysis	5,408	3,000

Benefits

The Systems Analysis sub-program provides the analytical and technical basis for informed decision-making for Hydrogen and Fuel Cell program 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 the energy-related economic benefits of fuel cells across applications and for multiple fuel pathways. This analysis assesses technology manufacturing and market uptake, R&D gaps, planning and budgeting, and interactions with other energy domains. The sub-program results provide metrics for multiple components, subsystems, and systems that are needed to determine customer requirements. Results also support annual updates to key program planning documents that provide the current direction and planned milestones for the program.

Detailed Justification

(dollars in thousands)

	FY 2010 Current Approp	FY 2012 Request
Systems Analysis	**5,408**	**2,912**

Systems Analysis provides the analytical and technical basis for determining technology gaps for R&D prioritization. The sub-program will quantify energy efficiency, economic, and environmental benefits of fuels across applications and for multiple fuel and energy pathways, and optimize cross-cutting synergies with other renewable technologies. In FY 2012, the sub-program will utilize existing program analytical models and tools to quantify GHG, criteria pollutants, and benefits of reduced petroleum use, as well as identify research, environmental, and economic gaps for various applications (such as materials handling, stationary and portable power, and CHP). Analysis efforts will assess: resource and renewable 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 wide scale commercialization. The use of hydrogen produced from renewable resources (such as wind, solar and biogas) for energy storage and as an energy carrier will be assessed to understand opportunities to alleviate electrical grid congestion and the distribution of energy from point of generation to end-users. The environmental benefits of

[a] In FY 2010, $132,000 was transferred to the SBIR program and $16,000 was transferred to the STTR program.

(dollars in thousands)

	FY 2010 Current Approp	FY 2012 Request

utilizing renewable fuels such as landfill gas, other biogases (e.g., from dairy farms) and unused sources of gaseous hydrogen gas for stationary fuel cells will be assessed on a well-to-wheels basis. The sub-program will also evaluate the impact of fuel quality on fuel cells for transportation and stationary power generation to determine the cost and emission tradeoffs for fuel purification processes.

In FY 2012, the Macro System Model (MSM), which provides overarching analysis for the program, will be used to analyze near- and mid-term market impacts and benefits for the integration of stationary fuel cells into the electricity supply.

In collaboration with other HFCT sub-programs, the Systems Analysis sub-program will:

- Update existing program models with emerging cost, performance, yield and environmental information from independent reviews and research projects. Model experts and project representatives will perform required model upgrades to improve model capabilities and their representation of actual technology performance;
- Provide system analysis support and input for all the program elements such as go/no-go decisions;
- Assess market penetration, job creation and opportunities for fuel cell applications in the near term, such as materials handling, backup power, and residential CHP markets; and
- Update and maintain the Analysis Portfolio, the prioritized analysis list, and the Analysis Resource Center database, to ensure analysis consistency and transparency. Update the Systems Analysis Plan, and assist in updating the Program's Technical Requirements document and Multi-Year Research, Development and Demonstration Plan.

Integration of stationary fuel cell power generation for the electrical sector will be examined to determine the potential benefits of and synergistic impact on cost and GHG reductions. Cross-cutting analysis of tradeoffs and synergies among regions for infrastructure and resource availability will be completed. Market studies, including an assessment of the opportunities for early market applications of fuel cells and the resulting impacts on job growth will also be conducted.

The analysis of the effects of a Federal fuel cell acquisition program from Recovery Act funding on fuel cell cost reduction and job creation will be conducted. Program element risk analysis will be conducted to evaluate progress towards program targets and goals. In addition, these funds will be used to support peer reviews as required.

SBIR/STTR	**0**	**88**

In FY 2010, $132,000 and $16,000 were transferred to the SBIR and STTR programs respectively. The FY 2012 amounts shown are estimated requirements for the continuation of the SBIR and STTR programs.

Total, Systems Analysis	**5,408**	**3,000**

Explanation of Funding Changes

	FY 2012 vs. FY 2010 Current Approp ($000)
Systems Analysis	
The reduction reflects deferred analysis of longer term markets, such as possible hydrogen-CO_2 synthetic fuels, in order to maintain an appropriate program balance between analysis and R&D.	-2,496
SBIR/STTR	
Changes in the SBIR/STTR funding are a direct result of changes in the funding of program activities and projected allocation among activities.	+88
Total Funding Change, Systems Analysis	**-2,408**

Market Transformation

Funding Schedule by Activity

(dollars in thousands)

	FY 2010 Current Approp[a]	FY 2012 Request
Market Transformation	15,005	0
SBIR/STTR	0	0
Total, Market Transformation	15,005	0

Benefits

By increasing the volume of product purchases for early-market applications, particularly for stationary power and specialty vehicles for material-handling (i.e., lift trucks), FY 2009 Recovery Act and FY 2010 early-market activities allowed domestic fuel cell manufacturers to accelerate development of high-volume and low-cost manufacturing capability, establish a component and material supplier base, and lower the cost of fuel cell power systems through manufacturing economies of scale.

The projected Recovery Act outlays for early market fuel cells will be $16 million through FY 2012. No funding is requested for early market fuel cell applications in FY 2012 as the program continues to gather and analyze data from the units that have been placed into the field.

Detailed Justification

(dollars in thousands)

	FY 2010 Current Approp	FY 2012 Request
Market Transformation	**15,005**	**0**

Under the Market Transformation sub-program, DOE coordinated with the Defense Logistics Agency (DLA) on the demonstration of fuel cell forklifts. As the main provider of fuel and supplies for the Department of Defense, as well as several civilian agencies, DLA supports a vast infrastructure of distribution centers across both the U.S. and abroad. By introducing fuel cell forklifts into their distribution centers, DLA is capitalizing on the opportunity to test fuel cells under real world conditions and provide feedback to manufacturers. Operations and performance data of the forklifts have been collected and analyzed.

Portions of this funding may be used for relevant training and education efforts to prepare a workforce with the skills and abilities needed in the clean energy economy. In addition, these funds may be used to support efforts such as peer reviews; data collection and dissemination; and fabrication, assembly, testing and other process analyses.

[a] In FY 2010, $19,000 was transferred to the SBIR program and $2,000 was transferred to the STTR program.

SBIR/STTR	**0**	**0**
In FY 2010, $19,000 and $2,000 were transferred to the SBIR and STTR programs respectively. As no funding is requested for this sub-program, there are no related SBIR and STTR estimates.		
Total, Market Transformation	**15,005**	**0**

Explanation of Funding Changes

	FY 2010 vs. FY 2012 Current Approp ($000)
Market Transformation	
Market Transformation activity is on hold while there is ongoing collection of performance and cost data from $42M in deployments underway through the Recovery Act.	-15,005
SBIR/STTR	
In FY 2010, $19,000 and $2,000 were transferred to the SBIR and STTR programs respectively. As no funding is requested for this sub-program, there are no related SBIR and STTR estimates.	0
Total Funding Change, Market Transformation	**-15,005**

Manufacturing R&D

Funding Schedule by Activity

(dollars in thousands)

	FY 2010 Current Approp[a]	FY 2012 Request
Manufacturing R&D	4,867	1,941
SBIR/STTR	0	59
Total, Manufacturing R&D	4,867	2,000

Benefits

Manufacturing R&D supports the mission of HFCT by developing advanced fabrication and process technologies to meet the cost targets of critical hydrogen and fuel cell technologies. These activities will help realize fuel cell and hydrogen system costs that are equivalent to internal combustion engines and gasoline. The manufacturing technology research will focus on enabling technology readiness. Benefits include growing the domestic supplier base, which will provide jobs in the U.S. in an emerging clean energy industry.

Detailed Justification

(dollars in thousands)

	FY 2010 Current Approp	FY 2012 Request
Manufacturing R&D	**4,867**	**1,941**

In FY 2012, the sub-program will continue its collaborative research efforts involving universities, industry, and National Laboratories in the development of fabrication processes amenable to low-cost, high-volume manufacturing. Near-term activities will encompass new and ongoing R&D of technologies critical to an early start-up of high-volume commercialized products such as: 1) membrane-electrode assemblies and gas diffusion layers for fuel cells; 2) distributed production systems and components; and 3) vessels for hydrogen storage. Specific manufacturing R&D projects will be identified as technology roadmaps are updated to reflect the needs of near-term applications such as low-cost stationary systems for distributed electric power generation. In its Phase III review of the FreedomCAR and Fuel Partnership, the National Academies stated that manufacturing innovation is "becoming essential for competitive success."[b]

Portions of this funding may be used to support efforts such as peer reviews; data collection and dissemination; and fabrication, assembly, testing and other process analyses.

[a] In FY 2010, $119,000 was transferred to the SBIR program and $14,000 was transferred to the STTR program.

[b] *Review of the Research Program of the FreedomCar and Fuel Partnership: Third Report*, National Research Council, 2010; available at: http://www.nap.edu/catalog/12939.html.

(dollars in thousands)

	FY 2010 Current Approp	FY 2012 Request
SBIR/STTR	**0**	**59**

In FY 2010, $119,000 and $14,000 were transferred to the SBIR and STTR programs respectively. The FY 2012 amounts shown are estimated requirements for the continuation of the SBIR and STTR programs.

Total, Manufacturing R&D	**4,867**	**2,000**

Explanation of Funding Changes

	FY 2010 vs. FY 2012 Current Approp ($000)
Manufacturing R&D	
The majority of activities will be deferred or funded at a reduced pace, in order to ensure adequate funding for critical-path R&D activities in Hydrogen Fuel R&D, Fuel Cell Systems R&D, and Safety, Codes & Standards.	-2,926
SBIR/STTR	
In FY 2010, $119,000 and $14,000 were transferred to the SBIR and STTR programs respectively. The FY 2012 amounts shown are estimated requirements for the continuation of the SBIR and STTR programs.	+59
Total Funding Change, Manufacturing R&D	**-2,867**

Technology Validation

Funding Schedule by Activity

(dollars in thousands)

	FY 2010 Current Approp[a]	FY 2012 Request
Technology Validation	13,005	7,938
SBIR/STTR	0	62
Total, Technology Validation	13,005	8,000

Detailed Justification

(dollars in thousands)

	FY 2010 Current Approp	FY 2012 Request
Technology Validation	**13,005**	**7,938**

In FY 2012 the technology validation activity will focus on diverse fuel cell applications, consistent with the National Academies' statement that technology validation's "importance cannot be overemphasized." [b] Hydrogen refueling for material handling equipment, backup power (e.g., cell towers), transportation, and stationary applications will be evaluated. Real-world operational data will be collected and analyzed to assess current technology and provide feedback to fuel cell R&D activities. Technology Validation will leverage partnerships with DOD and other agencies to validate hydrogen and fuel cell technologies under real-world conditions. The scope of activities includes collection and analysis of data from fuel cells, especially in early market applications. The program's validation activities will include early markets such as fuel cell buses and innovative technologies for infrastructure. Collaboration with the DOT includes validating fuel cell and hydrogen technologies in transit bus applications in coordination with the Federal Transit Administration, and harmonizing data collection efforts with other fuel cell bus (FCB) demonstrations worldwide.

Portions of this funding may be used to support efforts such as peer reviews; data collection and dissemination; and technical, market, economic, and other analyses.

SBIR/STTR	**0**	**62**

In FY 2010, $82,000 and $10,000 were transferred to the SBIR and STTR programs respectively. The FY 2012 amounts shown are estimated requirements for the continuation of the SBIR and STTR programs.

Total, Technology Validation	**13,005**	**8,000**

[a] In FY 2010, $82,000 was transferred to the SBIR program and $10,000 was transferred to the STTR program.

[b] *Review of the Research Program of the FreedomCar and Fuel Partnership: Third Report*, National Research Council, 2010; available at: http://www.nap.edu/catalog/12939.html.

Explanation of Funding Changes

	FY 2010 vs. FY 2012 Current Approp ($000)
Technology Validation	
The decrease sustains the essential activities to move fuel cell development from the demonstration stage toward commercialization through a leveraged program with local and State governments. Focus will be on limited demonstrations to validate innovative technologies under real-world conditions applicable to transportation and stationary sectors.	-5,067
SBIR/STTR	
In FY 2010, $82,000 and $10,000 were transferred to the SBIR and STTR programs respectively. The FY 2012 amounts shown are estimated requirements for the continuation of the SBIR and STTR programs.	+62
Total Funding Change, Technology Validation	**-5,005**

Safety, Codes & Standards

Funding Schedule by Activity

(dollars in thousands)

	FY 2010 Current Approp[a]	FY 2012 Request
Safety, Codes & Standards	8,653	6,837
SBIR/STTR	0	163
Total, Safety, Codes & Standards	8,653	7,000

Benefits

Underlying research to enable the development of technically sound codes and standards for the safe use and transport of hydrogen and other alternative fuels is essential for the commercialization of fuel cell technologies. This effort also supports the development of global technical regulations for fuel cell applications. Global consistency in standards will ensure that different technologies will not need to be developed for each region of the world. The drafting and adoption of hydrogen codes and standards is supported through the development of hydrogen characterization and behavior data, as well as through limited direct support of standards development organizations and codes development organizations. Hydrogen release data and incident scenario analysis will support a quantitative risk assessment approach for codes and standards development activities focused on enabling technology readiness.

Detailed Justification

(dollars in thousands)

	FY 2010 Current Approp	FY 2012 Request
Safety, Codes & Standards	**8,653**	**6,837**

In FY 2012, the Safety, Codes & Standards sub-program will quantify the effects of fuel contaminants on fuel cell system components to support the development of fuel quality standards, and will develop analytical methods to allow cost-effective verification of fuel purity. Metering technologies will also be supported to allow accurate measurement of delivered fuel. DOE will collaborate with DOT, EPA, NIST and other government agencies 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 Global Technical Regulation (DOT, EPA). Analysis of potential accident scenarios will be conducted to identify potential systems weaknesses. R&D focuses on mitigating the identified weaknesses to improve systems safety. The accident scenarios report will help guide a risk analysis effort that uses probabilistic risk analysis and failure mode affects analysis methods to quantitatively estimate systems risk. Risk assessment activities will provide information to guide the codes and

[a] In FY 2010, $166,000 was transferred to the SBIR program and $20,000 was transferred to the STTR program.

(dollars in thousands)

	FY 2010 Current Approp	FY 2012 Request

standards development process. Risk assessments will be made available to key industry stakeholders, such as fuel providers and insurers.

FY 2012 funding will facilitate the development of models such as computational fluid dynamics to support the risk assessment activities for fueling, production infrastructure, and transportation of hydrogen in tunnels, garages, and other confined spaces. The activity will also conduct comprehensive R&D to characterize the release of hydrogen when impeded by various obstacles/equipment to provide the input necessary to determine codes for separation distances. In addition, the PNNL Hydrogen Safety Panel will continue to develop and enhance safety information tools and monitor the safety of DOE hydrogen projects. The panel will conduct site visits, interviews and safety plan reviews of all DOE funded hydrogen projects.

In addition to R&D for safety, this activity will include 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, DOE will also expand the implementation and deployment of an introductory course designed specifically for code officials. Working with partners, the course will be made available to a national audience through distance learning and targeted, in-person training workshops in critical needs areas.

Portions of this funding may be to support efforts such as peer reviews; data collection and dissemination; and technical, market, economic, and other analyses.

SBIR/STTR	**0**	**163**

In FY 2010, $166,000 and $20,000 were transferred to the SBIR and STTR programs respectively. The FY 2012 amounts shown are the estimated requirements for the continuation of the SBIR and STTR programs.

Total, Safety, Codes & Standards	**8,653**	**7,000**

Explanation of Funding Changes

	FY 2010 vs. FY 2012 Current Approp ($000)
Safety, Codes & Standards	
Safety, Codes & Standards activities are restored as a separate sub-program. The decrease will allow critical safety, codes, and standards activities to continue while deferring funding for hydrogen sensors, and characterization of liquid hydrogen behavior in high volume releases.	-1,816
SBIR/STTR	
In FY 2010, $166,000 and $20,000 were transferred to the SBIR and STTR programs respectively. The FY 2012 amounts shown are the estimated requirements for the continuation of the SBIR and STTR programs.	+163
Total Funding Change, Safety, Codes & Standards	**-1,653**

Education

Funding Schedule by Activity

(dollars in thousands)

	FY 2010 Current Approp	FY 2012 Request
Education	2,000	0
Total, Education	2,000	0

Benefits

Education activities aid in overcoming institutional barriers to widespread use of hydrogen. Overcoming misunderstandings among users and officials can facilitate the achievement of the energy security and GHG reduction benefits attributable to the rest of the HFCT program.

Detailed Justification

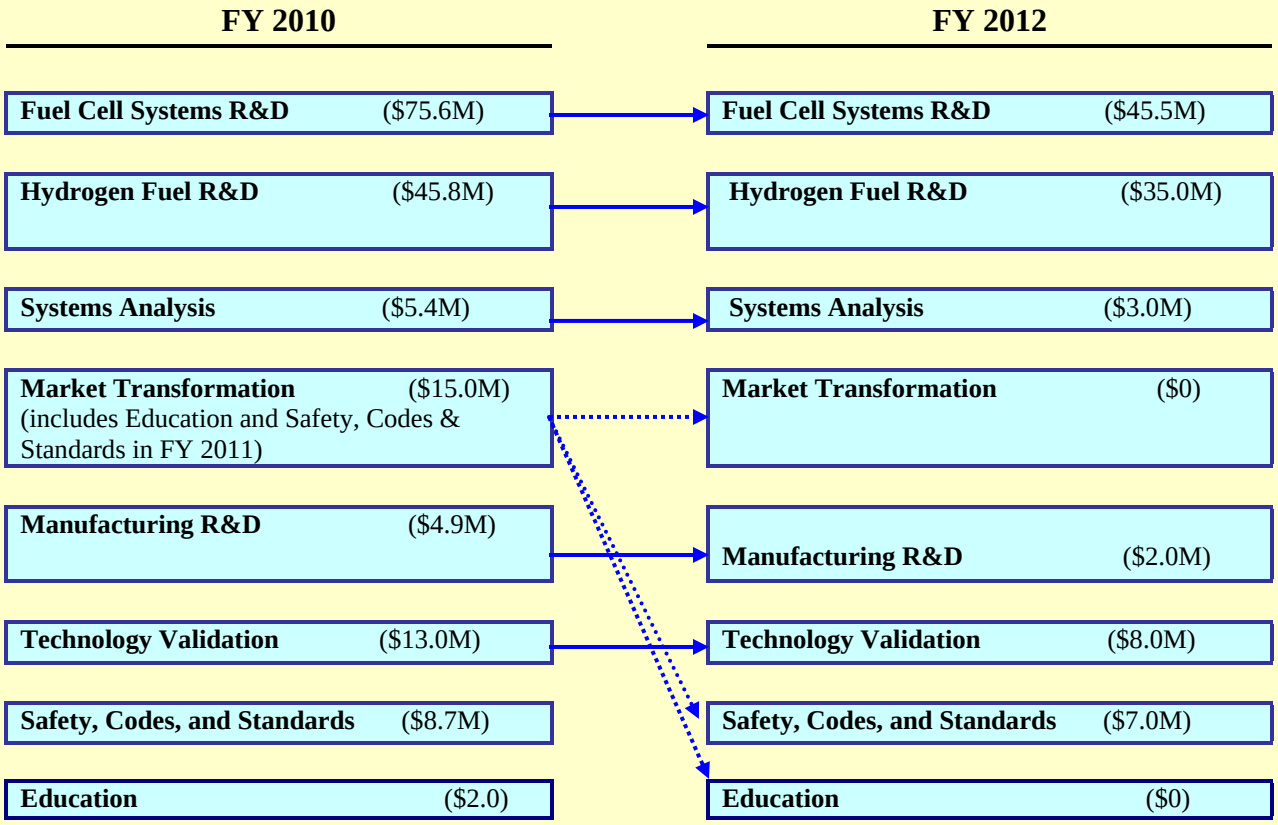
(dollars in thousands)

	FY 2010 Current Approp	FY 2012 Request
Education	**2,000**	**0**
Funding for education activities is deferred in FY 2012. Past activities have aided in overcoming institutional barriers to widespread use of hydrogen. Target audiences, identified by key government and industry stakeholders in the National Hydrogen Energy Roadmap, included State and local government representatives, safety and code officials, potential end-users, and the public. Activities included development of training for key stakeholder groups such as first-responders and local safety and code officials, and measuring awareness and knowledge of hydrogen and fuel cell technologies among stakeholder groups and the general public.		
Total, Education	**2,000**	**0**

Explanation of Funding Changes

	FY 2010 vs. FY 2012 Current Approp ($000)
Education	
Education activities have been deferred until R&D is advanced and market transformation is reinstated.	-2,000
Total Funding Change, Education	**-2,000**

Hydrogen and Fuel Cell Technologies
FY 2010 to FY 2012 Budget Structure Crosswalk



Biomass and Biorefinery Systems RD&D

Funding Profile by Subprogram

(dollars in thousands)

	FY 2010 Current Approp	FY 2012 Request
Biomass and Biorefinery Systems RD&D		
Feedstocks	36,212	16,000
Conversion Technologies	82,115	117,000
Utilization of Platform Outputs R&D	97,898	0
Integrated Biorefineries	0	25,000
Analysis and Sustainability	0	10,000
Biopower	0	22,500
Cellulosic Biofuels Reverse Auction	0	150,000
Total, Biomass and Biorefinery Systems RD&D	216,225	340,500

Public Law Authorizations:
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. 95-91, "Department of Energy Organization Act" (1977)
P.L. 95-618, "Energy Tax Act" (1978)
P.L. 95-619, "National Energy Conservation Policy Act" (NECPA) (1978)
P.L. 95-620, "Powerplants and Industrial Fuel Use Act" (1978)
P.L. 96-294, "Energy Security Act" (1980)
P.L. 100-12, "National Appliance Energy Conservation Act" (1987)
P.L. 100-615, "Federal Energy Management Improvement Act" (1988)
P.L. 101-218, "Renewable Energy and Energy Efficiency Technology Competitiveness Act" (1989)
P.L. 101-549, "Clean Air Act Amendments" (1990)
P.L. 101-575, "Solar, Wind, Waste, and Geothermal Power Production Incentives Act" (1990)
P.L. 102-486, "Energy Policy Act of 1992"
P.L. 106-224, "Biomass Research and Development Act" (2000)
P.L. 107-171, "Farm Security and Rural Investment Act" (2002)
P.L. 108-148, "Healthy Forest Restoration Act" (2003)
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"

Mission

The Biomass Program develops and transforms domestic, renewable, and abundant biomass resources into cost-competitive, high performance biofuels, biopower, and bioproducts through targeted planning, research, development and demonstration (RD&D) leveraging public and private partnerships.

Benefits

An economically-viable, sustainable, domestic biomass industry that produces clean, secure, renewable biofuels, biopower, and bioproducts will: 1) enhance U.S. energy security by reducing dependence on oil; 2) provide environmental benefits including reduced GHG emissions through substitution; and 3) create domestic economic growth and opportunities across the Nation by developing the entire supply chain domestically. The RD&D work conducted by the Biomass Program improves process and cost efficiencies, while indentifying and validating technological pathways for sustainable growth in the emerging American biofuels industry and biopower sector.

In FY 2012, the Biomass Program, in collaboration with Office of Science, will begin an innovative biofabrication effort to standardize and scale up the fabrication of fundamental biological components, allowing for rapid prototyping and testing for new approaches to synthesizing biofuels. Establishing this capability domestically will help America capture world leadership in the emerging field of biomanufacturing.

The program's integrated biorefinery projects and cellulosic biofuels reverse auction are also expected to stimulate direct private sector employment and the growth of domestic biofuels industry. The program's RD&D work and support of private sector innovation is critical to achieving the EISA RFS targets for advanced and cellulosic biofuels. The RFS requires 36 billion gallons of renewable fuel per year by 2022, of which 21 billion gallons is to be advanced biofuels.

The Biomass Program utilizes a peer review-driven resource loaded multi-year planning process that is based on extensive analysis. Technology performance is examined through annual state of technology assessments and performance against project technical milestones and passage through decision-critical stage-gates. This process is outlined in greater detail in the program's web-published Multi Year Program Plan.[a]

The ongoing work associated with the American Recovery and Reinvestment Act has further informed the Biomass Program's FY 2012 budget decisions. Nineteen small-scale integrated biorefinery projects are funded, the program's intermediate blends testing is being completed, and two R&D consortia are accelerating the Program's algal and advanced biofuels R&D efforts. This acceleration of the program's mission was taken into consideration when developing the FY 2012 request.

The Biomass Program pursues its mission through a set of integrated activities that are designed to increase the use of domestic renewable resources. Improvements are expected to continue to provide concomitant economic, environmental and security benefits. While the most significant benefits are expected to be a reduction of oil use and CO_2 emissions, consumers will benefit as well.

Program will facilitate rapid private sector growth in renewable energy supplies through technologies that produce competitive sources of fuels and electricity with full price parity with alternative methods of producing fuels, electricity, and feedstocks. Priority work includes RD&D critical to improving technology for biomass handling and conversion to fuel, power, and products, validating performance,

[a] http://www1.eere.energy.gov/biomass/pdfs/mypp.pdf.

reducing investment risk, and promoting deployment and market adoption. Strategic and sustainability analysis, biomass resource assessment, outreach, and market transformation work is also performed.

The program will leverage its planning, analysis and deployment funds by collaborating with EERE's Strategic Programs in activities that maximize the effectiveness of both program and corporate activities for EERE and DOE. The Biomass Program's RD&D supports a national reduction in GHG emissions, lowering the amount of carbon introduced into the Earth's atmosphere through displacing petroleum-based liquid transportation fuels.[a] Biopower technologies, if applied in a regionally appropriate manner, also have the potential to reduce fossil carbon contributions to atmospheric GHGs.

The displacement of fossil fuels from sources with sustainably produced advanced domestic biofuels will enhance energy security. New markets will be created simultaneously to produce sustainable feedstocks, biofuels, and biopower. The increased production of biofuels and biopower has the potential to help reshape markets, and support sustainable generation of transportation technologies capable of reducing fossil carbon emissions and ensuring future prosperity and security in the global community.

Annual Performance Results and Targets

The Department is in the process of updating its strategic plan, and has been actively engaging stakeholders including Congress. The draft strategic plan is being released for public comment concurrent with this budget submission, with the expectation of official publication this spring. The draft plan and FY 2012 budget are consistent and aligned. Updated measures will be released at a later date and available at the following link http://www.mbe.doe.gov/budget/12budget/index.htm.

[a] Further research and analysis is underway to better assess potential GHG contributions related to changes in land-use associated with increased biofuels production.

Feedstocks

Funding Schedule by Activity

(dollars in thousands)

	FY 2010 Current Approp	FY 2012 Request
Feedstocks		
Sustainable Production	6,646	973
Logistics	20,316	4,868
Algae & Advanced Feedstocks (formerly Algae)	9,250	9,737
SBIR/STTR	0	422
Total, Feedstocks	36,212	16,000

Benefits

An increased and reliable domestic supply of environmentally sustainable biomass feedstocks will be required for an expanded bioenergy industry. Feedstocks activities are critically important to increasing the availability and accessibility of domestic biomass resources and improving the infrastructure technologies needed to reliably supply cellulosic and alternative feedstocks to future large-scale biorefineries at reasonable costs. Investments in resource availability and feedstock logistics systems development are thus needed to ensure a stable feedstock supply and the economic viability of the domestic biofuels industry.

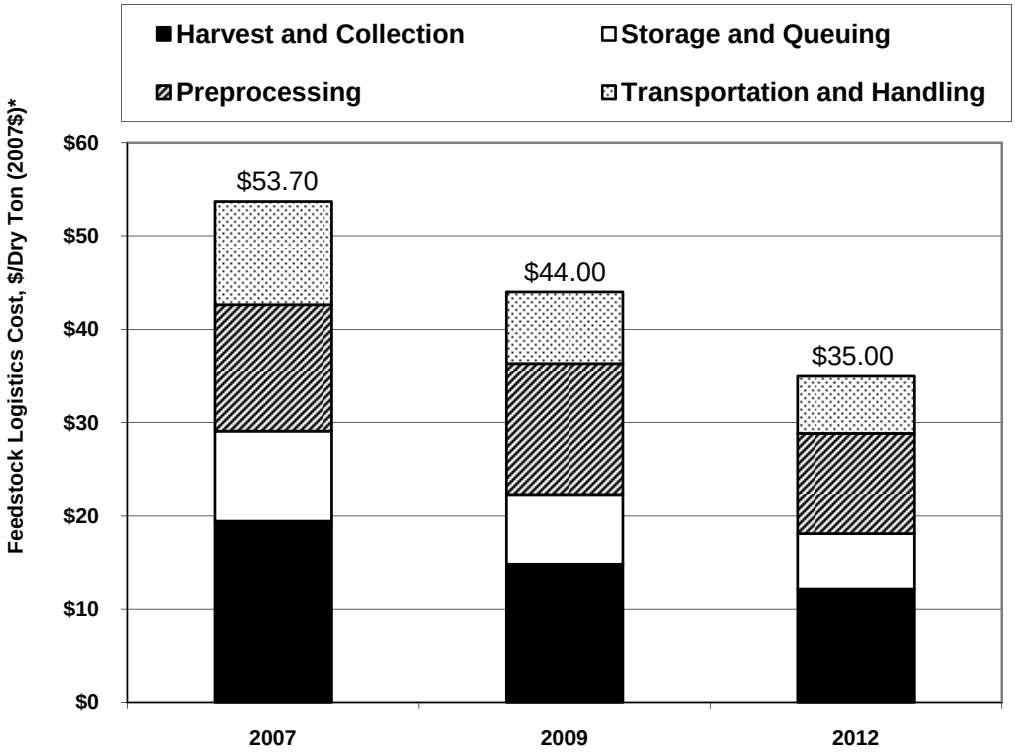
In order to identify a sustainable feedstock supply, resource assessment activities conducted in the Sustainable Feedstock Production area will continue to involve the evaluation of the amount of biomass feedstock resources potentially available in the U.S., where they will be located, at what cost, and under what environmental constraints. Results of these assessments will be incorporated into a GIS-based decision support tool incorporating best-available data from Federal agencies including DOE and USDA biorefinery project results and other assessments from public and private sources. This process will provide the best information to users, which will include Federal and State governments, biorefinery developers, growers, and researchers.

In the near term, the feedstock production goal is to establish criteria under which a sustainably produced, high quality feedstock supply can be available to support a growing biomass industry and meet biomass conversion quality specifications. This goal is necessary to spatially quantify the accessible resources and validate the percentage of resources that could be recovered cost effectively and sustainably.

Industry partnerships will continue to be used to improve feedstock logistics to enhance the economic viability of domestic biofuels. These collaborative efforts involve improvements in existing or the development of new feedstock handling and storage technologies, and proving their success through demonstration trials. The near-term cellulosic feedstock logistics goal is to reduce feedstock logistics costs, including harvesting, storage, preprocessing and transportation, to $0.39 per gallon of ethanol in 2012 (or approximately $35.00 per dry ton, in 2007$ and excluding payment to the grower). In order to reach this goal, the density of cellulosic biomass needs to be increased to 14 lbs per cubic foot. Providing a denser feedstock will have positive cost ramifications throughout the feedstock supply

chain. Indicators of progress toward this goal include cost-shared industrial partnerships for developing feedstock logistics systems.

Feedstock Logistics Cost Projections



*Excludes grower payment

Year	2007	2009	2012
Total, Feedstocks Logistics, $/Dry Ton	**$53.70**	**$44.00**	**$35.00**
Harvest and Collection	$19.45	$14.81	$12.15
Storage and Queuing	$9.64	$7.44	$5.95
Preprocessing	$13.54	$14.05	$10.74
Transportation and Handling	$11.07	$7.70	$6.16

In addition to terrestrial energy crops, algal feedstocks are being examined. Section 228 of EISA requires DOE to report the potential of microalgae as a feedstock for biofuels. This report concluded that microalgae are a potentially viable feedstock in the long-term, though algal biofuel technologies are still in relatively early stages of development. The Biomass Program released a final algae roadmap in June 2010 which documents technical challenges associated with producing algal biofuels and examines pathways to fuels from not only microalgae, but also cyanobacteria and macroalgae.

Feedstocks activities are an integral part of the Biomass Program's partnered strategic pathway of advancing biomass technologies from basic science to applied research and demonstration, utilizing a

market interdependent approach that incorporates linkages and feedback among each step in order to accelerate the benefits of technology development.

Detailed Justification

(dollars in thousands)

	FY 2010 Current Approp	FY 2012 Request
Sustainable Production	**6,646**	**973**

Sustainable Production previously addressed biomass feedstock resource assessment, yield improvement, and sustainable feedstock systems development. Yield improvement and sustainable feedstock systems development were primarily addressed via the continuation of existing feedstock production trials with the Regional Biomass Feedstock Development. Those trial results will be published in FY 2012. It is anticipated that Federal level sustainable feedstock production efforts will be led by USDA starting in FY 2012. Resource assessment efforts will be limited to feedstock characterization from samples obtained during the feedstock trials. Results from these assessments will be incorporated into a GIS-based decision support tool developed at Oak Ridge National Laboratory that can incorporate best-available data from Federal agencies including DOE and USDA biorefinery project results and other assessments from public and private sources.

Logistics	**20,316**	**4,868**

Feedstock Logistics R&D addresses barriers associated with accessing and delivering the feedstock supply to an integrated biorefinery. This work involves the following unit operations: harvesting, collection, preprocessing, storage, queuing, handling, and transport. Feedstocks' efforts expanded from laboratory design work into industrial partnerships through competitively awarded projects initiated in late FY 2009. These projects will improve the operation and efficiency of feedstock collection and delivery systems and will be completed in FY 2012. In collaboration with the Integrated Biorefineries subprogram, a deployable process demonstration unit (PDU) housed at the Idaho National Laboratory (INL) was developed for feedstock logistics systems.

(dollars in thousands)

	FY 2010 Current Approp	FY 2012 Request
Algae and Advanced Feedstocks	**9,250**	**9,737**

The feedstock production component of microalgae development will be integrated with algae efforts as algal biofuel challenges are addressed across the supply chain. The major components of this effort include: 1) resource assessments of the algae production inputs; 2) environmental assessments of the impacts of growing algae at scale; 3) identification and optimization of algae strains to improve feedstock production; 4) improvements of cultivation methods and operations; and 5) research of problems at the feedstock-fuel conversion interface, including harvesting and dewatering. Analytical and spatial modeling efforts will be directed to expand the current knowledge of algae production requirements. These include assessments on the availability of land, water and micronutrients on a national scale. Results of these modeling and analysis projects will be the inputs into a national GIS assessment tool, which can be used for visualization of scenarios of future biofuels development.

This tool will inform industrial stakeholders' decision-making processes and ultimately determine the feasibility of domestically producing four billion gallons of algal biofuels by 2022 in support of the advanced biofuels component of the EISA RFS. Research and modeling activities will also help determine likely environmental impacts associated with producing algal biofuels at that scale, under different production scenarios. In addition, research will begin characterizing basic properties of algae feedstocks to ensure compatibility and integration with the available cultivation strategies and downstream fuel conversion processes.

SBIR/STTR	**0**	**422**

SBIR/STTR funding transferred in FY 2010 was $697,000 for the SBIR and $84,000 for the STTR program. The FY 2012 amounts shown are estimated requirements for the continuation of the SBIR and STTR program.

Total, Feedstocks	**36,212**	**16,000**

Explanation of Funding Changes

	FY 2012 vs. FY 2010 Current Approp ($000)
Sustainable Production	
The decrease reflects the expectation that USDA will lead in the area of sustainable feedstock production through regional crop development centers, via its Agricultural Research Service, Forest Service, and National Institute of Food and Agriculture.	-5,673
Logistics	
The decrease reflects the completion of the industrial partner logistics projects and building of the PDU. Efforts will be focused on TRL 1-3 activities.	-15,488

	FY 2012 vs. FY 2010 Current Approp ($000)
Algae & Advanced Feedstocks	
The increase is comprised of new algae projects involving: feasibility, environmental, and resource assessments; exploration of conversion interface issues; and organism characterization.	+487
SBIR/STTR	
Changes in the SBIR/STTR funding are a direct result of changes in the funding of program activities.	+422
Total Funding Change, Feedstocks	**-20,212**

Conversion Technologies

Funding Schedule by Activity

(dollars in thousands)

	FY 2010 Current Approp	FY 2012 Request
Conversion Technologies		
Thermochemical	26,830	56,310
Biochemical	30,820	57,447
Algae	24,465	0
SBIR/STTR	0	3,243
Total, Conversion Technologies	82,115	117,000

Benefits

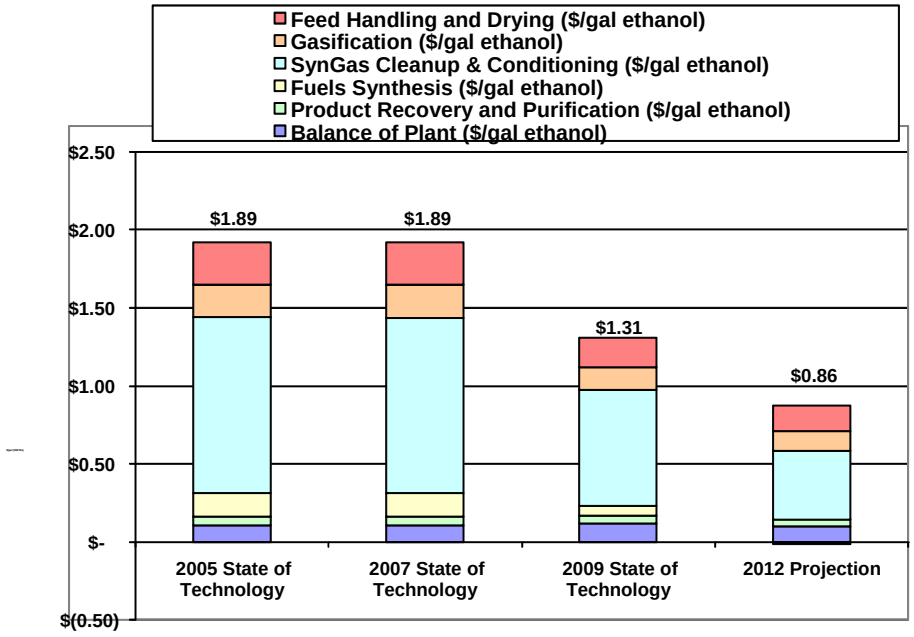
The Conversion Technologies subprogram supports the advancement of Thermochemical and Biochemical technologies for converting feedstocks and intermediates into quality, cost-competitive liquid transportation fuels, materials, and other chemicals. Thermochemical conversion R&D focuses on reducing the costs associated with producing liquid transportation biofuels from gasification and pyrolysis technologies, which includes R&D in feedstock interface, thermochemical processing, intermediate cleanup and conditioning, and upgrading for fuel synthesis. Biochemical conversion R&D will focus on process integration supported by further improvements to feedstock interface (pre-processing), pretreatment, enzymatic and chemical hydrolysis, and fermentation. These integrated steps are required to reduce production costs and therefore enable economically viable cellulosic biofuels production by biorefineries. Additionally, a new initiative will be launched to work with industry partners to design and construct complex, multi-component, biological systems to enhance the cost-effectiveness of advanced biochemical conversion technologies and facilitate the accelerated commercial deployment of these technologies helping America achieve leadership in the emerging field of bio-manufacturing.

This R&D work focuses on the development of technologies capable of converting biomass feedstocks into biofuels. The technical projections for the Conversion Technologies subprogram aligns progress with the achievement of modeled ethanol costs supporting the overall Biomass Program target of $1.76 per gallon of cellulosic ethanol in 2012 (in 2007$) in the near term and $2.76/gallon jet fuel, $2.84/gallon diesel and $2.85/gallon gasoline by 2017 (in 2007$) in the longer term. The Conversion Technologies annual performance targets for FY 2012 support the meeting of the overall 2012 programmatic cost target. The two sets of charts and tables below contain the Biomass Program's current conversion cost projections, which are used to make modeled ethanol selling price (MESP) projections. In the longer term (for years 2013-2015), the Thermochemical conversion performance measures are strategically shifting from cellulosic ethanol to "drop in" hydrocarbon fuels. Thermochemical conversion technologies have several other advantages, including their ability to convert a broad range of feedstocks as supplies shift seasonally or even on a day-to-day basis; full utilization of lignin and well as cellulosic material; efficient use of the complete energy content of the feedstock via co-generation of electricity; and, potential to produce a broad range of bio-products as well as biofuels, allowing adaptation to long-term shifts in transportation fuels markets.

Thermochemical Conversion of Woody Feedstocks to Ethanol ($/gal in 2007$s) via Gasification*

	2005 State of Technology[a]	2007 State of Technology	2009 State of Technology	2012 Projection
Processing Total * ($/gal ethanol)	$ 1.89	$ 1.89	$ 1.31	$ 0.86
Balance of Plant ($/gal ethanol)	$ 0.11	$ 0.11	$ 0.12	$ 0.10
Product Recovery and Purification ($/gal ethanol)	$ 0.06	$ 0.06	$ 0.05	$ 0.05
Fuels Synthesis ($/gal ethanol)	$ 0.15	$ 0.15	$ 0.07	$ (0.01)[b]
SynGas Cleanup & Conditioning ($/gal ethanol)	$ 1.13	$ 1.13	$ 0.74	$ 0.44
Gasification ($/gal ethanol)	$ 0.21	$ 0.21	$ 0.15	$ 0.13
Feed Handling and Drying ($/gal ethanol)	$ 0.27	$ 0.27	$ 0.19	$ 0.16

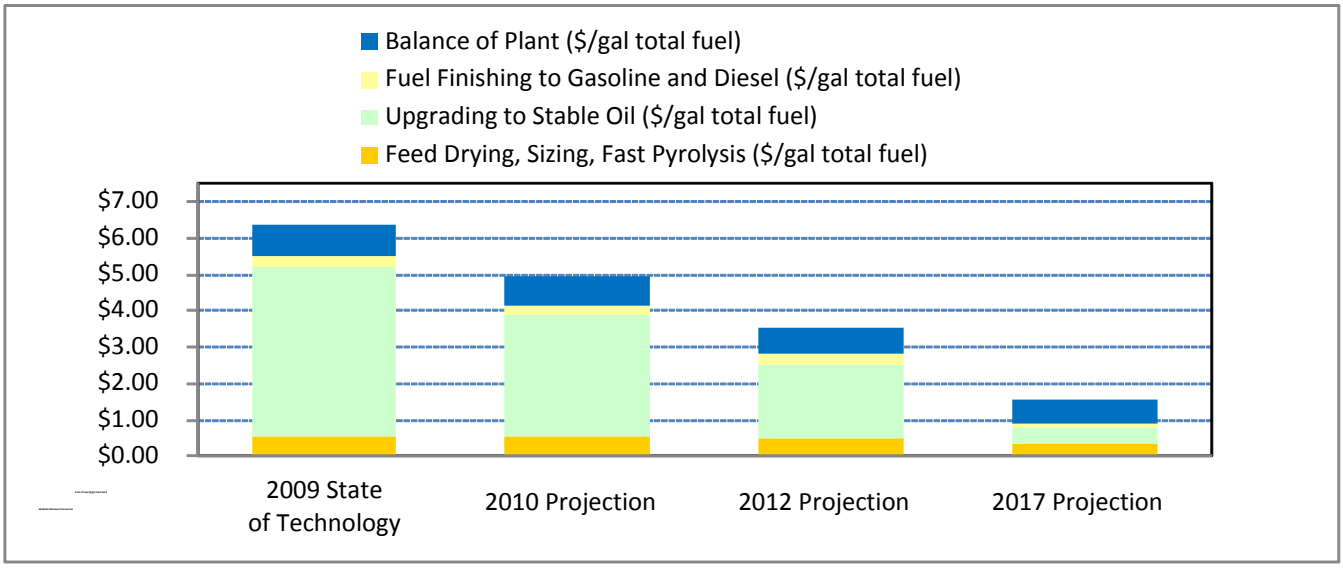
*These are solely the conversion costs additional feedstock costs are required to derive the modeled minimum ethanol selling price.



[a] Note: the numbers in the column below do not exactly add up to this value due to rounding in the computer software used. When the proper calculations were performed without rounding individual values, this number resulted; it is considered the most technically accurate.

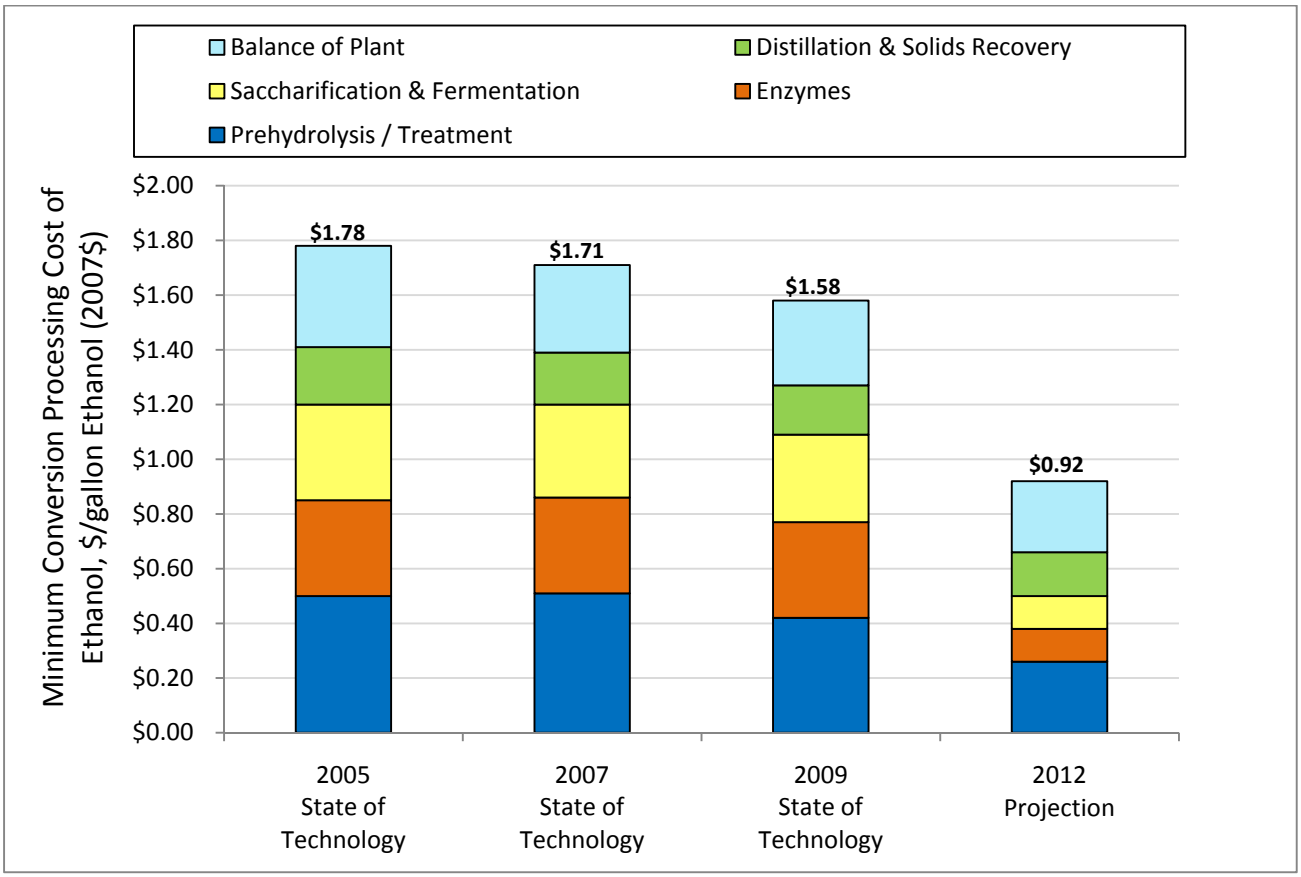
[b] A credit for a mixed alcohols co-product is factored into the calculation, thus in this particular instance, costs are reduced enough that the credit for the co-product is larger than the rest of the costs; thus a negative cost is shown.

Thermochemical Conversion of Woody Feedstocks to Renewable Gasoline and Diesel Blend Stocks ($/gallon gasoline in 2007$) via Pyrolysis



	2009 State of Technology	2010 Projection	2012 Projection	2017 Projection
Conversion Contribution ($/gal gasoline)	$6.30	$4.92	$3.51	$1.56
Conversion Contribution ($/gal diesel)	$6.37	$4.99	$3.57	$1.56
Conversion Contribution ($/gge total fuel)	$6.02	$4.71	$3.38	$1.48
Feed Drying, Sizing, Fast Pyrolysis ($/gal total fuel)	$0.54	$0.53	$0.52	$0.34
Upgrading to Stable Oil ($/gal total fuel)	$4.69	$3.34	$2.01	$0.46
Fuel Finishing to Gasoline and Diesel ($/gal total fuel)	$0.30	$0.29	$0.29	$0.12
Balance of Plant ($/gal total fuel)	$0.82	$0.81	$0.74	$0.64

Biochemical Conversion to Ethanol



	2005 State of Technology	2007 State of Technology	2009 State of Technology	2012 Projection
Processing Total	$1.79	$1.72	$1.58	$0.92
Prehydrolysis / Treatment	$0.50	$0.51	$0.42	$0.26
Enzymes	$0.35	$0.35	$0.35	$0.12
Saccharification & Fermentation	$0.35	$0.34	$0.32	$0.12
Distillation & Solids Recovery	$0.21	$0.19	$0.18	$0.16
Balance of Plant	$0.37	$0.32	$0.31	$0.26

(dollars in thousands)

	FY 2010 Current Approp	FY 2012 Request
Thermochemical	**26,830**	**56,310**

Thermal and catalytic conversion processes that can convert a variety of biomass materials to suitable intermediates (e.g., syngas and bio-oils) for subsequent conversion to fuels are under development. Thermochemical conversion R&D focuses on the reduction of costs associated with converting biomass to fuels, chemicals, and power, via gasification, pyrolysis, and catalytic hydrotreating and hydrocracking processing technologies. Intermediate products include clean synthesis gas, or syngas, (a mixture of primarily hydrogen and carbon monoxide), bio-oil (a liquid product from pyrolysis or liquefaction), and gases rich in methane or hydrogen. These intermediate products can be upgraded to fuels and chemicals such as ethanol, other alcohols, gasoline, diesel, jet fuel, ethers, synthetic natural gas, or may be used directly for heat and power generation. Core research addresses key technical barriers such as the need for the entire process to have higher yields and selectivity of the intermediates and end products. Due to subsequent catalytic conversion of syngas to fuels and products, there is a critical need for purification of the syngas and more robust production catalysts. A critical barrier for bio-oil is the need to stabilize bio-oil from unwanted side reactions and upgrading to a form that is more amenable to hydrotreating and hydrocracking catalysts (similar to those used in petroleum refineries).

FY 2012 activities include technology validation to economically convert biomass feedstocks, including forest residues and other woody resources to synthesis gas or bio-oils that are suitable for fuels and co-products. The target for gasification and subsequent ethanol production is a modeled minimum ethanol selling price (MESP) of $1.70/gallon of ethanol, resulting from achieving a conversion cost of $0.97/gallon (2007$, feedstock cost of $51.80/dry ton). The technology and data for achieving this modeling is a result of competitively selected National Laboratory, university, and industry projects. These projects involve developing syngas to liquid fuels technologies and pyrolysis oil to liquid fuel conversion technologies. A go/no go decision was made in FY 2010 to affirm that the current R&D program is on track to attain the programmatic FY 2012 target. Beginning in, and beyond FY 2012, the focus will shift ever more away from ethanol to drop-in hydrocarbon advanced biofuels with expanded application beyond light duty vehicles (e.g., heavy duty trucks, rail, and airplanes). A competitive solicitation was issued to support pyrolysis oil production R&D and subsequent upgrading to non-ethanol, infrastructure-compatible biofuels, including but not limited to new catalysts for upgrading of bio-oil.

FY 2012 activities also include the finalization of applied R&D in a small fully integrated system to convert biomass feedstocks such as woody feedstocks to synthesis gas and subsequent conversion to either ethanol or Fischer-Tropsch alkanes. The target for gasification and subsequent ethanol production is a modeled conversion cost of $0.86/gallon of ethanol (2007$) and current data shows clear progress to meeting this goal in FY 2012. This conversion cost will result in a modeled minimum ethanol selling price (MESP) of $1.57/gallon in 2012 (2007$, feedstock cost of $50.70/dry ton). The data for completing this target will be produced through National Laboratories, universities and industry-led projects.

Current projects will continue to develop bio-oil production technology and subsequent hydrotreating to renewable gasoline, diesel, and jet fuel in FY 2012. Projects selected in a competitive solicitation for

(dollars in thousands)

FY 2010 Current Approp	FY 2012 Request

non ethanol infrastructure compatible biofuels research will continue. Together with another solicitation to be initiated in FY 2012, these projects seek to resolve the critical barriers with catalysts for the production of renewable gasoline, diesel, and jet fuel such as lifetimes, activity, and selectivity. These processes and catalysis are a critical component in the successful thermochemical conversion of biomass to biofuels.

The fast pyrolysis technology will focus on achieving the renewable gasoline and diesel technical targets in 2017 of a modeled conversion cost of $1.56/gallon of gasoline or diesel. This conversion cost will yield a modeled minimum gasoline or diesel selling price of $2.04/gallon (2007$, feedstock cost of $50.70/dry ton). Additional R&D efforts for producing renewable-gasoline, -diesel, and –jet fuel will include (but not be limited to): hydrothermal liquefaction, catalytic pyrolysis, hydropyrolysis, gasification of biomass to syngas and subsequent conversion to renewable-gasoline, -diesel and –jet fuel, $>C_4$ alcohols, and ethers.

The objective will also be supported by expanding three key research areas to gain a better understanding of the fundamental sciences involved. Gasification fundamentals will include understanding the mechanisms involved in tar reforming, syngas "cleaning", and fuel synthesis particularly for infrastructure compatible fuels. Pyrolysis fundamentals will support efforts to improve bio-oil quality (reduction of total acid number, oxygen content, and residual char fines content) and bio-oil upgrading to gasoline and diesel blends. Catalyst fundamentals include examining the chemical and physical mechanisms involved in syngas and bio-oil catalysis, as well as developing catalysts to improve stability, selectivity, and activity for fuel intermediate and fuel production.

A full understanding of the factors controlling thermochemical conversion is needed to be able to develop new or improved technologies that increase yield and quality, and reduce cost. As the feedstock interface is further developed, cost and energy efficiency solutions can be employed to attain the feedstock with defined specification to readily enable optimal yields in conversion operations. Work will be done in collaboration with competitively selected laboratory, university, and industrial partners. In addition, these funds may be used to support efforts such as peer reviews, data collection and dissemination, and technical, market, economic, and other analyses.

Biochemical **30,820** **57,447**

The mission of Biochemical conversion is to develop technologies for the conversion of agricultural residues, energy crops and other biomass to mixed, dilute sugars, and further conversion to liquid fuels. Research is focused on reducing the biochemical conversion cost of producing liquid fuels by targeting key technology barriers in the unit operations processes, such as pretreatment, enzyme production, hydrolysis, and fermentation. Additional support is provided to advance technologies needed for successful integrated biorefineries and in supporting realization of the program's overall FY 2012 cost target. To meet this target, the program has established a modeled conversion cost target of $0.92 per gallon of ethanol , which, with an estimated feedstock cost of $50.90 per dry ton, contributes to the projected achievement of a modeled MESP of $1.49 per gallon in FY 2012 (2007$).

In FY 2012, Biochemical conversion R&D will continue to focus on integration and optimization of the individual process steps. Additionally, efforts will continue toward reducing cellulosic biofuel costs by focusing on barriers related to feedstock interface, pretreatment, hydrolysis, and conversion processes.

The continued development of these technologies will enable the conversion of a wider range of feedstocks and diversify the R&D portfolio to include the production of hydrocarbon cellulosic biofuels. Biochemical pathways for advanced hydrocarbon drop in fuel technologies will also continue to be explored as the program transitions its focus beyond its FY 2012 ethanol cost performance targets toward longer range targets.

Specific research objectives include improved hydrolysis and fermentation methods, resulting in a reduction in process time and a two percent increase in conversion of xylan to xylose. While these activities will focus on the current portfolio of feedstocks, the results will inform future activities as additional feedstocks (e.g., energy crops, other agricultural residues, algal biomass) and fuels are considered.

To improve overall efficiency and reduce conversion cost, efforts on process integration will be continued. These efforts will result in a greater degree of process integration between the unit operations (pretreatment, saccharification and fermentation steps), which is needed to achieve programmatic cost targets.

A greater fundamental understanding of the factors and causes underlying the recalcitrance of biomass to biological and chemical degradation is needed to make processing more specific and less costly. Recalcitrance refers to the resistance of plant cell walls to break down. This work will continue in FY 2012. Barriers and technical challenges identified in the first of a kind integrated biorefineries under development will determine the necessary fundamental research needs. These efforts will provide the basic science groundwork to develop applied, and ultimately integrated, process solutions for biomass conversion. Specifically, this work will produce advanced conversion processes and techniques for future biorefinery concepts.

Additionally, beginning in FY 2012, Biochemical R&D will expand its activities in support of waste-to-energy conversion process technologies. This will initially include feasibility analyses on converting waste biomass feedstocks such as organic residuals and industrial sludges into bioenergy, and may lead to research in molecular biology to enhance in-depth understanding of the microbial population dynamics at an ecosystem level to manipulate and optimize energy production, develop enhanced effluent refining operations, and maximize co-product generation and value. Analysis activities will evaluate the feasibility of various conversion processes including anaerobic digestion, and may lead to a better understanding of the need to integrate waste-to-energy processes into the biorefinery scenario, to maximize use of biomass and water resources, and enhance revenue generation.

Work will be done in collaboration with competitively selected industrial partners. In addition, funds may be used to support efforts such as peer reviews; data collection and dissemination; and technical, market, economic, and other analyses.

Insights gained from stakeholder workshop will guide a new, $15 million effort to be established in FY 2012 in collaboration with the DOE Office of Science on the role of synthetic biology on biomanufacturing. Through a competitive peer reviewed process, partners will be selected that demonstrate the ability to reduce the time and costs of engineering biological systems and to improve their efficiency, predictability, reliability, and safety and assist in maximizing the potential of genetically engineered microorganisms for the synthesis of fuels, commodity and specialty chemicals,

(dollars in thousands)

	FY 2010 Current Approp	FY 2012 Request

and materials from a variety of sugar sources (e.g., cellulose, starch, and sucrose) or sunlight/CO2. Specifically, efforts will be initiated to design and construct complex, multi-component, biological systems through a required set of basic capabilities: computer-aided design software; a repository of well-characterized, standardized synthetic biology components, methods and tools for assembling those components into large systems. The direct application of these technologies will be to assist the biomass industry to produce biofuels and bioproducts and will be facilitated by either industry partners or industrial advisory boards.

Algae	**24,465**	**0**

FY 2010 appropriations directed $35 million to algae; $25 million was categorized under the Platform R&D subprogram with the remainder categorized under the Feedstock Infrastructure subprogram. Due to ongoing multi-year projects being completely funded with FY 2010 appropriations, no additional funding is requested for FY 2012.

SBIR/STTR	**0**	**3,243**

SBIR/STTR funding transferred in FY 2010 was $2,672,000 for the SBIR program and $321,380 to the STTR program. The FY 2011 and FY 2012 amounts shown are estimated requirements for the continuation of the SBIR and STTR program.

Total, Conversion Technologies	**82,115**	**117,000**

Explanation of Funding Changes

	FY 2012 vs. FY 2010 Current Approp ($000)
Thermochemical	
The increase in funding is essential to enabling the transition of Thermochemical R&D in two key areas: 1) developing catalysts that are critical in increasing the yield and quality, and decreasing the cost of thermochemically produced biofuels; and 2) expanding non-food crop derived infrastructure compatible biofuels, such as advanced hydrocarbons, and the routes and intermediates for producing these biofuels. Competitive solicitations will target industrial partners, National Laboratories, and universities for the latest technology and transformative research ideas in support of the EISA RFS targets for advanced biofuels and the drive towards cost effective infrastructure compatible biofuels. Solicitations will also allow for core technology development that complement the National Biofuels Consortia, as well as scale-up of integrated systems that provide near term options to accelerate deployment.	
Additional funding will expand the sustainable feedstock interface which is a critical enabler for delivery of feedstocks with required cost, quality, and volume. Customized pretreated feedstocks for specific technologies will be fully integrated into the conversion systems and deliver increased yields and quality of biofuels.	+29,480
Biochemical	
The increase in funding is due to the launch of a new innovative effort to standardize and scale up the fabrication of fundamental biological components, which will allow bioengineers to rapidly prototype and test new approaches to synthesizing biofuels. Establishing this capability domestically will help America capture world leadership in the emerging field of biomanufacturing. Funding also initiates R&D focused on biochemical waste to energy technologies and potential applications. Additionally, relevant work from the Products Budget line will continue under this subprogram.	+26,627
Algae	
The decrease is due to fully funding the multi-year algal research consortia in FY 2010. Additional algae R&D is now categorized in the Feedstocks subprogram.	-24,465
SBIR/STTR	
Changes in the SBIR/STTR funding are a direct result of changes in the funding of program activities.	+3,243
Total Funding Change, Conversion Technologies	**+34,885**

Utilization of Platform Outputs R&D

Funding Schedule by Activity

(dollars in thousands)

	FY 2010 Current Approp	FY 2012 Request
Utilization of Platform Outputs R&D		
Integration of Biorefinery Technologies	84,278	0
Products Development	13,620	0
Total, Utilization of Platform Outputs R&D	97,898	0

Detailed Justification

(dollars in thousands)

	FY 2010 Current Approp	FY 2012 Request
Integration of Biorefinery Technologies	**84,278**	**0**

This work has been reclassified as the new Integrated Biorefineries subprogram.

Products Development	**13,620**	**0**

This activity is being discontinued. Relevant work will continue under the Biochemical key activity of the Conversion Technologies subprogram.

Total, Utilization of Platform Outputs R&D	**97,898**	**0**

Explanation of Funding Changes

	FY 2012 vs. FY 2010 Current Approp ($000)
Integration of Biorefinery Technologies	
This work has been reclassified as the new Integrated Biorefineries subprogram.	-84,278
Products Development	
This activity is being discontinued. Relevant work will continue under the Biochemical key activity of the Conversion Technologies subprogram.	-13,620
Total Funding Change, Utilization of Platform Outputs R&D	**-97,898**

Integrated Biorefineries

Funding Schedule by Activity

(dollars in thousands)

	FY 2010 Current Appropriation	FY 2012 Request
Integrated Biorefineries	0	24,860
SBIR/STTR	0	140
Total, Integrated Biorefineries	0	25,000

Benefits

An integrated biorefinery is a facility that converts biomass feedstock to advanced biofuels, biopower (e.g., process heat and steam, electricity), and/or bioproducts (e.g., chemicals). Integrated Biorefineries activities include public-private partnerships to design, construct, and operate fully integrated facilities at various scales using a variety of feedstock and conversion technology options. In FY 2007 and FY 2008, the program competitively selected small commercial scale (minimum 700 dry tonnes per day) and demonstration scale (minimum 70 dry tonnes per day) biorefinery projects. This funding supports the continuation of these projects. The operational data from these facilities is essential to benchmarking the state of technology in real industrial conditions, validating production costs at scale, and assessing the sustainability of biorefineries. Ultimately, these biorefinery projects will encourage private sector investments in future biorefineries.

Integrated Biorefineries' deployment efforts are directed at the Biomass Program's strategy to support meeting the EISA RFS advanced biofuels volumetric targets. Integrated biorefinery projects with the U.S. biofuels industry are aimed at overcoming key technical and economic barriers for producing advanced biofuels. These projects enable future scale up and replication of biorefineries by the private sector. As these biorefineries come online throughout the U.S., more petroleum will be displaced. An annual performance target monitors progress of these deployment activities in support of the EISA RFS volumetric advanced biofuels goal of 21 billion gallons by 2022. For FY 2012, this target is 15 million gallons of additional capacity.

Detailed Justification

(dollars in thousands)

	FY 2010 Current Approp	FY 2012 Request
Integrated Biorefineries	**0**	**24,860**

Over a half billion dollars in ARRA funding was invested in 19 biorefinery projects at the pilot, demonstration and commercial scale. These cost-shared partnerships are helping to bridge the "valley of death" between process development and commercial deployment of renewable biofuels technologies. The ARRA projects significantly enhance the biorefinery portfolio with a variety of feedstocks, conversion technologies and fuels produced. The table below shows how the 29 competitively selected integrated biorefinery projects in which the Program is invested are distributed by scale, feedstock type, and fuel type.

Pathway / Feedstock	Total	Agricultural Residues	Energy Crops	Forest Resources	Waste Processing	Algae Processing	Fuel Pathway	Ethanol / Other Alcohols	FT Liquids/ Renewable Hydrocarbon	Power	Products	Total
Total	29	7	4	13	1	4		17	11		1	29
Integrated Biorefinery Deployment	27	7	4	12	1	3		17	9		1	27
Pilot	12	3	3	5		2		6	6			12
Demonstration	11	2	1	5	1	1		7	3		1	11
Commercial	4	2		2				4				4
Continued Technology Development	2			1		1			2			2

In FY 2012, Integrated Biorefineries will continue cost-shared projects with industry partners selected through competitive solicitations in FY 2007 and FY 2008. The program may down select or delay at least four biorefinery projects based on comprehensive project review and peer review data. Funding levels will be determined on a project by project basis, as cost-share partners meet the necessary research, production and financial requirements to move from phase one awards (pre-construction engineering design, NEPA compliance and financial commitment) to phase two awards (facility construction). The comprehensive project reviews and peer reviews will also be considered in making the determinations about proceeding to construction.

SBIR/STTR	**0**	**140**

FY 2012 amounts shown are estimated requirements for the continuation of the SBIR and STTR program.

Total, Integrated Biorefineries	**0**	**25,000**

Explanation of Funding Changes

	FY 2012 vs. FY 2010 Current Approp ($000)
Integrated Biorefineries	
Up to four commercial- or demonstration-scale biorefinery projects may be down-selected or delayed based on the results of comprehensive project reviews and peer reviews. This will impact the Program's ability to support the volumetric goals for advanced biofuels in the EISA RFS. Further, cellulosic ethanol demonstration plants are being supported via the proposed Reverse Auction.	+24,860
SBIR/STTR	
Changes in the SBIR/STTR funding are a direct result of changes in the funding of program activities	+140
Total Funding Change, Integrated Biorefineries	**+25,000**

Analysis and Sustainability

Funding Schedule by Activity

(dollars in thousands)

	FY 2010 Current Appropriation	FY 2012 Request
Analysis and Sustainability		
Systems Analysis	0	4,000
Crosscutting Sustainability	0	4,000
Systems Integration	0	2,000
Total, Analysis and Sustainability	0	10,000

Benefits

The Biomass Program's Analysis and Sustainability activities play a vital role in supporting decision-making, demonstrating progress towards established goals, directing research activities, and are instrumental in setting the entire biofuel value chain on an environmentally sustainable 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.

Through quantification, analysis activities give the program context and justification for decisions regarding the future direction and scope of the program's RD&D work. This information is critical to 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. This critical information enables the program to better inform policy makers and private sector stakeholders, shaping the growth of America's nascent cellulosic and advanced biofuels industries.

Detailed Justification

(dollars in thousands)

	FY 2010 Current Approp	FY 2012 Request
Systems Analysis	**0**	**4,000**

Systems Analysis enhances each RD&D area individually and the program as a whole through the provision of critical quantitative measures of progress, future projections, and risk. Programmatic analysis activities are focused on clearly identifying synergies and addressing potential barriers, while progress is concurrently monitored and accomplishments validated in each of the program's technology areas. Programmatic analysis activities provide quantitative measurements and evaluations critical to strategic decisions at both the program and activity levels.

Specific focus areas include technical and economic feasibility analysis, integrated biorefinery analysis, and technology deployment analysis. Rigorous quantitative analysis is applied where possible, and the results are subsequently interpreted in the context of a greater body of work and peer

(dollars in thousands)

	FY 2010 Current Approp	FY 2012 Request

discourse to provide vital insight for RD&D prioritization, technology performance needs, and reasonable performance expectations.

Crosscutting Sustainability **0** **4,000**

Crosscutting Sustainability analysis involves the documentation and understanding of critical relationships between the production of biofuels and bioenergy, and environmental sustainability. The activity focuses on the development and application of guidelines for measuring environmental benefits and barriers of a domestic biofuels industry, including impact prevention and mitigation strategies. Technical targets will be established and used to direct future sustainability activities. Appropriate indicators are being identified and selected based on their relevance. Research activities addressing land use, water, GHG emissions, soil quality and air quality will improve information and understanding of holistic sustainability from a systems and life cycle perspective.

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 ethanol and advanced biofuels. Work is also underway to quantify the impact of consumptive water use and nutrient inputs on ground and surface water resources. Cross-cutting efforts are focused on continuously improving information and understanding sustainability principles from a systems and life cycle perspective, with particular attention being given to the nexus between feedstock production and conversion.

Systems Integration **0** **2,000**

Systems integration (SI) will provide independent, strategic, systems-level expertise and processes to enable data-driven decision-making, effective portfolio management and program integration for EERE Biomass Program and Project Managers.

Systems Integration provides tailored technical and programmatic support to the Biomass 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.

Specific activities include: systems engineering and strategic planning process facilitation (change control, Multi Year Project Plan, analysis planning); creation of an integrated baseline (data reconciliation between databases); and performance verification (risk assessment of pilot and demonstration scale projects, independent project analysis).

With the decision-making and data management tools and support framework provided, the Biomass 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.

Total, Analysis and Sustainability **0** **10,000**

Explanation of Funding Changes

	FY 2012 vs. FY 2010 Current Approp ($000)
Systems Analysis	
The increase is due to the reclassification of crosscutting funds into a new activity in the revised budget structure. The level of funding is consistent with prior year activities.	+4,000
Crosscutting Sustainability	
The increase is due to the reclassification of crosscutting funds into a new activity in the revised budget structure. The level of funding is consistent with prior year activities.	+4,000
System Integration	
The increase is due to the reclassification of crosscutting funds into a new activity in the revised budget structure. The level of funding is consistent with prior year activities.	+2,000
Total Funding Change, Analysis and Sustainability	**+10,000**

Biopower

Funding Schedule by Activity

(dollars in thousands)

	FY 2010 Current Approp	FY 2012 Request
Biopower	0	21,908
SBIR/STTR	0	592
Total, Biopower	0	22,500

Benefits

The biopower subprogram focuses on utilizing biomass for both large scale electricity generation and as a small scale heat source for cooking. The potential for electric biopower is highlighted in the Energy Information Administration's (EIA) 2010 Annual Energy Outlook where it is estimated that, excluding hydroelectricity, renewable energy consumption in the electric power sector is projected to grow from 1.2 quadrillion Btu in 2008 to 4.3 quadrillion Btu in 2035.[a] Biomass co-firing for utility power generation, referred to as biopower, has the potential to deliver a significant amount of renewable electricity in the U.S. over the next 30 years and contribute to GHG reductions and sustainable development. A biomass co-firing facility can use forest resources, agricultural residues, energy crops, and wastes, including municipal solid waste, to generate power. These types of biomass can require significant pre-treatment, such as pelletization or gasification. Various approaches for integrating these forms of biomass into utility power generation for up to 20 percent co-firing with minimal derating and improved efficiency will be assessed.

The demonstration of biomass co-firing technologies at pilot scale will lead to the construction of up to 10 MW of new generation capacity by 2015 and additional 20 MW by 2016,[b] building a bridge from a fossil carbon-based energy economy to one based on renewable energy systems. Successful pilot demonstration will accelerate industry adoption of higher percentage biomass co-firing at utilities and create green jobs in the renewable power sector while developing the biomass supply chain. Synergies are expected to result from the collaborative implementation of this initiative with industry and partnerships between EERE and the Office of Fossil Energy (FE) and the Office of Electricity Delivery and Energy Reliability (OE). The small scale cookstove is still used by nearly half the world's population, with biomass as the main cooking fuel. More efficient, and cleaner, use of biomass fuel in cookstoves will lead to reduced GHG emissions, less deforestation, and lower household expenses. Collaboration between Federal agencies, researchers, universities, industry, non-profits, and international representatives from areas currently using cookstoves will build upon and highly leverage efforts of both non-governmental organizations (NGOs) and government agencies involved in providing assistance to developing countries.

[a] Annual Energy Outlook 2010, http://www.eia.doe.gov/oiaf/aeo/

[b] The biopower strategy can be implemented with distributed or centrally located co-firing or repowering concepts.

Detailed Justification

(dollars in thousands)

	FY 2010 Current Approp	FY 2012 Request
Biopower	**0**	**21,908**

Biopower R&D on pretreatment and conversion of biomass to enable compatibility with utility power for up to 20 percent co-firing with minimal derating and improved efficiency will be demonstrated at pilot scale. Analysis including biopower-specific feedstock resource assessments and evaluating competition for biomass, availability of water, labor and transportation systems will be performed.

The Biomass Program sought information from technology vendors, utility and independent power producers, and other stakeholders, on their willingness to collaborate on three primary biopower topic areas and participate in a FOA. These topic areas include:

- Pre-treatment R&D: Develop technologies to densify biomass to increase energy and bulk density such as pelletization and torrefaction to meet feedstock specifications to enable up to 20 percent co-firing in utility systems with minimal derating and improved efficiency;
- Conversion R&D: Develop advanced conversion technologies with the objective of demonstrating higher overall biopower conversion efficiency (net power out divided by raw feedstock purchased) at up to 20 percent biomass co-firing in utility systems including pyrolysis and gasification to oil, biochar and syngas; and
- High Percentage Co-firing: Demonstrate up to 20 percent co-firing with pretreated or converted biomass at 10 MW pilot scale, while minimizing the capacity derating, improving efficiency, and lowering biomass power generation costs.

Options will be evaluated to determine the most efficient, cost-effective way to sustainably generate 30 MW of electrical power from biomass by 2016 while achieving the greatest reductions in greenhouse gases. An industry cost share of between 20 and 50 percent will be required on all biopower projects.

For cookstove RD&D, a technology roadmap will be developed by engaging both national and international stakeholders from other Federal agencies, universities, industry and NGOs, specifically targeting stakeholders from regions where cookstoves are widely used. The roadmap will determine the required areas for RD&D and the criteria for success at the project stage gates.

The cookstove RD&D will focus 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 will be considered, along with low cost materials of construction and sensors and controls. This RD&D will be conducted through a competitive solicitation with integrated project teams consisting of National Laboratories, universities, industry vendors, non-profits, and collaborators from other Federal agencies and developing countries, culminating in field demonstration and validation tests. Criteria for success are expected to include increases in efficiency and targets for emission reduction.

SBIR/STTR	**0**	**592**

FY 2012 amounts shown are estimated requirements for the continuation of the SBIR and STTR program.

Total, Biopower	**0**	**22,500**

Explanation of Funding Changes

	FY 2012 vs. FY 2010 Current Approp ($000)
Biopower	
This increase supports the establishment of a new subprogram for an entirely new DOE initiative that takes advantage of the improvements in thermal efficiency of power generation systems. These activities will address challenges from optimizing fuel type, feedstock logistics, regional supply issues, sustainability, including resources such as water, labor and grid limitations.	
This effort is a critical first step toward the implementation of large utility scale production of renewable electric power from biomass. In subsequent years, appropriate technologies can then be deployed at commercial scale to prove economic viability and establish a sustainable supply chain. These pioneering efforts are intended to create new economic opportunities, including jobs, across the supply chain and make a significant contribution to domestic renewable energy generation, further diversifying the U.S. renewable portfolio for enhanced energy and economic security.	+21,908
SBIR/STTR	
Changes in the SBIR/STTR funding are a direct result of changes in the funding of program activities.	+592
Total Funding Change, Biopower	**+22,500**

Cellulosic Biofuels Reverse Auction

Funding Schedule by Activity

(dollars in thousands)

	FY 2010 Current Approp	FY 2012 Request
Cellulosic Biofuels Reverse Auction	0	150,000
Total, Cellulosic Biofuels Reverse Auction	0	150,000

Benefits

The Energy Policy Act of 2005 (EPAct 05) Section 942, Pub. L. No. 109-58 (August 8, 2005), states that the Secretary of Energy, in consultation with the Secretary of Agriculture, the Secretary of Defense, and the Administrator of the Environmental Protection Agency, shall establish an incentive program for the production of cellulosic biofuels. A reverse auction will help defray the cost of cellulosic biofuel production and serve as an important incentive and financial benefit to show the investment community they have a cash flow to reduce risk. Incentives such as the reverse auction are critical to the financing of "first-of-a-kind" or "pioneer" plants. In 2008, the Biomass Program published a rule making to establish the framework for implementing this reverse auction.

It is impossible to know in advance the incentive levels on a per-gallon basis as these levels will be the result of a competitive bidding process.

Detailed Justification

(dollars in thousands)

	FY 2010 Current Approp	FY 2012 Request
Cellulosic Biofuels Reverse Auction	**0**	**150,000**

In July 2010, the Program issued a Notice of Program Intent to request documents for pre-certification as required by our rule making. The Biomass Program is now proposing to hold an expanded Cellulosic Biofuels Reverse Auction., open to both cellulosic ethanol and other advanced biofuels, as defined in EISA 2007.

DOE detailed analysis demonstrated that the Department needs to create a strong market signal for cellulosic ethanol and other advanced biofuels to solidify investment towards commercialization and meet the RFS targets. A reverse auction would solicit bids from potential producers of cellulosic biofuels, and those producers submitting the lowest bids would be awarded the production incentives.

Total, Cellulosic Biofuels Reverse Auction	**0**	**150,000**

Explanation of Funding Changes

	FY 2012 vs. FY 2010 Current Approp ($000)
Cellulosic Biofuels Reverse Auction	
The increase is due to the initiation of a new Cellulosic Biofuels Reverse Auction subprogram.	+150,000
Total Funding Change, Cellulosic Biofuels Reverse Auction	**+150,000**

Solar Energy

Funding Profile by Subprogram

(dollars in thousands)

	FY 2010 Current Approp[a]	FY 2012 Request
Solar Energy		
Photovoltaic R&D	125,778	336,600
Concentrating Solar Power	49,023	50,000
Systems Integration (Balance of System and Power Electronics)	23,055	43,400
Market Transformation (Standards/Operability/Training)	23,540	27,000
Fuels from Sunlight Hub	22,000	0
Total, Solar Energy	243,396	457,000

Public Law Authorizations:

P.L. 93-409, "Solar Heating and Cooling Demonstration 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. 95-91, "Department of Energy Organization Act" (1977)
P.L. 95-590, "Solar Photovoltaic Energy Research, Development and Demonstration Act" (1984)
P.L. 95-619, "National Energy Conservation Policy Act" (NECPA) (1978)
P.L. 96-294, "Energy Security Act" (1980)
P.L. 101-218, "Renewable Energy and Energy Efficiency Technology Competitiveness Act of 1989"
P.L. 101-575, "Solar, Wind, Waste, and Geothermal Power Production Incentives Act of 1990"
P.L. 102-46, "Solar, Wind, Waste, and Geothermal Power Production Incentives Technical Amendments Act" (1991)
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 Reinvestment and Recovery Act of 2009"

Mission

The Solar Energy Technologies Program's (SETP) main objective is to develop solar energy technologies so that they achieve grid-parity with conventional generation without any subsidies. The objective of DOE's "SunShot" initiative is to reduce the total costs of photovoltaic solar energy systems by about 75 percent so that they are cost competitive with other forms of energy without subsidies before the end of the decade. By reducing the cost for utility scale installations by about 75 percent to roughly $1 a watt - which would correspond to roughly 6 cents per kilowatt-hour - solar energy systems could be broadly deployed across the country.

This will increase American economic competitiveness and help the U.S. regain leadership in the global market for solar photovoltaics.

[a] In FY 2010, $3,218,000 and $386,000 were transferred to the SBIR and STTR programs respectivelyP.L. 111-85, DOE exercised the option to fund the NREL Ingress/Egress project with Recovery Act funds. The use of this option provided $22.0 million in funding for the Fuels from Sunlight Energy Innovation Hub, as reflected in this table.

The "Sunshot" objective is critical if the U.S. is to regain leadership in worldwide PV manufacturing. The program will continue to develop concentrating solar power (CSP) technologies with thermal storage to reach base-load grid parity by 2020.

The SunShot Initiative will be implemented through an integrated program conducted through the National Labs, industry, and universities, and in close collaboration with the Office of Science on fundamental research, specifically leveraging the Energy Frontier Research Center's (EFRCs) and the Advanced Research Projects Agency- Energy (ARPA-E) to advance work on power electronics. It also includes Building Integrated PV (BIPV) activities in the Buildings Technologies Program. BIPV is the integration of PV modules directly into building materials (e.g. roofing systems) such that workers in the construction trades can install these integrated PV components during the normal process of building construction or renovation with a minimum of additional training, equipment, or work-flow changes . To achieve the goal of grid-parity, the PV sub program invests in transformative research, development and deployment activities focusing on achieving radical improvements through manufacturing cost and efficiency improvements as well as new discoveries. A component of this program is focused on innovative manufacturing technology concepts as applied to PV and will help stimulate and spur the domestic PV manufacturing base. The program also supports Systems Integration by developing radically new approaches to reduce the cost and improve reliability and functionality of power electronics and supporting industry development through test and evaluation standards, and tools for understanding grid integration issues. The Market Transformation subprogram is being refocused to address quantitatively non-hardware related Balance of Systems (BOS) costs including delays in permitting, streamlined permitting, inspection, and interconnection as well as performing key analyses of policy options that can accelerate the rapid deployment of solar technologies. The Concentrating Solar Power subprogram invests heavily in thermal storage and supporting systems research and optimization to provide baseload power on demand.

Benefits

The U.S. is the world's largest consumer of electricity and, at the same time, has the largest solar resource of any industrialized country.[b] This has made it well positioned to capture significant benefits from the wide scale use of solar energy. However, despite significant cost reductions and market growth over the last 5 years,[c] the total cost of electricity from solar without Federal or state subsidies has not been economic to provide a significant share of U.S. electricity or contribute to greenhouse gas (GHG) emission reductions. Reaching a total installed system cost of $\$1/W_{DC}$ would be equivalent to the wholesale cost of electricity from fossil fuels – approximately $.05-.06/kWh – and result in rapid and large scale adoption of solar electricity across the U.S.

Analysis from the National Renewable Energy Laboratory (NREL) indicates that achieving $\$1/W_{DC}$ would result in cost parity with baseload rates across the U.S. By 2030, approximately 375 GW of solar capacity supplying approximately 13 percent of U.S. electricity would be installed. By 2050, approximately 600 GW of solar capacity would be installed, providing 18 percent of U.S. generation.

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[b] Based on radiation data collected by the National Renewable Energy Laboratory (NREL): http://rredc.nrel.gov/solar/old_data/nsrdb/

[c] Worldwide, the PV market has grown at a compound annual growth rate (CAGR) of 45 percent over the past 10 years; 47 percent from 2004 to 2009; and 20 percent from 2008 to 2009.[c,c] Growth in the U.S. has also strong, with a 5 year CAGR of 41 percent for the PV market, which includes a 40 percent increase from 2008 to 2009.[c] CSP technologies also experienced growth in recent years, with over 600 MW of grid-tied capacity installed worldwide through 2009, 400 MW of which is installed in the U.S.

Finally, the programs envisioned herewith will stimulate job growth within the U.S. and will go a long way to keep U.S. R&D innovation from leaving the shores.

In FY 2010, the Solar Program and ARPA-E jointly held a workshop to identify innovative pathways to achieve $1/W_{DC}$ PV systems as an approach to determining and overcoming barriers to LCOE cost-competitiveness. At $1/W_{DC}$ installed, PV would be broadly competitive across the U.S. without any subsidies. A rough breakdown of the $1/W installed cost would breakdown into $0.50/W_{DC}$ for the module, $0.10/ W_{DC}$ for the power electronics, and $0.40/ W_{DC}$ for the Balance of Systems (BOS).

Achieving the dollar-a-watt goal will require significant reductions and technological innovations in all PV system components. These 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. To achieve the dollar-a-watt goals, it will require a greater than 50 percent reduction in expected costs, from present, based on estimates for centralized utility systems. Distributed systems for residential and commercial applications will require a significantly greater reduction in cost that can be achieved if installation occurs at much greater scale than today.

Program analysis begun in FY 2010 indicated a need to significantly increase resources for thin film technologies – with a commensurate reduction in wafered silicon technologies – in order to achieve the module cost goals. The FY 2012 PV subprogram budget reflects this rebalancing and includes specific resources on other initiatives that will accelerate revolutionary change to drive PV advances toward $.50/W_{DC}$ modules. Program funding will also reflect a greater emphasis on high-risk, high-payoff beyond the consideration of the current industry that has the potential lead to radically different approaches to solar technology. Additional funding will be directed toward innovative BOS approaches, including Building Integrated PV (BIPV), which promises significant installation economies of scale. Development of power electronics with the requisite cost and performance targets will be done with ARPA-E, which will execute programs aimed at advancing power electronics components through the incorporation of advanced materials. These advances will be combined with development of power electronics improved smart grid communications and improved functionality for grid integration, including variable VAR control.

The Solar Program supports the achievement of a national reduction in GHG emissions. Solar technologies have the potential for significantly displacing fossil-based electricity generation, thus reducing the amount of carbon emitted into the atmosphere.

Solar technologies improve U.S. energy security by displacing natural gas used in the electricity sector, and, have in the longer term the potential to displace coal. This has a significant impact on reducing the need for imported liquefied natural gas (LNG). In addition, if plug-in hybrid electric vehicles (PHEVs) are successful at penetrating the market for transportation, then solar power, by providing electricity to charge PHEVs, would also help to displace the demand for petroleum and other fossil-based electricity generation for transportation purposes. The combination of solar and PHEVs could help the U.S. move to a much more secure and sustainable transportation system.

High Priority Performance Goal (HPPG)

The Solar Energy Program budget and activities contribute directly to the public interest enabling the Renewable Energy HPPG of doubling renewable energy generation. The performance measures for the program are directed to contributions toward the goal of significantly increasing renewable energy generation at a cost of a dollar a watt. Additional information on the intermediate performance critical to achievement is provided at: www.performance.gov.

Annual Performance Results and Targets

The Department is in the process of updating its strategic plan, and has been actively engaging stakeholders including Congress. The draft strategic plan is being released for public comment concurrent with this budget submission, with the expectation of official publication this spring. The draft plan and FY 2012 budget are consistent and aligned. Updated measures will be released at a later date and available at the following link http://www.mbe.doe.gov/budget/12budget/index.htm.

Photovoltaic R&D

Funding Schedule by Activity

(dollars in thousands)

	FY 2010 Current Approp[a]	FY 2012 Request
Photovoltaic R&D	125,778	333,200
SBIR/STTR	0	3,400
Total, Photovoltaic R&D	125,778	336,600

Benefits

The PV R&D subprogram seeks to achieve the "Sunshot" initiative goal of dollar-a-watt by accelerating R&D on technology with the highest potential to reach the $.50/$W_{DC}$ cost target before the end of the decade, investing in technologies with capability of reaching long-term carbon reduction goals, and ensuring a sustainable PV manufacturing base for the U.S. PV industry. For FY 2012, the PV subprogram's priorities are:

- Achieve significant increases in PV efficiencies so that commercial product efficiencies approach those of the best in class lab tested cells and best in class lab tested cells approach the theoretical efficiency values.
- Continue to invest in transformation breakthroughs in PV technology which offers new baselines of cost and performance, potentially also leading to new applications.
- Aggressively invest in initiatives and programs that strengthen U.S. manufacturing and make significant contributions to the development of the U.S. PV industry.
- Support key innovative manufacturing efforts that help bridge the gap between R&D and commercialization not served by current private sector financing sources.

In FY 2012 the Solar Program, in collaboration with ARPA-E and the Office of Science, will fund research and development with the "Sunshot" goal of achieving total installed systems costs at $1/$W_{DC}$ before the end of the decade.

[a] SBIR/STTR funding transferred in FY 2010 was $1,927,000 for the SBIR program and $231,000 for the STTR program.

	(dollars in thousands)	
	FY 2010 Current Approp	FY 2012 Request
Photovoltaic R&D	**125,778**	**333,200**

The PV subprogram consists of four focus areas: Advanced PV R&D, PV Prototype Development, PV Product & Manufacturing Development, and Measurement & Characterization. The first three focus areas represent a streamlined evolution of the PV technology from applied science to final product development. The final focus area of Measurement and Characterization enables the careful and precise measurement of PV performance, from the materials level to the final finished module level.

- **Advanced PV R&D (Approximate funding: $85.0M)**

The overall goal of this task is to carry out R&D to reduce the cost of fully installed solar power to $1 per watt, which is equivalent to about 5-6 cents per kilowatt-hour, making it broadly competitive. Currently, the installed cost of solar PV systems is about $4.00 per watt, so this is a reduction of roughly 3-4 times. The national average price for electricity today is about 11 cents per kilowatt-hour. At $1 per watt/6 cents per kilowatt-hour, solar systems would be broadly deployed without subsidy in most climate zones. Achieving this requires substantial new R&D effort, as detailed below.

Transformational Science and Technology: The core activity is the Next Generation PV R&D work, whose goal is to develop revolutionary and highly disruptive next-generation PV technologies, expected to produce prototype PV cells and/or processes, thus directly impacting the dollar a watt paradigm. R&D 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_{DC}$. This effort consists of work on cutting-edge next generation R&D, which currently includes technologies such as plasmonics, organic cells, and multiple exciton generation (MEG), helping bridge the gap between basic science and technology development. There is close coordination with Basic Energy Sciences within the DOE's Office of Science. *Bridge from Basic to Applied PV Research*: Working in close collaboration with the Office of Science, this program supports the transition of basic research at the Energy Frontier Research Centers (EFRCs) towards applied research. This bridge will enable the most promising and innovative early stage research to progress towards commercialization.

Program to Advance Cell Efficiency (PACE): PACE is a focused effort that is aimed at accelerating the process development and optimization protocols that will lead to enhancing the cell level efficiency. PACE will feature a strong collaboration with NSF to directly address scientific advances that can impact the $1/$W_{DC}$ goal. Several new PV materials and processes that were originally funded by DOE-EERE have begun to be commercialized in the past several years, including Copper Indium Gallium Selenide (CIGS) and Cadmium Telluride (CdTe). These commercial and near commercial technologies can greatly benefit from fundamental materials science, device physics, and processing improvements. These technologies have potentially much higher practical efficiencies and other performance levels than currently realized as demonstrated in the gap between laboratory results and realized commercial performance. For example, in the case of CdTe, commercial module efficiencies are around 11 percent whereas, in the laboratory, efficiencies approaching 17 percent has been demonstrated. Similarly, CIGS is available commercially at about 11-12 percent efficiency, and has achieved close to 20 percent in the

(dollars in thousands)

FY 2010 Current Approp	FY 2012 Request

laboratory. The research supported by this program will enable better performance regimes with improved efficiency, lifetimes, large-scale manufacturability.

National Laboratory Core Conversion Technology Research: Over the years, DOE has built up a comprehensive spectrum of expertise and resource base within the national laboratories, such as NREL. The Core Conversion Technology part of our investment within the Advanced PV R&D allocation is directly aimed at fully leveraging this prior investment to accelerate the RD&D of solar technologies. The Conversion Technology research program is a diverse, actively managed portfolio of R&D, to advance the state-of-the-art in PV cells. This portfolio includes all the major commercially relevant PV solar energy conversion technologies: Wafer Silicon, Film Silicon, CIGS/CZTS, CdTe, and High Efficiency Multi-Junction PV. The focus of the R&D is on semiconductor materials, device properties, and fabrication processes to improve the efficiency, stability, and cost of PV devices. These R&D activities will enable the new development and evolution of the core PV expertise and capabilities at the national labs, providing a national resource for PV innovation that can be transferred broadly across the U.S. PV industry. In order to enable the transfer of the knowledge-base developed within the national labs, researchers work closely with U.S. companies to help solve current problems and conduct further research on improvements that industry can adopt in the future. Aggressive technical milestones and project review ensure the supported research is cutting edge and relevant.

PV Prototype Cell Development

Sunshot Initiative Pre-Commercialization Pathways: In FY 2010, the PV subprogram merged two successful projects together to streamline the administration of the complementary Pre-Incubator and Incubator projects. The SunShot Initiative Pre-Commercialization Program (or Pre-Incubator program) targets small businesses in the concept verification stage and bridges their development to a proof-of-concept prototype. It is intended to help companies reach the stage of development between laboratory concept and pilot scale prototype. The PV Incubator project, launched in FY 2008, enables start-up PV companies at a more advanced stage with already verified laboratory prototypes to work with the National Laboratories to scale up laboratory processes into pilot manufacturing processes. Additional awards are issued each year, with the third and fourth rounds planned for FY 2010, respectively. Performers will continue to work closely with the labs to deliver new module prototypes and demonstrate greater than or equal to 3 MW of pilot production within 18 months of project start. This reduces risk in capital investments for manufacturing capacity expansion and allows private capital markets to fund the build-out of manufacturing capacity based on these projects. Starting in FY 2010, small businesses were provided the opportunity to apply to the Integrated Incubator project with Topic 1 closely aligned with the previous Pre-Incubator project and Topic 2 aligned with the previous Incubator project. Additional coordination with ARPA-E will take place to identify successful research funded under the PV Incubator project that may transition to ARPA-E's programs to rapidly develop and commercialize high-risk, high-potential technologies for the marketplace.

Process Development Integration (PDI): The new manufacturing-development focused PDI, housed in the Science and Technology Facility at NREL, gives stakeholders an extra level of insight into product development of all PV material technologies with specialized equipment that simultaneously allows the creation and analysis of PV devices. This national resource provides researchers from academia,

industry, and other national labs access to a leading edge PV process and testing facility that enables rapid development of new and cost effective PV technologies. Improvements in manufacturing will be accelerated with the capability to study their processes in more depth as the cells are developed at PDI. A number of U.S. companies have already taken advantage of this unique capability. The goal is to replicate this significant financial leverage with other start-up companies, enabled by the CRADA activities described below.

Commercialization CRADA Activities: This Industrial CRADA program funds scientists at NREL to work with companies who have the best overlap with NREL capabilities. After scientists and companies have initial conversations and a proposed CRADA, NREL conducts an internal proposal competition to select companies. Another off-shoot of this program, begun in FY 2010, is the Innovation by Design Program (IDP). IDP funds teams of NREL scientists to initiate research aimed to create a new and complete PV product ready for commercialization within 18 months.

R&D for $/W BOS and Cross-Cutting Technologies

PV Balance of Systems (PV-BOS): PV-BOS is a focused effort around addressing the major factors of the BOS costs. Module prices have fallen significantly in recent years and currently only represent between 33 percent and 50 percent of the total system cost (dependent on a number of factors including system size). The cost associated with the non-module part of the system is often referred to as the Balance of Systems (BOS). The PV-BOS program 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 PV (BIPV) which can allow the PV material to replace a functional outer surface of commercial and residential buildings. An example includes roofing membranes and roofing tiles with integrated PV devices. Besides potential cost savings through replacement of existing building materials, BIPV enables PV to blend into building aesthetics. BIPV technology development will be coordinated with the System Integration sub-program and pursued in partnership with the EERE Building Technologies Program in order to more effectively utilize the solar energy incident on the entire building envelope.

PV Supply Chain and Cross-Cutting Technologies: These activities seek to reduce manufacturing and product costs by improving processes and materials common to PV manufacturing that have the potential to impact the PV industry within two to six years. There are many examples of non-solar companies that have technologies and processes that are beneficial to the PV industry. These capabilities can be used in PV-specific manufacturing methods and products. Examples of such high-impact technologies include processing steps to improve throughput, yield, or diagnostics; material solutions to improve reliability or enhance optical, thermal, or electrical performance; or system components that streamline installation. The cost reduction as a result of these improvements might be small in terms of a single product or processing step; however the overall impact of these ideas become significant when implemented across the PV industry.

Integration for $1/W

PV Manufacturing Initiative ($25M): FY 2012 will represent the first full year of funding for the PV Manufacturing initiative started previously. This initiative accelerates the commercialization and cost reduction of PV technologies by coordinating solutions across industry that will facilitate PV

manufacturing in the U.S. The natural result of this initiative is the creation of a robust U.S. 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 facilities to speed the implementation of new cutting edge technologies that provide needed manufacturing process expertise.

Module Performance Accelerator ($50M): As part of achieving the PV subprogram's $1/W_{DC}$ and LCOE cost-competitiveness goals, the Module Performance Accelerator will focus on increasing efficiency and reducing cost to create a pathway to $0.50/W modules before the end of the decade. Aggressive development of new production-scale PV designs and processes at both large and small U.S. PV companies will be necessary to close the gap between production module and laboratory prototype cell efficiencies and to achieve $0.50/W modules. This effort will allow U.S. PV companies to accelerate PV module development beyond their existing technology roadmaps. It will enable industry to leverage its expertise to pursue innovative high-impact technologies with a higher level of risk than companies could otherwise afford in a competitive production environment.

Accelerating US PV Manufacturing ($50M): The goal of this task is to create research and demonstration grants to cost effectively produce the solar panels, electronics and other components needed to achieve the $1/watt goal -- so that America can produce and export affordable and high-efficiency solar PV systems. Within the dollar a watt framework, we propose to initiate a new effort that is aimed at an open competition that will challenge companies (particularly start ups that are most vulnerable to such CapEx limitations) to bring together a vertically integrated team including the end user/PV module integrator/electric utility/financial institution/state or local authority as strategic partners. Such teams will design innovative manufacturing pathways, at the scale of 20-100MW, that will enable the demonstration of PV modules for detailed evaluation, both on the technology impact (i.e., progress towards the dollar a watt goal) as well as the financial aspects. We envision that companies will use this approach to enhance their manufacturing processes on the way to demonstrate a true dollar a watt price structure before the end of the decade. The partnerships will enable the companies to rapidly implement their technology into an electricity grid. This program will require a minimum matching cost share of 1:1.

These projects will enable innovative technologies that are being developed under the auspicies of the SunShot Initiative to transition into the manufacturing stage, thus paving the way for the companies to demonstrate their economic viability. Some typical examples of innovative manufacturing pathways that are attractive for such a program would include, roll-to-roll, low cost manufacturing of PV modules; low cost solution based manufacturing processes for CIGS and CdTe based PV modules; integrated, distributed microinverter technologies. A significant number of them have emerged from the incubator programs.

Measurement and Characterization

Measurement and Characterization (M&C) provides test, measurement, and analysis support and research for all PV material technologies at the National Laboratories. M&C also collaborates with internal research groups, external research partners in university and industry laboratories, and PV manufacturers. This effort assists stakeholders through the test and analysis of thousands of materials and device samples annually, helping them to understand and direct work on their research and

(dollars in thousands)

	FY 2010 Current Approp	FY 2012 Request

commercial product development. M&C is broken down into major analysis areas including Analytical Microscopy, Electro-Optical Characterization, Surface Analysis, and Cell and Module Performance and in-line metrology. The expertise in these areas enables NREL to be a national resource and a world standard for measurements and characterization of PV cells and modules.

PV Metrology Innovation: Achieving $0.50/W module costs at a manufacturing scale will require greater visibility into the physical properties of materials and devices, including their evolution during cell and module fabrication. The PV Metrology Innovation program will enable new laboratory-scale characterization methods and diagnostics. It will also spur the development of improved in-line process monitoring to enable rapid cycles of learning, a reduction in manufacturing variation, and improvements in yield and throughput. These tools are anticipated to have broad impact across the PV industry.

SBIR/STTR	**0**	**3,400**

In FY 2010, $1,927,000 was transferred to the SBIR program and $231,000 was transferred to the STTR program respectively. FY 2012 amounts shown are estimated requirements for continuation of the SBIR/STTR programs.

Total, Photovoltaic R&D	**125,778**	**336,600**

Explanation of Funding Changes

	FY 2010 vs. FY 2012 Current Approp ($000)
Photovoltaic R&D	
The increase in PV subprogram funding reflects the first year of full funding for the PV Manufacturing Initiative, the Program to Advance Cell Efficiency, PV BOS, and the Module Performance Accelerator, as key elements in a coordinated "Sunshot" initiative to achieve $1/W, cost-competitive installed systems.	+207,422
SBIR/STTR	
In FY 2010, $1,927,000 was transferred to the SBIR program and $231,000 was transferred to the STTR program respectively. FY 2012 amounts shown are estimated requirements for continuation of the SBIR/STTR programs.	+3,400
Total Funding Change, Photovoltaic R&D	+210,822

Concentrating Solar Power

Funding Schedule by Activity

(dollars in thousands)

	FY 2010 Current Approp[a]	FY 2012 Request
Concentrating Solar Power	49,023	49,200
SBIR/STTR	0	800
Total, Concentrating Solar Power	49,023	50,000

Benefits

Widespread deployment of CSP with significant amounts of thermal storage is critical to achieving reduction in CSP system cost, load balancing to enable high levels of renewable generation integration, and the ability for CSP systems to short-term and diurnal disruptions in solar output. The goal for the CSP subprogram is for electricity from CSP to reach parity with the baseload power market with 12 to 17 hours of thermal storage by 2020. To achieve this objective, the CSP subprogram is investing in an array of near- and far-term thermal storage technologies. The subprogram is also investing heavily in CSP technologies, such as solar towers, that offer higher system efficiencies through higher temperature operation and reduced thermal losses requiring investment in high temperature materials. Finally, the program is investing in critical system demonstrations that can bridge the gap to the large scale private capital required to advance new CSP technologies into commercialization.

Detailed Justification

(dollars in thousands)

	FY 2010 Current Approp	FY 2012 Request
Concentrating Solar Power	**49,023**	**49,200**

Solicitations in FY 2007 through FY 2010 led to 40 R&D contracts with industry and universities, all of which were developed with the intent of developing components and systems that could lower system cost. Beginning in FY 2012, many of these efforts will be ending allowing a stronger shift to more advanced component, material, and system development. In FY 2012, the CSP subprogram will re-release a solicitation initiated previously intended to support demonstration of new technology at a scale sufficiently large to provide validation. Additional non-technical deployment issues, such as permitting on Federal lands and utility transmission analysis, are addressed through the Market Transformation section of this request. Addressing these issues is critical to the acceleration of CSP system deployments and further cost reductions.

a SBIR/STTR funding transferred in FY 2010 was $622,000 for the SBIR program and $75,000 for the STTR program.

(dollars in thousands)

FY 2010 Current Approp	FY 2012 Request

CSP Advanced Research

A solicitation challenging industry to develop CSP systems capable of operating competitively in the baseload power market resulted in 13 contracts (industry and university) being established in FY 2010. This is a stretch goal for CSP because baseload power is fueled primarily by coal, which is the least expensive fossil fuel. An NREL study for the Solar Program showed the cost of electricity from pulverized coal to be 20-40 percent less expensive than power from a gas turbine combined cycle plant. In addition, plants providing baseload power typically operate at a capacity factor greater than 70 percent, whereas solar power plants without storage typically have a capacity factor of about 25 percent. In order to meet the baseload goal by FY 2020, CSP systems that operate at higher temperatures are likely to be required. Higher temperature operation results in higher system efficiency and enables thermal storage systems to be less costly. For example, because towers operate at 565°C, about 180ºC higher than troughs, the mass of salt required for the same amount of energy storage is reduced by two-thirds. In order to meet the baseload goal, CSP systems must also incorporate 12 to 17 hours of thermal storage. Some of the storage activities described below will support this goal.

Although each of the CSP technologies (trough, dish, tower, and Fresnel) received awards, tower awards predominated due to the capability of towers to produce high temperatures and deliver low cost storage. As an example, a tower system will be explored that operates at 980°C, sufficient to enable use of highly efficient gas turbines. These baseload contracts will be in the engineering design phase of their awards in FY 2012. Lab research will augment the work being accomplished through the baseload contracts with activities aimed at making reflectors that are more durable and incorporate dirt resistant coatings to reduce the frequency that they need to be washed. This activity is representative of an effort in FY 2012 to reduce the amount of water required by CSP systems. Additional materials research will be conducted to increase the efficiency of solar absorbers as well as enable operation at temperatures up to 1,000ºC.

CSP Component, Systems Development, and Demonstration

In FY 2012, Component and Systems Development will focus on parabolic trough and dish technologies as the path toward reaching the FY 2015 intermediate power goal. Larger trough collectors combined with new high temperature heat transfer fluids will be evaluated. A trough that uses molten salt as the heat transfer fluid and storage media will be tested. The development of low cost polymer and thin glass reflectors will continue. The labs will work with industry on development of dish/engine systems that include storage and power tower concepts that include low cost heliostats. In FY 2010, Recovery Act funding was used to upgrade and expand facilities at Sandia and NREL to enable better technical assistance to industry in developing new concepts and providing unbiased evaluations of their technology. The labs closely coordinate their work with industry to ensure integration of R&D and avoid duplication of activities.

the goal is to help industry demonstrate new technology that helps achieve the 2015 cost goal While these demonstrations are meant to show that the new technologies are an economic, they also serve as a platform to address technical problems that cannot be found in small prototype units

(dollars in thousands)

	FY 2010 Current Approp	FY 2012 Request

Thermal Storage R&D

A solicitation focusing on establishing the technical feasibility of several storage concepts and identifying the potential for near-term thermal storage demonstrations resulted in 15 contracts (industry and university) in FY 2009. Research areas include new formulations of molten salt, high strength concrete, several phase change materials as storage media, and thermo-chemical storage. Most of these contracts will be completed during FY 2012. An advanced high-temperature storage solicitation, in conjunction with ARPA-E, is planned for funding in FY2012. NREL and Sandia are also heavily involved in thermal storage R&D. This work includes the addition of nanoparticles to increase the heat capacity of molten salt and expanding the operating temperature range of molten salts. The labs' new thermal storage facilities will be used to help industry evaluate their technology as well as support laboratory advanced heat transfer fluid and thermal energy storage concepts.

SBIR/STTR	**0**	**800**

In FY 2010, $622,000 was transferred to the SBIR program and $75,000 was transferred to the STTR program respectively. FY 2012 amounts shown are estimated requirements for continuation of the SBIR/STTR programs.

Total, Concentrating Solar Power	**49,023**	**50,000**

Explanation of Funding Changes

	FY 2010 vs. FY 2012 Current Approp ($000)
Concentrating Solar Power	
Some awards made in FY 2007 and FY 2008 under the CSP Research & Development FOA and the Thermal Storage and Heat Transfer Fluid FOA will reach their completion. In addition, funding for Demonstration Zone projects will transition from support of the projects being demonstrated to completing the environmental assessment of the Nevada National Security Site and preparing the site for the demonstrations.	+177
SBIR/STTR	
In FY 2010, $622,000 was transferred to the SBIR program and $75,000 was transferred to the STTR program respectively. FY 2012 amounts shown are estimated requirements for continuation of the SBIR/STTR programs.	+800
Total Funding Change, Concentrating Solar Power	**+977**

Systems Integration

Funding Schedule by Activity

(dollars in thousands)

	FY 2010 Current Approp[a]	FY 2012 Request
Systems Integration	23,055	43,150
SBIR/STTR	0	250
Total, Systems Integration	23,055	43,400

Benefits

Systems Integration (SI) activities reduce balance of system (BOS) costs in order to meet the "Sunshot" $1/W goal for PV systems and address the technical barriers to wide scale deployment of distributed and central station solar technologies in the U.S. Activities within this subprogram fall within four areas: balance of system hardware (BOS); grid integration; technology validation; and solar resource development. Balance of system development reduces the cost of new technologies not associated with the PV module including inverters, DC-DC converters, PV module racking, and other components. This activity is closely coordinated with the PV subprogram to ensure there is a unified vision for meeting the $1/W target. Within grid integration, SI addresses issues associated with high penetration (10 – 20 percent by energy) of solar technologies on the distribution and transmission grid including variability, voltage regulation, and system reliability. This includes both power electronics (e.g. inverters) through the new Solar Energy Grid Integration Systems – Advanced Concepts (SEGIS-AC) program and the high penetration solar deployment awards in which utilities demonstrate the feasibility of high penetrations of solar technologies on the grid. Technology validation focuses on reducing the risk of new and existing solar technologies by developing protocols for testing, evaluating, and improving the performance and reliability of components and systems. Information from this analysis is then included in system modeling software to share with stakeholders and ensure that the $1/W target is met. Technology validation also addresses developing new codes and standards so new technologies, especially those developed under the $1/W program, will be able to enter the marketplace. In solar resource assessment, SI evaluates the solar resource across the U.S. by partnering with organizations such as the National Oceanic and Atmospheric Administration (NOAA), as well as developing new techniques for forecasting that is essential for enabling solar technologies to be accepted in high penetrations by utilities.

[a] SBIR/STTR funding transferred in FY 2010 was $174,000 for the SBIR program and $21,000 for the STTR program.

Detailed Justification

(dollars in thousands)

	FY 2010 Current Approp	FY 2012 Request
Systems Integration	**23,055**	**43,150**

Systems Integration contains four primary activities: Balance of System Development, Grid Integration, Technology Validation, and Solar Resource Assessment.

Balance of System Development

To achieve PV BOS cost reductions consistent with the $1/W goal, the DOE will issue a Funding Opportunity Announcement (FOA) to industry, academia, federal laboratories and other stakeholders.

Solar Energy Grid Integration Systems – Advanced Concepts (SEGIS-AC): While today's inverters are designed to disconnect from the utility grid during abnormal conditions, inverters in the near future must be redesigned with new capabilities to enable high penetrations of solar technologies on the distribution system. These capabilities include the ability to provide reactive power, voltage control, ride-through disturbances, and work with energy storage. New inverter-utility communications protocols and standards will be required. In addition, this FOA will fund work in the development of advanced components that will reduce the size and costs of the components in solar power electronics as well as increase their reliability. This program will be closely coordinated with power electronics development programs conducted through ARPA-E and OE to ensure that the latest breakthroughs in advanced components are quickly incorporated into commercialized systems.

Grid Integration

Activities focus on developing technologies that enable the high-penetration of solar electric systems into the electricity grid. This area focuses on power electronics, integration into the distribution system, integration into the transmission system, and demonstration projects. Efforts will be coordinated with OE.

Distribution Grid Integration (DGI): Within the SI subprogram, the DGI activity focuses on distributed PV interconnect at the distribution level (<15kV). The DGI activity will conduct research and development activities that support the goal of enabling 10-20 percent solar energy penetration into the electric power system and reduce both the technical and economic barriers (which contribute to real and perceived risks) to achieving high levels of PV penetration. As the SETP moves the industry towards $1/W installed system costs, there will be an economic push to increase the amount of PV installed on the electric power system. System installers, utilities, and regulators need to make sure that the electric power system can integrate these high penetrations of solar without any undue burdens. In the area of technical concerns, electric utilities are resistant to large-scale PV penetration and concerned about the ability of the distribution grid to operate within design tolerances when faced with an increasing percentage of the generation mix being supplied by variable sources. Technical concerns involve grid stability, voltage regulation, power quality (voltage rise, sags, flicker, and frequency fluctuations), and protection and coordination. A key to understanding these impacts is the ability to accurately model the performance of PV systems in electrical distribution system modeling packages.

Transmission Grid Integration: With the $1/W goal in mind as well as the goal of achieving 10-20 percent energy nationwide penetration by 2030, future work needs to consider the grid impacts of larger penetrations of both CSP and PV technologies and how solar can achieve maximum value. Wind energy development benefits from economies of scale – the larger systems become, the more economic they

become. Solar is beginning to realize similar benefits. As larger systems come online, the costs of integration become nontrivial and need to be minimized. This will be accomplished by acquiring the necessary data, characterizing plant performance, developing generalized plant output models and forecasting tools, evaluating impacts on the grid, enhancing grid and operational capabilities (including response from conventional generation and demand), and developing codes and standards for the implementation of solar technologies. In addition, SI will continue to work with OE to address the lack of access to electrical transmission, a major inhibitor to the increased use of utility-scale solar systems.

High Penetration Solar Deployment: The subprogram will continue to support projects initially awarded by the High Penetration Solar Development solicitation funded by the Recovery Act that improve modeling tools based on the field verification of high penetration levels of PV into the distribution grid. In addition, the subprogram will continue work with utilities and industry partners to collect data from multi-megawatt systems to characterize the variable output for other utility partners.

Technology Validation

System Modeling & Analysis: Activities will continue in benchmarking, modeling, and analysis for PV systems and their integration into distribution and transmission systems. 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 environment and weather conditions in the U.S. The inclusion of these representative datasets will further validate the modeling of performance of PV systems operating in all U.S. regions. In FY 2012, the subprogram will also support continuing development and enhancements for the Solar Advisor Model (SAM), guided by the needs of the SAM user forum, as well as by market, value, and policy analyses. Performance modeling platforms will be developed to support analysis of the inherent variability of grid-connected solar electric systems.

Reliability: In FY 2012, the subprogram will continue to conduct both real-time/real-world reliability studies, as well as accelerated life-cycle testing in the lab, to identify failure modes and mechanisms in modules, inverters, and balance of system components. Using this reliability data, the subprogram will continue to develop and validate models that predict product reliability. The subprogram will continue to distribute these models to industry as they become available, enabling manufactures to produce more reliable components and system developers to make increasingly confident predictions of long-term performance, degradation, lifetime, and associated costs for system operation and maintenance. Reliability will continue to cross-functionally support Modeling and Analysis and Codes and Standards activities.

Test & Evaluation: In FY 2012, the subprogram will continue to conduct performance studies on fielded systems as well as on components in lab. Using this performance data, the program will continue to develop, improve, and validate system performance models, testing and evaluation technology, and test procedures. The subprogram will continue to distribute these models and procedures to industry as they become available, enabling manufactures to produce higher performing components and allowing system developers to design and build higher performing systems. Test and evaluation will continue to cross-functionally support the Reliability, Modeling and Analysis, Resource Assessment, and Codes and Standards activities. In addition, evaluations of CPV demonstration systems will continue.

Regional Test and Evaluation Partnerships (RTEP's): Evaluation of components, as well as whole systems will continue to be conducted in the field via university and private test lab partnerships. These field studies will continue to provide region-specific data from various climates throughout the country.

(dollars in thousands)

	FY 2010 Current Approp	FY 2012 Request

Findings at the RTEPs (both field and lab) will continue to be used to both validate and complement National Laboratory and industry findings.

Codes & 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 (NEC), Underwriters Laboratories (UL) standards review committees, International Electrotechnical Commission (IEC) committees, and the Institute of Electrical and Electronic Engineers (IEEE) PV and PV systems related committees.

The Solar America Board of Codes and Standards ("Solar ABCs"): Solar ABCs will be in the final year of activity in FY 2012. The Solar ABCs will coordinate resources and expertise to develop consensus on pressing industry topics and formally disseminate these expert findings to industry stakeholders. In addition, it will continue to provide access for stakeholders to participate with members of the standards development panels and committees as well as continuing to grow its centralized repository of documents, regulations, and technical materials related to solar codes and standards.

Solar Resource Assessment

In FY 2012, the subprogram will continue to improve resource maps for both PV and CSP technologies with an emphasis on providing data to assist industry in site selection and better assurance to utilities and financial institutions on system performance. Main activities will include: development, validation, and dissemination of reliable, accurate solar resource information; improvements of the quality and completeness of the National Solar Radiation Database; benchmarking U.S. solar databases against international data sets following internationally established protocols; and provision of solar products and tools to stakeholders through accessible web-based mechanisms and outreach activities. This work will be enhanced by collaboration with NOAA. The subprogram will also develop a better method of accurately forecasting the solar resource from satellite data, establishing a standard system of collecting data at specific sites, and disseminating resource information to project developers.

SBIR/STTR	**0**	**250**

In FY 2010, $174,000 was transferred to the SBIR program and $21,000 was transferred to the STTR program respectively. FY 2012 amounts shown are estimated requirements for continuation of the SBIR/STTR programs.

Total, Systems Integration	**23,055**	**43,400**

Explanation of Funding Changes

	FY 2012 vs. FY 2010 Current Approp ($000)
Systems Integration	
The difference in funding in FY 2012 represents an increase in funding between year three of the SEGIS award and year one of the SEGIS-AC award. The FY 2012 budget reflects a significant increase in funding for Systems Integration activities due to the inclusion of the Test & Evaluation Project funding which supports the overall "Sunshot" initiative to reduce balance of system hardware costs.	+20,095
SBIR/STTR	
In FY 2010, $174,000 was transferred to the SBIR program and $21,000 was transferred to the STTR program respectively. FY 2012 amounts shown are estimated requirements for continuation of the SBIR/STTR programs.	+250
Total Funding Change, Systems Integration	**+20,345**

Market Transformation

Funding Schedule by Activity

(dollars in thousands)

	FY 2010 Current Approp[a]	FY 2012 Request
Market Transformation	23,540	27,000
Total, Market Transformation	23,540	27,000

Benefits

Market Transformation activities increase domestic solar market penetration by removing regulatory and financial market barriers and reducing non-hardware system costs. A 2010 study by Lawrence Berkeley National Laboratory shows that while module and equipment costs for PV systems are decreasing, non-hardware costs are potentially flat or increasing. These non-hardware costs are significant and part of the installed price of a PV system. Under the SunShot Initiative, our Market Transformation activities are being directed towards directly and quantitatively addressing these non-hardware costs associated with Balance of Systems costs. Thus, this subprogram enables DOE to provide significant assistance to the goal of lowering the cost of solar power by identifying and reducing the market barriers to solar technology commercialization. The specific goal is to achieve $1/W installed PV system costs before the end of the decade. In FY 2012, the subprogram will look at new programs and initiatives under the $1/W Initiative to identify and address other balance of system costs and market barriers not currently being addressed. Efforts under this subprogram complement the R&D work of the PV and CSP subprograms, as well as Systems Integration work, by focusing on addressing these critical non-hardware installation costs and barriers.

[a] No SBIR was assessed to the Market Transformation subprogram since all of the activities relate to technology deployment.

Detailed Justification

(dollars in thousands)

	FY 2010 Current Approp	FY 2012 Request
Market Transformation	**23,540**	**27,000**

This subprogram is focused on two specific objectives: 1) Remove Market Barriers; 2) Reduce Non-Hardware Components of LCOE that impact the Dollar a Watt imperative.

Market Barrier Reduction

There are problems endemic to the solar market that are largely independent of system costs (oftentimes resulting from prohibitive or poorly designed policies, regulations, codes and standards) that are impeding further market development. Enabling economies of scale will increase market penetration resulting in reductions in all LCOE inputs, not just the non-hardware components.

Policy, Regulatory, Codes and Standards: FY 2012 funds will support the second year of a funding opportunity to engage in state utility commission proceedings on net metering, interconnection, third-party PPAs, and other regulatory issues as they are identified and continued work to identify, develop and disseminate best practices and convene key stakeholders to work through these complex problem sets. State and local policies and regulations as well as codes (building and electrical) and standards (interconnection) play a critical role in determining the speed and scale at which solar markets develop. In jurisdictions with above average solar resources, restrictive policies and regulations; e.g. illegality of third-party power purchase agreements (PPAs), restricted access for solar systems as a result of HOA covenants, and overly prescriptive or poorly designed incentive programs, can synthetically bound total installed solar capacity.

Utility Operations and Programs: In FY 2012, the Market Transformation subprogram will leverage the expertise of the national laboratories in the areas of grid integration and program analysis, engage in regional planning efforts, and work directly with utilities to address complex problems associated with rates and business models. Utilities play a dual role as both customers and suppliers of solar energy. As customers, utilities must integrate solar generation from residential, commercial and central station solar power plants onto their transmission and distribution systems. As suppliers, utilities run incentive programs that support the deployment of solar installations in their utility territories. As customers, utilities need to understand how to operate their system with increasing amounts of solar and evaluate the value of solar (i.e. deferred costs associated with generation and transmission for distributed solar). As suppliers of solar, utilities need to develop programs that are not overly complex and can be administered efficiently adding little to no cost to operations.

Non-Hardware BoS Cost Reduction

There are elements of the solar "project pipeline" that add to the total installed costs of solar systems. The significance of each varies dependent on project scale; e.g. residential/commercial vs. central station.

Permitting, Interconnection and Inspection: In FY 2012, the Market Transformation subprogram will engage with federal agencies including the Department of Interior and Department of Defense to accelerate solar permitting on federal lands, support development of open IT platforms to consolidate and standardize permitting and interconnection applications, partner with state and local agencies to

(dollars in thousands)

	FY 2010 Current Approp	FY 2012 Request

pilot streamlined processes, and disseminate best practices to thousands of local jurisdictions, state public utility commissions, and utilities. Activities will leverage existing partnerships with 25 Solar America Cities funded in FY2007, FY 2008 and by the Recovery Act. The Market Transformation subprogram supports activities to reduce the time and cost involved in the permitting, inspection, and interconnection processes associated with installing solar electric systems. At the distributed scale, these processes can represent hundreds of pages of paperwork and months of time delays in distributed PV project development, raising overhead costs for installers and therefore the price to the customer. The time and cost associated with these processes for central-scale solar projects is significantly greater, in some cases adding millions of dollars to the project cost and delaying the project for years. The Market Transformation subprogram supports technical analysis, tool development, stakeholder engagement, and information dissemination to promote widespread adoption of best practices for permitting, inspection, and interconnection by states, utilities, local jurisdictions, and federal agencies.

Installation: The Market Transformation subprogram supports activities to reduce costs associated with the installation process. In FY 2012, the Market Transformation subprogram will support the National Administrator of the Solar Instructor Training Network, which was created through Recovery Act and FY 2010 investments to provide a nationwide train-the-trainer foundation for scaling up downstream solar training programs at community colleges and other local educational institutions across the country; and to promote dissemination of quality curriculum and training best practices. To advance quality assurance in the growing domestic solar industry, additional funding will support organizations that certify solar industry personnel and accredit solar instructors. Poorly trained or managed installers often operate inefficiently, adding time and cost to solar projects by making mistakes that necessitate rework. Sub-optimal installations also often result in lower performance over the life of the system, reducing the buyer's return on investment. Uncertainty around system performance and safety increases the risk associated with solar projects, and therefore increases the cost of capital. The Market Transformation subprogram supports efforts to improve installation efficiency and quality through education and training for solar installers and instructors, and certification and accreditation standards.

Siting: In FY 2012, this subprogram will continue inter-governmental coordination on analysis and tools development that support smart siting of utility-scale solar projects (both PV and CSP) including finalization of the Solar Programmatic Environmental Impact Statement being conducted jointly with the Department of Interior's Bureau of Land Management; staffing a CEQ-DOE-DOI led interagency siting task force; development of a comprehensive GIS siting tool; and development of long-term monitoring strategies for utility-scale solar projects. The siting of large-scale solar projects is directly related to how long it will take that project to go through the permitting process, regardless of whether it is on federal, state or private land. The length of the permitting process impacts a developers ability to secure project financing, while environmental and other (e.g. Department of Defense) conflicts can result in serious delays to the project approval and construction timeline.

Total, Market Transformation	**23,540**	**27,000**

Explanation of Funding Changes

	FY 2010 vs. FY 2012 Current Approp ($000)
Market Transformation	
In FY 2012, the Market Transformation program is being expanded and restructured to provide more tailored support for the non-hardware related costs in reaching the "Sunshot" goal of $1/W installed PV system costs before the end of the decade. These non-hardware costs can be a significant portion of the total costs of installing PV systems. The new structure focuses specifically on two core function areas: 1) Market Barrier Reduction; and 2) Non-Hardware BoS Cost Reduction.	
The Solar America Cities and Solar America Communities (technical outreach awards) programs will be retooled to serve as conduits for dissemination, implementation and piloting of best practices for local governments developed in the subprograms two core function areas.	
A new funding opportunity will be issued to support direct engagement in state regulatory decision processes. Direct work with state regulators, legislators, governors and energy offices will be expanded to conduct analysis and develop and pilot best practices on solar-related policy, economic, and regulatory issues tailored to the needs of specific geographic regions.	
The subprogram's work with utilities will be retooled and expanded to provide additional direct support in the areas of solar program development, planning, and grid integration. (These activities will be developed in close coordination with the Systems Integration subprogram.)	
The Solar Instructor Training Network will be evaluated and retooled to ensure that efforts in this area are resulting in reduced system installation costs.	
The subprograms siting work will be expanded in order to develop a long-term infrastructure that supports the informed siting of large-scale solar (PV and CSP) projects. Critical to the success of these projects is the continued interagency work that is being co-led by DOE.	
The Solar America Showcases activity providing technical assistance to large-scale solar installations will be terminated. The domestic solar industry has matured to the point where these services can be supplied by private sector providers, allowing DOE to invest in emerging issues that need Federal support. The Government Solar Installation Program (GSIP) efforts to increase Federal sector integration of solar technologies will also be concluded. Analysis and technical assistance efforts will be undertaken by the Federal Energy Management Program instead.	
National Laboratory funding will be reprogrammed to help quantify the regulatory and process balance of system costs and support the development of metrics for measuring the impact of the subprogram's activities on reductions in those costs. Additionally,	+3,460

	FY 2010 vs. FY 2012 Current Approp ($000)
national laboratory funding will be used to support the development of best practices and pilot programs in the areas of solar jobs and economic development studies, utility rate analysis, forecasting, and advanced financing methods.	
Total Funding Change, Market Transformation	**+3,460**

Fuels from Sunlight Hub

Funding Schedule by Activity

(dollars in thousands)

	FY 2010 Current Approp[a]	FY 2012 Request
Fuels from Sunlight Hub	22,000	0
Total, Fuels from Sunlight Hub	22,000	0

Benefits

Modeled in part after DOE's successful Bioenergy Research Centers, the Hubs help advance highly promising areas of energy science and engineering from the early stage of research to the point where the technology can be handed off to the private sector. Each Hub fosters unique, cross-disciplinary collaborations by bringing together leading scientists to focus on a high priority technology. The Fuels from Sunlight Hub addresses the challenge of deriving fuels directly from sunlight in an efficient and economical way. The Hub approach encourages risk taking that can produce real breakthroughs, as opposed to the typical, more cautious approach that can result in meaningful, but often only incremental, improvements to existing technology. DOE will encourage risk-taking by making the initial grant period five years, renewed thereafter for up to 10 years. Any funding after 10 years would be predicated on "raising the bar" above that needed for simple renewal.

Detailed Justification

(dollars in thousands)

	FY 2010 Current Approp	FY 2012 Request
Fuels from Sunlight Hub	**22,000**	**0**

No funding is being requested for the Hub in FY 2012 within the Solar Program, as funds are requested by DOE's Office of Science.

Total, Fuels from Sunlight Hub	**22,000**	**0**

[a] Per P.L. 111-85, DOE exercised the option to fund the NREL Ingress/Egress project with Recovery Act funds. The use of this option provided $22.0 million in funding for the Fuels from Sunlight Energy Innovation Hub, as reflected in this table.

Explanation of Funding Changes

	FY 2010 vs. FY 2012 Current Approp ($000)
Fuels from Sunlight Hub	
No funding is being requested for the Hub in FY 2012 within the Solar Program, as funds are requested by DOE's Office of Science.	-22,000
Total Funding Change, Fuels from Sunlight Hub	**-22,000**

Wind Energy

Funding Profile by Subprogram

(Non-comparable, as Appropriated, Structure)

(dollars in thousands)

	FY 2010 Current Approp[a]	FY 2012 Request
Wind Energy		
Technology Viability	46,167	107,825
Technology Application	32,844	19,034
Total, Wind Energy	79,011	126,859

Funding Profile by Subprogram

(Comparable funding in the FY 2012 Request)

(dollars in thousands)

	FY 2010 Current Approp[a]	FY 2012 Request
Wind Energy		
Technology Development and Testing	46,167	107,825
Technology Application	32,844	19,034
Total, Wind Energy	79,011	126,859

Public Law Authorizations:

P.L. 94-163, "Energy Policy and Conservation Act (EPCA)" (1975)
P.L. 101-218, "Renewable Energy and Energy Efficiency Technology Competitiveness Act" (1989)
P.L. 101-575, "Solar, Wind, Waste, and Geothermal Power Production Incentives Act" (1990)
P.L. 102-486, "Energy Policy Act of 1992"
P.L. 109-58, "Energy Policy Act of 2005"

Mission

The mission of the Wind Energy Program is to enable rapid expansion of clean, affordable, reliable and domestic wind power to promote national security, economic growth, and improved environmental quality. The approach is to innovate, educate, and build a vibrant wind power industry to become a global leader in this clean, renewable energy source.

[a] SBIR/STTR funding transferred in FY 2010 was $881,000 for SBIR program, and $108,000 for the STTR program.

Benefits

Wind energy can help catalyze the timely, material and economic transformation of the nation's energy system. Wind energy benefits include: domestic energy generation, improved economic growth and improved environmental quality through reduction in green house gases, criteria pollutants, and water use.. Wind energy is currently the fastest growing renewable electricity generation technology in the world.[a] Since 2000, domestic wind energy generation has significantly expanded, increasing from 2.5 GW of installed capacity to 35 GW at the end of 2009, demonstrating its promise as an affordable energy supply option.[b] Comprehensive and coordinated planning by the Wind Energy Program can help secure U.S. leadership in clean energy technologies. The Wind Energy Program works to deploy existing technologies and discover new solutions. The Program facilitates accelerated wind growth by addressing key technology, market, and institutional areas of concern such as: electrical grid integration; wind resource assessment and forecasting; wind turbine reliability and cost; innovative technology development and improved manufacturing methods for reducing the cost of wind energy; public acceptance through education; siting and environmental barriers.

The U.S. is a prime location for leveraging excellent natural wind resources, providing local businesses with opportunities for wind technology manufacturing, installation, and facility operation. Large-scale deployment of wind technology diversifies the U.S. electric sector with next generation technology that does not emit GHGs, and provides economic growth throughout the U.S. In many areas of the country, wind energy has already boosted the local economy, as wind plant development creates jobs during both the construction phase and operations/maintenance phase of the plant. The Wind Program will focus resources on efforts to bring down the cost of offshore wind continue to intensify, as this challenging new environment requires a unique industry-government partnership, projects where success is most likely to contribute to full price parity, and where industry is unable to support research at the levels needed to meet cost targets. Additional work includes increasing the efficiency and reliability of wind turbines while lowering the energy costs of wind technologies. EERE also supports programs designed to catalyze the timely, material and economic transformation of the nation's energy system by accelerating the introduction of these technologies into the market, including work to address market perceptions, the challenge of integrating intermittent electric resources into utility systems, and work in utility policy and codes that can remove barriers to rapid introduction of renewables. Collaboration with the DOE – Office of Science and ARPA-E for scientific innovation and collaboration with the Office of Electricity Delivery and Energy Reliability (OE) on transmission integration and energy storage systems is an important part of this investment.

High Priority Performance Goal (HPPG)

The Wind Energy Program contributes directly to achieving the Renewable Energy HPPG. The performance measures for the program are directed to contributions toward the goal of doubling renewable energy generation. Additional information on the intermediate performance critical to achievement is provided at www.performance.gov.

[a] World Wind Energy Report 2009, World Wind Energy Association, March 2010. http://www.wwindea.org/home/images/stories/worldwindenergyreport2009_s.pdf

[b] 2009 Wind Technologies Market Report, DOE/GO-102010-3107, August 2010. http://www1.eere.energy.gov/windandhydro/pdfs/2009_wind_technologies_market_report.pdf

Annual Performance Targets and Results

The Department is in the process of updating its strategic plan, and has been actively engaging stakeholders including Congress. The draft strategic plan is being released for public comment concurrent with this budget submission, with the expectation of official publication this spring. The draft plan and FY 2012 budget are consistent and aligned. Updated measures will be released at a later date and available at the following link http://www.mbe.doe.gov/budget/12budget/index.htm.

Technology Viability

Funding Schedule by Activity

(Non-comparable, as Appropriated, Structure)

(dollars in thousands)

	FY 2010 Current Approp[a]	FY 2012 Request
Technology Viability		
Low-Speed Wind Technology	15,907	9,690
Distributed Wind Technology	5,907	3,198
Supporting Research and Testing	24,353	29,141
Offshore Wind	0	63,733
SBIR/STTR	0	2,063
Total, Technology Viability	46,167	107,825

Technology Development and Testing

Funding Profile by Subprogram

(Comparable funding in the FY 2012 Request)

(dollars in thousands)

	FY 2010 Current Approp[b]	FY 2012 Request
Technology Development and Testing		
Utility-Scale Systems Research Development and Testing	15,907	9,690
Small and Medium Systems Research Development and Testing	5,907	3,198
Advanced Components Research Development and Testing	24,353	29,141
Offshore Wind	0	63,733
SBIR/STTR	0	2,063
Total, Technology Development and Testing	46,167	107,825

[a] SBIR/STTR funding transferred in FY 2010 was $857,000 for SBIR program, and $103,000 for the STTR program.
[b] Ibid.

Benefits

The Wind Energy Program aims to reduce sources of risk that undermine the growth potential of wind energy in the U.S. by improving the cost, performance, and reliability of wind turbine technology.

Technology Development and Testing activities focus on R&D and testing to overcome barriers to wind energy's viability in the U.S. This includes facilitating major technology improvements and improving performance, cost effectiveness and reliability for wind energy systems. Achieving these goals will lower the cost of wind energy while increasing reliability, which will help wind energy gain wider acceptance domestically and accelerate deployment in the existing U.S. energy market. Emphasis is placed on utility scale technology because the resource potential is high and the economics are compelling.

Utility Scale Systems RD&T activities will focus on improving the reliability and affordability of utility scale wind turbine systems. The purpose of Small and Medium Systems RD&T is to support the development of a domestic commercially viable mid-size turbine between 100kW - 1MW to meet market demands. Small and Medium Systems RD&T will also assist in the development of standards performance testing for small wind systems. Small and medium sized turbines leverage transmission capacity where utility-scale cannot and support the highly-successful community-wind business models benefitting local economies. Laboratory-based Advanced Components Research Development and Testing will work to advance technologies that have shown potential to improve the performance, cost structure and reliability of wind turbine systems. Offshore Wind will focus on accelerated development of operational offshore projects and development of innovative technologies to resolve financial, regulatory, technical, environmental, and social challenges facing the offshore wind industry.

Detailed Justification

(dollars in thousands)

	FY 2010 Current Approp	FY 2012 Request
Utility-Scale Systems Research Development and Testing	**15,907**	**9,690**

The Utility Scale Systems RD&T activity primarily addresses major technology improvement opportunities and innovation potential identified in the Wind program technology roadmap by maintaining unique, world-class wind turbine testing facilities and through public/private partnerships, CRADAs, and subcontracts. Utility Scale Systems RD&T targets specific wind turbine components, including rotors, drivetrains, towers and foundations. The testing facilities, improved and maintained in collaboration with DOE's National Laboratories, provide testing capabilities that are unique in North America and vital to the continued innovation and improvement of wind turbine technology. The National Wind Technology Center (NWTC) has unique testing facilities necessary for validating new innovative designs for wind turbines and components. These facilities also evaluate cost goals for the program's performance improvement activities. Testing is conducted on full-scale turbine systems installed in the field and also on turbine components and subsystems. Component testing utilizes the NWTC's specialized blade and dynamometer test facilities. These tests support certification and validate innovative technology characterization. In FY 2012 the program will perform detailed reliability and performance testing on advanced drivetrains and blades using NWTC testing facilities. The DOE 1.5 MW wind turbine at NWTC will be utilized for in-depth loads analysis testing, condition health monitoring systems evaluation, and data mining for confirmation of computer modeling results.

Public/private partnerships and CRADAs support the commercialization of technology developments and emerging innovation and are accomplished through:

- Conceptual design studies;
- Component development and testing; and
- Full turbine prototype development and testing.

The Recovery Act enabled a substantial improvement of domestic Utility Scale Systems RD&T activity by funding a large wind turbine blade testing facility and a large drivetrain dynamometer test facility. Both the blade testing and the dynamometer test facilities support R&D activities which validate innovative new technology, and identify design and manufacturing flaws prior to commercial deployment that will result in improved product reliability. NREL will continue to support the testing and operation of both the Massachusetts Large Blade Test Facility and the Clemson University Large Dynamometer Facility, which complement NWTC facilities.

In 2012, the program will continue to lower the COE for wind turbine systems through existing and new Utility Scale Systems RD&T partnerships and CRADAs. R&D efforts in this area will focus on improving the performance and reliability of current generation utility scale wind turbines. Work is expected to continue on the Gearbox Reliability Collaborative (GRC) to address gearbox design and reliability issues, laboratory and field testing activities and the Blade Reliability Collaborative to address blade design and reliability issues via testing and the development of innovative inspection methods.

(dollars in thousands)

	FY 2010 Current Approp	FY 2012 Request

These collaborative efforts, along with the Reliability, Availability and Maintainability (RAM) Database activity, are central to the program's goal of addressing turbine reliability and performance issues.

Small and Medium Systems Research Development and Testing **5,907** **3,198**

Small and Medium Systems RD&T will support independent testing and certification efforts for small wind turbines. Efforts will provide guidance and transfer technical expertise from NREL to Regional Test Centers (RTCs) that conduct tests on small wind turbines to meet national and international standards. Clearly defined and precise manufacturing standards enable higher quality products to enter the market and increase consumer confidence in small and medium wind energy technology.

Supporting research and testing is an integral part of the Small and Medium Systems RD&T effort and will focus on industry partnerships to develop less expensive towers and more reliable blades and drivetrains. Development activities will involve cost shared development and prototype testing with industry of a mid-size turbine in the 100kW to 1MW range. Small and medium wind turbine systems or components will be field or laboratory tested at the NWTC, to assess loads, power performance, acoustic emission, power quality, and other performance parameters.

FY 2012 activities will include:

- Continued independent, laboratory field testing of small and medium turbines;
- The transfer of technical knowledge to RTCs for the testing and certification of small wind systems;
- Support for the development and adoption of national standards for small wind systems; and
- Collaboration with turbine manufacturers to deploy a mid-size turbine that promotes the U.S. supply chain and creates jobs in the small wind industry.

Advanced Components Research Development and Testing **24,353** **29,141**

Advanced Component RD&T provides targeted research and testing to improve the reliability, efficiency, and performance of wind turbines. Activities are continuously coordinated with industry and other research institutions to facilitate technology transfer and to transition design innovations and component improvements into full systems.

Through the National Laboratories, specialized technical expertise, comprehensive design and analysis tools, and unique, world-class testing facilities are utilized to solve problems that industry cannot solve alone due to high risk and limited R&D resources. This technical support is essential to public/private partnerships and collaboratives and engages the R&D capabilities of the National Laboratories, universities and private industry.

(dollars in thousands)

FY 2010 Current Approp	FY 2012 Request

The Recovery Act enabled a substantial expansion of domestic drivetrain RD&T capabilities by providing funding for upgraded dynamometer test facilities at NWTC and a new large dynamometer test facility at the former Charleston Naval Shipyard in partnership with Clemson University. The NWTC facility will be commissioned in FY 2012, with the Clemson facility following closely behind by the end of calendar year 2012. Both facilities will improve reliability by investigating gearbox failures, validating gearbox design codes, developing direct drive generator designs, and enabling enhanced Advanced Component RD&T capabilities in FY 2012 and beyond. R&D activities for investigating innovative solutions to radar systems mitigation issues will continue.

Offshore Wind **0** **63,733**

Research, development and testing activities under the Offshore Wind subprogram address national barriers to gigawatt-scale deployment of cost-effective offshore wind energy projects. DOE support for accelerated development of operational offshore projects and development of innovative technologies helps to resolve financial, regulatory, technical, environmental, and social challenges facing the offshore wind industry, thereby accelerating progress toward deployment of 54 GW of offshore wind energy by 2030.

Offshore wind technology funding will be used to deploy innovative U.S. offshore wind projects and to evaluate the projects through instrumentation, data collection and analysis. To drive down offshore wind cost of energy (COE), the program will pursue development partnerships for: innovative foundations (shallow, transitional, and deep water); drivetrain and blade designs; marine environment materials; installation techniques; and transmission planning and optimization. Regulatory, environmental, and social risks to project development will be addressed through collaborative research and interagency activities on permitting, siting strategies, potential environmental effects, and other related siting issues.

Investment in a national-scale offshore research program will accelerate successful implementation of more than 5 GW of currently planned offshore projects in the U.S. Analysis of lessons learned from the international offshore wind industry and technical advances and siting studies supported directly by the DOE program will benefit all stakeholders in facilitating effective strategies for project development in both State and Federal waters of all coastal and Great Lakes regions of the U.S.

The offshore program positions DOE in a pivotal role by engaging all stakeholders through interagency, Federal/State, and public/private collaboration to address common issues including marine spatial planning, site evaluations, and environmental effects research and mitigation. In addition, R&D partnerships established with university/industry consortia support long-range technology innovation, prototyping and testing initiatives.

FY 2012 funds will enable the program to continue and expand key initiatives. Particular emphasis will be placed on efforts directed toward reducing costs, increasing efficiency and reliability, and raising the confidence levels of project developers, financiers, regulators and other stakeholders through mitigation of risks and uncertainties. Critical FY 2012 focus areas include:

(dollars in thousands)

FY 2010 Current Approp	FY 2012 Request

Technology Development ($28M): Activities are targeted to overcome technological barriers to achieving a robust offshore wind industry able to achieve the deployment goal of 54 GW of offshore wind by 2030. The specific activities will focus on improvements to models, design tools, components, materials, turbines and balance of plant configurations that will lead to a lower COE, reduction in technological risk, and increased access to wind resources.

- Computational tools and test data: Performance modeling and validation, creation of design tools and standards, and field testing;
- Innovative turbines: New turbine design concepts, advanced drive concepts, materials, controls and power electronics; and
- Innovative foundations and balance of plant: Increased cost effectiveness of designs, materials and performance of support structures and facility subsystems such as electrical substations and distribution cabling.

Advanced Technology Demonstration Projects ($12M Excluding SOU2): Through cost-share projects chosen under competitive solicitations during FY 2011, DOE will continue in FY 2012 to partner with commercial developers, research consortia, power producers and utilities on first-of-a-kind offshore wind energy projects having the goal of proving out innovative, integrated turbine, structure, and balance of system designs for various marine operating conditions (e.g. adaptive marine engineering/structures for shallow, medium and deepwater depths; specialized designs to facilitate easy operations and maintenance at distances well offshore; resistance of system components to corrosion and strong, turbulent forces such as hurricanes, wave action; etc.). The initial scope of these project awards will focus on meeting project deployment needs, and will support only basic technical data reporting requirements.

In 2012 DOE will build upon the demonstration program begun previously through an initiative to add instrumentation, data collection capabilities, and verification protocols to these facilities, enabling rigorous prototype testing and performance validation of wind turbines and support structures to be carried out in an offshore environment. This activity will support additional field testing such as instrumenting system foundations in a floating environment using strain gauges, accelerometers, and other devices, and collecting data needed to validate modeling activities executed under the Technology Development effort outlined above. This type of objective testing, carried out in conjunction with industry, will provide invaluable additional data needed to lower capital costs, increase energy capture, reduce risk and expedite U.S.-developed technologies to market.

Market Barrier Removal ($8.7M): Efforts will increase the efficiency of the current offshore project deployment timeline and contribute to lowering the overall costs and risks of project development:

- Siting and permitting: Addressing market perception and benefits, regulatory processes, environmental considerations, and impact on marine operations, including radar effects mitigation;
- Complementary infrastructure: Establishing a robust domestic manufacturing and supply chain; transmission and interconnect planning; and facilitating optimized ports, vessels, and operations strategies; and
- Resource planning: Characterization of wind resources and facility design conditions, including validation of advanced remote sensing technologies and development of a national interagency

(dollars in thousands)

	FY 2010 Current Approp	FY 2012 Request
resource data campaign to the level of resolution needed for individual project economic assessment and technical design evaluation		
SBIR/STTR	**0**	**2,063**
In FY 2010, $857,000 and $103,000 were transferred to the SBIR and STTR programs respectively. The 2012 amounts shown are estimated requirements for the continuation of the SBIR and STTR program.		
Total, Technology Development and Testing	**46,167**	**107,825**

Explanation of Funding Changes

	FY 2012 vs. FY 2010 Current Approp ($000)
Utility-Scale Systems Research Development and Testing	
The FY 2012 funding level represents program realignment focus on advanced component research and development. The decrease will come from activities focused on pure deployment and intellectual property limited partnerships versus similar activities funded in FY 2010.	-6,217
Small and Medium Systems Research Development and Testing	
The FY 2012 funding level represents a decrease in deployment projects and a renewed focus on supporting world class testing facilities at NWTC, which provide technical support to regional testing partners that provide certification testing for small and medium sized wind systems.	-2,709
Advanced Components Research Development and Testing	
The FY 2012 funding level represents an increased focus on providing industry with objective data and benchmarks that will increase fleet-wide reliability, as well as developing next-generation technologies that take a longer term view of industry growth and high-impact breakthroughs.	+4,788
Offshore Wind	
The FY 2012 funding level represents an expansion of DOE's efforts to reduce the cost of offshore wind energy and to shorten the timelines for deploying offshore wind systems. With the requested budget, DOE will fund a comprehensive suite of research, development, and demonstration activities that will overcome specific financial, technical, and market barriers to the deployment of offshore wind power in U.S. waters. These activities will be organized into three areas of focus: Technology Development, Market Barrier Removal, and Advanced Technology Demonstration. Technology Development activities will develop modeling tools, optimized system designs, and turbine and balance-of-system components necessary for long-term efforts to reduce cost of offshore wind energy. Market Barrier Removal activities will close critical data gaps needed for efficient project permitting, develop optimized operations strategies for cost-competitiveness, and support transmission and interconnection planning to facilitate reliable integration of offshore wind energy into the electric power system. Advanced Technology Demonstration activities will create partnerships with the first offshore wind projects deployed in U.S. waters to reduce the perceived technology and permitting risks of these projects and to generate operating data to inform regulatory processes and increase the industry knowledge base. In FY 2010, offshore wind research and development activities were funded under the Low Wind Speed Technology B&R code.	+63,733

	FY 2012 vs. FY 2010 Current Approp ($000)
SBIR/STTR	
In FY 2010, $857,000 and $103,000 were transferred to the SBIR and STTR programs respectively. Changes in the SBIR/STTR funding are a direct result of changes in the funding of program activities.	+2,063
Total Funding Change, Technology Development and Testing	**+61,658**

Technology Application

Funding Schedule by Activity

(Non-comparable, as Appropriated, Structure)

(dollars in thousands)

	FY 2010 Current Approp[a]	FY 2012 Request
Technology Application		
Systems Integration	19,714	12,398
Technology Acceptance	13,130	6,500
SBIR/STTR	0	136
Total, Technology Application	32,844	19,034

Funding Schedule by Activity

(Comparable funding in the FY 2012 Request)

(dollars in thousands)

	FY 2010 Current Approp[b]	FY 2012 Request
Technology Application		
Renewable Systems Interconnection	14,039	3,925
Wind Resource Characterization	5,675	7,144
Manufacturing and Supply Chain	0	1,329
Technology Acceptance	13,130	6,500
SBIR/STTR	0	136
Total, Technology Application	32,844	19,034

[a] SBIR/STTR funding transferred in FY 2010 was $24,000 for the SBIR program and $5,000 for the STTR program.
[b] Ibid

Benefits

Wind Resource Characterization aims 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 and other complex phenomena due to current uncertainty in these areas.

Renewable Systems Interconnection (RSI) seeks to develop, validate, and/or support adoption of advanced power system operations to aid in accommodating wind energy's added variability and uncertainty through R&D and collaboration with industry, National Laboratories, other Federal agencies and universities.

The Manufacturing and Supply Chain activity will work proactively with industry, universities, National Laboratories and other stakeholders to improve and accelerate industry manufacturing performance. Activities will support enhanced quality and reduced cost of processes for manufacturing key wind turbine components, application of advanced materials, integration of manufacturing processes with emerging high reliability, and performance wind turbine technologies.

Technology Acceptance helps to mitigate environmental and siting barriers, develop an adequate workforce, and accelerate the development of wind energy markets. Technology Acceptance outreach activities help stakeholders and officials understand wind energy technologies and how wind can be integrated into their State energy systems.

Detailed Justification

(dollars in thousands)

	FY 2010 Current Approp	FY 2012 Request
Renewable Systems Interconnection (RSI)	**14,039**	**3,925**

The RSI activities will address wind technical barriers to the reliable interconnection of wind energy to the power system. Areas of focus will include the provision of frequency response and other ancillary services: impacts of wind energy on system regulation; load following; and reserves requirements unit commitment processes. Additionally, this activity will work to evaluate the role of various energy storage technologies in scenarios with large penetrations of wind and advanced system operational techniques to better accommodate wind energy. As wind penetration levels increase, it will become more important to apply advanced forecasting techniques to utility system operations as developed by the Wind Resource Characterization activity. This activity will also assist, through cooperation with OE, the development and most effective use of transmission facilities to foster the deployment of wind energy.

Wind Resource Characterization	**5,675**	**7,144**

Wind Resource Characterization will focus on research and partnerships as a follow on from the completion of the "Enhancing Short Term Wind Energy Forecasting for Improved Utility Operations" project initiated in FY 2010. This effort will support application of advanced atmospheric instrumentation and forecast modeling in partnership with NOAA, as well as additional field projects in different geographic regions if needed for further refinement of instrumentation and modeling of

(dollars in thousands)

FY 2010 Current Approp	FY 2012 Request

varying terrains and climates for wind development. Further advancements in wind forecasting techniques and enhancements in turbine resource assessments, as well as improvements in forecasting accuracy, will aid in reducing the cost of integrating variable wind resources into the grid.

Wind Resource Characterization efforts will be coordinated with similar efforts for other weather-dependent renewables, and will expand appropriate public/private partnerships to identify needs, establish R&D objectives, and collect information and data supporting rapid wind energy growth. High performance computational work will be coordinated with the Office of Science. Acquisition, expansion, refinement, and archiving of mesoscale datasets to aid in on-going utility power system planning efforts will continue. Atmospheric coupling and turbine wake-flow interactions will be further characterized to enhance generation forecasts for wind plants and for increased longevity of turbines through more reliable design criteria.

Manufacturing and Supply Chain **0** **1,329**

The wind turbine original equipment manufacturers (OEMs) rely heavily on components imported from other countries for final assembly of wind turbines. Suppliers to these OEMs must provide a competitive advantage, proving the cost and qualities are industry compliant. The program's activities on manufacturing process improvement will focus on enabling industry to validate new manufacturing processes via demonstration. This collaboration will allow objective assessment of the viability of multiple approaches to advanced composite blade manufacturing processes.

A concerted Federal government/industry initiative to address quality issues in a strategic, comprehensive and coordinated manner can lower the COE, raise reliability, raise quality, and aid in the introduction of innovative components. Activities will be conducted in four areas:

- Support fundamental research in crucial areas such as new materials, automation, non-destructive testing methodology;
- Identify manufacturing standards that ensure manufacturing and final acceptance meet IEC performance and quality assurance requirements;
- Identify opportunities that will increase labor productivity without increasing the cost of production, through various methods such best manufacturing practices, lean manufacturing, and Six Sigma practices; and
- Mapping wind turbine components to the U.S. Department of Commerce supply and parts database.

Technology Acceptance **13,130** **6,500**

FY 2012 activities will focus on strengthening the knowledge and improving the institutional structure and processes of organizations that communicate wind's benefits and challenges to stakeholders, primarily at the regional level. Communication and information dissemination are critical to affecting speed and scale of deployment, the acceptance of wind energy technology, and to address market barriers that are not related to cost or performance. Over time, it is expected that the maturing markets will become self-supporting and/or use funding from sources such as industry associations, non-governmental organizations, and State or local governments. In FY 2012, technical assistance will

(dollars in thousands)

	FY 2010 Current Approp	FY 2012 Request

continue to support markets where wind resources are great but have seen little to no deployment (e.g., community, small, tribal and public lands). The program will continue to assess and mitigate effects of wind turbines on the environment. These efforts will address barriers by funding collaborative research activities; working with other Federal agencies on siting issues; and disseminating objective technical information to stakeholders. The program will expand its efforts to assess, educate, and mitigate effects of wind turbines on radar. A collaborative approach will be developed through interagency cooperation with DOD, the Department of Homeland Security, NOAA, and the FAA. The program will produce a set of options available to developers that will mitigate wind-radar interference and provide funding for testing the options in the field. The program will also provide technical assistance to resolve radar issues at high priority wind projects. To support the growing needs of a well-trained and adequate wind workforce, the program will continue its workforce development initiatives and university-based wind education programs.

SBIR/STTR	**0**	**136**

In FY 2010, $24,000 and $5,000 were transferred to the SBIR and STTR programs respectively. The FY 2012 amounts shown are estimated requirements for the continuation of the SBIR and STTR program.

Total, Technology Application	**32,844**	**19,034**

Explanation of Funding Changes

	FY 2012 vs. FY 2010 Current Approp ($000)
Technology Application	
Renewable Systems Interconnection The FY 2012 funding level represents a decrease for activities focused on grid system planning and operation versus similar activities funded in FY 2010. This change reflects reduced grid planning support in response to increased OE efforts and the completion of analysis support for several advanced grid wind energy integration strategies.	-10,114
Wind Resource Characterization FY 2012 funding represents efforts that will support application of advanced atmospheric instrumentation and forecast modeling in partnership with NOAA, as well further refinement of instrumentation and modeling of varying terrains and climates for wind development.	+1,469
Manufacturing and Supply Chain FY 2012 funding level represents an increase in research in new materials, automation, and non-destructive testing methodology as well as development of manufacturing standards for wind components and systems and labor productivity enhancements.	+1,329
Technology Acceptance FY 2012 funding levels reflect the transition of regional wind collaboratives and stakeholder engagement initiatives to other non-program funding sources. The reduced funding level maintains essential commitments in transfer of technical information, technology education, and stakeholder coordination and engagement. The program will also reduce its investment in University education programs, as those programs transition their funding to non-DOE sources.	-6,630
SBIR/STTR In FY 2010, $24,000 and $5,000 were transferred to the SBIR and STTR programs respectively. The FY 2012 amount shown is the estimated requirements for the continuation of the SBIR and STTR program	+136
Total Funding Change, Technology Application	**-13,810**

FY 2010 - FY 2012 Budget Structure Crosswalk

Wind Energy Program

FY 2010 Current Appropriation		FY 2012 Request	
Technology Viability	**46,167**	**Technology Development and Testing**	**107,825**
Low Wind Speed Technology	15,907	Utility Scale Systems RD&T	9,690
Distributed Wind Technology	5,907	Small & Medium Systems RD&T	3,198
Supporting Research & Testing	24,353	Advanced Components RD&T	29,141
Offshore Wind	0	Offshore Wind	63,733
SBIR/STTR	0	SBIR/STTR	2,063
Technology Application	**32,844**	**Technology Application**	**19,034**
Systems Integration	14,039	Renewable Systems Interconnection	3,925
Wind Resource Characterization	5,675	Wind Resource Characterization	7,144
Manufacturing and Supply Chain	0	Manufacturing and Supply Chain	1,329
Technology Acceptance	13,130	Technology Acceptance	6,500
SBIR/STTR	0	SBIR/STTR	136
Total	**79,011**	**Total**	**126,859**

Geothermal Technologies

Funding Profile by Subprogram

(Non-comparable, or as-Appropriated, Structure)

(dollars in thousands)

	FY 2010 Current Approp[a]	FY 2012 Request
Geothermal Technologies		
Enhanced Geothermal Systems	43,120	101,535
Total, Geothermal Technologies	43,120	101,535

Funding Profile by Subprogram

(Comparable Structure to the FY 2012 Request)

(dollars in thousands)

	FY 2010 Current Approp[a]	FY 2012 Request
Geothermal Technologies		
Enhanced Geothermal Systems	43,120	61,535
Low Temperature and Coproduced Resources	0	14,000
Permeable Sedimentary Resources	0	6,000
Innovative Exploration Technologies	0	15,000
Systems Analysis	0	5,000
Total, Geothermal Technologies	43,120	101,535

Public Law Authorizations:
P.L. 93-410, "Geothermal Energy Research, Development, and Demonstration Act" (1974)
P.L. 95-91, "Department of Energy Organization Act" (1977)
P.L. 95-618, "Energy Tax Act" (1978)
P.L. 96-294, "Energy Security Act" (1980)
P.L. 101-218, "Renewable Energy and Energy Efficiency Technology Competitiveness Act of 1989"
P.L. 101-575, "Solar, Wind, Waste, and Geothermal Power Production Incentives Act of 1990"
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"

[a] SBIR/STTR funding transferred in FY 2010 was $786,000 for SBIR program and $94,000 for the STTR program.

Mission

The mission of the Geothermal Technologies Program (GTP) is to establish geothermal energy as a significant contributor to America's future electricity generation by partnering with industry, academia and the national laboratories to discover new geothermal resources, develop innovative methods, and demonstrate high-impact technologies.

Benefits

Geothermal energy is clean, domestic, and provides 24-hour renewable energy. Because of these advantages, geothermal resources will make a significant contribution to the President's national goal of doubling the share of clean energy to 80 percent by 2035. GTP is developing cost-effective ways to exploit the enormous and diverse geothermal energy resources using an integrated approach. The program's applied R&D priorities focus on developing cutting-edge technologies with real-world applications to advance a clean energy economy.

The program will continue to focus on high-risk, high-payoff Enhanced Geothermal Systems (EGS) technologies as well as low-temperature, coproduced, geopressured, and undiscovered hydrothermal resources that have near-term impacts. In the near-term, GTP will pursue geothermal resources that are lower temperature, coproduced, and geopressured (from high-pressured subsurface wells) to increase geothermal energy generation. Coproduced resources have a potential of 12 GWe, assuming a resource temperature of 140°C.[a] Additionally, GTP will develop innovative exploration technologies to locate undiscovered hydrothermal resources that do not show surface expression, which has the potential of 30 GWe.[b] For the near-to mid-term, GTP will promote the development of naturally permeable sedimentary resources where minimal to no stimulation of the geothermal reservoir is required, thus lowering financial and environmental risk. As a long-term goal, GTP will demonstrate the technical feasibility of high-risk, high-payoff EGS, which has great potential as a domestic baseload energy source and a projected resource capacity of nearly 16,000 GWe.

FY 2012 activities will build upon historic clean energy investments made by the Recovery Act to further the Nation's energy goals through sustained technology innovation and continued investments in enabling infrastructure. U.S. geothermal technology leadership generates export opportunities in sectors such as: power conversion, drilling and high temperature tools.

Typical geothermal power plants will use advanced closed loop conversion systems that will not add CO_2, NO_x, or other GHGs to the atmosphere. Based on a 2004 study, geothermal power plants emit on average 36 times less CO_2 than the average existing U.S. coal power plant per megawatt of electricity produced.

Technologies supported by GTP activities could contribute to U.S. energy supply by 2050 thereby diversifying the Nation's energy mix with clean, baseload energy sources and increasing national energy security.

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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.

b "Assessment of Moderate- and High-Temperature Geothermal Resources of the United States," Williams, Colin F. et al., U.S. Geological Survey, 2008, http://pubs.usgs.gov/fs/2008/3082/pdf/fs2008-3082.pdf.

High Priority Performance Goal (HPPG)

GTP contributes to achieving the Renewable Energy HPPG. The performance measures for the program are directed to contributions toward the goal of doubling renewable energy generation by 2012. Additional information on the intermediate performance critical to achievement is provided at www.performance.gov.

Annual Performance Results and Targets

The Department is in the process of updating its strategic plan, and has been actively engaging stakeholders including Congress. The draft strategic plan is being released for public comment concurrent with this budget submission, with the expectation of official publication this spring. The draft plan and FY 2012 budget are consistent and aligned. Updated measures will be released at a later date and available at the following link http://www.mbe.doe.gov/budget/12budget/index.htm.

Enhanced Geothermal Systems

Funding Schedule by Activity

(dollars in thousands)

	FY 2010 Current Approp[a]	FY 2012 Request
Enhanced Geothermal Systems	43,120	59,905
SBIR/STTR	0	1,630
Total, Enhanced Geothermal Systems	43,120	61,535

Benefits

Current estimates of the Enhanced Geothermal Systems (EGS) resource base show the huge potential of this technology - approximately 16,000 GWe.[a] Commercial EGS could provide baseload, indigenous power and contribute to the security and diversity of U.S. energy supplies. A successful system demonstration may foster rapid growth in the use of geothermal energy in the future. EGS utilizing closed loop advanced binary power plants have virtually zero carbon emissions and have the potential to substantially reduce GHG emissions.

Detailed Justification

(dollars in thousands)

	FY 2010 Current Approp	FY 2012 Request
Enhanced Geothermal Systems	**43,120**	**59,905**

Enhanced Geothermal Systems:

In FY 2012, GTP will conduct RD&D of technologies that enhance geothermal reservoir performance and sustainability, reducing the costs of energy production. While the tools developed are critical to EGS, they can also be used to characterize reservoirs and optimally utilize all types of geothermal resources.

DOE actively pursues EGS R&D and demonstration projects to improve performance and reduce cost, and to facilitate technology validation and subsequent deployment. While achieving cost-competitive electricity generation from EGS is a long-term goal, in the near-term RD&D projects will move industry along the learning curve toward technological readiness. GTP will initiate a geothermal R&D effort to validate tools, methodologies, predictive models, and determine the optimal technologies and methods for scale up. This effort will provide capabilities that can be applied across the spectrum of geothermal resources and will be developed in broad collaboration with industry, academia and other government agencies.

EGS Research & Development:

Although demonstrations are underway, the economic viability of EGS depends on developing and improving enabling technologies. Currently, costs associated with drilling, reservoir creation and

[a] "Updated U.S. Geothermal Supply Curve," Chad Augustine, Katherine Young and Arlene Anderson, National Renewable Energy Lab and U.S. DOE, 2010, http://www.nrel.gov/docs/fy10osti/47458.pdf.

maintenance are prohibitive to the widespread adoption of EGS and new tools are needed to address induced seismicity. Critical technologies which are currently the focus of R&D include:

- High temperature tools, equipment and sensors;
- Zonal isolation tools;
- Smart tracers;
- Monitoring and logging tools;
- Coupled models to predict reservoir development and performance;
- Advanced drilling systems;
- Well stimulation technologies;
- Advanced fracture characterization technologies;
- Induced seismic monitoring, prediction and mitigation tools; and
- Advanced power conversion technologies.

While these technologies are vital to the success of EGS, they also apply across the geothermal continuum. Achievements through past R&D solicitations include improvements in fracture characterization and high-temperature tools. Software initially developed through a previous DOE award has been extended to constrain the absolute, as well as relative, locations of earthquake clusters with high accuracy. Ultimately, this software will improve EGS reservoir characterization capabilities by constraining the positions of fracture networks in three dimensions. While tools like these are necessary for the development of EGS to monitor fracture development and propagation, they are also extremely valuable to all types of geothermal resources. Seismic tools assist in mapping the subsurface, which allows a developer to optimally utilize any type of geothermal reservoir.

DOE funded advances in high-temperature motor coil insulation will increase component resistivity to reliably withstand high temperatures (up to 250˚C) for more than 1,000 hours. A 300ºC, 30,000 psi rated pressure and temperature well monitoring tool is under development. An enhanced silicon carbide electronic platform could survive up to 300ºC with acceptable functionality. By sustaining high temperature operation, these tools and sensors will facilitate lower operation costs and increased efficiency of both EGS and hydrothermal systems.

EGS Demonstration Projects:

Based on expert input and program analysis, the economic viability of EGS depends upon three critical achievements:

- Demonstration of a commercial-scale reservoir. This requires stimulation and maintenance of a large volume of rock (equivalent to several cubic kilometers) in order to minimize temperature decline in the reservoir.
- Sustained reservoir production. GTP analyses indicate that 200°C fluid flowing at 60-80 kg/sec (equivalent to about 5 MWe) with a thermal drawdown rate of 0.3 percent is needed for sustained

economic viability.

Replication of EGS reservoir performance. EGS technology must be proven to work at commercial scales over a range of sites with different geologic characteristics.

These three components are currently being assessed through current demonstration projects. As projects complete permitting and begin reservoir creation, an increasingly large data set will be available along with lessons learned from earlier projects. Upon reservoir creation, the sustained reservoir production at each location will be assessed.

DOE requires all EGS demonstrations to collect stress data, background seismicity and geology data prior to actual field stimulation. Once the data are collected, the demonstration awardees will use predictive stimulation models to estimate and forecast potential induced seismicity magnitude and potential radius of seismicity. This information provided by awardees will be used to develop site-specific risk mitigation strategies. DOE will task a team of experts to review these results as a part of a go/no-go decision point. If judged satisfactory, awardees will be given the go-ahead to conduct field work with adequate permits from local authorities. Otherwise, awardees will be asked to gather more data and conduct more analysis.

During FY 2012, GTP will address priority R&D needs and will continue to demonstrate and validate flow rate or injection rate improvements at seven EGS field sites. These sites, which will be within or beyond reservoir stimulation phases, will demonstrate reservoir enhancements (through hydraulic, chemical, thermal, or other stimulation methods) and heat recovery (from stimulated rock volume using water as a fluid). While EGS demonstration projects will continue to provide valuable reservoir characterization and stimulation data, the emphasis in FY 2012 will shift to EGS R&D projects focusing on technology areas that need attention and development, identified by examining Recovery Act project successes and knowledge base deficiencies.

CO_2 as Geofluid in EGS

GTP will also explore the use of super-critical carbon dioxide ($scCO_2$) as a geofluid to harvest heat and produce electricity. This will decrease water consumption for EGS and could double heat recovery-to-power conversion efficiency. These efforts crosscut all geothermal resources because CO_2 can be used in any system where a geofluid is circulated to extract heat area.

In FY 2012 GTP (in partnership with FE R&D) will advance understanding of the geochemical evolution of the reservoir, and flow and mixing of $scCO_2$ with host fluids. The program will also develop and modify monitoring tools and methods to track CO_2 in geothermal reservoirs.

SBIR/STTR	**0**	**1,630**

In FY 2010, $786,000 and $94,000 were transferred to the SBIR and STTR programs respectively. The FY and 2012 amounts shown are estimated requirements for the continuation of the SBIR and STTR program.

Total, Enhanced Geothermal Systems	**43,120**	**61,535**

Explanation of Funding Change

	FY 2012 vs. FY 2010 Current Approp ($000)
Enhanced Geothermal Systems	
This increase will fund the assessment of next generation geothermal energy systems that use waste carbon dioxide instead of scarce water to capture heat and make electricity and the acceleration of current EGS RD&D efforts.	+16,785
SBIR/STTR	
In FY 2010, $786,000 and $94,000 were transferred to the SBIR and STTR programs respectively. The FY 2012 amount shown is the estimated requirements for the continuation of the SBIR and STTR program.	+1,630
Total Funding Change, Enhanced Geothermal Systems	**+18,415**

Low Temperature and Coproduced Resources

Funding Schedule by Activity

(dollars in thousands)

	FY 2010 Current Approp[a]	FY 2012 Request
Low Temperature and Coproduced Resources	0	13,629
SBIR/STTR	0	371
Total, Low Temperature and Coproduced Resources	0	14,000

Benefits

Coproduction from oil and gas wells in 31 states is estimated to have a potential of 12 GWe, assuming a resource temperature of 140°C.[a] Oil and gas operations currently treat the vast majority of water produced (averaging ten barrels of water per barrel of oil)[b] as a waste stream and pay to dispose of that waste. Low temperature power conversion units could take this waste stream and use the thermal energy already contained within it to run turbines for generating electricity.

These efforts will leverage existing surface and subsurface infrastructure to generate renewable, cost-competitive electricity. This subprogram's initial modeled LCOE estimates are 11¢/kWh in 2009 and 8¢/kWh by 2016.[c] However, a more robust and credible baseline based upon real demonstration project data will be established in FY 2012. GTP estimates that low temperature, coproduced and geopressured resources could enable approximately 3 GWe online by 2020.

Detailed Justification

(dollars in thousands)

	FY 2010 Current Approp	FY 2012 Request
Low Temperature and Coproduced Resources	**0**	**13,629**

In FY 2012, GTP will research, develop and demonstrate innovative power generation technologies, advanced working fluids, hybrid cooling systems, and high-performance heat exchangers to reduce LCOE of low temperature and coproduced resources. In FY 2010, low temperature and coproduced resources demonstrations were included as supporting activities in the EGS subprogram.

In FY 2012, efforts will focus on leveraging the success and lessons learned from 17 projects awarded with Recovery Act and FY 2010 appropriation funds. GTP will identify and bridge research and development gaps by developing ground-breaking technologies. GTP will issue a funding opportunity announcement soliciting cost-shared projects in research, development and demonstration that will

[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.

[b] North American Petroleum Expo, 2009.

[c] This is an offline analysis that built upon 2009-2010 RMOTC data and projections by experts at the February 5, 2010 Roadmapping event.

(dollars in thousands)

	FY 2010 Current Approp	FY 2012 Request

advance the technologies and ultimately reduce the LCOE from 9-11[a] cents per kWh to 8-10 cents per kWh by 2016.

GTP, in partnership with DOE FE, has been operating a binary organic rankine cycle power unit since September 2008, generating electricity from fluids produced from an operating oil and gas field. The Rocky Mountain Oilfield Testing Center (RMOTC) project is located at the Teapot Dome oil field, also known as the Naval Petroleum Reserve No. 3. Since September 2009, the unit has averaged a net power output of 198 kW, while the percentage of time online for the unit has been 97 percent, almost eliminating downtime caused by field activities. The unit produces electricity 24 hours a day, seven days a week, and is the only project of its kind currently operating in the U.S. GTP will continue to collaborate with FE to develop and validate coproduced, geopressured, and low temperature geothermal technologies, such as through the demonstration project at RMOTC.

Coproduced fluids from productive or marginal oil or gas wells will likely become cost-competitive in the near-term, as these resources have the advantages of an additional revenue stream and existing surface and subsurface infrastructure. Geopressured resources will require some innovative technologies for higher temperatures and pressures, but will still have the economic advantage of a secondary revenue stream. Low temperature resources (with no secondary revenue stream or existing infrastructure) will have the most to gain from knowledge gained in O&M and improved power plant efficiency. R&D will also drive down plant and operating costs through improved efficiencies in binary working fluids, heat-exchangers, cooling systems, down-hole tools and other applications.

SBIR/STTR	**0**	**371**

The FY 2012 amount shown is estimated requirements for the continuation of the SBIR and STTR program.

Total, Low Temperature and Coproduced Resources	**0**	**14,000**

[a] Based on preliminary analysis of a single data point from the Rocky Mountain Oil and Gas Test Site coproduction demonstration project.

Explanation of Funding Changes

	FY 2012 vs. FY 2010 Current Approp ($000)
Low Temperature and Coproduced Resources	
This increase in funds reflects the creation of this new subprogram formerly part of EGS.	+13,629
SBIR/STTR	
Changes in the SBIR/STTR funding are a direct result of changes in the funding of program activities.	+371
Total Funding Change, Low Temperature and Coproduced Resources	**+14,000**

Permeable Sedimentary Resources

Funding Schedule by Activity

(dollars in thousands)

	FY 2010 Current Approp[a]	FY 2012 Request
Permeable Sedimentary Resources	0	5,841
SBIR/STTR	0	159
Total, Permeable Sedimentary Resources	0	6,000

Benefits

The development of permeable sedimentary rock reservoirs will accelerate and expand the utilization of geothermal energy sources in the near-to-mid term. In the Gulf Coast, northeast, and mountain regions sedimentary geothermal resources have the potential to contribute a significant amount of renewable energy. An estimated domestic resource base for conductive sedimentary systems is $1.00x10^{23}$ Joules.[a] Circulating geofluids in naturally permeable sedimentary reservoirs requires little to no reservoir stimulation through hydraulic fracturing because of natural porosity of the rock. Consequently, these systems will have reduced seismic risk.

Detailed Justification

(dollars in thousands)

	FY 2010 Current Approp	FY 2012 Request
Permeable Sedimentary Resources	**0**	**5,841**

In FY 2012, GTP will demonstrate technical feasibility of energy production from permeable sedimentary geothermal reservoirs.

To capture heat economically, circulating geofluid must access a high surface area and a large volume of rock. The investment in subsurface characterization in sedimentary formations by oil and gas developers can be leveraged to reduce up-front development risks, which are currently some of the greatest barriers and cost to geothermal development. Similarly, tools and technologies from the oil and gas industry can be immediately adopted for use. Water for use as a heat recovery fluid, or geofluid, may be readily available from the coproduced and discarded water of neighboring oil or gas reservoirs. Surface piping, well pads, access roads associated with neighboring oil and gas development and other in-place infrastructure may be directly applicable to geothermal development.

A recent analysis of geothermal power capacity in sedimentary formations shows that the LCOE from a non-convective sedimentary geothermal system could be at or below $0.10/kWh for systems at 150ºC and a flow capacity of at least 100,000 mD-ft (milliDarcy-feet).[b] The LCOE target of $0.10/kWh or below is a reasonable initial goal for GTP. GTP plans to achieve this goal through cost-shared projects with industry, universities and national laboratories, as well as by working with other government

[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.

[b] "Geothermal Power Capacity of Wells in Non-Convective Sedimentary Formations," Subir Sanyal and Steven Butler, Proceedings World Geothermal Congress 2010, Bali, Indonesia, 25-29 April 2010.

(dollars in thousands)

	FY 2010 Current Approp	FY 2012 Request

agencies to remove barriers to the development and market adoption of these geothermal systems.

This new subprogram will allow GTP to develop new component technologies and demonstrate them in the field. A field demonstration of a new innovative heat recovery system will include a rigorous analysis to provide techno-economic insight and determine the commercialization potential of the technology.

SBIR/STTR	**0**	**159**

The FY 2012 amount shown is estimated requirements for the continuation of the SBIR and STTR program.

Total, Permeable Sedimentary Resources	**0**	**6,000**

Explanation of Funding Changes

	FY 2012 vs. FY 2010 Current Approp ($000)
Permeable Sedimentary Resources	
This increase in funds will implement a new subprogram to research, develop, and demonstrate geothermal energy production in permeable sedimentary systems. The program will initiate contracts through cost-shared competitive solicitations to validate component technologies and/or demonstrate energy production through field-scale projects.	+5,841
SBIR/STTR	
Changes in the SBIR/STTR funding are a direct result of changes in the funding of program activities.	+159
Total Funding Change, Permeable Sedimentary Resources	**+6,000**

Innovative Exploration Technologies

Funding Schedule by Activity

(dollars in thousands)

	FY 2010 Current Approp[a]	FY 2012 Request
Innovative Exploration Technologies	0	14,602
SBIR/STTR	0	398
Total, Innovative Exploration Technologies	0	15,000

Benefits

The Innovative Exploration Technologies subprogram will accelerate the discovery and utilization of the estimated 30,000 MWe of undiscovered hydrothermal resources in the Western U.S. by supporting development of advanced exploration technologies. More effective exploration methods will help address a major barrier to geothermal energy production by lowering the high upfront risk and cost of project development. Locating hidden geothermal resources will support near term expansion of renewable energy because hydrothermal resources can be brought online relatively quickly using current technologies.

Advancing exploration technologies will benefit other geothermal program areas including low temperature and coproduced resources, EGS and permeable sedimentary resources. Subsurface characterization and imaging are critical for the efficient utilization of all types of geothermal resources. This effort will spur the growth of geothermal energy, an underutilized baseload resource, providing a secure, clean and domestic source of electricity and heat with associated environmental and economic benefits.

Detailed Justification

(dollars in thousands)

	FY 2010 Current Approp	FY 2012 Request
Innovative Exploration Technologies	**0**	**14,602**

In FY 2012 the program will conduct RD&D of exploration tools (e.g., remote sensing, seismic processing, and structural, geochemical and thermal signature tools) for resource confirmation in undiscovered geothermal fields. These tools will reduce high upfront exploration risks and project costs, encouraging the discovery of up to 30,000 MWe of conventional hydrothermal. GTP will advance game changing exploration technologies, both down hole and non invasive, that have the potential to significantly lower upfront risk, e.g. airborne gravity. GTP seeks to improve distribution and resolution of data to better characterize the subsurface resource on a regional basis.

GTP will issue a new funding opportunity announcement to academia, industry and national laboratories. The opportunity will seek applications for RD&D designed to improve technologies shown to be promising in Recovery Act projects and to address technology gaps and opportunities for exploration technology advancement identified by technology road mapping. GTP will also continue to

	(dollars in thousands) FY 2010 Current Approp	FY 2012 Request
adapt technologies used in oil and gas exploration focusing on reducing their cost for geothermal applications.		
SBIR/STTR	**0**	**398**
The FY 2012 amount shown is the estimated requirement for the continuation of the SBIR and STTR program.		
Total, Innovative Exploration Technologies	**0**	**15,000**

Explanation of Funding Changes

	FY 2012 vs. FY 2010 Current Approp ($000)
Innovative Exploration Technologies	
This increase reflects the establishment of Innovative Exploration Technologies as a new subprogram to reduce high upfront exploration risks and costs through R&D of geophysical, geochemical and geological tools.	+14,602
SBIR/STTR	
Changes in the SBIR/STTR funding are a direct result of changes in the funding of program activities.	+398
Total Funding Change, Innovative Exploration Technologies	**+15,000**

Systems Analysis

Funding Schedule by Activity

(dollars in thousands)

	FY 2010 Current Approp[a]	FY 2012 Request
Systems Analysis	0	4,867
SBIR/STTR	0	133
Total, Systems Analysis	0	5,000

Benefits

Systems analysis provides analytical tools and assessments such as, a detailed risk analysis, and an updated Multi-Year Research, Development and Demonstration Plan to ensure that GTP meets its annual performance targets.

Geothermal resource assessments, including information contained in the National Geothermal Data System, will help industry to determine the available, accessible, and cost-effective geothermal resources in the U.S., ultimately reducing costs and risks. Resource assessments and supply curves are valuable to the program for techno-economic modeling and program planning.

GETEM and other techno-economic systems analysis tools are used to evaluate and compare geothermal project cases. Resulting information can reveal opportunities for technology advancement and identify the major barriers, which informs program planning and performance evaluation.

GTP's international partnerships are intended to accelerate the development of geothermal technologies. Through cooperative projects and information sharing, the participating countries limit blind alleys and unnecessary duplication.

Detailed Justification

(dollars in thousands)

	FY 2010 Current Approp.	FY 2012 Request
Systems Analysis	**0**	**4,867**

Systems Analysis will continue analysis activities previously conducted under the EGS subprogram in FY 2010. In FY 2012, this new subprogram will conduct systems analysis, implement data gathering, and assess the geothermal resource base for all geothermal resources. Development of analytical tools aims to reduce the costs and risks associated with geothermal development, which inhibit the growth of geothermal in the U.S. This subprogram also provides analytical and technical support to inform the direction of GTP and project prioritization, and evaluates GTP's performance and ability to achieve its goals.

The focus in FY 2012 is to: complete the Geothermal Vision Study; incorporate low temperature, coproduced and geopressured supply curve data into departmental and other models; determine

(dollars in thousands)

	FY 2010 Current Approp.	FY 2012 Request

geothermal jobs and economic development impacts; identify geothermal transmission needs; and assess the importance of policies and regulations such as Feed-In Tariffs. In partnership with the U.S. Geological Survey, GTP will complete the sedimentary basin resource assessment.

The program participates in two major international efforts: the International Partnership for Geothermal Technology (IPGT) and the International Energy Agency's Geothermal Implementing Agreement (IEA-GIA). The IPGT's goals closely match those of the GTP, and all IPGT collaborations will lead to material gains for the program and the U.S. geothermal industry. A collaborative project between Iceland and the U.S. on advanced 3D geophysical imaging for resource characterization to explore valuable tools for reservoir exploration and characterization began in FY 2010.

SBIR/STTR	**0**	**133**

The FY 2012 amount shown is the estimated requirement for the continuation of the SBIR and STTR program.

Total, Systems Analysis	**0**	**5,000**

Explanation of Funding Changes

	FY 2012 vs. FY 2010 Current Approp ($000)
Systems Analysis	
This increase reflects the establishment of Systems Analysis as a new subprogram to provide analytical and technical support for GTP's RD&D portfolio.	+4,867
SBIR/STTR	+133
Changes in the SBIR/STTR funding are a direct result of changes in the funding of program activities.	
Total Funding Change, Systems Analysis	**+5,000**

Geothermal Technologies Program
FY 2010 to FY 2012 Budget Structure Crosswalk
(dollars in thousands)

FY 2010		FY 2012	
Geothermal Technologies Program (Non-Comparable, or as Appropriated Structure)	**(43,120)**	**Geothermal Technologies Program** (Comparable Structure to the FY 2012 Request)	**(101,535)**
Enhanced Geothermal Systems	**(43,120)**	**Enhanced Geothermal Systems**	**(61,535)**
		Low Temperature and Coproduced Resources	**(14,000)**
		Permeable Sedimentary Resources	**(6,000)**
		Innovative Exploration Technologies	**(15,000)**
		Systems Analysis	**(5,000)**

Water Power

Funding Profile by Subprogram

(dollars in thousands)

	FY 2010[a] Current Approp	FY 2012 Request
Water Power	48,669	38,500
Total, Water Power	48,669	38,500

Public Law Authorizations:
P.L. 109-58, "Energy Policy Act of 2005"
P.L. 110-140, "Energy Independence and Security Act of 2007"

Mission

The mission of the Water Power Program is to research, test, and develop innovative technologies capable of generating renewable, environmentally responsible, and cost-effective electricity from water. These include MHK technologies, a suite of renewable technologies that harness the energy from untapped wave, tidal, current and ocean thermal resources, as well as technologies and processes to improve the efficiency, flexibility, and environmental performance of conventional hydropower (CH) generation.

Benefits

R&D of innovative water power technologies and growth of a viable water power industry directly contribute to strengthening U.S. scientific discovery, promoting clean and secure energy, increasing economic prosperity, and demonstrating U.S. leadership in addressing climate change. MHK technologies represent a substantial opportunity for the U.S. to engage directly in an emerging area of energy while developing an entirely new suite of renewable technologies to reduce emissions, and help states meet energy and climate objectives and requirements such as Renewable Portfolio Standard (RPS) targets.

CH generates approximately 67 percent[b] of the Nation's renewable energy supply. Improving existing CH systems represents one of the fastest and most cost-effective options for increasing clean and renewable energy generation in the U.S, and represents significant renewable generation potential in a wide variety of geographic regions, including the West, the Southeast and the Ohio River Valley. Investment in CH demonstrates a commitment to quickly expanding carbon-free generation and to ensuring that this large renewable energy resource is an effective and environmentally responsible instrument that reduces greenhouse gas (GHG) emissions.

FY 2012 funding supports hydroelectric feasibility studies to assess the potential for incremental or new hydropower generation through equipment additions and upgrades to increase generation, and powering

[a] SBIR/STTR funding transferred in FY 2010 was $1,188,000 for SBIR program, and $143,000 for the STTR program.

[b] "Electricity Net Generation from Renewable Energy by Energy Use Sector and Energy Source." Renewable Energy Consumption and Electricity Preliminary Statistics, July 2009: http://www.eia.doe.gov/cneaf/alternate/page/renew_energy_consump/table3.html.

existing non-powered dams. These feasibility studies will identify projects that can most quickly and cost-effectively increase water electricity generation. The program is also investing in hydropower grid services projects undertaken in partnership with industry that will improve methods for quantifying and valuing the ancillary benefits of conventional and pumped storage hydropower assets to meet the needs of the Nation's changing electricity grid. These projects compliment the program's Hydropower Modernization Initiative funded by the Recovery Act.

The program's priorities are aligned with the development of a viable and competitive water power industry. The program invests heavily in cost-shared partnerships with wave, tidal, ocean current, river in-stream and ocean thermal technology developers that will create technology and manufacturing sectors to further spur economic development in maritime and coastal communities. The program's university research fellowship program supports the development of a new generation of engineers and scientists and promotes the resurgence of academic interest in the hydropower industry. DOE funded hydropower projects also increase demand for highly skilled technical workers with specific capabilities in hydropower technology design, manufacture and operations.

The program's priorities and activities are aligned to reduce GHG emissions by developing emission-free MHK technologies, supporting new and incremental conventional and pumped storage hydropower generation, and maximizing ancillary benefits to support grid flexibility, stability and the integration of other generation sources.

The program's investments in the assessment of water power resources provide a significant opportunity to increase clean and secure domestic energy generation, reduce foreign fuel dependency emit little or no carbon or other air polluting emissions, and provide reliable energy sources with possible base-load contributions. Wave and tidal resources are highly predictable and often close to load centers. Investment in hydropower efficiency and infrastructure will increase generation and flexibility of domestic assets and allow for dramatically higher levels of renewable energy to be integrated into the U.S. electric grid.

High Priority Performance Goal (HPPG)

The Water Power Program contributes to achieving the Renewable Energy HPPG. The performance measures for the program are directed to contributions toward the goal of doubling renewable energy generation. Additional information on the intermediate performance critical to achievement are provided at www.performance.gov.

Annual Performance Results and Targets

The Department is in the process of updating its strategic plan, and has been actively engaging stakeholders including Congress. The draft strategic plan is being released for public comment concurrent with this budget submission, with the expectation of official publication this spring. The draft plan and FY 2012 budget are consistent and aligned. Updated measures will be released at a later date and available at the following link http://www.mbe.doe.gov/budget/12budget/index.htm.

Water Power

Funding Schedule by Activity

(dollars of thousands)

	FY 2010[a] Current Approp	FY 2012 Request
Water Power	48,669	37,366
SBIR/STTR	0	1,134
Total, Water Power	48,669	38,500

Benefits

Preliminary resource assessments indicate that MHK technologies have the potential to contribute significantly to the country's energy portfolio. Many of these resources also offer the potential of highly predictable energy generation serving high value base loads within close proximity of coastal load centers.

Through program activities, the MHK industry in the U.S. will be able to demonstrate the functionality of wave and hydrokinetic devices through comprehensive testing at progressive technology stages. Establishing baseline cost and performance is the key initial step in identifying cost reduction pathways leading to the program's goal of reducing LCOE and accelerating commercial deployment.

The program's work in FY 2012 will support at least 25 CH feasibility studies to determine the incremental generation potential of existing hydropower facilities, and detailed engineering studies to identify specific steps and technologies necessary to realize the potential. Through this process, the program will identify opportunities for up to 100 MW of hydropower upgrades by 2015. In addition, program-supported R&D will help integrate the value of ancillary services into energy markets and deployment models to accurately account for the full benefits of hydropower generation.

This work represents critical initial steps in advancing the program's medium-term goals of achieving 500 MW of new hydropower through equipment additions and upgrades and operational improvements at existing non-powered dam facilities.

[a] SBIR/STTR funding transferred in FY 2010 was $1,188,000 for SBIR program, and $143,000 for the STTR program.

Detailed Justification

(dollars in thousands)

	FY 2010 Current Approp	FY 2012 Request
Water Power	**48,669**	**37,366**

The Water Power Program's activities support both MHK and CH advanced technology systems development and testing, design and evaluation, economic analysis and market development, as well as environmental and siting issues.

Marine and Hydrokinetic (MHK) Technologies (Approximate funding: $17.8M)

To support the development and deployment of MHK technologies, Water's R&D activities are aligned to: demonstrate device functionality; increase device and array efficiency; improve device availability and reliability; and reduce development, deployment, operations and maintenance costs. A portion of R&D spending is allocated to studying potential environmental impacts, including identifying strategies to minimize time, costs and potential environmental effects that may hinder siting and deployment of MHK systems. In addition, the program is working to assess and quantify the economic benefits of these technologies by integrating cost and performance data into key deployment and economic models.

In FY 2012 the program will develop, deploy and test devices to establish baseline cost of energy and performance by FY 2013 in order to reduce cost of energy for these technologies. Specifically in FY 2012, the program will continue projects awarded via competitive industry solicitations to advance the technical and operational readiness of innovative, early-stage MHK systems and components across technology readiness levels (TRLs). These projects will prove device functionality, evaluate technical and economic viability, and generate cost, performance and reliability data. As devices are tested and data is generated, DOE will continue to compile, analyze, and disseminate information to accurately characterize and evaluate the performance of MHK technologies. The program aims to test at least10 devices across a variety of TRLs by 2013.

The program recognizes the need for R&D that can improve performance and reduce costs across a wide range of technology types and device designs, spurring the development and advancement of the industry. In FY 2012, the program will finalize a three-year collaborative effort with National Laboratories, universities, and Federal partners to conduct R&D to; develop design codes, instrumentation and testing protocols; and develop device and reliability models and tools necessary for the development of MHK systems. The program's goal is to develop a sufficient number of system design tools and models that are adopted by at least a quarter of industry and/or universities within the applicable sector.

To facilitate open-water, grid-connected device testing and deployment, the program is investing in environmental and siting projects to quantify the potential impacts of developing and deploying these devices and will disseminate this data to regulators and developers.

(dollars in thousands)

FY 2010 Current Approp	FY 2012 Request

In FY 2012, the program will continue activities with National Laboratories, universities and industry groups to quantify changes in key environmental processes, measure and link key biological responses to these environmental changes, and extrapolate information from these studies to assess cumulative impacts of these stressors. These activities are also necessary for the development of fully representative baseline cost of energy, since the cost of conducting environmental studies, permitting and siting devices is currently a significant component of total project cost. The program will synthesize this data into its cost of energy models.

The program will also conduct economic analysis and other programmatic market development activities, including integrating cost and performance data into key models to quantify the market penetration and economic benefits of these technologies.

Conventional Hydropower (CH) (Approximate funding: $19.6M)

Conventional hydropower in the U.S. generated 272 TWh[a] in 2009, the most of any renewable energy technology and close to 7 percent f the Nation's total electricity supply. Initial, preliminary resource assessments indicate significantly greater resource potential can be achieved through equipment additions and upgrades, development of new advanced technologies, and optimizing operations at existing and new facilities. Demands are also increasingly placed on conventional hydropower to provide ancillary services to the grid, including load management, spinning reserves, and frequency regulation. These benefits are of particular importance as variable renewable technologies grow in the U.S.

In FY 2012, the program will continue to identify promising existing facilities and non-powered dams for the development of cost effective additional generation resources in order to demonstrate industry-wide opportunities. The program is investing in the subsequent phases of the Hydropower Advancement Project to design and conduct upgrade feasibility studies at hydroelectric sites and non-powered dams to identify sites with the highest potential for low-cost efficiency, equipment additions and upgrades and operational improvements. In partnership with industry, engineering studies will be performed at promising sites to develop innovative approaches and utilize advanced technologies to maximize generation at chosen sites.

FY 2012 investments are targeted at stimulating private sector deployment of efficiency upgrades to increase generation and allocating R&D to reduce key cost drivers to small hydropower, environmental mitigation and pumped storage technologies. Additionally, the program is supporting the development of operational tools to maximize generation at existing and new facilities, quantifying the full value of ancillary services, and facilitating mechanisms for the market to monetize these services.

Operational improvements can yield up to 10 percent to 15 percent in increased incremental generation at existing and new facilities. In FY 2012, the program will work with National Laboratories, industry and Federal partners to develop and demonstrate an integrated set of tools, models and approaches for optimizing the operational efficiency and environmental performance of hydropower plants.

[a] Report #:DOE/EIA-0383(2009)

(dollars in thousands)

	FY 2010 Current Approp	FY 2012 Request

A considerable amount of incremental hydropower generation can be developed at competitive cost through upgrades at existing facilities[a]. The successful development of these resources is dependent on new advanced technologies, including new small hydropower and environmental mitigation technologies and methods, which will reduce the cost and environmental impacts associated with vast untapped small hydropower resources.

Specifically, investments will focus on projects that identify key cost drivers, demonstrate innovative systems designs, and reduce LCOE of hydropower generation including non-powered dams. The program's goal is to reduce the high range of small hydropower LCOE along cost reduction pathways and spur the development, demonstration and deployment of technologies with improved performance over those currently in use in the U.S.

Environmental mitigation technologies that improve environmental performance and reduce operational constraints of hydro generation are also under development. Specifically, projects that identify key cost drivers for mitigation hardware such as fish-friendly and aerating turbines, fish ladders and re-regulating weirs, and develop and demonstrate innovative system designs and approaches to reducing environmental impacts of large and small hydropower generation will be supported. Additionally, these technologies will reduce the time associated with key stages in the pre-application portion of the hydropower licensing process, and increase the number of non-powered dams and low-head sites available for sustainable hydropower development. In parallel with technology development and deployment activities, the program will support a variety of analytical activities including market analysis to integrate cost and performance data into key models to improve the representation of hydropower in deployment models, as well as quantify the ancillary value of hydropower to the grid.

SBIR/STTR	**0**	**1,134**

In FY 2010, $1,188,000 and $143,000 were transferred to the SBIR and STTR programs respectively. The FY 2012 amount shown is the estimated requirements for the continuation of the SBIR and STTR program.

Total, Water Power	**48,669**	**38,500**

[a] Estimation of Economic Parameters of U.S. Hydropower Resources. June 2003. http://hydropower.inel.gov/resourceassessment/pdfs/project_report-final_with_disclaimer-3jul03.pdf

Explanation of Funding Changes

	FY 2012 vs. FY 2010 Current Approp ($000)
Water Power	
The decrease in FY 2012 funding levels is the result of two factors. First, the funding for specific solicitations expires by FY 2012 and no follow on funding is requested. Second, R&D allotments were shifted from earlier-stage MHK device concepts to the support and testing of more mature and near-term deployable MHK technologies. This realignment reduces the funding level for emerging MHK technology development by approximately $2 million. Remaining funding will continue to support device testing for MHK technologies at a slightly reduced level to establish baseline cost of energy and performance and identify technology improvement opportunities.	**-11,303**
SBIR/STTR	
In FY 2010, $1,188,000 and $143,000 were transferred to the SBIR and STTR programs respectively. The FY 2012 amount shown is the estimated requirements for the continuation of the SBIR and STTR program.	**+1,134**
Total Funding Change, Water Power	**-10,169**

Vehicle Technologies

Funding Profile by Subprogram

(dollars in thousands)

	FY 2010 Current Approp[a]	FY 2012 Request
Vehicle Technologies		
Batteries and Electric Drive Technology	98,566	188,000
Vehicle and Systems Simulation & Testing	43,732	58,000
Advanced Combustion Engine R&D	55,987	49,000
Materials Technology	49,303	38,000
Fuels Technology	23,421	18,503
Outreach, Deployment & Analysis	33,214	236,500
Total, Vehicle Technologies	304,223	588,003

Public Law Authorizations:
P.L. 95-91, "U.S. Department of Energy Organization Act" (1977)
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"

Mission

The mission of the Vehicle Technologies Program (VTP) is to develop and promote energy-efficient and environmentally friendly transportation technologies that will enable America to use significantly less petroleum and reduce greenhouse gas (GHG) emissions while meeting or exceeding drivers' performance expectations and environmental requirements.

Benefits

The VTP mission and activities are planned and executed in a manner congruent with explicit and implicit national priorities, strategies, and goals. These activities will generate benefits in both the near- and long-term from technologies that address high priority issues of energy security, climate change, and economic impact. VTP's activities primarily focus on highway vehicles (passenger and commercial), which account for 55 percent of total U.S. oil use, more than all U.S. domestic oil production.[b] More energy-efficient, fuel-diverse, and cost-competitive vehicles will enable individuals and businesses to accomplish their daily tasks while reducing consumption of petroleum, lowering greenhouse gas (GHG) emissions, and decreasing energy expenditures. The President has announced and is proposing in the 2012 Budget a major new initiative to make the U.S. the first country to put 1 million electric vehicles on the road by 2015[c]. This initiative supports advanced technology vehicle manufacturing and adoption through new consumer rebates, investments in battery and electric vehicle R&D – including a new Energy Innovation Hub within the Office of Science -, and competitive programs to encourage

[a] SBIR/STTR funding transferred in FY 2010 was $6,377,000 for the SBIR program and $765,000 for the STTR program.
[b] Tables 1.13, 1.14, and figure 1.8 in the 29th edition of the Transportation Energy Data Book, 2010. See http://cta.ornl.gov/data/index/shtml.
[c] Remarks by the President in the State of Union Address, President Barrack Obama, United States Capital, January 25, 2011. http://www.whitehouse.gov/the-press-office/2011/01/25/remarks-president-state-union-address

communities that invest in electric vehicle infrastructure. Within EERE this initiative includes funding for battery and electric vehicle R&D and a new $200 million competitive program to help communities become early adopters of electric vehicles through regulatory streamlining, infrastructure investments, vehicle fleet conversions, and other investments. Due to the high use of oil by highway transportation, President Obama has stated, "Increasing fuel efficiency in our cars and trucks is one of the most important steps that we can take to break our cycle of dependence on foreign oil. It will also help spark the innovation needed to ensure that our auto industry keeps pace with competitors around the world."[a]

The FY 2012 activities focus on meeting the President's 2015 electrification goal, and addressing key programmatic goals through 2020 and beyond. VTP's combined activities are intended to increase electrification and fuel efficiency thereby lowering GHG emissions, and, specifically, to meet the following goals:

- Invest in developing and deploying electric vehicle technologies enabling 1 million electric drive vehicles on the road by 2015.
- By 2020 save 1.8 million barrels per day of petroleum for highway use.
- Develop and deploy advanced battery manufacturing capacity to support 500,000 plug-in hybrid electric vehicles (PHEVs) a year by 2015.
- Develop technologies enabling the improvement of the fuel economy of new vehicles to achieve an average corporate average fuel economy (CAFE) standard of 37.8 miles per gallon (mpg) for cars and 28.8 mpg for light trucks by 2016.

These goals are supported by DOE's R&D investments in technology for vehicle energy efficiency and petroleum displacement, as well as by the American Recovery and Reinvestment Act (Recovery Act) efforts to establish manufacturing for advanced vehicles and batteries, demonstration of advanced vehicles, and improved fuels infrastructure and utilization.

The FY 2012 request supports these new efforts to encourage advanced technology vehicle manufacturing and adoption in the U.S., investments in R&D, and a program to help communities across the country become early adopters of electric vehicles. The vehicle technologies developed and manufactured with the support of annual appropriations and Recovery Act funding will help to improve the U.S. vehicle fleet fuel economy to meet strict new CAFE requirements. In addition, the Program targets are designed to take vehicle improvements well beyond those needed to meet CAFE. The chance of achieving these important goals has been greatly enhanced by the Recovery Act investments of up to $2.8 billion in advanced efficiency technologies for highway transportation. Recovery Act projects started in 2009 are expected to accelerate the introduction of PHEVs and other advanced efficiency technologies in cars and trucks, and to lower their cost by establishing manufacturing capacity for batteries and electric drives. Investments are being made in higher efficiency combustion engines, vehicle light-weighting, ethanol and biodiesel deployment, battery and electric drive manufacturing, and vehicle electrification deployment and infrastructure development because of the associated contributions to reduced transportation energy use. These efficiency gains and fuel alternatives also provide other benefits, such as improving air quality, reducing CO_2 emissions, and enhancing energy security.

To accelerate the introduction and market acceptance of electric vehicles, the Program is greatly expanding its emphasis on the electrification of the vehicle (i.e., new generations of hybrid electric vehicles, plug-in hybrids, electric vehicles) through research and development of batteries and power

[a] Remarks on Jobs, Energy Independence, and Climate Change, President Barack Obama, Jan. 26, 2009 http://www.whitehouse.gov/blog_post/Fromperiltoprogress/

electronics, systems R&D on the electric drive to improve performance and cost, development of EV supporting infrastructure (e.g., advanced chargers, streamlined codes and standards), and efforts to help communities across the country become early adopters of electric vehicles. In addition, the Program is focused on developing highly efficient trucks, the testing of non-petroleum fuels so that they can move seamlessly into the marketplace, and other work that will facilitate rapid introduction of these technologies. In FY 2012, efforts focus on the area of Energy Systems Simulation for Internal Combustion Engines for the development of advanced chemical kinetics, computational fluid dynamics and large eddy simulation models, and experimental verification to validate these models. Increased focus will also be placed on identifying common barriers and activities for future efforts in power electronics (PE), which is an essential component of almost every aspect of electric vehicles. Entirely new areas of activity will begin, including non- and off-highway activities to incorporate rail and off-highway transportation modes and associated opportunities to reduce petroleum use and GHG emissions, and a Vehicle Miles Traveled (VMT) Reduction and Legacy Fleet Improvement activity to support the more efficient use of existing light-duty vehicle stock. By modifying its portfolio to include improving the efficiency of off-road vehicles, addressing rail efficiency, and decreasing the energy used in vehicles already on the road, VTP will expand the number of transportation pathways through which DOE can help to reduce petroleum consumption. These activities generate three major types of benefits:

By using advanced efficiency technologies and non-petroleum fuels, oil use can be substantially reduced, making the Nation less vulnerable to oil supply disruptions or price spikes. PHEVs will allow consumers to displace petroleum with electricity, based on price and convenience.

VTP contributes to reducing GHGs (most importantly CO_2) by providing technology which will make the Nation's highway vehicles more efficient and make it possible to use low carbon fuels. Lightweight materials, advanced combustion, and hybrid drive-trains all reduce CO_2 emissions. For example, a hybrid vehicle that combines advanced, more efficient combustion with lightweight materials and a hybrid drive-train could easily double the fuel efficiency of a conventional vehicle – resulting in half the GHG emissions.

New technologies developed and manufactured within the U.S., and fuels produced domestically, will create jobs and economic growth. Achieving the VTP goals for reducing the cost of advanced vehicle technologies will save the consumer money that can stimulate other areas of the economy and accelerate the adoption of efficient vehicles.

Annual Performance Results and Targets

The Department is in the process of updating its strategic plan, and has been actively engaging stakeholders including Congress. The draft strategic plan is being released for public comment concurrent with this budget submission, with the expectation of official publication this spring. The draft plan and FY 2012 budget are consistent and aligned. Updated measures will be released at a later date and available at the following link http://www.mbe.doe.gov/budget/12budget/index.htm.

Batteries and Electric Drive Technology

Funding Schedule by Activity

(dollars in thousands)

	FY 2010 Current Approp[a]	FY 2012 Request
Batteries and Electric Drive Technology		
Battery/Energy Storage R&D	76,271	136,080
Advanced Power Electronics and Electric Motors R&D	22,295	46,656
SBIR/STTR	0	5,264
Total, Batteries and Electric Drive Technology	98,566	188,000

Benefits

The Battery and Electric Drive Technology (BEDT) subprogram addresses the utilization of electric energy storage, electric drives, and energy recovery in new, more efficient vehicle designs. The subprogram funds R&D on the core technologies necessary for hybrid and electric vehicles to achieve significant improvements in fuel economy without sacrificing safety, the environment, performance, or affordability. The following measures of the BEDT subprogram can contribute to meeting strategic objectives of developing, demonstrating, and deploying clean, efficient energy technologies:

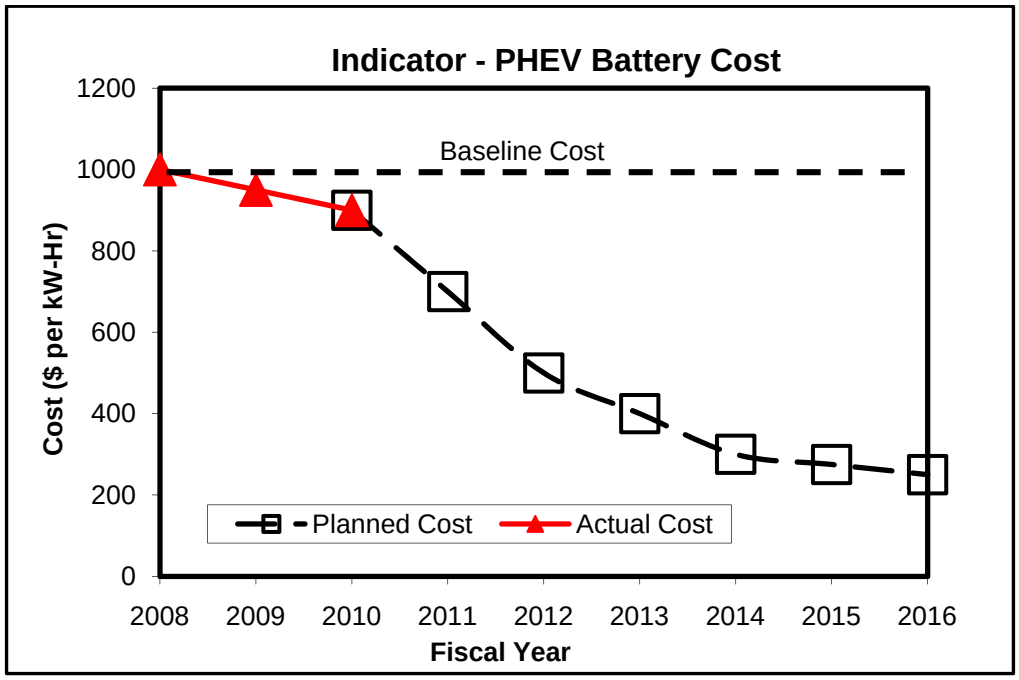
- Reduce the production cost of a high energy battery from $1,000/kWh in 2008 to $300/kWh by 2014, enabling cost competitive market entry of PHEVs.
- Reduce the cost of an electric traction drive system that can deliver 55kW of peak power for 18 seconds and 30kW of continuous power from $22/kW in 2008 to $12/kW in 2015, enabling cost competitive market entry of PHEVs and HEVs.

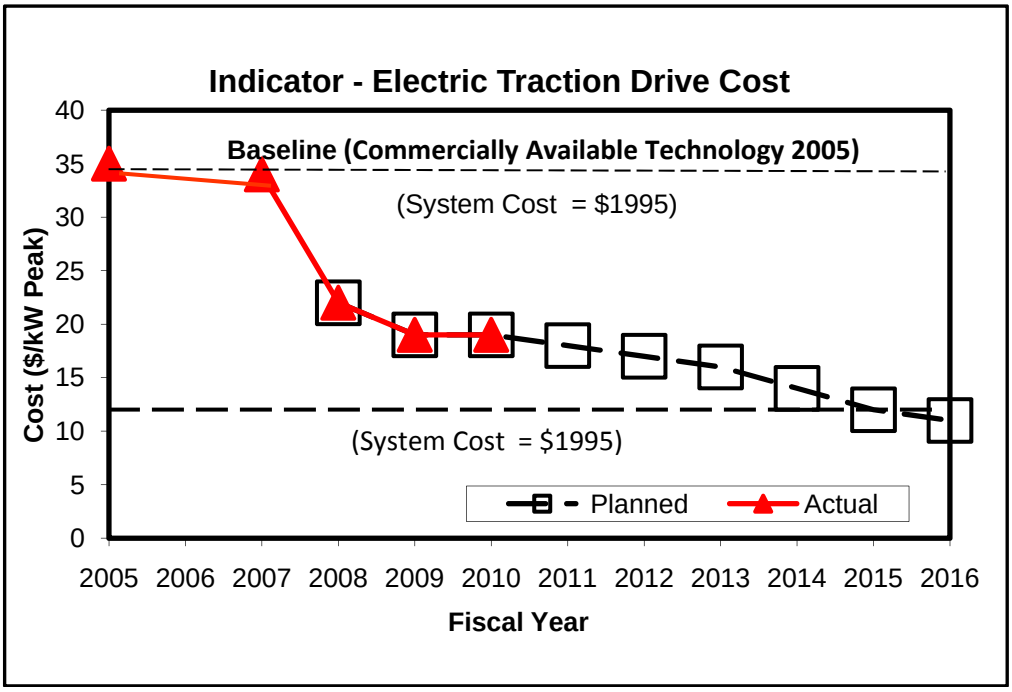
In FY 2012, the BEDT subprogram will continue to accelerate the development of low-cost, high-energy batteries and corresponding improvements to the electric drive systems (motors, power electronics, and electric controls) needed for cost-effective PHEVs. PHEVs offer the potential to provide significant additional fuel savings, particularly for commuter and local driving, for either combustion or fuel cell powered hybrid passenger vehicles.

The effects of the Recovery Act funding for the manufacturing of advanced batteries and electric drive components are not considered in the analyses that evaluate the impact of R&D on battery or electric drive component cost which already assume high volume manufacturing. Recovery Act funds are expected to hasten the introduction of PHEV and other electric drive vehicles.

Progress for energy storage and electric propulsion system R&D is indicated by cost per kilowatt-hour battery system and combined inverter/motor cost estimated for a production level of 100,000 systems per year. Actual and projected progress for PHEV battery cost and integrated inverter/ motor cost indicators are shown graphically below:

[a] SBIR/STTR funding transferred in FY 2010 was $2,535,125 for the SBIR program and $304,215 for the STTR program.





Note: 2005 and 2007 "Actual" data are cost for commercially available systems. In 2008 and subsequent years, "Actual" represents program results (modeled). The FY 2007 cost target is not shown because it was for a component of the electric drive, an electric motor, and cannot be put on a comparable basis with the systems cost targets beginning in FY 2008.

Detailed Justification

(dollars in thousands)

	FY 2010 Current Approp	FY 2012 Request
Battery/Energy Storage R&D	**76,271**	**136,080**

The Battery/Energy Storage R&D activity supports the development of advanced high-energy batteries for PHEVs and EVs, high-power batteries for HEVs, and R&D into advanced materials to enable the development of next generation batteries and systems. Low-cost, abuse-tolerant batteries with higher energy, higher power, and lower weight are needed for the development of the next-generation of HEVs, PHEVs, and pure EVs.

Battery/Energy Storage R&D addresses the first building block of a hybrid-electric vehicle, electricity storage. The needs of "regular" hybrid vehicles and PHEVs are similar, but not identical; PHEVs need to be able to store considerably more total energy in their batteries. Developing batteries that are rugged, long-lasting, affordable, lighter, hold a substantial charge, and work in all climates and seasons is still a major R&D challenge.

The primary R&D focus will continue to be on lithium-based batteries. Lithium-based batteries offer the potential to meet all three applications. Other innovative technologies like ultracapacitors and advanced lead acid batteries offer the promise of significantly lower cost with possibly similar performance of lithium ion batteries in high power applications. Thus, those technologies are also being researched, tested, and developed.

VTP will continue work in the area of extremely high energy battery chemistries for use in EVs and PHEVs, and high power systems for HEVs. Higher energy (for EVs and PHEVs) and higher power (for HEVs) couples promise to significantly lower system cost as fewer cells should be needed in the entire system. One focus of this work will be on new materials and couples that offer a minimum of two times improvement in either energy or power over today's technologies. Some specific technologies which are of interest include, but are not limited to: the design and development of robust cells that contain high voltage (5V) and/or high capacity (>300mAh/g) cathodes; alloy or Lithium metal anodes; Lithium/air and Lithium/S systems; and high voltage and solid polymer composite electrolytes. In addition, VTP will continue work on cells and/or systems that offer significant cost reductions. The focus of this work will be on robust cells or systems that contain new materials and couples that offer a minimum of two times reduction in cost over existing technologies.

(dollars in thousands)

FY 2010 Current Approp	FY 2012 Request

Research will be conducted to expedite the development of more efficient designs and design processes (e.g., current collectors, separators, packaging) for high-volume production of large format Li-ion batteries. Currently, the "non active" components of a battery (~70 percent by weight of the battery) increase the volume, weight, and cost of the finished product. Approaches to reduce the inactive components in the cell and battery will be pursued. Developing much thicker electrodes and solid electrolytes would reduce the amount of inactive components required. In addition, today's thermal management technologies add weight, cost, and complexity to the system which could be reduced through the use of novel thermal management technology. Research will be conducted to both manage batteries' temperature and reduce the system cost. Approaches that significantly extend the operating temperature range of batteries will also be investigated.

In addition to new high-capacity electrode materials and high-voltage electrolytes, research efforts will be devoted to: the development of additives to prevent overcharging; additives that form a good interface between the electrode and the electrolyte for improved life and fast charge capability; and electrolyte formulations and additives for low-temperature operation.

Full system development will continue in cooperation with industry both through the United States Advanced Battery Consortium (USABC) and direct contracts with DOE. All awards are selected under a competitive process and are cost-shared by developers. The FY 2012 activity will emphasize accelerating the development of batteries for PHEVs and EVs. This activity will also continue to validate requirements and refine standardized testing procedures to evaluate performance and life of PHEV and EV batteries, as well as identify areas requiring additional R&D. As the battery becomes larger, abuse-tolerance becomes more of a concern, requiring higher stability between the electrodes and the electrolyte, and enhanced thermal management at the system level. The focus of the high-power USABC subcontracts will be cost reduction, as high-power Li-ion systems appear able to meet the critical performance requirements.

VTP will continue to support the development of a Li-ion materials supply base in order to strengthen the U.S. based manufacturing of Li-ion batteries and to ensure success of battery manufacturing facility awards made under the Recovery Act. Studies of recycling and reuse of lithium batteries will continue. In addition, these funds may be used to support peer reviews; data collection and dissemination; and technical, market, economic, and other analyses.

Ultracapacitors (Ucaps), hybrid ultracapacitors (in which one electrode may be an activated carbon and the other an electrode typical of a battery, such as in a Li-ion battery) and advanced lead acid batteries offer the possibility of significantly lower system cost with moderate reductions in certain performance characteristics. These and other non-traditional technologies will be tested in the laboratory, evaluated in vehicle simulations, and researched using advanced diagnostics to understand opportunities to enable more fuel efficient automobiles. Ucaps have relatively low specific energy (less than three watt-hours per kilogram), which limits their capacity to serve as the main energy-storage devices in hybrid vehicles. However, they offer the possibility of improved vehicle performance in a battery-plus-ultra-capacitor hybrid configuration and a 10 to 20 percent fuel economy improvement in city driving if used in a start/stop application. The battery/Ucap

configuration will be evaluated and optimized for lower cost and improved durability in a PHEV platform when the Ucap is sized for power assist and the battery is sized for energy. Ucap R&D focuses on the use of low-cost, high-capacity carbon electrodes and improved electrolytes, which will allow the capacitors to operate at a higher voltage to improve specific energy.

In coordination with BES and OE, the VTP Battery/Energy Storage activity will participate in integrated activities to support development of nanoscale materials and architectures for electrical energy storage. Nanomaterials can exhibit superior performance over conventional battery materials in terms of high pulse discharge and recharge power, and improved performance at low temperatures. However, the behavior of these materials is not well understood and is thought to be more than just a length-scale effect. New diagnostic tools and techniques will be required to investigate these materials.

VTP will begin preliminary work on specific recycling research topics. Possible topics include improving the efficiency and cost effectiveness of current recycling processes, enhancing recycling processes to recover more materials, and restoring or refurbishing partially spent batteries to near new performance levels.

VTP will continue the EV battery Secondary Use R&D activity that was started in 2010. In addition, VTP will collect information on battery end-of-life performance, obtain industry input, evaluate second use applications, and conduct testing to assess the suitability of used batteries for secondary use.

In conjunction with SuperTruck activities initiated in 2010, energy storage technologies and systems specific to heavy vehicle applications will optimize maturing battery technologies for long-haul truck applications.

Additional funding will be used to support the Battery Readiness Initiative (BRI). The purpose of BRI is to move mature battery technologies closer to market entry through the design and development of advanced pre-production battery prototypes. BRI will also support the market entry of advanced battery materials by supporting material scale-up, pilot production, and commercial sampling activities. The initiative will also accelerate the development of advanced battery computer aided engineering tools and support battery standardization activities. All of this activity will result in accelerated development of lower cost, higher performing, and more abuse tolerant batteries which will lead to faster adoption of EDVs in the light duty vehicle marketplace.

This new VTP activity will prototype advanced electric drive vehicle (EDV) batteries to understand their behavior in simulated drive conditions, encourage their more rapid adoption by industry, and drive down their costs. The activity will be undertaken with integrated teams of battery and automotive manufacturers. All awards will be selected under a competitive process and cost-shared by industry. Awards will be chosen based on the teams' ability to deliver full EDV batteries that provide high performance (extended all electric range), low cost (such that the battery cost has the potential of achieving VTP’s 2014 cost goal of $300/kWh) and that provide a path towards high volume production and sales of EDV batteries and vehicles. This activity will require the delivery of significant numbers (hundreds or thousands) of pre-production EDV cells and batteries for testing

under realistic performance conditions and will include the integration and use of the batteries in hardware-in-the-loop simulations. The activity will provide valuable data regarding battery operation and the results will be used to drive down battery cost through optimization of battery cell and pack designs.

VTP will accelerate the market entry of advanced batteries by supporting the scale-up, pilot production, and commercial validation of new battery materials and processes. EDV batteries utilize significant amounts of advanced materials such as novel cathodes, anodes, and electrolytes. Furthermore, low cost manufacturing processes for producing these new materials and incorporating them into electrodes, cells, and batteries need to be developed. New materials are being developed by universities, National Laboratories, and industry, that address barriers such as battery cost, life, and safety, but the production scale-up of such materials is often limited in scope. Battery materials and cell manufacturing needs to evolve from loosely measured and controlled processes that often rely on the "resident expert" and perfect repetition to make reproducible batteries, to processes that have adapted significant automated and metrological methods. New tools that can be adopted industry-wide will be developed by cross-disciplinary teams, taking advantage of the complementary skills and approaches of university, National Laboratories, and industrial scientists and engineers.

Developing new battery designs is extremely time-consuming and expensive. Computer aided engineering (CAE) tools have been widely used throughout the aerospace and automotive industry to speed up the product development cycle. In contrast, the battery industry still relies heavily on the building and testing of prototypes in the design cycles. A virtual design toolset could identify an optimal design in days or weeks, compared to months or years for a hardware-based process. The development of battery CAE tools will accelerate design cycles, reduce the number of prototypes needed, reduce battery development cost and provide a competitive advantage to U.S. OEMs, suppliers, and battery manufacturers. In this activity, VTP will work with industry, National Laboratories and universities to accelerate the development of tools that model battery behavior, such as electrochemical processes, electrical performance and degradation, life prediction, thermal profiles, and battery cost. Furthermore, VTP will define global modeling parameters in order to develop a flexible, plug-and-play, open architecture software that will allow disparate, independently developed sub-models to operate in unison. This new framework will enable automobile manufactures, battery developers, material suppliers, research institutions, and universities the ability to incorporate different battery material, cell, and pack models into one system capable of modeling an entire electrochemical system. By introducing battery simulations and design automation at an early stage in the battery design life cycle it is possible to significantly reduce the product cycle time allowing quicker entry of new technologies into the market and reducing battery development costs.

VTP will support the accelerated development of standards for battery design, and will encourage and facilitate the implementation of these standards throughout the industry. While standards for conventional automotive starting batteries have been well established (with a family of system voltages, physical dimensions in group sizes, and performance ratings), there are few existing comparable standards for electric drive vehicle battery systems. Current lithium-ion battery technologies are manufactured in a wide range of system voltage, cell size and shape (e.g.,

cylindrical, prismatic, or laminate), and materials used (e.g., metal oxides, iron phosphates). Although many standards-setting organizations such as SAE, IEEE, UL, IEC, and ISO have begun initial work to develop standards, the work is conducted largely on a volunteer basis, and therefore takes an extremely long period of time to develop and implement. VTP will work closely with major standards-setting organizations, battery manufacturers, and automotive OEMs, and provide financial assistance to speed the development of standards for battery design, performance ratings, commonality in labeling, and battery safety standards. In addition, VTP will work collaboratively with relevant agencies (such as the U.S. Department of Transportation and the United Nations) to develop standards for shipping/transportation of batteries. The establishment of battery standards will help to reduce battery costs, and thereby accelerated the widespread market introduction of electric drive vehicles.

The Battery/Energy Storage activity coordinates with other DOE programs working in advanced battery technologies to maximize returns on DOE's investments. Interactions include cooperation with Office of Science/BES to investigate electrochemical phenomena and to develop new battery materials. VTP works closely with ARPA E to identify and develop transformational EDV battery technologies. The activity also coordinates with the Battery/Energy Storage program in OE on the development of batteries and components that might serve both transportation and stationary applications. Interagency coordination on advanced battery development is conducted through the government-sponsored Interagency Advanced Power Group (IAPG) comprised of representatives from DOE, NASA, the Army, the Navy, and the Air Force.

Advanced Power Electronics and Electric Motors R&D **22,295** **46,656**

The Advanced Power Electronics and Electric Motors activity supports long-term R&D of power electronics, electric motors, electric drive systems, and other electric propulsion components, as well as thermal management technologies necessary for the development and ultimate adoption of PHEVs, HEVs, and pure EVs. Supporting R&D on capacitors, magnets and wide band-gap materials (such as silicon carbide [SiC] and gallium nitride [GaN]) for advanced power electronics technologies also enables the higher operating temperatures that are necessary to reduce system costs and meet PHEV and fuel cell HEV performance and reliability requirements.

Advanced Power Electronics and Electric Motors R&D addresses the second building block, which includes all the electric and electronic devices that tie the power stored in the battery to the vehicle's drivetrain: power control circuits; charging circuits; electric motors; logic to synchronize the power from the battery and motors with the main vehicle engine; and other related components. The power electronics for a PHEV will be considerably more complex than for a regular hybrid to accommodate additional charging modes and more complex driving modes.

The power electronics module conditions the flow of electrical power from the energy-storage device (such as a battery) to the electric motor. This module also provides functionality that enables lower-cost and more efficient motors, while protecting them from harmful voltage and current conditions, and helps reduce the overall size of the battery. R&D efforts focus on developing advanced, low cost technologies compatible with the high-volume manufacturing of motors,

inverters, and DC/DC converters for electric drive vehicles. Focus on electric drive systems will enable coordinated R&D of the power electronics and electric motors to further reduce cost, weight and size.

In FY 2012, industry R&D efforts will continue to develop power electronics and electric motors associated with increased vehicle electrification. Electrification of light-duty vehicles has great potential to reduce dependence on oil, and advanced power electronics and electric motors are critical components for the successful deployment of advanced vehicles. These activities will enable substantial reductions in cost, weight, and volume while ensuring a domestic supply chain. Emphasis will be placed on R&D for advanced packaging, enhanced reliability, and improved manufacturability. Efforts will also accelerate technology transfer from research organizations to domestic manufacturers and suppliers.

The activity also supports R&D of inverters and motors (permanent magnet [PM] and non-PM), DC-to-DC converters, SiC/GaN components, low-cost permanent magnet materials, high-temperature capacitors, advanced thermal systems, and motor control systems to meet future passenger vehicle hybrid systems requirements. Work in these areas will address the performance requirements for vehicle electrification, including utilizing power electronics to provide plug-in capability by integrating the battery charging function into the traction drive, thereby reducing electric propulsion system cost.

The activity also supports DOE's power electronics crosscut initiative by continuing vehicle-focused R&D projects in power electronics that apply across program areas such as capacitor dielectric material development, wide bandgap materials, and semiconductor packaging R&D. The effort will evaluate the impact these existing projects have on similar applications across DOE, to understand common barriers, identify areas for future efforts, and share progress on R&D.

Activities focusing on advanced materials will enable the production of prototype devices to accelerate the process of transferring research results to device manufacturers. Joint efforts with other programs and agencies in wide band gap materials and other enabling devices and technologies will be emphasized to enable earlier use of advanced devices and components. In FY 2012, VTP will continue to support the development of power electronics and motor technologies and devices to strengthen the U.S. based manufacturing to ensure success of manufacturing facility awards made under the Recovery Act.

Ongoing efforts will continue to focus on reducing and ultimately eliminating the use of rare earth materials in electric motors. Magnet material research is focused on near-term efforts to reduce the amount of rare earth materials in current generation magnets and long-term research to develop novel, low cost magnetic materials without any rare earth content that can meet automotive requirements. Other projects at National Laboratories and with industry partners focus on technology replacement, developing novel motor designs and concepts that reduce or eliminate rare earth materials while meeting future performance targets.

The power electronics and electric motors activity coordinates with other DOE programs with relevant work in advanced technologies to maximize the return on DOE's technology investments in

(dollars in thousands)

	FY 2010 Current Approp	FY 2012 Request

this area. Interagency coordination on advanced power electronics and motors development is conducted through the IAPG. The synergies of technologies for advanced vehicles, including PHEVs, HEVs, and EVs, will be achieved by maintaining close collaboration among researchers, device manufacturers, and users of the technologies. The developed technologies will be validated for performance and conformance to specifications. Crosscutting technologies also will be evaluated for potential application in advanced vehicles. Collaboration with SuperTruck activities will leverage recent advancements and further improve power electronics and electric motors for use in heavy-duty trucks. In addition, these funds may be used to support efforts such as peer reviews; data collection and dissemination; and technical, market, economic, and other analyses.

Electric vehicle drive systems, which include electric motors and power electronics, are a key technology for enabling advanced vehicle propulsion systems that reduce the petroleum dependence of the transportation sector. To have a significant effect and increase market penetration of advanced electric vehicles, electric drive technologies must be economical in terms of cost, weight, and size while meeting performance and reliability requirements. However, the push to meet these individual improvements must be balanced and considered as an overall drive system. A systems solution approach will realize significant breakthroughs for how power electronics and electric motors are structured, integrated, and executed. This new focus will provide a systematic, coordinated development of electric drive system technology to meet performance targets and realize drastic cost reductions. Significant tasks will include design and integration studies, definition of system requirements, and evaluating new technologies and topologies all with the primary focus of cost reduction. Specifically, cost reductions may be realized through the elimination of rare earth materials, the development of common part sizing, improvements in manufacturability, and/or the integration of other drive system components such as chargers and DC/DC converters.

SBIR/STTR	**0**	**5,264**

In FY 2010, $2,535,125 and $304,215 were transferred to the SBIR/STTR programs respectively. The FY 2012 amount shown is the estimated requirement for the continuation of the SBIR and STTR program.

Total, Batteries and Electric Drive Technology	**98,566**	**188,000**

Explanation of Funding Changes

	FY 2012 vs. FY 2010 Current Approp ($000)
Battery/Energy Storage R&D	
Additional funding will be used to support the Battery Readiness Initiative (BRI). The purpose of BRI is to move mature battery technologies closer to market entry through the design and development of advanced pre-production battery prototypes. BRI will also support the market entry of advanced battery materials by supporting material scale-up, pilot production, and commercial sampling activities. The initiative will also accelerate the development of advanced battery computer aided engineering tools and support battery standardization activities. All of this activity will result in accelerated development of lower cost, higher performing, and more abuse tolerant batteries which will lead to faster adoption of EDVs in the light duty vehicle marketplace.	+59,809
Advanced Power Electronics and Electric Motors R&D	
This increase in funding will initiate competitively awarded research and development of electric vehicle drive system R&D efforts focusing on a system-level design to optimize performance and dramatically reduce cost. This new focus will provide a systematic, coordinated development of electric drive system technology.	+24,361
SBIR/STTR	
In FY 2010, $2,535,125 and $304,215 were transferred to the SBIR/STTR programs respectively. The FY 2012 amount shown is the estimated requirement for the continuation of the SBIR and STTR program.	+5,264
Total Funding Change, Batteries and Electric Drive Technology	**+89,434**

Vehicle and Systems Simulation and Testing

Funding Schedule by Activity

(dollars in thousands)

	FY 2010 Current Approp[a]	FY 2012 Request
Vehicle and Systems Simulation and Testing		
Vehicle and Systems Simulation and Testing	43,732	52,332
Non- and Off-Highway Vehicles	0	5,000
SBIR/STTR	0	668
Total, Vehicle and Systems Simulation and Testing	43,732	58,000

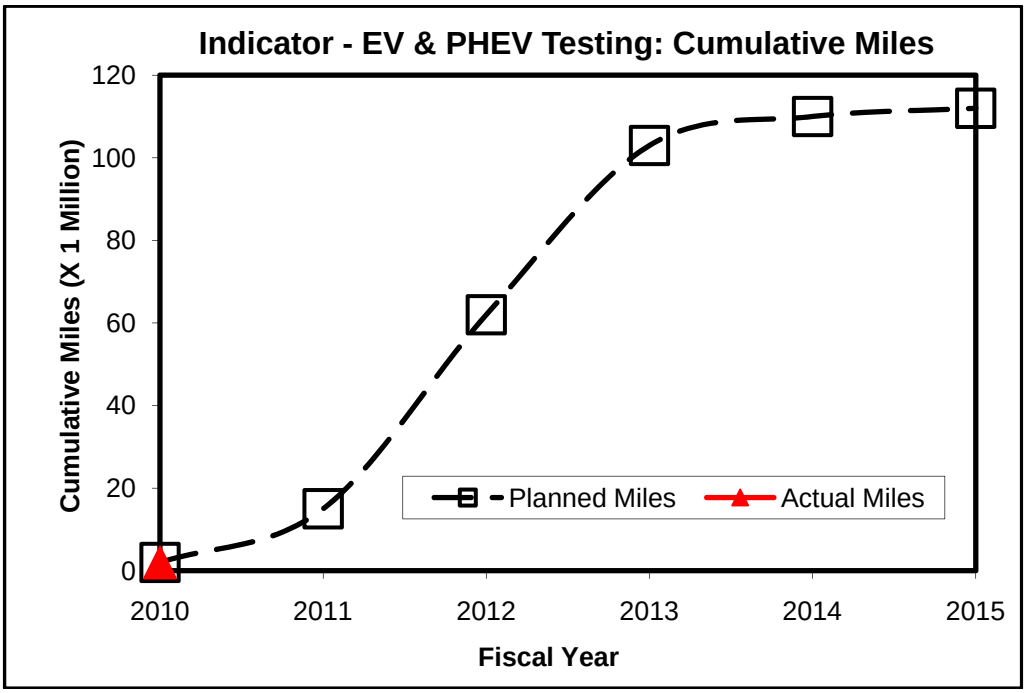
Benefits

The Vehicle and Systems Simulation and Testing (VSST) subprogram addresses the utilization of electric energy storage, electric drives, energy recovery, and other efficiency improving technologies in new, more efficient vehicle designs. These crosscutting activities contribute to meeting the VTP strategic objective of developing, demonstrating, and deploying clean energy technologies.

In the VSST activity, modeling and simulation tools are developed and utilized to help specify the necessary performance characteristics of powertrain technologies in order to establish program goals and predict the overall efficiency and performance for various vehicle configurations. Simulations and laboratory testing are used to evaluate the development of individual components and predict how well they will integrate with other components in a vehicle system. Vehicle-level testing is done through dynamometer, closed-track, and on-road evaluations in conjunction with industry partners to measure the real-world performance of advanced technology vehicles, and to validate simulation results. Development of supporting infrastructure, such as advanced vehicle chargers, and the interaction of advanced vehicles with infrastructure is also evaluated. Each of these activities contributes to the development of components, vehicles, and testing codes and standards that are necessary for the successful market introduction of electric-drive vehicles. In addition, VSST conducts R&D to reduce auxiliary vehicle loads and parasitic losses in both passenger vehicles and commercial medium and heavy duty vehicles. In the Non- and Off-Highway Vehicles activity, the key effort is to identify and utilize information from highway vehicle R&D that can improve efficiency as a means to reduce petroleum use.

VSST contributes to meeting national energy security, environmental, and economic objectives by striving to demonstrate market readiness of electric-drive vehicle technologies by 2015. Market readiness will be determined from accumulated test data from over 100 million test miles of electric propulsion vehicles as indicated in the progress indicator figure below. The Non- and Off-Highway Vehicles activity will benefit the Nation's oil and GHG reduction efforts by improving the efficiency of vehicles in these sectors. These vehicles are expected to account for 25 percent of transportation GHG emissions by 2030.

[a] SBIR/STTR funding transferred in FY 2010 was $531,936 for the SBIR program and $63,832 for the STTR program.


Indicator - EV & PHEV Testing: Cumulative Miles
Cumulative Miles (X 1 Million)
120
100
80
60
40
20
0
2010
2011
2012
2013
2014
2015
Fiscal Year
Planned Miles
Actual Miles

Detailed Justification

(dollars in thousands)

	FY 2010 Current Approp	FY 2012 Request
Vehicle and Systems Simulation and Testing	**43,732**	**52,332**

VSST integrates the modeling, systems analysis, vehicle testing and evaluation, codes and standards development, and systems optimization efforts that support VTP. The key activity uses a systems approach to define technical targets and requirements, guide technology development, and validate the performance of VTP-sponsored technologies for passenger and commercial vehicles. To accomplish this, VSST develops and validates models and simulation tools to predict the performance, component interaction, fuel economy, and emissions of advanced vehicles. With industry input, these models are used to:

- Develop performance targets for the complete range of vehicle platforms and their components;
- Develop advanced control strategies to optimize the interaction between components and the overall performance and efficiency of advanced HEV, PHEV, EV and fuel cell vehicles; and
- Develop advanced vehicle performance and characteristics data that is then used to predict market potential and petroleum displacement, which helps guide VTP-wide research.

FY 2012 actions will support modeling of advanced electric drive vehicles and systems, as well as baseline testing and evaluation of both commercial and passenger electric drive vehicles in cooperation with manufacturers, utilities, and other industry partners. Laboratory and field evaluations of advanced prototype and pre-production electric drive vehicles with dual energy storage systems and other advanced energy storage devices, electric motors, and power electronics will be conducted. The VSST activity will also research heavy vehicle systems to develop models, as well as conduct R&D on technologies that will reduce non-engine parasitic energy losses from aerodynamic drag, friction and wear, under-hood thermal conditions, accessory loads, and tires.

In FY 2012, the activity will continue simulation studies of advanced control strategies and components for PHEVs and other electric drive vehicles, as well as the validation of advanced electric drive vehicle technology components in the laboratory and on the road. Test data will be used to enhance vehicle and systems modeling capabilities, to validate the accuracy of the component models, and to measure progress towards meeting performance targets. VSST will continue to collaborate with EPA to share vehicle modeling and simulation expertise, as well as results from vehicle testing activities. VSST will also work with industry partners to test the enhanced capabilities of the heavy vehicle systems model to incorporate on-road tests and proprietary industry data, and complete the integration of turbulence and other computational fluid dynamics (CFD) models. The activity will continue efforts to incorporate detailed component models into the overall vehicle systems integration model to ensure the use of the most accurate component data. This effort supports the Autonomie modeling platform, a centralized vehicle modeling and simulation tool developed through a cooperative research and

development agreement (CRADA) with industry to standardize vehicle modeling across manufacturers and component suppliers, thus reducing component and vehicle development costs and bringing technologies to market faster. The Autonomie model also increases the accuracy of simulation results and enables simulations that support R&D in all other VTP subprograms.

VSST will utilize the Mobile Automotive Technology Testbed (MATT) and hardware-in-the-loop (HIL) techniques that operate selected pieces of hardware linked to a real-time simulation of a virtual vehicle, to emulate vehicle systems to determine systems interactions (e.g., energy storage requirements for different cumulative electric range control strategies and power electronics components and configurations). In FY 2012, VSST will continue HIL evaluations of advanced energy storage systems and dual battery systems, advanced combustion technologies developed by other VTP R&D subprograms, and the use of engine emission models for analyzing the impact of emission control equipment on the fuel economy of all vehicle classes. VSST will validate, in a systems environment, performance targets for deliverables from power electronics and energy storage technology R&D activities, and examine overall vehicle impacts associated with integration of other advanced vehicle technologies.

The activity will conduct evaluations of advanced original equipment manufacturer (OEM) PHEVs and electric drive vehicles and their recharging infrastructure, and complete tests of vehicles retrofitted with components developed through VTP R&D activities. Evaluations will include testing on laboratory dynamometers, closed tracks, and real-world monitored fleets. Test results will help identify component and system performance and reliability weaknesses to be addressed through future R&D activities. Data from these tests will expand the currently limited electric drive vehicle knowledge base and help accelerate market introduction of these fuel saving vehicles.

The Recovery Act provided substantial new resources for EERE to expand the impact of base activities. The Transportation Electrification Initiative is enabling the purchase, deployment, and evaluation of thousands of PHEVs and EVs and charging infrastructure for test demonstrations in various locations across the U.S., as well as education and training programs to support these activities. The data collected from the Recovery Act Transportation Electrification advanced electric drive vehicle demonstrations will be analyzed to identify technology needs and improvements to be addressed through VTP R&D activities to accelerate the market introduction of electric drive vehicles. Efforts focus on infrastructure/vehicle interface evaluations and potential impacts on the electricity grid. VSST will work with OE to demonstrate the potential benefit of electric drive vehicle commercialization coupled with smart grid technologies to improve the value proposition of electric drive vehicles while promoting grid reliability and utilization.

VSST will expand activities in FY 2012 to develop, evaluate, and demonstrate advanced wireless charging technologies with efficiencies approaching those of plug-connected recharging equipment. These stationary and in-motion EV wireless chargers will increase the use of electricity for vehicle propulsion and reduce petroleum consumption while reducing the size and cost of batteries required to meet consumers' range expectations and needs. VSST will expand its

(dollars in thousands)

	FY 2010 Current Approp	FY 2012 Request

government/industry cooperative efforts to identify and resolve codes and standards for component, vehicle, infrastructure, communications, and testing that need to be updated for new vehicle technologies. Specific activities will include development and validation of component safety, performance, and communications standards for electric-drive vehicles and infrastructure, as well as conducting on-vehicle testing of components integrating new standards to ensure vehicle performance, reliability, efficiency, and safety. Work will be initiated to develop and validate additional codes and standards identified as deficient through partnership with government and industry stakeholders and to coordinate U.S. standards with those in Europe and Asia to reduce vehicle costs through component compliance in multiple markets.

In FY 2012, additional vehicle testing data will be collected through VSST activities, as well as other independent testing sources, and will be utilized to validate medium duty vocations in the heavy vehicle model. In FY 2012, VSST will continue to fund financial assistance awards with SuperTruck awardees to develop, build and demonstrate advanced Class 8 tractors & trailers with a 50 percent improvement in on-road fuel economy. The funds will also support CRADAs and National Laboratory projects to reduce drive-train friction and wear, and develop and evaluate under-hood thermal management approaches that will improve vehicle efficiencies while increasing component reliability and life. VSST will also work directly with industry partners to accelerate the development and validation of advanced medium and heavy hybrid vehicles.

In FY 2012, VSST will also work to develop high efficiency vehicle air conditioning and HVAC components and technologies to reduce vehicle heating and cooling load requirements. These technologies will help reduce the amount of battery energy or petroleum used for HVAC loads in passenger and commercial vehicles, thus dramatically improving overall vehicle efficiency and range.

Non- and Off-Highway Vehicles	**0**	**5,000**

VSST's Non- and Off-Highway activity will incorporate rail and off-highway transportation modes and associated opportunities to reduce petroleum use and GHG emissions. New rail activities will be coordinated with the Department of Transportation, locomotive manufacturers, rail companies, and others to develop a rail oil and GHG reduction roadmap. Early activities will center on the application of existing advanced VTP technologies initially developed for heavy vehicles—combustion, light-weighting, and alternative fuels—to rail systems, where appropriate. New off-highway activities will focus on identifying and coordinating with stakeholders, with whom VTP will adapt and deploy existing technologies, as appropriate. For both rail and off-highway activities, VTP will identify and initiate new R&D where existing VTP technologies are not applicable. In addition, these funds may be used to support efforts such as peer reviews; data collection and dissemination; and technical, market, economic, and other analyses.

	(dollars in thousands) FY 2010 Current Approp	FY 2012 Request
SBIR/STTR	**0**	**668**

In FY 2010, $531,936 and $63,832 were transferred to the SBIR and STTR programs respectively. The FY 2012 amount shown is the estimated requirement for the continuation of the SBIR and STTR program.

Total, Vehicle and Systems Simulation and Testing	**43,732**	**58,000**

Explanation of Funding Changes

	FY 2012 vs. FY 2010 Current Approp ($000)
Vehicle and Systems Simulation and Testing (VSST)	
Development of wireless charging technologies for both stationary and in-motion EVs will be expanded to decrease the size of batteries needed in EVs, increase the useable range of EVs without plugging in to recharge, increase the use of electricity for vehicle propulsion, and increase consumer acceptance of EVs. In addition, development of advanced air conditioning and HVAC components and systems and technologies to reduce HVAC loads and component sizes will be conducted to minimize the amount of battery energy used to meet HVAC requirements, thus improving the overall efficiency and range of EVs. Development, validation, and coordination of codes and standards that currently limit and slow the introduction of EVs will be conducted in cooperation with vehicle and component manufacturers, standards setting organizations, and utilities	+8,600
Non and Off-Highway Vehicles	
The Non- and Off-highway is a new activity in FY 2012. This funding will enable VTP to leverage existing technologies for application to rail and off-highway transportation modes, thereby expanding the number of transportation media through which VTP reduces petroleum consumption and GHG emissions.	+5,000
SBIR/STTR	
In FY 2010, $531,936 and $63,832 were transferred to the SBIR and STTR programs respectively. The FY 2012 amount shown is the estimated requirement for the continuation of the SBIR and STTR program. .	+668
Total Funding Change, Vehicle and Systems Simulation and Testing	**+14,268**

Advanced Combustion Engine R&D

Funding Schedule by Activity

(dollars in thousands)

	FY 2010 Current Approp[a]	FY 2012 Request
Advanced Combustion Engine R&D		
Combustion and Emission Control	47,239	40,824
Solid State Energy Conversion	8,748	6,804
SBIR/STTR	0	1,372
Total, Advanced Combustion Engine R&D	55,987	49,000

Benefits

The Advanced Combustion Engine R&D subprogram focuses on removing critical technical barriers to commercializing higher 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. Using these advanced engines in HEVs and PHEVs will enable even greater fuel savings benefits. Improvements in engine efficiency alone have the potential for dramatically increasing vehicle fuel economy and reducing GHG emissions. Accelerated research on advanced combustion regimes, including homogeneous charge compression ignition (HCCI) and other modes of low-temperature combustion, lean-burn gasoline, and multi-fuel operation, is aimed at realizing this potential.

The Advanced Combustion Engine R&D subprogram contributes to VTP goals by dramatically improving the efficiency of internal combustion engines, and by identifying fuel properties that improve the system efficiency or enable displacement of petroleum-based fuels. Improved efficiency and petroleum displacement can directly reduce petroleum consumption and GHG emissions.

The following representative measures of the Advanced Combustion R&D subprogram can contribute to meeting strategic objectives of developing, demonstrating and deploying clean energy technologies:

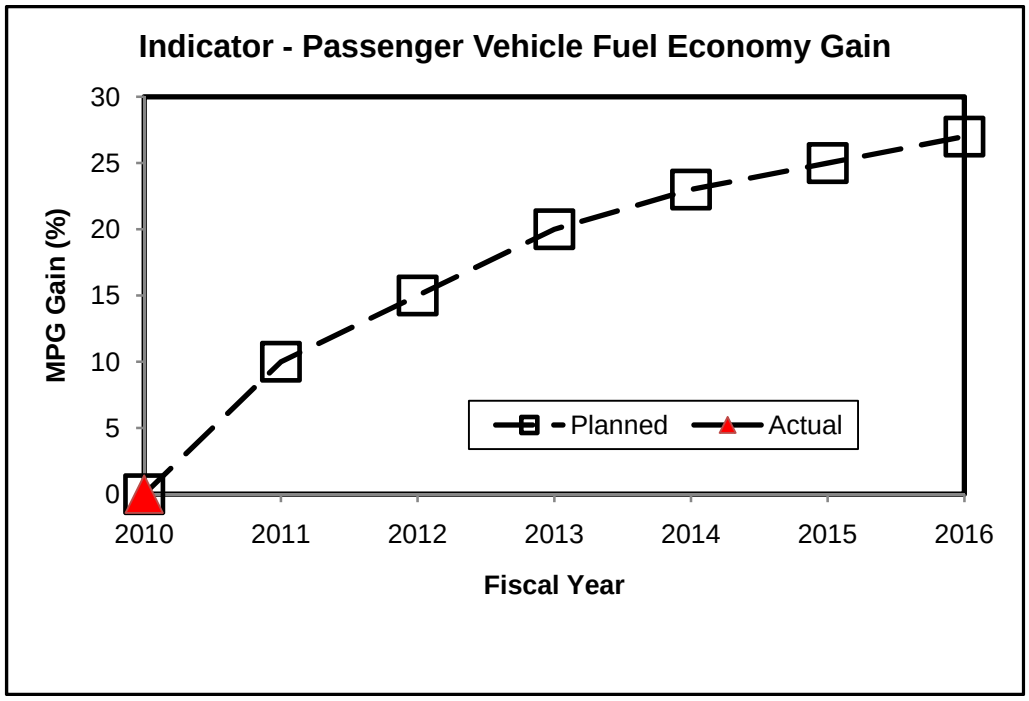
- Passenger vehicles: Increase the efficiency of internal combustion engines resulting in fuel economy improvements of 25 percent for gasoline vehicles by 2015 compared to a 2009 baseline gasoline vehicle.
- Commercial vehicles: Increase the efficiency of internal combustion engines demonstrating a fuel economy improvement of 20 percent in 2015, and 30 percent in 2018, when compared to a 2009 baseline vehicle.

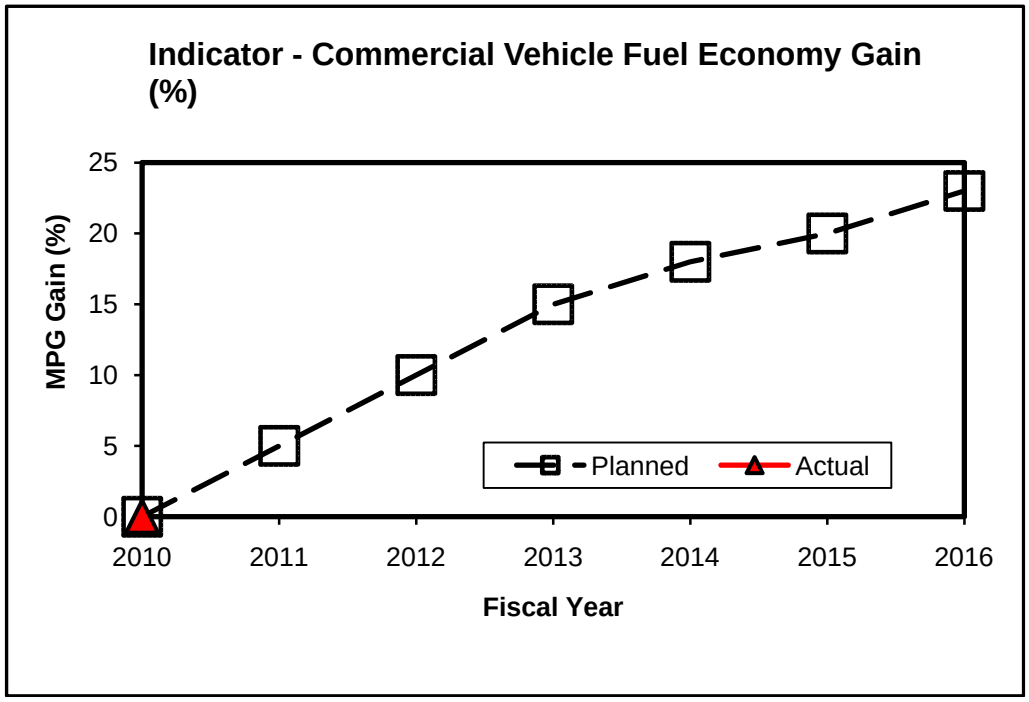
Passenger and commercial vehicle goals will be met while utilizing advanced fuel formulations that incorporate non-petroleum based blending agents to reduce petroleum dependence and enhance combustion efficiency.

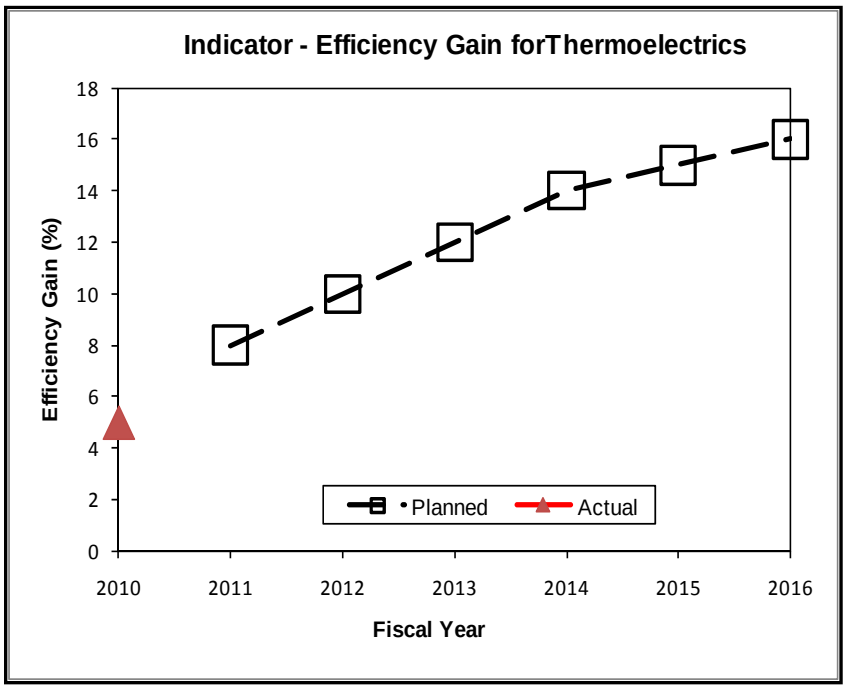
- Solid State Energy Conversion: Increase the efficiency of thermoelectric generators to convert waste heat to electricity from eight percent in 2011 to greater than 15 percent in 2015 and reduce air conditioning load by 30 percent in 2015.

[a] SBIR/STTR funding transferred in FY 2010 was $1,439,489 for the SBIR program and $172,499 for the STTR program.

Progress of R&D for improving passenger and commercial vehicle combustion engine efficiency is shown graphically below.







Detailed Justification

(dollars in thousands)

	FY 2010 Current Approp	FY 2012 Request
Combustion and Emission Control	**47,239**	**40,824**

Combustion and Emission Control research supports the VTP goal of enabling energy-efficient, clean vehicles powered by advanced internal combustion engines using clean, petroleum- and non-petroleum-based fuels and hydrogen. This activity develops 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, while ensuring that no new toxic air emissions are generated. The activity will be closely coordinated with VTP's Fuels Technology subprogram as different fuel characteristics and reduced property variability may be needed to meet the goals.

This activity focuses on developing cost-competitive technologies for passenger and commercial vehicle engines operating in advanced combustion regimes, including HCCI and other modes of low-temperature combustion (LTC), which will increase efficiency beyond current advanced diesel levels and further reduce engine-out emissions of NO_x and particulate matter (PM) to near-zero levels. The goals for 2015 emphasize increasing the efficiency of internal combustion engines resulting in fuel economy improvements over real-world driving cycles.

Meeting anticipated future emission standards will be challenging for high efficiency diesel and lean-burn gasoline engines. To address this issue, research on innovative emission control strategies will be pursued through National Laboratory, industry and university projects designed to reduce cost and

(dollars in thousands)

FY 2010 Current Approp	FY 2012 Request

increase performance and durability of NO_x reduction and PM oxidation systems. Project areas include development of low-cost base metal catalysts (to replace expensive platinum group metals), lighter and more compact multifunctional components, and new control strategies.

By overcoming these challenges, more efficient lean-burn combustion engines can be cost-competitive with current gasoline engines in passenger vehicles, and can further improve the efficiency and reduce the cost of engines used in commercial vehicles.

Examples of specific activities to be conducted for passenger and commercial vehicles include the development of multi-mode combustion processes which combine the various forms of HCCI, partial HCCI, traditional diffusion combustion, and lean-burn combustion with gasoline and ethanol.

Components needed to enable the advanced combustion system described above includes advanced ultra high pressure fuel injection and charge air systems, high flow exhaust gas recirculation systems and waste heat recovery. Advanced injectors must be capable of tightly packed multiple injection events within a given engine cycle. Advanced charging air systems will allow for precision control of air flow and charge temperature. Efforts will be undertaken to develop and integrate innovative control strategies for NO_x and PM emissions to meet the durability requirement of 435,000 miles for commercial vehicles and 120,000 for passenger vehicles, while meeting emission standards and anticipating changes in emission control strategies and regulations due to changing engine-out emissions constituents. The activity will also investigate the use of these advanced technologies for off-highway and locomotive applications in collaboration with the Non- and Off-Highway Vehicles activity.

In FY 2012, the Combustion and Emission Control activity will continue funding one of the four non-ARRA funded cooperative agreements awarded in FY 2010 for passenger vehicle advanced power-train systems targeting the demonstration of a 25 to 40 percent improvement in vehicle fuel economy by 2015. The activity will also continue three of six awards made to universities to conduct research on combustion and develop emission controls systems for advanced engines. The activity will delay or eliminate non-ARRA SuperTruck awards from the FY 2010 solicitation. These awards were to develop a complete engine system incorporating technologies for heavy-duty diesel engines, such as optimized combustion, fuel injection, emissions control, and waste heat recovery systems while reducing parasitic, friction and pumping losses to meet these engine system goals.

Through simulation and experimentation, the activity will conduct R&D on advanced thermodynamic strategies that will enable engines to approach 60 percent thermal efficiency. Development of detailed chemical kinetic models of advanced combustion regimes and emissions processes will continue including fuel composition effects that will aid the development of advanced, high-efficiency combustion engines using LTC and mixed-mode combustion regimes. The activity will utilize X-rays from the Advanced Photon Source to study fuel-injection spray characteristics near the injection nozzle.

The activity will support the Energy Systems Simulation-ICE Initiative, in collaboration with Office of Science/BES, in the development of advanced chemical kinetics, computation fluid dynamics (CFD) and large eddy simulation (LES) models, and computationally intensive direct numerical simulations (DNS) to model transients and cycle to cycle variability in engine combustion events. The activity will support the development of better solver algorithms to make these models more computationally tractable while

(dollars in thousands)

FY 2010 Current Approp	FY 2012 Request

providing experimental verification (e.g. laser diagnostics for optical engines and Advanced Photon Source for spray diagnostics) to validate these models. The activity will simulate stochastic in-cylinder processes, minimize the cycle-to-cycle variations inherent in ICEs and allow for more rapid optimization of overall engine combustion and air handling. In addition, this activity will develop more accurate liquid fuel injection models that simulate cavitations, atomization, and vaporization. Working cooperatively with industry, VTP will make these codes user friendly to reduce the number of iterations needed to design a more efficient combustion engine. This activity will also develop robust engineering design tools for validation of simulation models using full-scale engine testing and diagnostics.

In addition, these funds may be used to support efforts such as peer reviews; data collection and dissemination; and technical, market, economic, and other analyses.

Solid State Energy Conversion	**8,748**	**6,804**

The Solid State Energy Conversion activity develops technologies to convert waste heat from engines and other sources to electrical energy to improve overall thermal efficiency and reduce emissions. This activity will focus on the R&D of thermoelectrics and other solid state systems that recover energy from waste heat and provide cooling/heating for vehicle interiors. Thermoelectric generators can directly convert a nominal 1kW of electric power from engine waste heat for passenger vehicles and up to 5kW for commercial vehicles.

In FY 2012, this activity will pursue cost-shared cooperative agreements (typically three to five years in duration) with industry and academia to develop and fabricate high-efficiency thermoelectric generators to produce electricity from waste heat and thermoelectric air conditioner/heaters to replace current R134-a gas air conditioners in passenger and commercial 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 10 percent. This activity will continue to support a collaborative effort with the National Science Foundation to fund thermoelectric projects at several universities. Research on advanced thermoelectric materials and scale-up for demonstration in vehicle applications will also continue.

In addition, these funds may be used to support efforts such as peer reviews; data collection and dissemination; and technical, market, economic, and other analyses.

SBIR/STTR	**0**	**1,372**

In FY 2010, $1,439,489 and $172,499 were transferred to the SBIR and STTR programs respectively. The FY 2012 amount shown is the estimated requirement for the continuation of the SBIR and STTR program.

Total, Advanced Combustion Engine R&D	**55,987**	**49,000**

Explanation of Funding Changes

	FY 2012 vs. FY 2010 Current Approp ($000)
Combustion and Emission Control	
Funding will be delayed or eliminated for three of four cooperative agreements for passenger vehicle advanced power-train systems and three of six university awards on combustion and emissions control systems for advanced engines will be reduced. The FY 2012 funding level maintains one cooperative agreement and three university awards. In addition, the activity will delay or eliminate non-ARRA supported SuperTruck awards from the FY 2010 solicitation. Reductions will also be made at the National Laboratories for research on high efficiency combustion processes and emission control systems. These reductions will be made in order to focus on large-scale computational simulations of combustion, a potentially cost-effective means to develop efficient combustion engines.	-6,415
Solid-State Energy Conversion	
To focus on higher priority activities within the Advanced Combustion Engine R&D, solid-state energy conversion activities will be reduced from three to two awards made to industry teams previously to improve the efficiency of thermoelectric generators to recover energy from waste heat.	-1,944
SBIR/STTR	
In FY 2010, $1,439,489 and $172,499 were transferred to the SBIR and STTR programs respectively. The FY 2012 amount shown is the estimated requirement for the continuation of the SBIR and STTR program.	-1,372
Total Funding Change, Advanced Combustion Engine R&D	**-6,987**

Materials Technology

Funding Schedule by Activity

(dollars in thousands)

	FY 2010 Current Approp[a]	FY 2012 Request
Materials Technology		
Propulsion Materials Technology	12,989	9,720
Lightweight Materials Technology	30,652	26,244
High Temperature Materials Laboratory	5,662	972
SBIR/STTR	0	1,064
Total, Materials Technology	49,303	38,000

Benefits

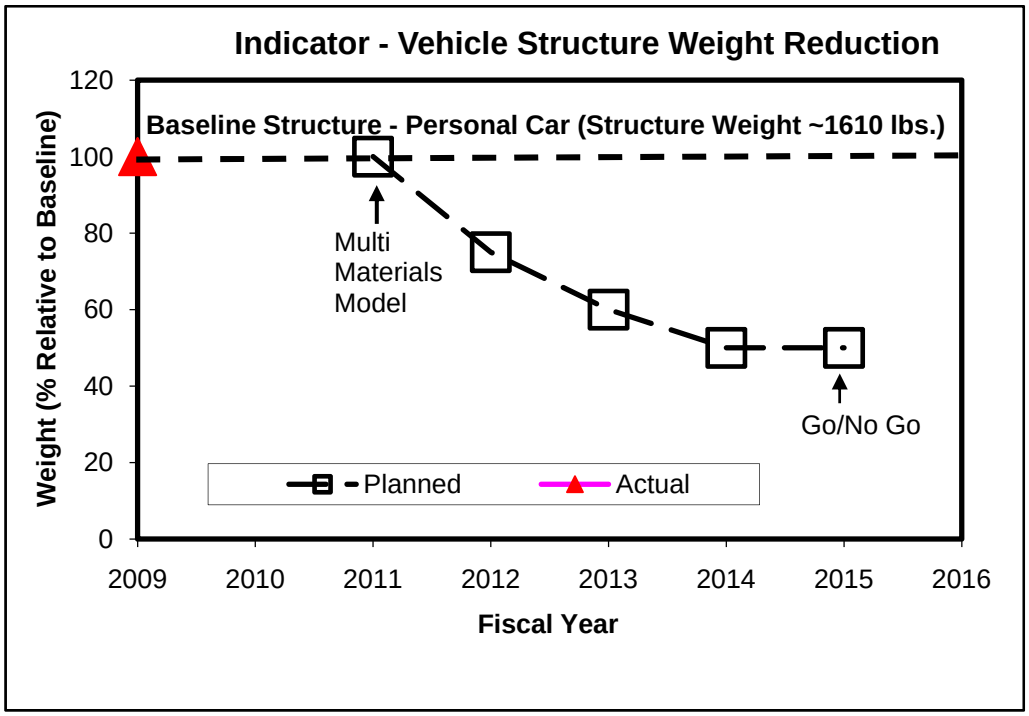
The Materials Technology subprogram develops higher performing, more cost-effective materials that will make lighter vehicle structures and more efficient power systems. Lighter vehicles require less energy to operate and thus reduce fuel consumption. Likewise, better propulsion materials can enable more efficient power systems that will contribute to a vehicle's reduced energy consumption. For a mid-sized or larger vehicle, every 10 percent reduction in a vehicle's weight could result in a six to eight percent increase in vehicle fuel economy.[b]

The following measure of the Materials Technology subprogram can contribute to meeting strategic objectives of developing, demonstrating and deploying clean energy technologies:

- By 2015, validate (to within 10 percent uncertainty) the cost-effective reduction of the weight of passenger vehicle body and chassis systems by 50 percent with safety, performance, and recyclability comparable to 2002 vehicles.

Progress is indicated by the change in vehicle weight (percent relative to baseline) as determined from materials development progress and the corresponding modeled change in vehicle weight. Annual progress is shown graphically below.

[a] SBIR/STTR funding transferred in FY 2010 was $1,268,075 for the SBIR program and $152,169 for the STTR program.
[b] Argonne National Laboratory Power Train Systems Analysis Toolkit (PSAT) analysis, 2008.



Note: 2009 value is baseline

Detailed Justification

(dollars in thousands)

	FY 2010 Current Approp	FY 2012 Request
Propulsion Materials Technology	**12,989**	**9,720**

The Propulsion Materials Technology key activity will continue R&D on improved materials to enable the development of lightweight highly efficient propulsion systems for advanced passenger cars and commercial vehicles operating on a combination of conventional and non-petroleum fuels and electricity. Improved propulsion materials are critical to meeting the performance and cost targets of advanced technologies being developed by VTP.

In FY 2012, research efforts will support three VTP teams: 1) Advanced Combustion Engines; 2) Fuels; and 3) Hybrid Electric Systems to achieve energy efficiency improvements and petroleum displacement goals. Much of the materials work will support diesel engines because they currently operate at much higher efficiencies and pressures than gasoline engines and will provide insights to the materials hurdles confronting engine designers as they strive to achieve the higher peak cylinder pressures necessary for improved thermal efficiency. Researchers will use specialized characterization and processing techniques to develop materials for in-cylinder thermal management, friction reduction, improved dynamic response, increased peak cylinder pressure, and increased power to weight ratios supporting the development of high efficiency advanced combustion engines. In cooperation with the VTP fuels team, researchers will identify and mitigate interaction issues between

(dollars in thousands)

	FY 2010 Current Approp	FY 2012 Request

new fuel formulations and engine component materials. Materials will be developed to improve the performance of energy recovery systems such as turbo-compounding and solid state thermoelectric devices. Efforts to develop materials for hybrid- and electric-drive components will target cost effective domestic magnetic materials for drive motors and high-temperature power electronics. All activities include technology transfer components to communicate results to industry, thereby accelerating deployment of beneficial technologies. In addition, these funds may be used to support efforts such as peer reviews; data collection and dissemination; and technical, market, economic, and other analyses.

Lightweight Materials Technology **30,652** **26,244**

This activity supports R&D on advanced concepts to reduce the weight of vehicles, accomplished primarily by substitution of lower density or stronger materials for current materials. Materials include magnesium, aluminum, advanced high-strength steels, titanium, as well as polymer- matrix composites reinforced with fibers. Since cost-effectiveness is the major materials challenge, this element supports R&D and validation of materials needed to meet the goal of 50 percent body and chassis weight reduction, as well as designing and manufacturing components and structures from these materials. The objective is to lower the potential costs and cost uncertainties of advanced materials to achieve the FY 2015 goal of cost neutrality.

In FY 2012, funding will continue to focus on new development and demonstrations of technologies for reducing the effective costs of magnesium, next generation advanced high strength steel, aluminum, carbon-fiber and carbon-fiber composites, and components and structures made from these materials. Funding will support work on multi-material enabling technologies, such as advanced joining or corrosion prevention techniques. Work will also continue in the field of modeling and integrated computational materials engineering (ICME). One focus will be on completion of a detailed design and cost model for a multi-materials vehicle (MMV) that is 25 percent lighter weight compared to the baseline assessment currently underway. In addition, these funds may be used to support efforts such as peer reviews; data collection and dissemination; and technical, market, economic, and other analyses.

High Temperature Materials Laboratory (HTML) **5,662** **972**

The HTML facility is an advanced materials characterization laboratory which provides materials characterization services for VTP, academia, and a number of small business industrial users through the HTML Users Program at the Oak Ridge National Laboratory. To focus on other priority activities within the Materials Technology Subprogram, the FY 2012 funding provides limited support of the HTML facilities and instruments and reduces support of the HTML user program. In addition, these funds may be used to support efforts such as technology transfer/technology exchange meetings and forums with industry stakeholders, peer reviews, data collection and dissemination, and technical, market feasibility, economic, and other analyses.

(dollars in thousands)

	FY 2010 Current Approp	FY 2012 Request
SBIR/STTR	**0**	**1,064**

In FY 2010, $1,268,075 and $152,169 were transferred to the SBIR and STTR programs respectively. The FY 2012 amount shown is the estimated requirement for the continuation of the SBIR and STTR program.

Total, Materials Technology	**49,303**	**38,000**

Explanation of Funding Changes

	FY 2012 vs. FY 2010 Current Approp ($000)
Propulsion Materials Technology	
Work on longer-term technologies such as low friction coatings will be reduced to focus on activities with higher near term potential. The hydrogen/natural gas injector work has demonstrated benefits and has reached its conclusion. Non-rare earth magnetic materials work will be transitioned to the hybrid drive systems team.	-3,269
Lightweight Materials Technology	
The reduction in the Lightweight Materials Technology key activity is due to a shift in focus to higher priority efforts in VTP. This will necessitate the following changes: no new platforms will be addressed for research in metal extrusions; and only predictive engineering tools will be pursued for polymer composites. In addition, the number of anticipated new demonstration projects planned to be funded in FY 2012 through the USAMP cooperative agreement will be reduced.	-4,408
High Temperature Materials Laboratory (HTML)	
This reduction eliminates funding for the HTML User program, however maintains funding for overhead for the HTML. The current User program offsets the costs of conducting research at the facility if the project meets the criteria (e.g., results are published). This aspect of the program will be eliminated.	-4,690
SBIR/STTR	
In FY 2010, $1,268,075 and $152,169 were transferred to the SBIR and STTR programs respectively. The FY 2012 amount shown is the estimated requirement for the continuation of the SBIR and STTR program.	+1,064
Total Funding Change, Materials Technology	**-11,303**

Fuels Technology

Funding Schedule by Activity

(dollars in thousands)

	FY 2010 Current Approp[a]	FY 2012 Request
Fuels Technology		
Advanced Petroleum Based Fuels (APBF)	6,780	0
Fuels and Lubricant Technologies (formerly Non-Petroleum Based Fuels and Lubricants)	16,641	17,985
SBIR/STTR	0	518
Total, Fuels Technology	23,421	18,503

Benefits

The Fuels Technology subprogram supports the mission of VTP to develop more energy-efficient and environmentally friendly fuels that enable the U.S. to use less petroleum. Activities are coordinated with, and are supportive of, EPA's fuels and emissions related activities as well as with VTP's Advanced Combustion Engine R&D subprogram.

The lubricant R&D activities are designed to reduce the detrimental effects of lubricants on emissions formation and exhaust after treatment devices and improve fuel economy. The relative impact of lubricant combustion products on emissions has increased as overall emissions have declined. Moreover, lubricants can contain specific undesirable compounds not generally found in fuels that contribute to pollutant formation in unique ways, specifically to toxics and particular matter (PM) formation and to after treatment system degradation. Lubricant R&D will elucidate the mechanisms by which these pollutants are produced and direct development of lubricants without these properties. In addition, improved lubricants (e.g., engine and transmission oils) are among the few simple and inexpensive technologies that can improve the fuel economy and emissions of vehicles already in use.

Renewable and alternative fuels R&D is required to develop and test fuels that can directly displace petroleum fuels in the transportation sector (e.g., advanced next-generation biofuels). Under current law, the U.S. is mandated to use substantially more renewable fuel in the near future – 36 billion gallons annually by 2022 versus about 10 billion today. This mandate cannot be implemented using currently available fuels. R&D is needed to improve the compatibility of vehicles and fueling infrastructure with renewable and alternative fuel components and to assess the impacts of new components on the environment and human health.

[a] SBIR/STTR funding transferred in FY 2010 was $602,375 for the SBIR program and $72,285 for the STTR program.

Detailed Justification

	(dollars in thousands)	
	FY 2010 Current Approp	FY 2012 Request
Advanced Petroleum Based Fuels (APBF)	**6,780**	**0**

Activities specific to petroleum-based fuels have concluded. Fuel science activities related to fuels in general that have formerly been conducted under this budget line have been subsumed by the Fuels and Lubricant Technologies activity.

Fuels and Lubricant Technologies (formerly Non-Petroleum Based Fuels and Lubricants)	**16,641**	**17,985**

The Fuels and Lubricant Technologies activity evaluates advanced fuels, fuel components and lubricants used, or proposed for use, in current and advanced engines. Fuels of interest range from pure alternative fuels to fuels containing mixtures of conventional and unconventional components (e.g., butanol or green diesel). Biomass-based, renewable fuels and bio-synthetic fuels are emphasized. Specific areas being investigated include fuel quality and stability; detailed chemical composition and its relationship to fuel bulk properties; the effect of physical and chemical properties on engine performance and emissions; and safety associated with storage, handling, and toxicity.

Next-generation biofuels are of particular interest due to their potential interchangeability with conventional fuels in use today and their small carbon footprint, relative to most alternatives. Fuel interchangeability eliminates an enormous barrier to the increased use of biofuels by eliminating the need to develop a new fuel distribution, blending and fueling infrastructure. However, assessments of candidate "drop-in" replacement fuels are necessary to ensure that such potential fuels serve their intended purpose. Specific areas being investigated include fuel quality and stability; detailed chemical composition and its relationship to fuel bulk properties; the effect of physical and chemical properties on engine performance and emissions; and safety associated with storage, handling, and toxicity.

Advanced lubricants, for both engines and transmissions, have great potential to directly improve fuel economy by reducing parasitic efficiency losses (e.g., internal friction). Lubricants also represent a rare opportunity to develop a technology that can be used as a retrofit to existing technology, in many cases, increasing and vastly accelerating petroleum displacement in the marketplace.

In FY 2012, the activity will continue studies of the effects of physical and chemical property variations in renewable and alternative fuels on the performance and emissions of advanced combustion engines. These activities will be undertaken in close coordination with the Advanced Combustion Engine R&D subprogram. In addition, the activity will expand studies of next-generation biomass-derived transportation fuels into a comprehensive R&D and testing program to assess the feasibility of large-scale deployment of such fuels. In FY 2012 the activity will also initiate a comprehensive study of advanced lubricants for increased efficiency.

(dollars in thousands)

	FY 2010 Current Approp	FY 2012 Request
SBIR/STTR	**0**	**518**

In FY 2010, $602,375 and $72,285 were transferred to the SBIR and STTR programs respectively. The FY 2012 amount shown is the estimated requirement for the continuation of the SBIR and STTR program.

Total, Fuels Technology	**23,421**	**18,503**

Explanation of Funding Changes

	FY 2012 vs. FY 2010 Current Approp ($000)
Advanced Petroleum Based Fuels (APBF)	
In FY 2012, APBF will discontinue studies on the impact of lubricants on emissions from conventional vehicles and studies on the influence of petroleum-based fuels and fuel composition on advanced combustion regimes; and will cease development of computer models for the chemical kinetics of fuels that supported computer aided engine design. These conventional fuels-related activities are being discontinued to focus on higher priority technologies for transportation electrification, including advanced batteries, power electronics, electric motors for hybrid and plug-in hybrid electric vehicles, as well as deployment activities to develop infrastructure for increased use of these technologies. Future requirements will be assessed and included as appropriate.	-6,780
Fuels and Lubricant Technologies (formerly Non-Petroleum Based Fuels and Lubricants)	
The FY 2012 funding increase will support the acceleration and expansion of activities related to next-generation renewable/biofuels and the initiation of a study of the potential impact of advanced lubrication on fuel economy.	+1,344
SBIR/STTR	
In FY 2010, $602,375 and $72,285 were transferred to the SBIR and STTR programs respectively. The FY 2012 amount shown is the estimated requirement for the continuation of the SBIR and STTR program.	+518
Total Funding Change, Fuels Technology	**-4,918**

Outreach, Deployment & Analysis

Funding Schedule by Activity

(dollars in thousands)

	FY 2010 Current Approp	FY 2012 Request
Outreach, Deployment & Analysis		
Graduate Automotive Technology Education (GATE)	1,000	1,000
Advanced Vehicle Competitions	2,000	1,000
Legislative and Rulemaking	2,004	2,000
Vehicle Technologies Deployment	25,510	229,000
Biennial Peer Reviews	2,700	500
VMT Reduction and Legacy Fleet Improvement	0	3,000
Total, Outreach, Deployment & Analysis	33,214	236,500

Benefits

The Outreach, Deployment & Analysis subprogram contributes directly to VTP's climate benefits by accelerating the movement of advanced technologies into widespread usage. For the existing program, the university-based activities contribute to a green workforce that will incorporate energy efficiency thinking into their entire careers, and the deployment activity directly accelerates the movement of advanced-technology vehicles into the marketplace.

Subprogram functions include both regulatory and voluntary components. The regulatory elements include legislative, rulemaking, and compliance activities associated with alternative fuel requirements identified by EPAct 1992 and 2005. Voluntary efforts include demonstration of advanced technology vehicles to verify market readiness, and public information, education, outreach and technical assistance efforts. VTP works with public/private partnerships between DOE and local coalitions of key stakeholders across the country (such as Clean Cities) to implement strategies and projects that displace petroleum. In addition, the annual DOE/EPA Fuel Economy Guide publication and related data dissemination efforts (required by law) are produced, along with the website www.fueleconomy.gov.

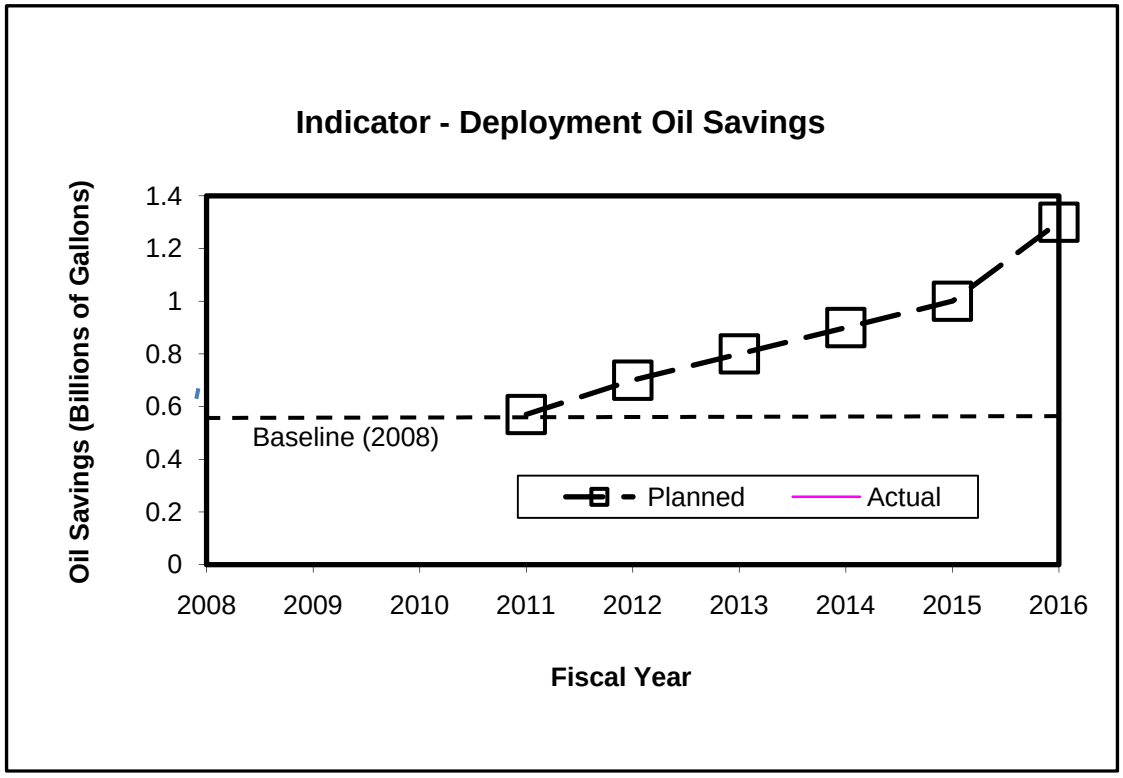
Activities such as the Advanced Vehicle Competitions and Graduate Automotive Technology Education (GATE) encourage the interest of university student engineers and engage their participation in advanced technology development. This helps address the need for more highly trained engineers in hybrid and fuel cell technologies to overcome barriers in the marketplace. GATE also supports a pipeline into the auto industry of new engineers familiar with the most advanced technologies.

The Legislative and Rulemaking activity implements a variety of statutory responsibilities placed on DOE by EPAct 2005 and other statutes and legislation. The main responsibilities include oversight and regulation of the requirements for States and alternative-fuel providers to operate AFV vehicle fleets.

A key goal of the subprogram is to:

- Achieve a petroleum reduction of 2.5 billion gallons per year by 2020 through the adoption of alternative fuels and advanced technology vehicles, development of the infrastructure needed to support them, and increased public awareness about the energy and environmental benefits associated with using these fuels and technologies.

The progress indicator for this goal is shown below.



Applied R&D benefits are not parsed to individual subprograms because of the interdependency of the R&D and technologies within the program. VTP continually assesses and draws from feedback, new information and advances among science, research, technologies and key market elements to accelerate the benefits of technology development and adoption.

Detailed Justification

(dollars in thousands)

	FY 2010 Current Approp	FY 2012 Request
Graduate Automotive Technology Education (GATE)	**1,000**	**1,000**

In FY 2012, this activity will establish and expand course study work and research to support graduate engineering degrees with a focus or certificate in critical automotive technology areas. This activity will help train a future workforce of automotive engineering professionals knowledgeable about, and experienced in, developing and commercializing advanced automotive technologies to help overcome technology barriers preventing the development and production of cost-effective, high-efficiency vehicles for the U.S. market. In addition, these funds may be used to support efforts such as peer reviews; data collection and dissemination; and technical, market, economic, and other analyses.

Advanced Vehicle Competitions	**2,000**	**1,000**

The Advanced Vehicle Competitions activity will educate the next generation of young engineers in automotive technology, providing first-hand experience with advanced technologies such as PHEVs and advanced combustion alternative fuel vehicles. In addition, these funds may be used to support efforts such as peer reviews; data collection and dissemination; and technical, market, economic, and other analyses.

Legislative and Rulemaking	**2,004**	**2,000**

The Legislative and Rulemaking activity consists of implementation of: the State and Alternative Fuel Provider Regulatory program (10 CFR Part 490); alternative fuel designations; the Private and Local Government Fleet Regulatory program; and the implementation of 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. The fleet programs require selected covered fleets to procure passenger AFVs annually. DOE reviews and processes petitions to designate new alternative fuels under EPAct. In addition, these funds may be used to support efforts such as peer reviews; data collection and dissemination; and technical, market, economic, and other analyses.

(dollars in thousands)

	FY 2010 Current Approp	FY 2012 Request
Vehicle Technologies Deployment	**25,510**	**229,000**

The Vehicle Technology Deployment activity promotes the adoption and use of petroleum reduction technologies and practices by working with Clean Cities coalitions and their stakeholders, industry partners, fuel providers, and end-users. Technology focus areas include: alternative fuel and electric drive advanced technology vehicles and related fueling/charging infrastructure; idling reduction for commercial trucks and buses; expanded use of non-petroleum and renewable fuels; hybrid vehicles; driving practices for improved efficiency; and engine/vehicle technologies that maximize fuel economy. Working in conjunction with technology experts at the National Laboratories, activities include outreach, training, and technical assistance related to each technology focus area. Critical tools and information will be provided via the Internet, telephone hotline, publications, and direct interaction with experts. The program will also continue efforts to provide technical assistance for early adopters of technologies, and provide training and workshops to coalitions, public safety officials, and stakeholders related to infrastructure development and targeted niche market opportunities that include: transit, refuse trucks, school bus, delivery trucks, and municipal fleets.

Section 405 of EPAct 1992 and Sections 721, 1001, and 1004 of EPAct 2005 direct DOE to:

- Expand consumer education;
- Promote technology transfer; and
- Address implementation barriers.

VTP will identify and support opportunities to showcase the technology focus areas and continue to build national and regional alliances to promote petroleum reduction strategies and will support further expansion of alternative fuel and electric drive infrastructure deployment. Public awareness of these technologies will be enhanced by high visibility demonstration projects at national parks and other public locations whenever possible. Efforts to support the development and promote the use of the (legislatively mandated) Fuel Economy Guide and associated website (www.fueleconomy.gov) will continue. In addition, these funds may be used to support efforts such as technology transfer/technology exchange meetings and forums with industry stakeholders, peer reviews, data collection and dissemination, and technical, market feasibility, economic, and other analyses.

FY 2012 Vehicle Technologies Deployment funding includes $200 million for the expansion of electric drive vehicle deployment and related infrastructure development activities, in support of the President's goal to put 1 million electric vehicles on the road by 2015. This competitive grant program will support communities to become early adopters of electric drive vehicles through regulatory streamlining, infrastructure planning and development, and other investments.

Biennial Peer Reviews	**2,700**	**500**

Funding is used to conduct reviews of the government/industry partnerships by an independent third party, such as the NAS/National Academy of Engineering, to evaluate the progress and direction of the program. Reviews will include evaluation of progress toward achieving the technical and program

(dollars in thousands)

	FY 2010 Current Approp	FY 2012 Request

goals supporting each partnership, as well as an assessment of 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. In addition, these funds may be used to support efforts such as technology transfer/technology exchange meetings and forums with industry stakeholders, peer reviews, data collection and dissemination, and technical, market feasibility, economic, and other analyses.

VMT Reduction and Legacy Fleet Improvement	**0**	**3,000**

The new activity will support the more efficient use of existing light-duty vehicle stock by encouraging efficient driver behavior, reducing the number of vehicle miles traveled (VMT), and by developing and deploying simple aftermarket tools and technologies to reduce fuel consumption. This activity will encourage more efficient light vehicle driver behavior via the development and deployment of driver feedback devices that stimulate efficient driving. The activity will also encourage less frequent use of light vehicles by initiating a dialogue with DOT, EPA, and others on strategies to reduce VMT and subsequently implementing those strategies. VTP will interact with DOT and tire manufacturers to develop a tire improvement strategy, which will assess technology gaps to cost-competitive low rolling resistance tires and identify demonstration and deployment strategies to raise consumer awareness and achieve quick market penetrations throughout the legacy fleet. In addition, these funds may be used to support efforts such as technology transfer/technology exchange meetings and forums with industry stakeholders, peer reviews, data collection and dissemination, and technical, market feasibility, economic, and other analyses.

Total, Outreach, Deployment & Analysis	**33,214**	**236,500**

Explanation of Funding Changes

	FY 2012 vs. FY 2010 Current Approp ($000)
Graduate Automotive Technology Education (GATE)	
No change.	0
Advanced Vehicle Competitions	
Funding is decreased to focus on priority activities in VTP. The decrease will reduce the number of students exposed to advanced automotive technologies through the competition series, scale back the number of participating universities and the scope of the competition.	-1,000
Legislative and Rulemaking	
No significant change.	-4
Vehicle Technology Deployment	
Increased funding will be used to support expanded transportation electrification efforts, advanced technology vehicle deployment, and infrastructure development activities. This includes competitive awards to deploy electric vehicles and the charging infrastructure services needed to support them.	+203,490
Biennial Peer Reviews	
In FY 2010, funding was provided for a one-time comprehensive analysis of energy use within the light duty vehicle transportation sector. No funds are requested for this analysis in FY 2012.	-2,200
VMT Reduction and Legacy Fleet Improvement	
The VMT Reduction and Legacy Fleet Improvement Activity is new in FY 2012. This funding will enable VTP to reduce the fuel consumption and emissions of vehicles already on the road by developing and deploying feedback devices that encourage efficient driver behavior, by reducing miles traveled, and by developing and deploying cost-efficient, fuel-efficient aftermarket tires.	+3,000
Total Funding Change, Outreach, Deployment & Analysis	**+203,286**

Building Technologies

Funding Profile by Subprogram

(dollars in thousands)

	FY 2010 Current Approp[a]	FY 2012 Request
Building Technologies		
Residential Buildings Integration	39,194	49,000
Commercial Buildings Integration	38,290	224,000
Emerging Technologies	84,562	102,700
Technology Validation and Market Introduction	22,000	25,000
Equipment Standards and Analysis	35,000	70,000
Total, Building Technologies	219,046	470,700

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. 95-618, "Energy Tax Act" (1978)
P.L. 95-619, "National Energy Supply Policy Act" (NECPA) (1978)
P.L. 95-620, "Power Plant and Industrial Fuel Use Act" (1978)
P.L. 96-294, "Energy Security Act" (1980)
P.L. 100-12, "National Appliance Energy Conservation Act" (1987)
P.L. 100-357, "National Appliance Energy Conservation Amendments" (1988)
P.L. 100-615, "Federal Energy Management Improvement Act" (1988)
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"

Mission

The mission of the Building Technologies Program (BTP) is to develop and promote efficient, environmentally friendly, and affordable technologies, systems, and practices for our Nation's residential and commercial buildings that will lower greenhouse gas (GHG) emissions, foster economic prosperity and increase National energy security while providing the energy-related services and performance expected from our buildings.

Benefits

Buildings account for approximately 40 percent of U.S. energy use and more than 70 percent of the electric energy consumed in the U.S.[b] By helping to reduce this significant demand, the program aligns with DOE's goal to provide clean, secure energy by developing reliable, affordable, and

[a] Per P.L. 111-85, DOE exercised the option to fund the NREL Ingress/Egress project with Recovery Act funds. The use of this option provided $22.0 million in funding for the Energy Efficient Building Systems Design Energy Innovation Hub.
[b] U.S. DOE Energy Efficiency and Renewable Energy, *2009 Buildings Energy Databook.* November 2009: http://buildingsdatabook.eren.doe.gov/Default.aspx.

environmentally sound energy efficiency technologies, which significantly reduce the energy consumption of both new and existing residential and commercial buildings.

The FY 2012 President's Budget includes a major new initiative – the Better Buildings Initiative – that seeks to achieve a 20 percent improvement in commercial building energy efficiency by 2020. This initiative will catalyze private sector investment through incentives to upgrade offices, stores, schools, and other municipal buildings, universities, hospitals, and other commercial buildings. These incentives include a new tax incentive for building energy efficiency, more financing opportunities for commercial retrofits, a Race to Green competitive grant program for state and municipal governments including incentives for states and municipalities that streamline regulations, codes and performance standards (which is included in the BTP program), and a Better Buildings Challenge with the private sector. This includes expanded research on components and integrated systems that can dramatically increase energy efficiency at a lower cost than building new power plants without sacrificing functionality or safety.

BTP's FY 2012 activities reflect a significant shift by EERE in budget development of incorporating analytically based integrated planning, review, and performance assessment of its programs. BTP's FY 2012 portfolio will achieve rapid gains in the efficient use of buildings energy through a balanced set of strategies. This includes expanded research on components and integrated systems that can dramatically increase energy efficiency at a lower cost than building new power plants without sacrificing functionality or safety. The FY 2012 budget focuses on advanced building components (next generation lighting, heating and refrigeration devices, sensors and controls, windows, shell materials, etc.) and systems integration. Other strategies include appliance standards to bring additional cost savings to consumers appliance standards, accelerated development and adoption of new building codes, development of new information tools on building energy efficiency, building Energy Scores, innovative financing, support for building retrofits, and other methods to accelerate adoption of new efficiency technologies and practices. High-priority FY 2012 investments include providing additional funding to a commercial buildings retrofit initiative (>30 percent of U.S. electricity demand), which is critical to achieving emissions reductions. The initiative will increase integrated commercial buildings technical research to develop and demonstrate new retrofit practices, technologies, and tools for the many types of commercial buildings across the country. This work will support Clean Energy Ministerial initiatives and leverage training programs started under the Recovery Act. The BTP program generates the following benefits:

The U.S. building sector is responsible for 38 percent of total U.S. carbon dioxide emissions.[a] BTP contributes to the reduction of GHG emissions by providing technologies that, when commercialized, will make the Nation's buildings more energy efficient. The efficiency gains from these advanced technologies not only reduce the overall energy demand from buildings but also reduce consumption of electricity generated from fossil fuels. The use of energy efficient components and whole-building (systems integrated) design strategies will eventually permit low carbon buildings to become an everyday reality, while keeping the net costs of new components at the same level as existing technologies.

Advanced efficiency technologies can directly reduce oil use in regions of the country that rely on home heating oil, making the Nation less vulnerable to oil supply disruptions or price spikes. R&D activities in components such as advanced envelope and window technologies reduce heating loads in buildings, which reduces building energy use, and therefore reduces the utilization of source energy used in power plants.

[a] 2009 Buildings Energy Data Book.

Reduced energy use in buildings can be expected to reduce energy bills for American families and businesses. New technologies developed with the help of BTP and manufactured by the domestic industry will create jobs, spur economic growth, and continue America's role as a global innovator and exporter of high-tech products. Efficient buildings have the added benefit of mitigating the need for the electric power industry to construct expensive new power plants.

BTP projects accelerate deployment of energy efficient retrofits by improving the technology available to retrofit existing buildings, helping Americans save money on their electric bills and lowering GHG emissions. Achieving BTP's goals of reducing the cost of advanced building technologies and homeowner energy bills will permit consumers to use these saved dollars elsewhere.

The proposed FY 2012 investments complement funds provided by the American Recovery and Reinvestment Act (Recovery Act), which support the development of advanced building technologies and deployment mechanisms. Specifically, they support the BTP goals of creating technologies and design approaches that lead to cost effective energy efficient buildings, including making America's existing housing stock more efficient through application of new retrofit technologies and practices. FY 2012 activities will build upon historic clean energy investments in the Recovery Act to further the Nation's energy goals through sustained technology innovation and continued investments in infrastructure. To enable decision makers and the public to follow performance and plans, the program posts its progress in these activities online, at: http://www.energy.gov/recovery/index.htm.

Annual Performance Targets and Results

The Department is in the process of updating its strategic plan, and has been actively engaging stakeholders including Congress. The draft strategic plan is being released for public comment concurrent with this budget submission, with the expectation of official publication this spring. The draft plan and FY 2012 budget are consistent and aligned. Updated measures will be released at a later date and available at the following link http://www.mbe.doe.gov/budget/12budget/index.htm.

Residential Buildings Integration

Funding Schedule by Activity

(dollars in thousands)

	FY 2010 Current Approp[a]	FY 2012 Request
Residential Buildings Integration	39,194	47,902
SBIR/STTR	0	1,098
Residential Buildings Integration	39,194	49,000

Benefits

Residential Building Integration (RBI) R&D activities will provide energy technologies and solutions to retrofit homes in support of the high priority performance goal for home retrofits. These activities and outputs lead directly to decreased energy use in homes, reduced carbon emissions, and lower homeowner energy bills. BTP activities also invest in National Laboratories and R&D projects contributing to the deployment of science and basic research to create the energy technologies of the future.

Detailed Justification

(dollars in thousands)

	FY 2010 Current Approp	FY 2012 Request
Residential Buildings Integration	39,194	47,902

RBI will continue its R&D into cost-effective, production ready systems. Building America demonstrates strategies to achieve cost-effective energy savings on a production basis by building community subdivisions which will reduce whole-house energy use in new homes by an average of 30 percent by 2013 and 50 percent by 2026 (compared to the IECC 2009 and the Building America Benchmark). Building America is a private/public partnership that conducts research on energy solutions for new and existing homes on a cost-shared basis with major stakeholders in the homebuilding industry. Building America combines the knowledge and resources of industry leaders with DOE's technical capabilities to act as a catalyst for energy efficient change in the home-building industry. Industry partners provide all costs for equipment, construction materials and construction labor used in research projects

DOE conducts residential systems research driven by climate zone specific performance targets and the financial constraint of zero or less net cash flow in three stages for each climate zone. During three stages, Building America acts as a national residential energy systems test bed where homes with

[a] SBIR/STTR funding transferred in FY 2010 was $800,000 for the SBIR program and $96,000 for the STTR program.

different system options are retrofitted or designed and built and tested at three levels of system integration, including technology pathways, systems and measures, test houses and pilot communities. These research efforts will result in energy efficient Measures Guidelines and final Energy Efficient Residential Solutions Packages (EERSPs). See tables below for schedules for completion of the packages for new and existing homes. EERSPs provide an integrated, system engineered set of technologies and builder or contractor procedures that achieve a set energy savings level in a particular climate or region.

From the EERSPs developed above, "Best Practices" manuals are designed for contractors, builders, manufacturers, homeowners, real estate agents, educators, insurance companies, and mortgage providers. The manuals present research results in illustrated text targeted to a specific audience to make it easily assimilated. Manuals also synthesize research findings into energy-efficient processes for the building industry. The manuals provide the primary means to communicate research results in the EERSPs to a wider, less technical audience via the web, email and Building America attendance at national conferences. These manuals show consumers, builders, contractors, appraisers, and others how to cost effectively implement energy saving retrofits.

Table 1: Completion of New Homes Energy Efficient Residential Solution Packages

Research Pilots (IECC 2009 + BA Benchmark	Hot	Marine & Mixed Humid	Cold
30%	2011	2012	2013
50%[a]	2014	2015	2016

Table 2: Completion of Existing Homes Energy Efficient Residential Solution Packages

Existing Home (Pre/Post)	Hot	Mixed-Humid & Marine	Cold
30%	2012	2013	2014
50%	2015	2016	2017

BTP will also develop retrofit measure guidelines that further increase benefits and reduce costs for implementation of retrofit measures. BTP will complete existing homes research for advanced efficiency measures at the 10-15 percent efficiency level in all climate zones in FY 2012. The annual performance goals in Table 1 reflect the transition to IECC 2009 in the 2011 Building America Benchmark and are technically equivalent to the former Building America goals at the 50 percent level of energy savings compared to the 2010 Building America benchmark. The hot dry and hot humid climate zone have been combined into one report and the marine and mixed humid climates have also been combined. The combined reports will have separate sections describing the climate specific technologies and how to implement these technologies. These reports capture the lessons learned from implementing advanced energy efficient technologies in field tests throughout the Nation and communicate it to builders and contractors.

The RBI goal is to maximize cost effective energy efficiency in homes. Consistent definitions of retrofit measures, standardized analysis tools, and standard work scopes and installation guidelines are required

[a] The 70 percent design guide for mixed-humid and cold climates may not be technically achievable because of a shift in focus from new construction to pre-existing homes (retrofit) R&D.

(dollars in thousands)

FY 2010 Current Approp	FY 2012 Request

to enable the development of a large, nationwide, market for energy retrofits. This research will include pilot communities that document and measure costs and energy savings. Based on lessons learned from the pilot communities, the research will provide recommendations for improvements in the Work Scopes, Measures Implementation Guidelines, Design Details, Training and Certification Requirements, and Quality Assurance/Quality Control Procedures that were used to implement measures used in community-scale pilot studies. The data and the resulting case studies from these analyses will be used to support the alignment of DOE's Builders Challenge and the EPA's ENERGY STAR new homes program and to initiate wider-scale retrofit programs.

In FY 2012, DOE will complete analysis of the pilot tests initiated in FY 2010 under the Home Energy Scoring Program. This program was launched in cooperation with local governments, electric utilities, and nonprofit partners in ten pilot communities across the country (in both urban and rural areas that cover a range of climates) to gauge how homeowners received the program and whether the availability of accurate information creates a positive incentive to obtain energy improvements for their homes. Based on pilot test results, DOE expects to launch the Home Energy Score nationally in FY 2012. This will expand the Home Energy Score program to more communities across America, empowering homeowners with better information about the energy efficiency of their homes and specific guidance about how to save money by saving energy.

BTP will also increase research and deployment of energy efficiency within existing homes by supporting the Better Buildings Residential Program, DOE's large scale existing homes retrofit initiative. This support will include resources dedicated to the evaluation, monitoring, and implementation of Better Buildings Residential projects with the eventual goal of applying proven best practices to a National retrofit program. In addition, BTP will work with the National Association of Home Builders (NAHB) and national retailers to promote energy efficient home remodeling and retrofits through innovative financing.

In addition, these funds may be used to support efforts such as peer review, data collection and dissemination; technical, market, economic and other analyses.

SBIR/STTR	**0**	**1,098**

In FY 2010, $800,000 and $96,000 was transferred to the SBIR and STTR programs respectively. The FY 2012 amount shown is the estimated requirement for the continuation of the SBIR and STTR program.

Total, Residential Buildings Integration	**39,194**	**49,000**

Explanation of Funding Changes

	FY 2012 vs. FY 2010 Current Approp ($000)
Residential Buildings Integration	
The increase in funding will enable an increasing emphasis on retrofit R&D to address the large energy saving potential in the existing housing stock. Funding from this reconfiguration will be used to manage and implement the Better Buildings Residential Program and expand the Home Energy Score Program, developing lessons learned from these pilots into a national program.	+8,708
SBIR/STTR	
In FY 2010, $800,000 and $96,000 was transferred to the SBIR and STTR programs respectively. The FY 2012 amount is the estimated requirement for the continuation of the SBIR and STTR program.	+1,098
Total Funding Change, Residential Buildings Integration	**+9,806**

Commercial Buildings Integration

Funding Schedule by Activity

(dollars in thousands)

	FY 2010 Current Approp[a]	FY 2012 Request
Commercial Buildings Integration	38,290	219,923
SBIR/STTR	0	4,077
Total, Commercial Buildings Integration	38,290	224,000

Benefits

In FY 2012 the Better Buildings Initiative seeks to achieve a 20 percent improvement in commercial building energy efficiency by 2020. This initiative will catalyze private sector investment through incentives to upgrade offices, stores, schools, and other municipal buildings, universities, hospitals, and other commercial buildings. These incentives include a new tax incentive for building energy efficiency, more financing opportunities for commercial retrofits, a Race to the Green competitive grant program for state and municipal governments including incentives for States and municipalities that streamline regulations, codes and performance standards (which is included in the BTP program), and a Better Buildings Challenge with the private sector.

By the end of FY 2012, Commercial Buildings Integration (CBI) R&D activities, in collaboration with industry, will develop, document, and disseminate a complete set of 16 technology packages that provide builders energy efficient options to meet their complex performance demands. These packages will enable the achievement of a 30 percent to 50 percent reduction in the purchased energy use in new, small to medium-sized commercial buildings relative to ASHRAE 90.1-2004. In FY 2012, CBI will also complete ten retrofit and ten new commercial buildings case studies (that achieve 30 and 50 percent increase, respectively, in energy efficiency relative to the ASHRAE 90.1-2004 benchmark) with five years or less payback. These activities and outputs lead to decreased energy use in commercial buildings and reduced energy bills for American businesses, with direct benefits to the U.S. economy making a significant contribution to the President's goal of 20 percent by 2020.

[a] SBIR/STTR funding transferred in FY 2010 was $634,000 for the SBIR program and $76,000 for the STTR program.

Detailed Justification

(dollars in thousands)

	FY 2010 Current Approp	FY 2012 Request
Commercial Buildings Integration	**38,290**	**219,923**

Race to the Green competitive grant program to State and municipal governments including incentives to improve and streamline codes, performance standards and regulations relating to commercial energy efficiency, DOE will provide competitive grants to empower States and localities to create the conditions for dramatically accelerating energy-efficiency upgrades to existing buildings that will more than pay for themselves. By implementing suites of policies such as adopting modern building codes, benchmarking and disclosing building energy use, and establishing public energy-savings targets, state and local governments can overcome traditional barriers to building energy efficiency and deliver significant energy and cost savings.

CBI is an integral part of the BTP program, engaging private sector companies, public, non-government and trade organizations through Commercial Building Energy Alliances and a competitively selected CBI supporting consortium. As directed by EISA, BTP consults with the supporting partnership consortium and others to establish CBI priorities and plans. Based on those plans, BTP is executing a program of critical RD&D such as sensors and controls; miscellaneous electrical load (MELs); and technology deployment to meet subprogram goals. CBI is also engaging the commercial buildings industry, manufacturer and supplier base, financial institutions, and stakeholder organizations in overcoming regulatory and market barriers to the adoption and use of the technologies, practices, tools, and techniques being developed. Commercial Building Energy Alliances for Retailers, Commercial Real Estate (owned and leased, hospitality), Hospitals, and Institutions (higher education, state, and local government) are vehicles for peer assistance, technology procurement, and sharing of technology assessments and best practices.

BTP is also providing cost-shared research and technical assistance on a competitive basis to Commercial Building Partners. Commercial Building Partners are comprised of business entities with building portfolios of significant square-footage that regularly engage in new construction, and also implement retrofits of existing buildings on a regular basis. Commercial Building Partners are firms that have committed to a building retrofit that reduces energy use by 30 percent, and the design of a prototype new building at 50 percent reduced energy use, relative to ASHRAE 90.1-2004. Building Partners activities enable the development of an in-depth understanding of the technical challenges and gaps, market factors and barriers, and business cases and obstacles associated with achieving CBI goals. As CBI progresses, retrofit and prototype savings targets will be increased to reflect research successes and availability of new and advanced technologies, tools, and practices. In addition to Commercial Building Partner activities, BTP is engaging the full spectrum of research performers (i.e., National Laboratories, universities, and private sector companies) in cost-shared research needed to develop technologies, tools, and practices required to meet the long-term CBI goals.

(dollars in thousands)

FY 2010 Current Approp	FY 2012 Request

Commercial Building Partnerships are opportunities for DOE to experiment with commercial buildings, the Energy Alliance partners, as well as to enable emerging technology RD&D. In late FY 2010, DOE initiated approximately 20 new retrofit projects with partners. These projects will be measured and validated with regard to the focused technology or strategy deployed. The resulting data will be disseminated into the marketplace, focusing on owners, engineers, architects, and operations and maintenance staff.

In addition, DOE works with the High-Performance Green Building Partnership Consortia, a DOE-recognized building industry group, which provides high-performance green building information and disseminates research results. DOE will support the consortia in development of green building retrofit guides in FY 2012.

To support the robust challenge to continuously maintain energy improvements achieved in corporate properties in the commercial and industrial sectors, DOE will accelerate the introduction of the Global Superior Energy Performance partnership (GSEP) nationally. GSEP was announced internationally as part of the Clean Energy Ministerial and will coordinate national level certification programs. These programs will require commercial facilities to implement energy management systems such as the forthcoming ISO 50001 energy management standard and related measurement and verification protocols. To deploy the program, region-focused and specialty-focused extension centers will develop tools, resources, and materials to use nationally and internationally in support of the GSEP. Once companies take up the challenge to make and maintain energy efficiency improvements, corporations' acceptance and action on the challenge will then create demand within the commercial retrofit marketplace.

DOE is committed to accelerating community scale deployment and engagement in retrofit research and implementation. The U.S. construction industry is highly fragmented with more than a million companies participating in the market. Over 80 percent are small firms with less than 10 employees, two-thirds have fewer than five employees, and less than 1,000 firms employ 500 or more persons. The composition of the construction workforce differs from the U.S. workforce due to the large number of self-employed workers (sole proprietorships and partnerships). Within the construction industry, there are 1.8 million self-employed workers. This fragmentation makes it challenging to achieve the commercial building energy efficiency transformation needed to ensure success in a 21st century economy. BTP will develop a community scale commercial buildings extension partnership, modeled after successful programs in agriculture and manufacturing, as a deployment vehicle for best available technologies, practices, materials, and equipment. This partnership program will:

- Provide ongoing support to the retrofit industry through workforce development efforts focused on standardizing training and certification of the related workforce. Education efforts are directed at unskilled and skilled craft workers, operations and maintenance workers, foremen, and field engineers;
- Deliver technical and business assistance to small and medium enterprises through the delivery of a comprehensive program of analysis, benchmarking, demonstration, road-mapping, advisory, and clearinghouse services, leveraging the existing commercial buildings alliances and partnerships; and

(dollars in thousands)

FY 2010 Current Approp	FY 2012 Request

- Provide analysis of financial, tax, and regulatory incentives to promote the accelerated adoption of emerging new technologies, practices, materials, and equipment and support energy efficiency as a good business decision.

In FY 2012, BTP will also invest in research and deployment activities in the areas of building operations, maintenance, commissioning, and auditing. The Commercial Buildings Program will pilot a small scale commercial building extension program with the National Institute of Standards and Technology (NIST) and universities. This partnership will allow university students and professors to work within their communities to grow the auditing, operations, and commissioning activities with local businesses. It also provides a national network for easily disseminating information and data regarding commercial building retro-commissioning and retrofits.

Commercial Building Design Technology Packages Performance Targets

Characteristics	Units	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Small and Medium Sized Commercial Building Design Technology Packages	30% Energy Savings	0	1	1	2	4	4	0	0	0	0	0	0	0
Commercial Building Design Technology Packages	50% Energy Savings	0	0	0	0	0	0	4	0	0	0	0	0	0
Case Studies (Retrofit)	30% Energy Savings	0	0	0	0	0	0	0	5	10	10	10	10	10
Case Studies (New Buildings)	50% Energy Savings	0	0	0	0	0	0	0	5	10	10	10	10	10

In FY 2012, BTP will continue work on the development of retrofit and new buildings case studies that will help drive a net cost-effective increase (50 percent) in commercial building energy efficiency over ASHRAE 90.1-2004. The Commercial Building Design Team will develop a case study final report documenting all findings to include energy savings, redesign costs, and payback period for each building constructed or retrofitted. These reports will be of laboratory technical quality and peer-reviewed for public distribution. FY 2012 will focus more efforts on documenting energy savings in existing buildings, with ten case studies.

Advanced Energy Design Guides are “code plus” documents, which push 2009 ASHRAE 90.1 or 2009 IECC to be 30-50 percent more efficient. Energy Alliance members will nominate retrofit specific guides in order to concentrate activities, define clear working group meetings with outside partners/stakeholders, and draft a deployment structure that is clear and accessible. These activities will be coordinated with the Code’s program, launched with industry backing, and will be available for communities to adopt. Work on these guides will wind down in FY 2010.

(dollars in thousands)

FY 2010 Current Approp	FY 2012 Request

Analytical studies on cool roofs report very large carbon mitigation potential through the direct rejection of heat from urban surfaces. However, these claims have not yet been validated. In FY 2010, BTP hosted an international scientific peer review panel and developed a comprehensive research roadmap plan for cool roofs.

Beginning in FY 2012, research will be conducted to develop an accelerated performance rating for cool roofs from the current requirement of three years to six months, allowing for faster introduction of new innovative products in the marketplace. The "aged" performance rating is critical because all roofs get soiled, which reduces their energy performance over time and ratings provide realistic energy savings potential. Significant effort will be required to promulgate the new test procedure in U.S. standard organizations, as well as within International Standard Organizations. Cool roof materials reflect more heat than standard materials and thus lower thermal conduction into buildings, decrease air conditioning requirements and provide additional benefits of urban heat island mitigation in hot climates.

In addition, these funds may be used to support efforts such as peer review, data collection and dissemination; technical, market, economic and other analyses.

SBIR/STTR	**0**	**4,077**

In FY 2010, $634,000 and $76,000 was transferred to the SBIR and STTR programs respectively. The FY 2012 amount shown is the estimated requirement for the continuation of the SBIR and STTR program.

Total, Commercial Buildings Integration	**38,290**	**224,000**

Explanation of Funding Changes

	FY 2012 vs. FY 2010 Current Approp ($000)
Commercial Buildings Integration	
Additional funding is allocated to a major initiative in retrofitting commercial buildings (>30 percent of U.S. electricity demand) critical to achieving Administration goals for emissions reductions. The initiative will increase integrated commercial buildings technical research to develop and demonstrate new retrofit practices, technologies, and tools for the many types of commercial buildings across the country. This work will support Clean Energy Ministerial initiatives and leverage the training programs started under the Recovery Act. DOE will challenge industry to design cost-effective integrated building systems, including sensors, software, and inexpensive meters, to identify and diagnose energy waste and improve efficiency for building owners and	+181,633

	FY 2012 vs. FY 2010 Current Approp ($000)
managers.	
DOE will implement the Race to Green competitive solicitation to state and local governments for innovative programs, including incentives to encourage improvements to codes regulations, and performance standards relating to commercial buildings.	
SBIR/STTR	
In FY 2010, $634,000 and $76,000 was transferred to the SBIR and STTR programs respectively. The FY 2012 amount is the estimated requirement for the continuation of the SBIR and STTR program.	+4,077
Total Funding Change, Commercial Buildings Integration	**+185,710**

Emerging Technologies

Funding Schedule by Activity

(dollars in thousands)

	FY 2010 Current Approp[a]	FY 2012 Request
Emerging Technologies		
Lighting R&D	25,562	25,832
Space Conditioning and Refrigeration R&D	9,000	19,690
Building Envelope R&D	16,000	25,345
Analysis Tools	5,500	4,837
Solar Heating and Cooling	6,500	0
Energy Innovation Hub: Energy Efficient Building Systems Design[b]	22,000	24,369
SBIR/STTR	0	2,627
Total, Emerging Technologies	84,562	102,700

Benefits

Emerging Technologies activities will accelerate the introduction of highly efficient technologies and practices for both new and existing residential and commercial buildings. Emerging Technologies activities support BTP goals through R&D of advanced lighting, building envelope, windows, space conditioning, water heating, and appliance technologies and analysis tools. Without advanced components and subsystems, such as the SSL technologies developed by these activities, the goal of maximizing cost effective energy efficiency in buildings will not be met.

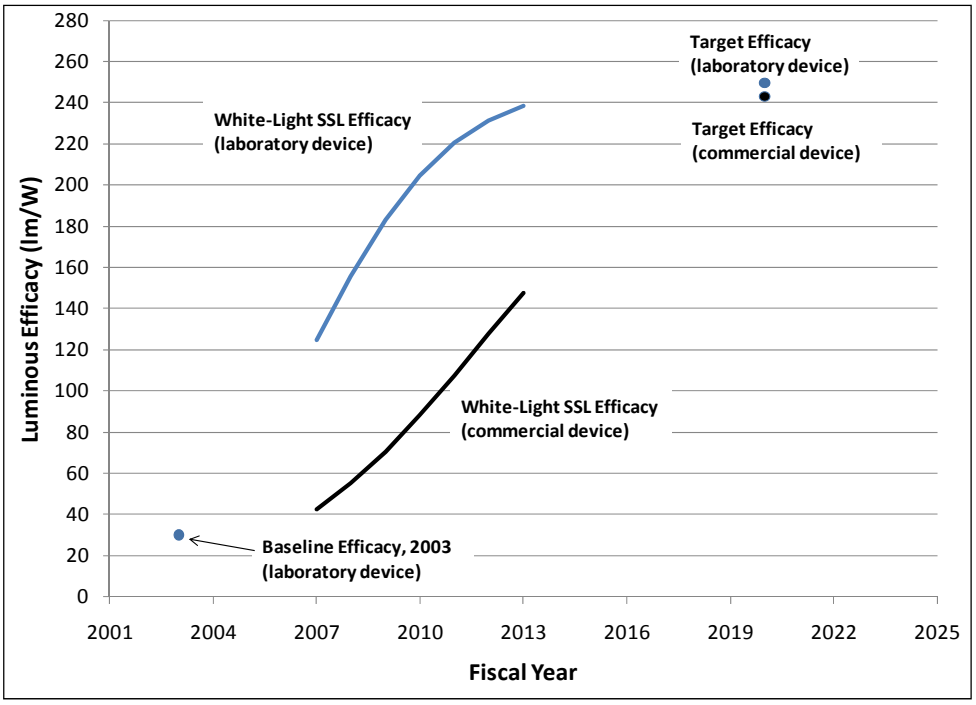
[a] SBIR/STTR funding transferred in FY 2010 was $1,204,000 for the SBIR program and $144,000 for the STTR program.
[b] Per P.L. 111-85, DOE exercised the option to fund the NREL Ingress/Egress project with Recovery Act funds. The use of this option provided $22.0 million in funding for the Energy Efficient Building Systems Design Energy Innovation Hub.

(dollars in thousands)

	FY 2010 Current Approp	FY 2012 Request
Lighting R&D	**25,562**	**25,832**

The R&D agenda of the SSL activities is established through an annual consultative process with general lighting industry, compound semi-conductor industry, universities, research institutions, National Laboratories, trade organizations, other industry consortia, and the Next Generation Lighting Industry Alliance (DOE's competitively selected SSL Partnership). A majority of the tasks are competitively bid and awarded to entities with proposals that meet these priorities and the SSL portfolio's stated objectives. The SSL activity classifies projects into three R&D classes: LED Core Technology, Product Development, and Manufacturing Improvements.

Efficacy Projection for White-Light SSL Laboratory Devices (Projections 2005 to 2012)



This projection is translated into point values in the following table, with the five-year target milestones.

Point Values of Efficacy Projections for White-Light SSL Laboratory Devices

(fiscal year)

Characteristics	Units	2003 (baseline)	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
SSL Performance Targets	Lm/W	30	65	79	95	101	110	120	123	126	129	130
Actual		48	65	79	95	107	117	–	–	–	–	–

(dollars in thousands)

FY 2010 Current Approp	FY 2012 Request

SSL R&D Topics

Topic	LEDs		OLEDs	
	Current R&D	Future R&D	Current R&D	Future R&D
Core:	• Phosphors • Semiconductor materials • Defect Physics • Light extraction	• Substrates, buffers and wafers • Alternative Structures • Encapsulating and packaging • Fabrication of component prototypes	• Novel Materials • New architectures • Light extraction • Improved charge injection • Transparent electrodes	• Encapsulating materials • Material/structures evaluation • Substrate materials • Down conversion materials • Modeling of material principles • Electrodes and interconnects • Fabrication and patterning techniques
Product Development:	• Luminaire life and performance • Optical coupling and modeling • Packaging • Manufactured materials • Thermal design • Materials in devices • Light extraction from devices	• Electronic development • Fabrication and manufacturing challenges • Device architectures • Mechanical design	• Application of materials in fabrication • Applied light extraction • Manufacturing process optimization • Device encapsulation and packaging	• Surface modification techniques • Demonstration architectures • Simulation tools for devices • Power spreading and driver electronics • Luminaire design • Synthesis manufacturing scale-up • Tools for manufacturing
Manufacturing:		• Epitaxial growth tools and processes • LED chip manufacturing • Automated LED packaging • LED luminaire manufacturing		• Production of OLED lighting prototypes • Paths to high volume manufacturing of OLED devices

The SSL portfolio currently funds nine core priority R&D topics and eleven Product Development priority R&D topics.[a] The second round solicitation awards[b] of the SSL Manufacturing R&D Initiative

[a] For further information on the SSL R&D Pathways, as discussed at the SSL Workshop by the research community and documented in the Multi-Year Program Plan FY 2009 – FY 2014, see the SSL website: (www.ssl.energy.gov)

[b] The date of the first reward will be March 1, 2011.

(dollars in thousands)

FY 2010 Current Approp	FY 2012 Request

may support topics such as: LED Driver Manufacturing, Tools for Epitaxial Growth, OLED Deposition and Patterning Equipment, and OLED Materials Manufacturing. Each year, R&D topics are reviewed for progress, completion of topical areas, new topics to start, and advice from the Alliance and the research community. The R&D topics are reprioritized for each annual solicitation.

FY 2012 focuses will include:

- Core Technology Research: Applied research for technology development, with particular emphasis on meeting efficiency, performance, and cost targets (LED Novel Substrates, buffers and wafers; and OLED Novel Transparent Electrodes);
- Product Development: Using the knowledge gained from basic or applied research to develop or improve commercially viable materials, devices, or systems (LED Electronic Component Research; and OELD Panel Outcoupling); and
- Manufacturing Improvement: Accelerating SSL technology adoption through manufacturing improvements that reduce costs and enhance quality.

Emerging Technologies activities will continue to analyze and address barriers to enable market introduction and commercialization of technologies resulting from these research projects. Included in this activity is the Bright Tomorrow Lighting Prize (L Prize), the first government-sponsored technology competition designed to spur lighting manufacturers to develop high-quality, high-efficiency SSL products to replace the common light bulb.

In addition, these funds may be used to support efforts such as peer review, data collection and dissemination; technical, market, economic and other analyses.

Space Conditioning and Refrigeration R&D **9,000** **19,690**

Space conditioning systems, which transformed the 20th Century by enabling building users to become more productive and comfortable, will continue to play a critical role in achieving BTP's low energy building goal. Space conditioning equipment for residential and commercial buildings consumes approximately 32.5 percent of the total energy used in buildings and is the most important contributor to summer peak electricity demand.[a]

Although the energy efficiency of HVAC equipment has increased substantially in recent years, new approaches and technologies are needed to continue this trend. The dramatic reductions in HVAC energy consumption necessary to support low energy building goals require a systems-oriented approach. This approach characterizes each element of energy consumption, identifies alternatives, and determines the most cost-effective combination of options. Therefore, the first task in this effort will involve system characterizations, identification of necessary upgrades to analysis tools, and an assessment of cost and performance of alternative solutions.

To achieve low energy buildings, the Space Conditioning R&D activity will reduce the energy consumption of commercial HVAC and residential water heating equipment by 80 percent over baseline levels by 2020. The residential baseline for HVAC (or HVAC & water heating) is the IECC

[a] 2009 Buildings Energy Data Book, U.S. Department of Energy, November 2009.

(International Energy Conservation Code) 2006.

Space Conditioning System Performance Goals

Characteristics	Status	2007 Target	2010 Target	2020 Target
Annual Residential HVAC, Water Heating and Dehumidification Energy Consumption Reduction vs. Building America benchmark IECC 2006 (demonstrated product)	Baseline	25%	50%	–
Annual Residential Water Heating Energy Consumption Reduction vs. IECC 2006 as the benchmark	Baseline	–	–	80%
Annual Commercial HVAC Energy Consumption Reduction vs. 2004 Baseline	Baseline	–	–	80%

In FY 2012, BTP will continue the development of an air-to-air integrated heat pump system that can meet the air heating, cooling, dehumidifying, ventilating, and water heating requirements of a tight-envelope mechanically ventilated low energy home, and the development of a ground-source integrated heat pump (GS-IHP). New strategies for achieving cost effective energy efficiency will also be assessed, looking at the contribution to low energy buildings, as well as overall market potential. These strategies will include novel ways of integrating highly efficient space conditioning and water heating, while also insuring comfort through proper ventilation and humidity control. Strategies which are essential to achieving low energy homes, but which also have widespread application potential to existing buildings, will be a particular focus of the research.

BTP will continue looking into affordable advanced materials, components, refrigeration cycles, and systems in FY 2012, which improve system energy consumption (including CO_2 systems). BTP will also continue research on non-vapor compression technologies with humidity control to reduce the energy consumption of HVAC, dehumidification, and water heating equipment by 50 to 80 percent over baseline levels. In addition, BTP will work on retrofit technologies, application of nanotechnology to AC component design, development of zero-global warming potential refrigerants, development of next-generation residential water heaters at a cost effective price premium with multi-functional capabilities, development of integrated end-use appliances, and identification of the most promising target technologies and components in miscellaneous electric loads to reduce energy consumption by 30 percent.

Another priority in FY 2012 is the continued development of a new generation of working fluids, refrigerants and blowing agents, with greater energy efficiency and lower global warming impacts. Refrigerants and blowing agents are used in wide variety of appliances, air conditioning, and refrigeration equipment. Refrigerants are the “lifeblood” of vapor compression cycle equipment, which dominates the global residential and commercial HVAC market. New findings and policy developments regarding climate change are putting new pressures on HFC alternatives, because of their high-Global Warming Potential (GWP) values. DOE has a critical stake in the development, evaluation and eventual choice of any new working fluids. A roadmap will be developed that include goals, estimated impacts of

(dollars in thousands)

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achieving these goals, and timetables.

Beginning in FY 2012 work will continue on the next generation water heating research: CO_2 heat pump water heaters and absorption natural gas water heaters. BTP will identify Not-in-Kind (NIK) technologies that can replace or be integrated with conventional vapor compression technologies to provide energy savings or other relevant environmental benefits. These different NIK technologies should be comparable or have better performance than state-of-art (SOA) vapor compression systems. NIK technologies could include but are not limited to thermoelectric cooling, thermotunneling (thermionic), thermoacoustic cooling, magnetic refrigeration, absorption cycle heat pumps and compressor-driven metal hydride heat pumps.

The Solar Heating and Cooling (SH&C) key activity is being combined with the Space Conditioning and Refrigeration R&D key activity in FY 2012. SH&C strives to provide the thermal energy needs of a low energy building. Building end uses that can be met by solar thermal technologies include domestic water heating, space heating, and space cooling. The overall goal is a 40 to 50 percent cost reduction of installed SH&C systems with a levelized cost of energy of $0.06 to 0.08/kWh over the life of the system by FY 2015.[a] The overall goal and research agenda for SH&C will be reviewed and by FY 2012 the appropriate role for SH&C within the Space Heating and Cooling Portfolio will be determined.

In addition, these funds may be used to support efforts such as peer review, data collection and dissemination; technical, market, economic and other analyses.

Building Envelope R&D **16,000** **25,345**

Window Technologies

Window performance continues to be vital to reaching residential and commercial buildings goals. Development of cost effective, highly efficient, and dynamic glazing and fenestration systems for all building types throughout the U.S. will require a portfolio of technologies matched to those types and climatic conditions. The table below lists the performance measurement targets for the windows program. All performance measurements are relative to historical baselines that were set as the baseline for new construction in 2003.

[a] Warm climates had a baseline of $0.12 to 0.14/kWh in 1999 and cold climates, on which research has just begun, have a baseline of $0.18 to 0.20/kWh with a base year of 2009.

(dollars in thousands)

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Windows Performance Goals

Percent Reduction in Energy Use[a]

Characteristics	2003 Status	2010 Result	2015 Target	2020 Target
Energy Consumption Improvement	Base ENERGY STAR (Low E)	37%	40-50%	40-60%

In FY 2012, BTP will continue competitive fundamental science research to develop the second generation of materials, chemical engineering applications, and advanced manufacturing processes that can offer "leap frog" reductions in the cost of dynamic windows while maintaining a high level of reliability and durability with a broad range of optical properties. The second generation of dynamic windows is targeted to enter the market between 2012 and 2015 with substantially lower consumer prices. BTP will also work on cost effective R10 (U value of 0.10) highly insulating windows with conventional low cost multi-pane designs, as well as higher risk, high performance vacuum glazings. These products are needed for colder climates to offer significant savings in existing and new construction applications for all buildings. New innovative integrated daylighting systems will offer greater savings for the commercial building markets.

Thermal Insulation and Building Materials

The Building Envelope element will contribute to low energy building goals and deep retrofit solutions by advancing a portfolio of new insulation, moisture and design guidelines, advanced air sealing techniques, and dramatic performance improvement in exterior insulation finishes systems (EIFS), with both residential and commercial wall applications.

Reducing energy losses through the building enclosure will contribute significantly to DOE's attainment of a practical low energy building. In pursuit of the next generation of attic/roof systems that will save 50 percent energy over the Building America baseline. The next generation of attic/roof systems integrating thermal mass, ventilation, radiant barriers and advanced insulated roof structures will be completed in cold and mixed climates for the residential, steep slope commercial retrofit and new construction markets in FY 2012. In FY 2012, dynamic roof surface systems will begin to enter the marketplace; however price premiums will still exist. DOE will be working with American Society for Testing and Materials (ASTM) to help develop testing protocols and further evaluations.

The table below lists the performance goals for Thermal Insulation activities. All performance measurements are relative to historical baselines that were set as the Building America regional baseline for new construction. Achieving cost-effectiveness and durability are critical aspects of these targets.

[a] These percentage reductions will only be considered complete after meeting technical performance requirements such as incremental price/sq. ft., size (sq. ft.), visual transmittance, solar heat gain coefficient, durability (American Society for Testing and Materials Tests), U-value, and incremental cost $/sq. ft. FY10 result is for cold and mixed climates for affordable highly insulating windows that have been commercialized for the first time in the U.S.

(dollars in thousands)

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Thermal Insulation and Materials Performance Goals

Characteristics	2004 Status (units: R-Value*)	2010 Result (units: R-Value*)	2015 Target (units: R-Value*)
Advanced attic/roof system	30	Dynamic annual performance equal to conventional R-45	Improved dynamic annual performance at no extra cost
Wall insulation	10	Dynamic annual performance equal to conventional R-25[a]	Improved dynamic annual performance at no extra cost

***** R-value measures the resistance to heat flow for a material. The higher the R-value, the better walls and roof will resist the transfer of heat

BTP is developing advanced envelope materials in response to needs identified by the Residential Buildings and Commercial Integration subprograms. Large scale whole house, full scale applications for insulation with phase change materials that offer thermal mass effects to dramatically reduce peak loading. In FY 2012, studies will be continued along with work on new ASTM test standards to provide a metric to market dynamic insulation systems. In addition, new lower cost phase change material will enter the market to allow for a viable industry segment compared to the current niche market that was initiated by a DOE 100 R&D Award in FY 2009.

Under the DOE-wide Dollar-A-Watt Initiative, BTP will work with the Solar Energy Technologies Program (SETP) to understand the potential of Building-Integrated Photovoltaics (BIPV) for renewable energy generation. BIPV is the integration of PV modules directly into building materials (e.g. roofing systems) such that workers in the construction trades can install these integrated PV components during the normal process of building construction or renovation with a minimum of additional training, equipment, or work-flow changes. Because of this integrated installation process, BIPV offers one potential technology pathway to reduce "balance of systems" (BOS) costs for PV installations, which are an increasingly large fraction of the total installed cost of PV systems as the cost of PV modules continues to fall.

In addition, these funds may be used to support efforts such as peer review, data collection and dissemination; technical, market, economic and other analyses.

Analysis Tools **5,500** **4,837**

Similar technologies and design approaches will be applied to improve the performance of existing buildings to accompany BTP's goals related to new construction. The goals cannot be met through research alone to significantly improve the performance of components (e.g., windows, appliances,

[a] Subject to no additional operating cost, within the traditional 3.5-in. wall dimension, with acceptable durability characteristics.

(dollars in thousands)

	FY 2010 Current Approp	FY 2012 Request

heating and cooling equipment, and lighting). Meeting the goals also requires a revolutionary approach to building design and operation that can achieve up to 70 percent reductions in load, coupled with careful integration with onsite renewable energy supplies, as well as thermal and electrical storage. Building energy performance is the result of interactions among many elements including climate (outdoor temperature, humidity, solar radiation and illumination); envelope heat and moisture transfer; internal heat gains; lighting power; HVAC equipment; controls; thermal and visual comfort; and energy cost. These complex interactions cannot be understood and quantified without simulation tools. For example, the effect of dimming controls on the electric lights with daylighting includes reductions in lighting electricity use and heat gain from lights. Lower heat from lights reduces cooling use (amount depends on cooling equipment efficiency) and in the winter can significantly increase the heating energy. Thus, the annual impact of daylighting on energy use requires detailed calculations that consider these interactions.[a] This in turn requires powerful simulation tools that support evaluation of new demand-reduction and energy-supply technologies throughout building design, operation, and retrofit.

EnergyPlus is leveraged as the basis for a number of commercial products and is a cornerstone of analysis resulting in Advanced Energy Design Guides, codes, and standards. The EnergyPlus Development Team is an ongoing and effective collaboration between National Laboratories, universities, and industry. The team works to accomplish tasks from a prioritized enhancement list developed in consultation with industry. In addition, work will continue to increase the execution speed of EnergyPlus. Two major releases were completed in FY 2010 (October 2009 and April 2010). The releases included updates to increase robustness along with adding several features such as better input data, enhanced control systems, and the addition of several building component models. The EnergyPlus team provides training and user support increasing the adoptability of the program. In addition, these funds may be used to support efforts such as peer review, data collection and dissemination; technical, market, economic and other analyses; and international activities.

Solar Heating and Cooling	**6,500**	**0**

In FY 2012, this technology area will be combined with Space Conditioning and Refrigeration R&D in the Space Conditioning and Refrigeration R&D key activity.

[a] In a series of field evaluation case study reports, NREL found that simulation tools were one of the essential elements for tuning the building design as well as the operating building performance [Paul A. Torcellini, Ron Judkoff, and Drury B. Crawley, "Lessons Learned: High-Performance Buildings," ASHRAE Journal, September. 2004].

(dollars in thousands)

	FY 2010 Current Approp	FY 2012 Request
Energy Innovation Hub: Energy Efficient Building Systems Design	**22,000**	**24,369**

As part of the DOE-wide Energy Innovation Hub initiative, EERE awarded the Energy-Efficient Building Systems Design Hub in August 2010 to a consortium of academic, industry and National Laboratory partners led by Pennsylvania State University. The consortium, known as the Greater Philadelphia Innovation Cluster (GPIC), will conduct a program of RD&D to accelerate the innovation and deployment of energy-efficiency technology for buildings.

The GPIC RD&D program focuses on several technology areas including: integrated computer design tools; dynamic subsystems such as building envelopes, HVAC equipment, on-site energy generation, waste-heat utilization, and energy storage; and building control systems to integrate overall building energy operations. The program also focuses on efforts in education and workforce development, by working with regional Workforce Investment Boards to train the construction and retrofit-related workforce in energy technologies and energy-efficient building practices. Finally, the program will focus on understanding the impacts of policy, market, and behavioral factors in the spread and adoption of energy-efficient technologies in buildings.

The program will be divided into five tasks: 1) Integrated Design Processes and Computational Tools for the Delivery and Operation of Energy Efficient Building Systems; 2) Whole-Building Systems, Enabling Components, Robust Controls, and Diagnostics; 3) Economic, Policy, and Behavioral Factors Influencing Building Energy Consumption; and 4) Demonstration, Knowledge Management and Deployment.

Similar to the other Energy Innovation Hubs, the GPIC consortium is basing its operations on a new model of conducting multidisciplinary, integrated research programs. DOE will encourage risk-taking by the consortium by making the initial grant period five years, renewed thereafter for up to 10 years. For the period of the grant, Principal Investigators from the 22 Hub partners will be co-located at a single research facility in the Philadelphia Navy Yard, a former Department of Defense facility closed in the mid-1990s under the Base Closure and Realignment (BRAC) process. The consortium will use the Navy Yard, which has over 200 buildings and an independent electric microgrid, as a "virtual municipality" test bed for energy technology systems and "policy simulation experiments".

The work of the Hub will be integrated with three other related DOE investments in the Philadelphia Navy Yard, including the Mid-Atlantic Clean Energy Applications Center (focusing on combined heat and power technology), the GridSTAR Smart Grid Training Application Resource Center (focusing on training smart grid installers), and the Northern Mid-Atlantic Solar Regional Training Center (focusing on train-the-trainer programs for solar installers).

The Hub also serves as the anchor of the multi-agency Energy Regional Innovation Cluster (E-RIC) initiative. Under this initiative, several other Federal agencies will award funding to organizations partnering with the GPIC to bring expertise in manufacturing and supply chain issues; economic development; education; and workforce development. The participating E-RIC agencies include the NIST, the Department of Commerce's Economic Development Administration (EDA), the Department of Education, the Department of Labor, the Small Business Administration (SBA), and the National

(dollars in thousands)

	FY 2010 Current Approp	FY 2012 Request

Science Foundation (NSF).

In addition, these funds may be used to support efforts such as peer review, data collection and dissemination; technical, market, economic and other analyses.

SBIR/STTR **0** **2,627**

In FY 2010, $1,204,000 and $144,000 was transferred to the SBIR and STTR programs respectively. The FY 2012 amounts shown are estimated requirements for the continuation of the SBIR and STTR program.

Total, Emerging Technologies **84,562** **102,700**

Explanation of Funding Changes

	FY 2012 vs. FY 2010 Current Approp ($000)
Lighting R&D	
Existing Manufacturer R&D Initiatives projects will be maintained.	+270
Space Conditioning and Refrigeration R&D	
Increase in funding is due to combining Solar Heating and Cooling with Space Conditioning and Refrigeration R&D and expanded investment in the next generation of working fluids, refrigerants, and blowing agents with greater energy efficiency and reduced global warming impacts. These next generation fluids will replace those technologies that are slated to be discontinued due to pending regulatory legislation in the next few years and research is critical to replacing the fluids for the next generation of air conditioners, refrigerators, and other such appliances.	+10,690
Building Envelope R&D	
To accelerate the development of BIPV systems, BTP will work with SETP in incorporating input from an August 2010 "$1/W" workshop and a Request for Information (RFI) issued in December 2010. Research may focus on: (a) packaging and encapsulation materials and methods that allow integration into a variety of residential and commercial building envelope components, while avoiding reductions in PV cell performance from rooftop heating; (b) systems that reduce the installation	+9,345

	FY 2012 vs. FY 2010 Current Approp ($000)
time and cost relative to standard rack-mounted or Building-Applied Photovoltaics (BAPV); and (c) approaches to avoiding or reducing system costs in other building material needs through BIPV installation. BTP will also conduct a series of workshops with the roofing and construction industry to better understand the workforce and training barriers to integrating BIPV systems into the standard building construction and renovation workflow.	
Analysis Tools	
Software modules are needed to give EnergyPlus design software the capability to run models incorporating the latest in energy efficient building technologies. The funding decrease will reduce the number of new features – originally planned for five functionality improvements - designed for EnergyPlus. Due to a reduced emphasis on new construction, one less module will be released and the funds will be refocused on higher priority R&D.	-663
Solar Heating and Cooling Systems (SH&C)	
Reduction reflects the combination of SH&C activities with Space Conditioning and refrigeration R&D.	-6,500
Energy Innovation Hub: Energy Efficient Building Systems Design	
The funding increase reflects accelerated activity after the initial period awarding and establishing the Hub.	+2,369
SBIR/STTR	
In FY 2010, $1,204,000 and $144,000 was transferred to the SBIR and STTR programs respectively. The FY 2012 amounts shown are estimated requirements for the continuation of the SBIR and STTR program.	+2,627
Total Funding Change, Emerging Technologies	**+18,138**

Technology Validation and Market Introduction

Funding Schedule by Activity

(dollars in thousands)

	FY 2010 Current Approp	FY 2012 Request
Technology Validation and Market Introduction		
Rebuild America	1,000	0
ENERGY STAR	7,000	10,000
Building Energy Codes	9,000	10,000
Solar Decathlon	5,000	5,000
Total, Technology Validation and Market Introduction	22,000	25,000

Benefits

Technology Validation and Market Introduction (TVMI) activities increase efficiency levels of buildings and equipment. ENERGY STAR encourages the adoption of very efficient products through a large network of stakeholders using marketing and procurement tools and by training builders to retrofit existing homes.

Building Energy Codes submits code proposals, supports the upgrading of model building energy codes, and provides technical and financial assistance to States to update, implement, and enforce their energy codes to meet or exceed model codes in support of Section 304 of ECPA. It also promulgates standards for manufactured housing as required by Section 413 of EISA. These activities and outputs increase the energy performance of newly constructed homes and commercial buildings, target consumers, assist them in reducing energy bills, and contribute to job creation in the construction industry.

Solar Decathlon is a high-profile university competition that promotes public awareness of highly efficient building technologies and energy efficient homes using solar energy. The competition fosters innovation and encourages incorporation of new building technologies and design practices into engineering and architecture university curricula.

(dollars in thousands)

	FY 2010 Current Approp	FY 2012 Request
Rebuild America	**1,000**	**0**

The Rebuild America activities, e.g. EnergySmart Schools and EnergySmart Hospitals have been realigned with the Commercial Buildings Integration activities in FY 2011.

ENERGY STAR	**7,000**	**10,000**

Through its partnership with more than 7,000 private and public sector organizations, ENERGY STAR delivers the technical information and tools that organizations and consumers need to choose energy efficient solutions and best management practices.

DOE will continue to raise the efficiency targets of ENERGY STAR products and support program enhancements as stated in the MOU between DOE and EPA signed September 30, 2009. The DOE ENERGY STAR team will work with EPA to help promote currently labeled products. A three-pronged strategy will be deployed in FY 2012 to support the portfolio of existing technologies: 1) develop and maintain procedures for testing ENERGY STAR products; 2) verify compliance with program requirements, while identifying and addressing product performance issues; and 3) work with EPA and participating manufacturers, retailers, and energy efficiency program sponsors on certification and product testing.

In addition, these funds may be used to support efforts such as peer review, data collection and dissemination; technical, market, economic and other analyses.

Building Energy Codes	**9,000**	**10,000**

In FY 2012, BTP will initiate analyses, support upgrading the next generation of ASHRAE 90.1 codes, and set substantial new efficiency targets. Upgrades will include performance criteria based on size, internal functions, and envelope characteristics (beyond the current prescriptive criteria) permitting the next substantial increase in code stringency.

Efforts to improve the ASHRAE and IECC Codes must align with the existing cycles used by the two bodies to update their respective codes. The cycles include periods for new technical proposals, review, comment, and revision, and generally take three years. In previous revision cycles, both the ASHRAE and IECC codes have been improved incrementally at the rate of one to two percent per cycle. With increased emphasis on building energy codes, the current goal is to increase both ASHRAE and IECC codes by 50 percent over baseline in the ongoing revision cycle and increase adoption by all States. Significant progress has been made towards these goals, with estimated increases of 10 to 11 percent for ASHRAE and 15 percent for IECC since 2006. These ongoing improvements contribute to reaching DOE's goal of maximizing cost-effective energy efficiency.

DOE will also conduct analyses and publish determinations in the Federal Register as to whether each new edition of the baseline model codes will improve the energy efficiency of buildings. Determinations are to be issued within one year of the publication of the model codes. DOE will

(dollars in thousands)

FY 2010 Current Approp	FY 2012 Request

improve energy code compliance tools, integrating them with the design process and non-energy code enforcement. Technical assistance will be provided to States to adopt, update, implement, and enforce their energy codes to meet the 2009 IECC and Standard 90.1-2010.

DOE will also propose standards for energy efficiency in manufactured housing that will meet or exceed the 2009 IECC. Manufactured housing codes will be updated within one year of each IECC code revision.

In addition, these funds may be used to support efforts such as peer review, data collection and dissemination; technical, market, economic and other analyses.

Solar Decathlon	**5,000**	**5,000**

The U.S. Department of Energy Solar Decathlon is an award-winning program that challenges 20 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 affordability, consumer appeal, and design excellence with optimal energy production and maximum efficiency. As a result, the Solar Decathlon continues to be a successful technology, innovation, and workforce development program for thousands of college graduates. The highly energy efficient buildings will be constructed and judged in 2012.

Total, Technology Validation and Market Introduction	**22,000**	**25,000**

Explanation of Funding Changes

	FY 2012 vs. FY 2010 Current Approp ($000)
Rebuild America	
Rebuild American activities have been realigned within the Commercial Building Integration subprogram.	-1,000
ENERGY STAR	
Accelerated review and development of test procedures for ENERGY STAR products.	+3,000
Building Energy Codes	
Increase efforts to raise energy efficiency level of building codes with more analysis and submission of code proposals.	+1,000

	FY 2012 vs. FY 2010 Current Approp ($000)
Solar Decathlon	
No change.	0
Total Funding Change, Technology Validation and Market Introduction	+3,000

Equipment Standards and Analysis

Funding Schedule by Activity

(dollars in thousands)

	FY 2010 Current Approp	FY 2012 Request
Equipment Standards and Analysis	35,000	70,000
Total, Equipment Standards and Analysis	35,000	70,000

Benefits

Equipment Standards and Analysis activities lead to improved efficiency of appliances and equipment by conducting analyses and developing standards that are technologically feasible and economically justified. In 2012, BTP will work on 42 active rulemakings and 8 final rules. Test procedures and energy conservation standards developed by this subprogram correlate directly to energy policy objectives such as increasing energy savings, reducing peak electricity demand, and reducing carbon emissions. According to a study by American Council for an Energy Efficient Economy (ACEEE), "peak capacity reduction from existing standards is expected to reach 72 GW in 2010, or about 7 percent of the projected U.S. generating capacity."[a]

Detailed Justification

(dollars in thousands)

	FY 2010 Current Approp	FY 2012 Request
Equipment Standards and Analysis	**35,000**	**70,000**

In FY 2012, DOE will accelerate development of 4 minimum energy efficiency standards that are technologically feasible and economically justified. DOE continues to be committed to clearing the backlog of delayed actions that accumulated during prior years, while simultaneously applying all new requirements instituted by EPAct 2005 and EISA. In FY 2012, DOE will continue to take all necessary steps, consistent with the consent decree, EPAct 2005, and EISA, to finalize legally required efficiency standards consistent with all applicable judicial and statutory deadlines.

As part of its base schedule to clear the backlog and meet all statutory obligations, the subprogram continues with its ongoing rulemakings and will begin rulemakings for 9 product categories in FY 2012. The base schedule that drives the initiation of these rulemakings is a result of DOE's multi-year planning effort to comply with all statutory rulemaking obligations. Initiating these rules in FY 2012 will enable DOE to meet the deadlines for these products in future years.

[a] Neubauer, Max, et al., "Ka-BOOM! The Power of Appliance Standards." Report Number ASAP-7/ACEEE-A091. July 2009, p. 9. http://www.standardsasap.org/documents/Ka-BOOM!%20Executive%20Summary.pdf

(dollars in thousands)

	FY 2010 Current Approp	FY 2012 Request

Funds may also be used to prepare for challenges such as new technologies utilized in appliances including compound use appliances, networked or interconnected appliances, and test procedure sensing devices that can give false readings of efficiency levels. In accordance with EISA, in FY 2012 DOE will continue work on incorporating standby and off mode power consumption into test procedures for residential products. Activities in FY 2012 will also include responses to waiver requests from manufacturers and requests for input and recommendations to the DOE Office of Hearings and Appeals. Resource planning is critical to minimize delays and availability conflicts of DOE staff and associated contractor support.

The FY 2012 funding increase will serve several simultaneous purposes including: accelerating the rate at which mandated standards and test procedures are promulgated; increasing the coverage of the program by promulgating standards and test procedures for products for which standards currently do not exist; and reducing the time period between updates to these standards. The program has analyzed the impact of various funding levels with respect to the speed and scale of the rulemakings and potential energy savings. From a list of more than 100 products that are candidates for new and accelerated rulemakings, DOE has tentatively selected several high priority product categories to add to the program or accelerate compared to the base schedule. DOE will conduct a related test procedure rulemaking for each product that is accelerated. 6 product types have been identified as the most likely candidates for new rulemakings beyond the prior-year's multiyear schedule.

In addition, these funds may be used to support efforts such as peer review, data collection and dissemination; technical, market, economic and other analyses. Increased funding will also reinforce the effectiveness of the standards by ramping up enforcement activities. As standards increase in stringency over time, enforcement activities will become more important as the risk of non-compliance increases.

Total, Equipment Standards and Analysis	**35,000**	**70,000**

Explanation of Funding Changes

	FY 2012 vs. FY 2010 Current Approp ($000)
Equipment Standards and Analysis	
The funding increase in 2012 will allow DOE to increase the scope and effectiveness of its energy conservation standards by accelerating the test procedure and standards rulemakings that are currently scheduled, allowing for the use of DOE's existing authorities to establish standards for additional products that have large energy savings potentials. DOE will continue to work on its rulemakings and will begin rulemakings for 9 product categories in FY 2012. These products, which have potentially high energy savings, are tentatively scheduled to commence in FY 2012. These rulemakings are in addition to those already planned to begin in FY 2012 as part of DOE's base schedule to meet DOE's statutory obligations. DOE will also expand its activities in certification and enforcement in order to increase the effectiveness of existing energy conservation standards. Certification and enforcement improvements will include updates to existing certification and reporting requirements for manufacturers along with increases in the frequency and scope of product testing to verify compliance with DOE standards.	+35,000
Total Funding Change, Equipment Standards and Analysis	**+35,000**

Industrial Technologies

Funding Profile by Subprogram

(Non-Comparable, or as-Appropriated, Structure)

(dollars in thousands)

	FY 2010 Current Approp[a]	FY 2012 Request
Industrial Technologies		
Industries of the Future (Specific)	11,798	100,784
Industries of the Future (Crosscutting)	51,594	129,000
Industrial Technical Assistance	30,878	75,000
Manufacturing Energy Systems	0	15,000
Total, Industrial Technologies	94,270	319,784

Funding Profile by Subprogram

(Comparable Structure to the FY 2012 Request)

(dollars in thousands)

	FY 2010 Current Approp[a]	FY 2012 Request
Industrial Technologies		
Industries of the Future (Specific)	11,798	0
Next Generation Materials	0	100,784
Next Generation Manufacturing Processes (formerly Industries of the Future Crosscutting)	51,594	129,000
Industrial Technical Assistance	30,878	75,000
Manufacturing Energy Systems	0	15,000
Total, Industrial Technologies	94,270	319,784

Public Law Authorizations:
P.L. 94-163, "Energy Policy and Conservation Act" (EPCA) (1975)
P.L. 94-385, "Energy Supply and Production Act" (ECP A) (1976)
P.L. 95-91, "Department of Energy Organization Act" (1977)
P.L. 95-619, "National Energy Supply Policy Act" (NECPA) (1978)
P.L. 95-620, "Powerplants and Industrial Fuel Use Act" (1978)
P.L. 96-294, "Energy Security Act" (1980)
P.L. 101-218, "Renewable Energy and Energy Efficiency Technology Competitiveness Act" (1989)
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"

[a] In FY 2010, $1,546,030 and $183,840 were transferred to the SBIR and STTR programs respectively.

Mission

The Industrial Technologies Program (ITP) conducts research and other activities that lead to high levels of energy productivity (output per unit of energy used). ITP prioritizes RD&D of new manufacturing technologies and materials that are needed to ensure that U.S. producers lead the world in modern production technologies. These technologies can reduce costs, reduce energy use, reduce pollution and improve product quality. They also help ensure that U.S. producers are fully competitive in the production of clean energy technologies including advanced photovoltaics, lighting devices, sensors and controls, batteries, wind system components and other devices essential for meeting U.S. energy and efficiency goals. The program also works to ensure access to the latest information about ways to increase energy productivity and options for investing in new systems.

Benefits

The energy productivity of industry is critical for lowering U.S. energy needs while increasing the output and cutting production costs of U.S. manufacturing. This is also critical for meeting emission goals since 94 percent of industrial carbon emissions are the direct result of energy use.[a] New manufacturing methods and new materials needed by U.S. producers to compete in world markets often also lead to sharply increased energy productivity. These include use of the revolutionary potential of advances in material science, biotechnology, nanotechnology, information technology, inexpensive sensors and controls, and other areas provide powerful new tools for achieving this. ITP technologies help maintain the competitiveness of U.S. producers ensuring growth in manufacturing investment and employment. A robust and competitive domestic manufacturing base is critical for national security both because it reduces our dependence on oil and ensures domestic supplies of key products. The goal of the program is to develop a suite of advanced manufacturing technologies and practices that provide pathways for doubling the energy productivity of U.S. industry and enable the associated carbon reductions by 2020.

The President's plan to Win the Future includes investing in advanced manufacturing technologies. These technologies can both revitalize existing manufacturing industries and support the development of new products in emerging industries like clean energy. This plan includes increased funding for breakthrough R&D in advanced manufacturing technologies, reauthorization of the clean energy manufacturing tax credit, and partnerships with industry to enhance advanced manufacturing R&D investments.

New directions proposed for FY 2012 include a greatly expanded emphasis on advanced manufacturing techniques that can lead to dramatic increases in energy productivity such as use of ionic liquids, membrane separations, and continuous monitoring and optimization of processing. Included is support for a new critical materials energy innovation hub. The program will also focus on new materials that can provide improved functional properties while using far less energy to provide the functionality. Examples include advanced composites, titanium and nano technologies. The program will focus on advances that help a wide range of U.S. industries including the industries specifically targeted by the "industries of the future" programs that it builds upon.

The program will also build and strengthen its highly successful program for helping business learn about and adopt strategies that can lead to striking gains in the energy productivity of existing facilities. ITP estimates that technologies developed and activities undertaken since 1977 have cumulatively saved almost 187 million metric tons of carbon equivalent (MMTCe). Cumulative energy savings tracked

[a] Emissions of Greenhouse Gases in the United States 2008 report, December, 2009 http://www.eia.doe.gov/oiaf/1605/ggrpt/index.html

over that period are estimated at nearly 9.3 Quads. In 2008, the most recent year for which complete data are available, the program directly contributed to industrial energy savings of more than 760 trillion Btus worth about $6.9 billion.[a]

A new process to quantify benefits is being developed to better assess the total impact of ITP and EERE's activities on energy consumption, greenhouse gas emissions, and the economic strength of U.S. manufacturers.

Annual Performance Results and Targets

The Department is in the process of updating its strategic plan, and has been actively engaging stakeholders including Congress. The draft strategic plan is being released for public comment concurrent with this budget submission, with the expectation of official publication this spring. The draft plan and FY 2012 budget are consistent and aligned. Updated measures will be released at a later date and available at the following link http://www.mbe.doe.gov/budget/12budget/index.htm.

[a] See 2010 Impacts report at http://www1.eere.energy.gov/industry/about/pdfs/impacts2008_intro.pdf

Industries of the Future (Specific)

Funding Schedule by Activity

(dollars in thousands)

	FY 2010 Current Approp[a]	FY 2012 Request
Industries of the Future (Specific)		
Chemicals Industry	4,407	0
Forest and Paper Products Industry	1,390	0
Steel Industry	4,205	0
Aluminum Industry	1,796	0
SBIR/STTR	0	0
Total, Industries of the Future (Specific)	11,798	0

Benefits

In FY 2012, Industry-Specific activities will be concluded as ITP shifts its focus to support technologies under the Next Generation Manufacturing Processes and Next Generation Materials subprograms that can both revitalize existing manufacturing industries and support the development of new products in emerging industries like clean energy.

Detailed Justification

(dollars in thousands)

	FY 2010 Current Approp	FY 2012 Request
Chemicals Industry	**4,407**	**0**

Ongoing multi-year activities initiated in prior years will continue to completion using prior year funding; work related to chemicals may be conducted by the Next Generation Manufacturing Processes and Next Generation Materials subprograms provided that they meet high system performance characteristic.

Forest and Paper Products Industry	**1,390**	**0**

Work related to forest and paper products may be conducted by the Next Generation Manufacturing Processes subprogram provided that they meet high system performance characteristic.

Steel Industry	**4,205**	**0**

Work related to steel may be conducted by the Next Generation Manufacturing Processes and Next Generation Materials subprograms provided that they meet high system performance characteristic.

[a] SBIR/STTR funding was transferred in FY 2010 was $288,000 to the SBIR programs and $35,000 to the STTR program.

(dollars in thousands)

	FY 2010 Current Approp	FY 2012 Request
Aluminum Industry	**1,796**	**0**
Work related to aluminum may be performed by the Next Generation Manufacturing Processes and Next Generation Materials subprograms provided that they meet high system performance characteristic.		
SBIR/STTR	**0**	**0**
In FY 2010, $288,000 was transferred to the SBIR program and $35,000 was transferred to the STTR program respectively. The FY 2012 amount shown is an estimated requirement for continuation of the SBIR and STTR programs.		
Total, Industries of the Future (Specific)	**11,798**	**0**

Explanation of Funding Changes

	FY 2012 vs. FY 2010 Current Approp ($000
Chemicals Industry	
This decrease reflects a reoriented FY 2012 program, emphasizing the new Next Generation Manufacturing Processes and Next Generation Materials subprograms.	-4,407
Forest and Paper Products Industry	
This decrease reflects a reoriented FY 2012 program, emphasizing the new Next Generation Manufacturing Processes and Next Generation Materials subprograms.	-1,390
Steel Industry	
This decrease reflects a reoriented FY 2012 program, emphasizing the new Next Generation Manufacturing Processes and Next Generation Materials subprograms.	-4,205
Aluminum Industry	
This decrease reflects a reoriented FY 2012 program, emphasizing the new Next Generation Manufacturing Processes and Next Generation Materials subprograms.	-1,796
SBIR/STTR	
In FY 2010, $288,000 was transferred to the SBIR program and $35,000 was transferred to the STTR program respectively. The FY 2012 amount shown is an estimated requirement for continuation of the SBIR and STTR programs.	0
Total Funding Change, Industries of the Future (Specific)	**-11,798**

Next-Generation Materials

Funding Schedule by Activity

(dollars in thousands)

	FY 2010 Current Approp	FY 2012 Request
Next Generation Materials	0	77,962
Energy Innovation Hub for Critical Materials	0	20,000
SBIR/STTR	0	2,822
Total, Next Generation Materials	0	100,784

Benefits

ITP's Next Generation Materials activities will help deliver the breakthroughs that the Nation needs to significantly reduce energy and carbon intensity throughout the economy over the coming decades. At the same time, these advances will enhance the competitiveness of U.S. manufacturing industries, helping to create and preserve jobs. Breakthroughs in materials science and engineering will enable unprecedented material properties and order-of-magnitude improvements (e.g., tenfold lifetime extension) in components. Novel, cost-competitive materials and products (e.g., nanomaterials, new cements) will be invented to support the low-carbon economy.

Detailed Justification

(dollars in thousands)

	FY 2010 Current Approp	FY 2012 Request
Next Generation Materials	**0**	**77,962**

In FY 2012, this activity will initiate planning and provide funding for new R&D to develop the novel materials required to support next-generation manufacturing processes and clean energy (green) manufacturing. New projects will be selected competitively to develop inexpensive carbon fibers, new cement technologies, low-cost titanium fabrication, and biomimetic materials. In addition, projects will focus on coatings, thin films, and electrochemicals that require functional surface interactions; other high-performance materials, such as ceramics, engineered polymers, and metallics that operate in extreme environments; and multi-materials, such as composites and smart materials, for incorporation into energy systems. The activity will also define new concepts and conduct early-stage R&D for dramatically improving material properties that facilitate new, low-carbon products. Where possible, materials by design tools will be leveraged to accelerate discovery and characterization of new materials.

(dollars in thousands)

	FY 2010 Current Approp	FY 2012 Request
Energy Innovation Hub for Critical Materials	**0**	**20,000**
A competition for a critical materials hub will be conducted in FY 2012. The new hub will fund R&D on novel approaches to reducing our dependencies on critical materials. The hub will focus on R&D leading to material and technology substitutes that will improve flexibility and help meet the material needs of the clean energy economy. Additional R&D goals include strategies for recycling, reuse and more efficient use that could significantly lower world demand for newly extracted materials.		
SBIR/STTR	**0**	**2,822**
No funds were transferred to SBIR/STTR in FY 2010 as this is a new subprogram. The FY 2012 amount shown is an estimated requirement for continuation of the SBIR and STTR program.		
Total, Next Generation Materials	**0**	**100,784**

Explanation of Funding Changes

	FY 2012 vs. FY 2010 Current Approp ($000
Next Generation Materials	
This increase reflects the establishment of the Next Generation Materials subprogram and initiation of competitively selected R&D projects that focus on innovations in materials and materials processing technologies.	+77,962
Energy Innovation Hub for Critical Materials	
Increase reflects the establishment of a new critical materials hub in FY 2012. The hub will focus on R&D leading to material and technology substitutes that will improve flexibility and help meet the material needs of the clean energy economy.	+20,000
SBIR/STTR	
No funds were transferred to SBIR/STTR in FY 2010 as this is a new subprogram. The FY 2012 amount shown is an estimated requirement for continuation of the SBIR and STTR program.	+2,822
Total Funding Change, Next Generation Materials	**+100,784**

Industries of the Future (Crosscutting)

Funding Schedule by Activity

(Non-Comparable, or as Appropriated Structure)

(dollars in thousands)

	FY 2010 Current Approp[a]	FY 2012 Request
Industries of the Future (Crosscutting)		
Industrial Materials of the Future	4,468	4,088
Energy-Intensive Process R&D	14,252	89,300
Fuel and Feedstock Flexibility	3,633	2,000
Nanomanufacturing	4,543	5,000
Combined Heat and Power Generation	24,698	25,000
Desalination	0	0
SBIR/STTR	0	3,612
Total, Industries of the Future (Crosscutting)	51,594	129,000

Next Generation Manufacturing Processes

Funding Schedule by Activity

(Comparable Structure to the FY 2012 Request)

(dollars in thousands)

	FY 2010 Current Approp[a]	FY 2012 Request
Next Generation Manufacturing Processes	51,594	125,388
SBIR/STTR	0	3,612
Total, Next Generation Manufacturing Processes	51,594	129,000

Benefits

ITP's activities in Next Generation Manufacturing Processes will provide critical energy and environmental improvements to increase the competitiveness of U.S. manufacturing industries. Next-generation technologies that enable companies to rapidly produce energy-efficient, competitively priced, high-quality products will rejuvenate U.S. manufacturing and stimulate job growth. New manufacturing production systems will make U.S. factories more productive and agile, enabling rapid response to dynamic global markets.

[a] SBIR/STTR funding was transferred in FY 2010 was $1,260,000 to the SBIR programs and $151,000 to the STTR program.

Detailed Justification

(dollars in thousands)

	FY 2010 Current Approp	FY 2012 Request
Next Generation Manufacturing Processes	**51,594**	**125,388**

This activity involves a refocusing of existing Industries of the Future Crosscutting activities and the initiation of new R&D to provide energy-intensive industries with accelerated access to Next Generation Manufacturing Processes. New competitively selected efforts will define concepts, conduct early-stage R&D, and develop prototypes. R&D will focus on developing new production systems, including innovative bioprocessing techniques that mimic the low-emission, low-temperature fabrication methods of living systems; high-performance catalysts and separations; nano-scale manufacturing and processing; next-generation computational tools, including computational modeling, advanced characterization, and integrated sensor and process control systems; and smart process manufacturing.

Previously initiated multi-year activities for the former Industrial Materials of the Future activity will continue using only prior-year funds; work related to this former activity is now being conducted through the Next Generation Materials subprogram. Previously initiated multi-year activities for the former Energy-Intensive Process (EIP) R&D and Fuel and Feedstock Flexibility activities will also continue using only prior-year funds; work related to these former activities is now being conducted through the Next Generation Manufacturing Processes subprogram provided that they meet high system performance characteristic. Previously initiated multi-year R&D activities for the former Nanomanufacturing and Combined Heat and Power Generation activities will also continue using only prior-year funds; work on these activities is now being conducted through the Next Generation Manufacturing Processes and Next Generation Materials subprograms provided that they meet high system performance characteristic. ITP will help manage project ramp-down and completion using prior-year funds; promising technologies from existing work will be encouraged to apply for new awards.

SBIR/STTR	**0**	**3,612**

In FY 2010, $1,260,000 and $151,000 were transferred to the SBIR and STTR programs, respectively. The FY 2012 amount shown is an estimated requirement for the continuation of the SBIR and STTR programs.

Total, Next Generation Manufacturing Processes	**51,594**	**129,000**

Explanation of Funding Changes

	FY 2012 vs. FY 2010 Current Approp ($000)
Next Generation Manufacturing Processes	
This increase reflects the initiation of competitively selected R&D projects that focus on innovation in manufacturing processes. Projects will develop novel manufacturing methods that incorporate alternative production pathways or completely reinvent processes to achieve step-change reductions in energy and carbon footprints.	+73,794
SBIR/STTR	
In FY 2010, $1,260,000 and $151,000 were transferred to the SBIR and STTR programs, respectively. The FY 2012 amount shown is an estimated requirement for the continuation of the SBIR and STTR programs.	+3,612
Total Funding Change, Next Generation Manufacturing Processes	**+77,406**

Industrial Technical Assistance

Funding Schedule by Activity

(dollars in thousands)

	FY 2010 Current Approp	FY 2012 Request
Industrial Technical Assistance		
Energy Efficiency Partnerships	0	50,000
Energy Services Development	3,878	11,000
Save Energy Now LEADER Partnerships	27,000	10,000
ISO/ANSI Standards Certification	0	4,000
Total, Industrial Technical Assistance	30,878	75,000

Benefits

ITP's Industrial Technical Assistance activities achieve energy savings and carbon reductions by:

- Disseminating energy tools, information, and training to State, utility, and local partners;
- Identifying plant-wide opportunities for energy savings and process efficiency;
- Training and engaging engineering students and manufacturing plant staff in conducting technology delivery activities that help plants access and apply today's most efficient technologies and energy management practices, thus building a greener workforce for the future; and
- Promoting a corporate culture of energy efficiency and carbon management throughout industry.

Detailed Justification

(dollars in thousands)

	FY 2010 Current Approp	FY 2012 Request
Energy Efficiency Partnerships	**0**	**50,000**

This request supports a DOE partnership between DOE and the National Institute of Standards and Technology (NIST). This activity will accelerate development of advanced technologies that allow existing manufacturing facilities to access energy efficient technologies including but not limited to cogeneration, waste heat recovery, and other technologies. This activity will also support interactions and build on existing relationships between DOE and the Department of Commerce and its agencies, including NIST.

Energy Services Development	**3,878**	**11,000**

The Energy Services Development activity funds a network of universities that deploy undergraduate and graduate engineering students to conduct free energy audits of small and medium-sized manufacturers. The audits identify a range of efficiency improvements, including no-cost and low-cost recommendations, providing assistance to U.S. manufacturers struggling to cope with high energy prices. In FY 2012, this activity will: conduct up to 300 facility assessments at small and mid-sized manufacturers supporting students at the 26 IAC universities participating in the program; conduct

(dollars in thousands)

	FY 2010 Current Approp	FY 2012 Request

market transformation activities to accelerate the adoption of combined heat and power and other clean energy technologies via the DOE Clean Energy Regional Application Centers (commonly referred to as the RAC); and assist other centers. This activity also trains more engineers and scientists in the energy field.[a] Alumni are very much in demand by top firms as energy managers with real-world knowledge and experience, which allows them to be ready to work on projects immediately and improves their bottom line numbers.

***Save Energy Now* LEADER Partnerships**	**27,000**	**10,000**

Through the *Save Energy Now* (SEN) LEADER Partnership, ITP continues to partner with leading industrial companies, plants, and supply chains to reduce their energy intensity by at least 2.5 percent annually over a 10 year period in alignment with Section 106 of EPAct 2005. As of December 2010, 104 firms had signed a SEN LEADER Pledge to reduce their energy intensity by 25 percent or more in 10 years. SEN will help energy-intensive plants implement cost-effective energy-saving and carbon-reducing technology solutions through the dissemination of energy tools, information, and training either directly or through State, utility and local partners. ITP will continue to provide industrial process application tools for evaluating major energy systems such as: steam; pumping; process heating; and compressed air systems emphasizing system-level improvements. ITP will build off the success of over 950 completed Energy Savings Assessments (ESAs) at large plants, which have identified over billion dollars in potential annual energy cost savings since 2006.

ISO/ANSI Standards Certification	**0**	**4,000**

In FY 2012, ITP will continue development of and launch a credible, transparent industrial energy efficiency certification program that uses recognized standards (ISO 50001 Energy Management Standard, Measurement and Verification (M&V) protocol, and system assessment standards). This certification program will provide a systematic mechanism to demonstrate progress in energy savings over time; provides third-party verification of savings; and develops a workforce of professionals (certified practitioners) with expertise in energy management, systems assessments, and M&V.

Total, Industrial Technical Assistance	**30,878**	**75,000**

[a] White House Press Office http://www.whitehouse.gov/the_press_office/Remarks-by-the-President-at-the-National-Academy-of-Sciences-Annual-Meeting/

Explanation of Funding Changes

	FY 2012 vs. FY 2010 Current Approp ($000)
Energy Efficiency Partnerships	
This increase reflects the creation of a new activity within the Industrial Technical Assistance subprogram, which will accelerate the development of advanced technologies that allow existing manufacturing facilities to access energy efficient technologies including but not limited to cogeneration, waste heat recovery, and other technologies.	+50,000
Energy Services Development	
This change reflects the transfer of the DOE Clean Energy Application Centers from Combined Heat and Power Generation and expanded funding for training energy engineers at the IAC centers.	+7,122
***Save Energy Now* LEADER Partnerships**	
This reduction reflects refocus of efforts to more effectively leverage funding, and the transfer of ISO/ANSI plant certification to separate activities.	-17,000
ISO/ANSI Standards Certification	
This change reflects the deconsolidation of related efforts from the SEN LEADER Partnerships activity, and expansion of efforts via the launch of the Certified Practitioners green workforce program.	+4,000
Total Funding Change, Industrial Technical Assistance	**+44,122**

Manufacturing Energy Systems

Funding Schedule by Activity

(dollars in thousands)

	FY 2010 Current Approp[a]	FY 2012 Request
Manufacturing Energy Systems	0	14,580
SBIR/STTR	0	420
Total, Manufacturing Energy Systems	0	15,000

Benefits

Anchored at premier U.S. universities, Manufacturing Energy Systems (MES) centers will help catalyze private efforts to build a clean energy future. With access to all academic departments at the MES institutions, the centers will harness the scientific ingenuity of American universities to address critical barriers. ITP's MES centers will strengthen the clean energy economy by:

- Clearly defining highly specific research needs, contributing to the targeted development of technologies to significantly reduce carbon emissions;
- Enabling rapid translation of laboratory innovation into commercial products;
- Helping build the knowledge base and deploy the human capital necessary to address energy and climate change challenges;
- Spawning complementary businesses that will facilitate technology development and adoption; and
- Enhancing the competitiveness of America's manufacturers, leading to the creation of jobs in manufacturing and other domestic industries.

Detailed Justification

(dollars in thousands)

	FY 2010 Current Approp	FY 2012 Request
Manufacturing Energy Systems	**0**	**14,580**

The Manufacturing Energy Systems will serve as knowledge development and dissemination centers to address distinct clean energy manufacturing areas with critical technical needs—expediting the translation of innovative concepts into commercial processes and products. These centers will provide multi-disciplinary insight and investigation into salient manufacturing and cross-cutting challenges by finding new and improved ways to manufacture emerging and breakthrough clean energy technologies. Activities will complement and coordinate with ongoing RD&D in other EERE programs to address gaps in manufacturing concept innovation for emerging technologies. In FY 2012, ITP will competitively select and fund centers to address critical clean energy technical areas, and initiate concept definition and early-stage R&D to address manufacturing issues.

[a] No funds were transferred to SBIR/STTR in FY 2010 as this is a new subprogram.

(dollars in thousands)

	FY 2010 Current Approp	FY 2012 Request
SBIR/STTR	**0**	**420**

No funds were transferred to SBIR/STTR in FY 2010 as this is a new subprogram. The FY 2012 amount shown is an estimated requirement for continuation of the SBIR and STTR programs.

Total, Manufacturing Energy Systems	**0**	**15,000**

Explanation of Funding Changes

	FY 2012vs. FY 2010 Current Approp ($000)
Manufacturing Energy Systems	
This increase reflects establishment of the MES subprogram to launch centers that will address clean energy manufacturing needs and enable rapid translation of laboratory innovation into commercial products.	+14,580
SBIR/STTR	
No funds were transferred to SBIR/STTR in FY 2010 as this is a new subprogram. The FY 2012 amount shown is an estimated requirement for continuation of the SBIR and STTR programs.	+420
Total Funding Change, Manufacturing Energy Systems	**+15,000**

Industrial Technologies Program FY 2010 – FY 2012 Crosswalk

WBS	FY10		WBS	FY12
	Industrial Technologies Program			Industrial Technologies Program
1	Industries of the Future (Specific)		1	Next Generation Materials
1.1	Chemicals Industry		1.1	Next Generation Materials
1.2	Forest and Paper Products Industry		1.2	Energy Innovation Hub for Critical Materials
1.3	Steel Industry			
1.4	Aluminum Industry			
2	Industries of the Future (Crosscutting)		2	Next Generation Manufacturing Processes
2.1	Industrial Materials of the Future			
2.2	Energy-Intensive Process R&D			
2.3	Fuel and Feedstock Flexibility			
2.4	Nanomanufacturing			
2.5	Combined Heat and Power Generation			
3	Industrial Technical Assistance		3	Industrial Technical Assistance
3.1	Energy Services Development		3.1	Energy Efficiency Partnerships
3.2	Save Energy Now Leaders Partnerships		3.2	Energy Services Development
			3.3	*Save Energy Now* LEADER Partnerships
			3.4	ISO/ANSI Standards Certification
			4	Manufacturing Energy Systems

Federal Energy Management Program

Funding Profile by Subprogram

(dollars in thousands)

	FY 2010 Current Approp	FY 2012 Request
Federal Energy Management Program		
Project Financing	11,800	10,072
Technical Guidance and Assistance	8,000	12,000
Planning, Reporting and Evaluation	3,000	5,000
Federal Fleet	3,000	2,000
DOE Specific Investments	6,200	4,000
Total, Federal Energy Management Program	32,000	33,072

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, "DOE Organization Act" (1977)
P.L. 95-619, "National Energy Conservation Policy Act" (NECPA) (1978)
P.L. 100-615, "Federal Energy Management Improvement Act" (1988)
P.L. 102-486, "Energy Policy Act (EPACT) of 1992"
P.L. 109-58, "Energy Policy Act of 2005"
P.L 110-140, "Energy Independence and Security Act of 2007(EISA)"

Mission

The Federal Energy Management Program (FEMP) facilitates the Federal Government's implementation of sound, cost effective energy management and investment practices to enhance the Nation's energy security and environmental stewardship. By increasing its use of energy efficiency and renewable energy, the Federal sector will lead by example, reduce its GHG emissions, and meet more of its energy requirements from clean technologies and secure sources.

Benefits

FEMP activities support all Federal agencies in meeting requirements of Executive Orders 13514 and 13423, EPACT 1992, EPAct 2005 and EISA 2007.

FEMPs FY 2012 activities reflect a significant shift by EERE in budget development of incorporating analytically based integrated planning, review, and performance assessment of its programs. The focus and changes in funding decisions represented in the FY 2012 budget for FEMP derive from the planning process, as well as anticipated changes resulting from DOE's implementation strategy for EO 13514 per DOE's Strategic Sustainability Performance Plan (SSPP). As a result, the FEMP budget is transitioning away from direct investments for capital projects at DOE, and refocusing FY 2012 resources on supporting all agencies, in meeting their GHG targets through energy and cost reduction measures. FEMPs activities will generate the following benefits:

FEMP activities will contribute to reducing the energy intensity at Federal facilities, lowering their energy bills and providing environmental benefits. By providing interagency coordination, technical expertise, training, reporting tools, financing resources and contracting support, FEMP helps agencies

make cost-effective investments in energy efficiency and renewable energy technologies at Federal facilities and in Federal fleets. Economy-wide benefits that follow from FEMP activities are a net reduction in consumer cost and a net reduction in electric power industry costs.

FEMP provides support to Federal agencies to meet their GHG reduction goals which were established according to the requirements of EO 13514. FEMP also assists agencies in tracking their GHGs by providing guidelines, GHG tracking tools, and one-to-one technical assistance. Since GHG is primarily driven by energy use, reducing GHG is primarily accomplished by reducing energy use and lowering its cost to the Federal Government.

By promoting the use of alternative fuel in Federal agency fleets, the Federal Fleet program helps to decrease our Government's dependence on oil. Private sector development of alternative fuel stations at Federal sites will be supported to demonstrate opportunities for further petroleum displacement.

Annual Performance Results and Targets

The Department is in the process of updating its strategic plan, and has been actively engaging stakeholders including Congress. The draft strategic plan is being released for public comment concurrent with this budget submission, with the expectation of official publication this spring. The draft plan and FY 2012 budget are consistent and aligned. Updated measures will be released at a later date and available at the following link http://www.mbe.doe.gov/budget/12budget/index.htm.

Project Financing

Funding Schedule by Activity

(dollars in thousands)

	FY 2010 Current Approp	FY 2012 Request
Project Financing	11,800	10,072
Total, Project Financing	11,800	10,072

Benefits

These energy efficiency and renewable energy projects improve the energy efficiency of Federal facilities. Projects save energy at Federal facilities and are implemented with little or no upfront cost to the Government. By providing a means for Federal agencies to utilize renewable energy and energy efficiency technologies, these programs help reduce GHG emissions associated with power usage at Federal facilities and promote the use of clean, secure alternatives to conventional technologies.

FEMP's goal is to facilitate new energy investments through the ESPC and UESC programs that result in an estimated lifecycle savings of 33 trillion Btus (TBtus) in FY 2012. The energy savings from Project Financing activities are estimated to be 63 percent of FEMP's annual target to reduce a total of 52 TBtus in FY 2012, equivalent to displacing the energy use of about 24,000 households over the lifetime of the investment.

Detailed Justification

(dollars in thousands)

	FY 2010 Current Approp	FY 2012 Request
Project Financing	**11,800**	**10,072**

Federal agency use of ESPCs was authorized by Congress to provide an alternative to direct appropriations for funding energy-efficient improvements in Federal facilities. Under ESPCs and UESCs, agencies can take advantage of private sector expertise with little or no upfront cost to the Government. The Government pays back the energy service company through energy cost savings over the life of the projects. ESPC and UESC projects can include energy and water-efficient improvements, renewable energy technologies, alternative fuel (biomass/landfill), combined heat and power, advanced metering, power management and reduced water consumption technologies.

DOE is responsible for the management, oversight and reporting of a Government-wide multiple-award ESPC available to all Federal agencies. FEMP will continue to make improvements in ESPC project facilitation, outreach, financing, training, reporting, measurement and verification, and competition. FEMP project facilitators will continue to provide ESPC and UESC assistance, 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.

(dollars in thousands)

	FY 2010 Current Approp	FY 2012 Request
Analytical activities will continue in support of reporting requirements for project metrics, milestones and program plans to implement improvements in the ESPC and UESC activities. Activities supporting the use of State-provided public benefit funds for Federal facilities and the use of power purchase agreements will continue.		
Total, Project Financing	**11,800**	**10,072**

Explanation of Funding Changes

	FY 2012 vs. FY 2010 Current Approp ($000)
Project Financing	
The decrease to direct Project Financing reflects expanded emphasis on Technical Guidance and Assistance to encourage more productive use of each agency's appropriated resources for energy/facility O&M and improvements.	-1,728
Total Funding Change, Project Financing	**-1,728**

Technical Guidance and Assistance

Funding Schedule by Activity

(dollars in thousands)

	FY 2010 Current Approp	FY 2012 Request
Technical Guidance and Assistance	8,000	12,000
Total, Technical Guidance and Assistance	8,000	12,000

Benefits

Technical Guidance and Assistance supports FEMP's mission to help agencies implement projects and practices that reduce energy bills, reduce GHG emissions, and promote the use of water conservation, energy efficiency and renewable energy. FEMP's technical assistance on energy efficiency and renewable technologies results in accelerated acceptance of these technologies in the Federal sector.

FEMP's goal is to provide technical assistance that result in an estimated lifecycle savings of 19 trillion Btus in FY 2012. The energy savings from Technical Guidance and Assistance are estimated to be 37 percent of FEMP's annual target to reduce a total of 52 TBtus, equivalent to displacing the energy use of about 13,000 households over the lifetime of the investment. Additionally, FEMP will create an annual metric for tracking and reporting the number of Federal agency employees trained.

Detailed Justification

(dollars in thousands)

	FY 2010 Current Approp	FY 2012 Request
Technical Guidance and Assistance	**8,000**	**12,000**

FEMP's broad range of assistance includes analytical support to Federal agencies from its laboratories, new technology deployment, development of Federal agency efficiency standards, specification of products for agency procurement, energy assessments and assistance to help other agencies develop comprehensive planning and internal processes to reduce their energy use and to achieve Federal water consumption goals. Technology areas include lighting, renewable energy and Combined Heat and Power (CHP) technologies. EPAct 2005 and EISA 2007 establish FEMP's responsibility for carrying out a number of activities, including developing product specifications and issuing guidance on metering, new construction, and other energy-related building topics. FEMP will continue to update its specifications for highly energy efficient products. These specifications will be provided to the General Services Administration and Defense Logistics Agency as required by the Federal purchase requirement set forth in EPAct 2005. Technical Guidance and Assistance also provides program-specific technical training and information.

FEMP is expanding its efforts in two areas: (1) "continuous commissioning" to ensure that existing investments in energy efficiency and building control systems are kept at peak operating efficiency; and (2) an expansion of FEMP's interagency technical support and assistance which often takes the form of

(dollars in thousands)

	FY 2010 Current Approp	FY 2012 Request
design and analysis of new energy efficiency or renewable energy projects. There is a great deal of unmet demand at agencies for this assistance. The use of leveraged funds from Federal agencies will continue to be employed.		
Total, Technical Guidance and Assistance	**8,000**	**12,000**

Explanation of Funding Changes

	FY 2012 vs. FY 2010 Current Approp ($000)
Technical Guidance and Assistance	
Increased funding will support Federal cost and GHG reduction efforts by developing guidance, technical assistance and GHG reporting protocols. The increase will also fund an expansion of technical assistance to support agency project implementation to reduce emissions.	+4,000
Total Funding Change, Technical Guidance and Assistance	**+4,000**

Planning, Reporting and Evaluation

Funding Schedule by Activity

(dollars in thousands)

	FY 2010 Current Approp	FY 2012 Request
Planning, Reporting and Evaluation	3,000	5,000
Total, Planning, Reporting and Evaluation	3,000	5,000

Benefits

Through planning, reporting and evaluation, FEMP meets the reporting requirements set forth by Congress and Executive Orders. Tracking, reporting and evaluating are necessary to guide the planning process by assessing the lessons and effectiveness of the Government's efforts to achieve the greatest possible reductions in energy costs, improvements in air quality, and to promote water conservation, energy efficiency and renewable energy technologies. These best practices are not only used by FEMP to improve its performance, but also shared throughout the Federal Government to support collaboration in meeting energy savings goals and deployment of energy efficiency technologies. Information is shared through means such as the FEMP website, interaction with personnel from other agencies on the various interagency panels hosted by FEMP, and multiple training activities. FEMP's collaboration with other Federal agencies to co-sponsor the annual GovEnergy meeting also provides information to thousands of Federal and non-Federal stakeholders on new technologies, processes, and procedures to increase energy efficiency and to increase generation of renewable energy in the Federal Government.

Detailed Justification

(dollars in thousands)

	FY 2010 Current Approp	FY 2012 Request
Planning, Reporting and Evaluation	**3,000**	**5,000**

Data collection, verification and reporting continue to be centralized for the Federal agencies at FEMP with the assistance of technical experts for preparing analysis and verification of data. This also includes maintaining DOE facility information and developing annual plans and reports. Information will be made available on Federal progress toward statutory and E.O. goals on the FEMP website and technical updates to web-based materials will continue for the Federal sector. Activities include preparing Annual Report to Congress as required by EPACT 2005 and EISA 2007 regarding progress by Federal agencies toward the goals that address energy efficiency and renewable energy usage; providing outreach and communication regarding new technologies, fact sheets and guidelines to agencies; support for the GovEnergy Conference; website improvement and training; and the DOE and Federal Awards program.

Technical analysis will continue as required to respond to analytical reporting requirements, multi-year planning and peer reviews. Program assistance will continue in preparing and updating the Federal sector plans for meeting legislative and E.O. goals, as well as recognizing progress through the

(dollars in thousands)

	FY 2010 Current Approp	FY 2012 Request
Presidential and Federal awards programs. Activities will include improving the functionality of GHG reporting required by E.O. 13514 and conducting an evaluation of actual and verifiable energy savings and carbon emissions reductions from federal energy management investments across the Federal Government.		
Total, Planning, Reporting and Evaluation	**3,000**	**5,000**

Explanation of Funding Changes

	FY 2012 vs. FY 2010 Current Approp ($000)
Planning, Reporting and Evaluation	
Increase in funding will be used to complete a system to calculate greenhouse gas emissions from reported Federal energy savings and to conduct an evaluation by an accredited university or independent outside expert organization on actual and verifiable energy savings and carbon emissions reductions from federal energy management investments across the Federal Government.	+2,000
Total Funding Change, Planning, Reporting and Evaluation	**+2,000**

Federal Fleet

Funding Schedule by Activity

(dollars in thousands)

	FY 2010 Current Approp	FY 2012 Request
Federal Fleet	3,000	2,000
Total, Federal Fleet	3,000	2,000

Benefits

By promoting the use of alternative fuel in the fleets of Federal agencies, the Federal Fleet activity decreases the Nation's dependence on oil, reduces GHG emissions and provides leadership and examples for other large fleet operations. FEMP provides technical assistance and support to agencies to reduce their petroleum consumption by 20 percent between FY 2005 to FY 2015, and to increase alternative fuel consumption by 10 percent per year over the same period. These activities will support private sector development of alternative fuel stations at Federal sites and demonstrate opportunities for petroleum displacement to increase alternative fuel use and its fueling infrastructure.

Detailed Justification

(dollars in thousands)

	FY 2010 Current Approp	FY 2012 Request
Federal Fleet	**3,000**	**2,000**

FEMP provides guidance and assistance to help implement Federal legislative and regulatory requirements mandating reduced petroleum consumption and increased alternative fuel use. FEMP'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 and tracking and reporting Federal progress annually. FEMP provides information and resources for Federal requirements, technology resources, infrastructure development, data analysis and trends, coordination of an interagency working group (INTERFUEL), and 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. FEMP outlines reporting requirements and processes, including regulations, timelines, and tools to help Federal agencies meet annual requirements.

FEMP will continue to report on and conduct analysis of Federal vehicle fleet activities and help agencies implement compliance measures in their fleet management activities. Federal vehicle fleet activities provide guidance and support to each agency to help them comply with legislative and E.O. requirements to reduce dependence on petroleum.

Total, Federal Fleet	**3,000**	**2,000**

Explanation of Funding Changes

	FY 2012 vs. FY 2010 Current Approp ($000)
Federal Fleet	
Because of a redirection across the EERE portfolio and issuance of guidance, FEMP will reduce technical support but maintain core reporting activities.	-1,000
Total Funding Change, Federal Fleet	**-1,000**

DOE Specific Investments

Funding Schedule by Activity

(dollars in thousands)

	FY 2010 Current Approp	FY 2012 Request
DOE Specific Investments	6,200	4,000
Total, DOE Specific Investments	6,200	4,000

Benefits

DOE Specific Investments include activities that ensure implementation of Federal and Departmental environmental, energy and transportation management goals throughout the DOE complex, including mandates from EPAct 2005, EISA 2007 and Executive Orders 13514 and 13423. These activities further DOE's strategic goal of energy security by ensuring that DOE increases its energy productivity and energy diversity, and reduces GHG emissions while enhancing DOE's ability to lead by example. DOE is committed to reducing Scope 1 and 2 GHG emissions by 28 percent and Scope 3 emissions by 13 percent by 2020; through its efforts to reduce energy intensity by 30 percent from FY 2003 by FY 2015; reduce water use intensity by 16 percent from FY 2007 through FY 2015; use 7.5 percent of electricity from renewable sources by FY 2013; and ensure 15 percent of facilities meet the Guiding Principles (GP) for Federal Leadership in High Performance Sustainable Buildings (HPSB) by FY 2015.

Detailed Justification

(dollars in thousands)

	FY 2010 Current Approp	FY 2012 Request
DOE Specific Investments	**6,200**	**4,000**

Activities include evaluating, analyzing and reporting data for DOE on its sustainability achievements, as well as implementing and updating the DOE Strategic Sustainability Performance Plan (SSPP). These activities will be managed by the Sustainability Performance Office in conjunction with FEMP, DOE corporate offices, the Under Secretaries, Program Support Offices, National Laboratories and DOE Sites. In addition, activities will include support and technical assistance for operations and maintenance, retro commissioning and audits of DOE sites; assistance for mission critical energy intensive buildings and processes: supercomputers and scientific computing, data centers, accelerators, lasers, laboratories and their supporting structure; support for meeting the requirements of E.O. 13423, E.O. 13514, and related statutory sustainability requirements and internal DOE policies and orders; support for policy guidance, technical assistance and information on High Performance Sustainable Buildings (HPSB) and sites; support for use of ESPCs and UESCs at DOE facilities; providing technical guidance and assistance to DOE offices; establishing incentive awards; implementing sustainable design principles; identifying and deploying alternative energy, energy efficiency, water and renewable energy technologies; providing information and outreach; assisting with development and implementation of site energy, metering, water and other sustainability plans; and supporting ESPC

(dollars in thousands)

	FY 2010 Current Approp	FY 2012 Request
and UESC projects, training, renewable power purchase agreements, project development and implementation assistance. Administrative and technical support will be provided for DOE workgroups, the National Laboratory Directors Council (NLDC), the Energy Facilities Contractor Group (EFCOG), as well as interagency group representation.		
Total, DOE Specific Investments	**6,200**	**4,000**

Explanation of Funding Changes

	FY 2012 vs. FY 2010 Current Approp ($000)
DOE Specific Investments	
Decrease in funding reflects the elimination of direct funding by FEMP for capital projects at DOE sites as these projects will be funded by the DOE program offices in accordance with the implementation policy set forth in the Department's SSPP. Also, technical assistance and project transaction services for DOE sites will be reduced. DOE's SSPP assigns goal achievement to various DOE Programs who will determine the optimum funding strategy for the project investments required to achieve plan goals. The reduction reflects the transfer of responsibility relating to such projects.	-2,200
Total Funding Change, DOE Specific Investments	**-2,200**

Facilities and Infrastructure

Funding Profile by Subprogram

(dollars in thousands)

	FY 2010 Current Approp	FY 2012 Request
Facilities and Infrastructure		
National Renewable Energy Lab		
Operations and Maintenance		
General Plant Projects	10,000	11,515
General Purpose Equipment	5,000	3,185
Upgrade East Access to STM	4,000	0
Maintenance and Repair	0	3,300
Safeguards and Security	0	8,407
Total, Facilities and Infrastructure	19,000	26,407

Public Law Authorizations:

P.L. 95-91, "Department of Energy Organization Act" (1977)
P.L. 109-58, "Energy Policy Act of 2005"
P.L. 110-140, "Energy Independence and Security Act of 2007"

Mission

The National Renewable Energy Laboratory (NREL) is dedicated to the research and development 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) activities 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.

Benefits

This Facilities and Infrastructure budget funds capital investments necessary to provide the Nation with a vibrant world-class RDD&D program to advance energy policy. Included in this budget are:

- General Purpose Equipment (GPE) investments that acquire shared science and support capabilities;
- Capital line item projects that include acquisition of new science and support capabilities, modification of existing capabilities, and improvements to NREL site infrastructure to accommodate the EERE approved Ten Year Site Plan;
- General Plant Project (GPP) investments to support the safe and efficient operation of NREL and EERE Programs. Projects keep the real property investments at NREL in a high quality serviceable condition to support R&D activities; and
- Safeguards and Security (S&S) investments provide for a safe work environment for research and support staff and the protection of property; both physical and intellectual.

All investments support and enable energy efficiency and renewable energy priorities, EERE mission needs, DOE Directives, and the safe and efficient operation of EERE's National Laboratory

implementers. These investments also fulfill EERE's stewardship responsibility for NREL. Funding ensures the readiness of EERE's Laboratory network to conduct renewable energy research in the energy efficiency and renewable energy arenas.

Detailed Justification

(dollars in thousands)

	FY 2010 Current Approp	FY 2012 Request
Operation and Maintenance (NREL Specific)		
▪ **General Plant Projects**	**10,000**	**11,515**

The GPP request supports 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, CO. These projects include: safety 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.

▪ **General Purpose Equipment**	**5,000**	**3,185**

The GPE request maintains 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; safety and security equipment; administrative equipment; communications equipment; and other categories of general equipment.

▪ **Upgrade East Access to STM**	**4,000**	**0**

The project upgrades and reconfigures the east access interchange (the original site access point) to increase safety and efficiency due to current and future site growth. This project will improve traffic flow through the east access by adding turning lanes and improved signals. These changes will improve the safety of NREL employees and the community during peak arrival and departure times, as well as for emergency access and evacuation purposes. The western-most portion of the original interchange was designed and constructed thirty years ago. FY 2010 funding completed this project.

▪ **Maintenance and Repair**	**0**	**3,300**

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 GCE) is being broken out separately to improve transparency.

(dollars in thousands)

	FY 2010 Current Approp	FY 2012 Request
▪ **Safeguards and Security**	**0**	**8,407**

S&S activities at NREL provide for a safe work environment for the research and support staff and the protection of property; both physical and intellectual. Beginning in FY 2012, DOE is implementing a standard S&S policy that ensures transparency for budgeting and costing activities. S&S activities will have standardized definition and consistency in the collection, disclosure, and recovery of expenses. S&S is a direct funded activity across the DOE Laboratory system. Previously, these funds were recovered through indirect assessment.

Construction

▪ **Energy Systems Integration Facility**	**0**	**0**

The Energy Systems Integration Facility (ESIF) creates a unique national capability to simulate, model, and create cost-effective renewable electricity generation, storage, and distribution components and systems to reduce the financial, technical, and market risk of wide-scale deployment and commercialization within the Nation's existing grid and emerging distributed energy infrastructure. The facility will integrate the effort of multiple EERE Technology Programs. The ESIF relies on advanced computational science capability to design, model, simulate, test, and improve solar, wind, fuel cell, buildings systems, and integrated energy systems, including electricity storage systems to meet requirements for integration into specific utility systems. ESIF enables the development of new approaches to integrate renewables into existing energy systems to accelerate the deployment of renewable energy technologies. This facility will provide a world class research environment for renewable energy development and deployment. Funding for this project was completed in FY 2011.

Total, National Renewable Energy Laboratory	**19,000**	**26,407**

Explanation of Funding Changes

	FY 2012 vs. FY 2010 Current Approp ($000)
Operation and Maintenance	
▪ **General Plant Projects**	
The increase in funding is due to significant growth and associated restructuring of the NREL campus.	+1,515
▪ **General Purpose Equipment**	
The decrease in funding reflects the change in emphasis towards EERE's compliance with the DOE's S&S directives. Further evaluation of all laboratory equipment during FY 2011 will determine budget needs for future years to maintain a viable research environment.	-1,815
▪ **Upgrade East Access to STM**	
Activity decreases due to full funding requirement met for the upgrade East access to STM during FY 2010.	-4,000
▪ **Maintenance and Repair**	
Increased 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. This funding (previously funded within GPP and GCE) is being broken out separately to improve transparency.	+3,300
Safeguards and Security	
The increase in funding is due to the new DOE policy that all organizations fund S&S directly instead of funding indirectly through user assessments.	+8,407
Total, Operation and Maintenance	**+7,407**
Construction	
▪ **Energy Systems Integration Facility**	
Reflects full funding of ESIF in FY 2011. There are no new facility construction line item projects requested in FY 2012.	0
Total, Construction	**0**
Total Funding Change, National Renewable Energy Laboratory	**+7,407**

Capital Operating Expenses and Construction Summary

Capital Operating Expenses

(dollars in thousands)

	FY 2010 Current Approp	FY 2012 Request
General Plant Projects	10,000	11,515
GPP – Upgrade East Access to STM	4,000	0
General Purpose Equipment	5,000	3,185
Maintenance and Repair	0	3,300
Safeguards and Security	0	8,407
Total, Capital Operating Expenses	19,000	26,407

Construction Projects

(dollars in thousands)

	Total Estimated Cost (TEC)[a]	Prior-Year Appropriation	FY 2010	FY 2011	FY 2012	Unappropriated Balance
Energy Systems Integration Facility	132,000	95,500	0	39,500	0	0
Total, Construction Projects	132,000	95,500	0	39,500	0	0

Major Items of Equipment

(dollars in thousands)

	Total Project Cost (TPC)	Total Estimated Cost (TEC)	Prior-Year Appropriations	FY 2010	FY 2011	FY 2012	Completion Date
Major Items of Equipment	0	0	0	0	0	0	N/A
Total, Major Items of Equipment	0	0	0	0	0	0	N/A

[a] The Total Project Cost (TPC) is $135M. The $3M difference between TPC and TEC is for Other Project Costs.

08-EE-01, Energy Systems Integration Facility, National Renewable Energy Laboratory, Golden, Colorado
Project Data Sheet is for PED/Construction

1. Significant Changes

The most recent DOE O 413.3A approved Critical Decision (CD) is CD-1 approved on May 10, 2010 for the Energy Systems Integration Facility (ESIF) project by the Under Secretary of Energy. Planning and development activities, including a stakeholder workshop and updated cost estimate and conceptual design, have determined that the total project cost for this project is $135 Million.

A Federal Project Director (FPD) has been assigned to this project with Level II certification. The FPD has completed all coursework and is expected to attain Level III certification during this project.

This Project Data Sheet is an update of the FY2011 PDS. The Congress included $55,000,000 [less a 0.91 percent across-the-board rescission] in FY2008 appropriations and $41,000,000 in FY209 appropriations to begin design/construction for this project. The project funding profile is $54.5M in FY2008, $41.0M in FY2009 and $39.5M requested in FY2011. Construction will commence upon CD-2/3 approval.

2. Design, Construction, and D&D Schedule[a]

(fiscal quarter or date)

	CD-0	CD-1	PED Complete	CD-2	CD-3	CD-4	D&D Start	D&D Complete
FY2007	8/9/2007	2QFY2010	4QFY2010	TBD	TBD	TBD	---	TBD
FY2009	8/9/2007	2QFY2010	4QFY2010	TBD	TBD	TBD	---	TBD
FY2010	8/9/2007	2QFY2010	4QFY2010	TBD	TBD	TBD	---	TBD
FY2011	8/9/2007	2QFY2010	4QFY2010	TBD	TBD	TBD	---	TBD
FY2012	8/9/2007	5/10/2010	2QFY2011	2QFY2011	2QFY2011	4QFY2013	---	TBD

CD-0 – Approve Mission Need
CD-1 – Approve Alternative Selection and Cost Range
CD-2 – Approve Performance Baseline
CD-3 – Approve Start of Construction
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

[a] Project does not have CD-2/3 approval. Schedules are to be determined upon completion of a validated Performance Baseline. Preliminary schedule for CD-4 is approximately 4QFY2013.

3. Baseline and Validation Status[a,b]

(dollars in thousands)

	TEC, PED	TEC, Construction	TEC, Total	OPC Except D&D	OPC, D&D	OPC, Total	TPC
FY2007	NA	TBD	TBD	TBD	TBD	TBD	TBD
FY2008	NA	TBD	TBD	TBD	TBD	TBD	TBD
FY2009	NA	TBD	TBD	TBD	TBD	TBD	TBD
FY2010	NA	TBD	TBD	TBD	TBD	TBD	TBD
FY2011	NA	TBD	TBD	TBD	TBD	TBD	TBD
FY2012	NA	TBD	TBD	TBD	TBD	TBD	TBD

4. Project Description, Justification, and Scope

The Energy Information Administration forecasts that energy consumption in the U.S. will increase by 34 percent by 2030.[c] The current energy infrastructure and total energy demand cannot be replaced by a single production source. Renewable energy sources including solar, wind, and fuel cell technologies need to be a significant part of the energy supply to accommodate the increased demand. In the U.S., solar and wind resources and fuel cell technologies offer a major opportunity to supply energy for production of electricity; however, their variability, decentralization, and intermittency can make them challenging to integrate into energy production and delivery systems while continuing to ensure low cost and high system reliability. Developing integrated energy systems and testing technologies that include energy generation, storage, distribution, and utilization are critical to maximize the potential benefits of renewable technologies.

The U.S. Department of Energy (DOE) recognizes the need to develop an integrated energy systems approach that will result in large scale adoption of renewable energy. Inherent variability in power quality and intermittency of renewable generation systems requires full characterization to lower economic and technical risk for maximum deployment acceleration of these carbon-free power systems. The scope defined is technology improvements on the generator systems equipment (Renewable Energy generator plant, inverters, transformers, power conditioning/controls systems, etc) side of the interconnection point. Activities, therefore, need to include efforts to:

- Develop foundation of advanced renewable resource evaluation and forecasting tools for adoption of renewable technologies at scale;
- Develop and characterize renewable generator performance and power quality (voltage variability, harmonics, etc.);
- Combine renewable resource assessments data with renewable generation project performance data for model validation;
- Test and validate optimized renewable energy generators and associated equipment (e.g., electricity storage for PV systems, etc.) to reduce operability and reliability risks;
- Model, simulate, and evaluate increased market penetration of renewable generation to optimize RE generation portfolios for specific regions, and to identify and mitigate issues related to intermittency and variability;
- Build common platforms for renewable systems integration hardware testing to enable evaluation of many different, novel generator/controller/load scenarios quickly and cheaply;

[a] Costs are to be determined upon completion of a validated Performance Baseline.
[b] No construction funds (excluding approved long lead procurement and preliminary design) will be used until the project performance baseline has been validated and CD-2/3 has been approved.
[c] Annual Energy Outlook 2006; Energy Information Administration

- Explore a variety of end-user-level systems configurations in a controlled environment allowing for the understanding of fundamental integration and interconnection issues;
- Enable the ability to explore systems configuration optimization at a scale that is cheaply and quickly configured and reconfigured; and
- Fully incorporate technical, economic, and financial analyses with technical validation efforts.

Energy Efficiency and Renewable Energy (EERE) Programs support the R&D needed to bring critical new technologies to a point where industry is able to commercialize renewable energy-based energy systems, fuel cells, and plug-in hybrid vehicles. To meet programmatic milestones, EERE requires an effective research facility, with appropriate testing, modeling and data management capabilities, to reduce R&D time and enable quicker deployment of cost-effective technologies to the marketplace.

DOE must increase its ability to characterize and test pre-commercial-scale integrated renewable energy systems to maximize the benefit of individual program funding. The ability to test and evaluate integrated systems will help maximize the benefit to each technology program to accomplish the EERE mission in support of the Department's Strategic Goals. This scale of testing can be done more quickly at less cost than commercial-scale demonstrations, and will allow industry to try a variety of new and advanced component and system combinations before deciding on which paths forward make the best economic sense to commercial deployment with the lowest technological and financial risks.

The capability must be designed for industry collaboration through cost-shared partnerships. A user-oriented facility must be located where it can easily be accessed by researchers and by energy stakeholders from utility, fuel cell, electricity, and other key sectors. It will allow industry partners to test their individual technologies and systems in a controlled integrated energy system platform, and optimize the technologies for earlier market penetration. Experience has shown that validating and correcting problems in a laboratory environment enables technologies to go from concept to production more quickly, reduces overall cost, improves reliability, and reduces risks. This, in turn, makes early-stage projects more easily financed at better terms. Establishing this capability will foster information exchanges to help grow these emerging industries.

The Energy Systems Integration Facility (ESIF) supports the development and deployment of energy efficiency and renewable technologies that include:

- Increase U.S. energy diversity thus reducing vulnerability to disruption and increasing the flexibility of the market;
- Improve the quality of the environment by reducing greenhouse gas emissions and environmental impacts from energy production and use; and,
- Create a more flexible, more reliable, and higher capacity U.S. energy infrastructure.

The ESIR research capability will:

- Contain computational support for characterization of solar, wind, fuel cell, and integrated energy systems, including electricity storage that can effectively design, engineer, test, and verify technologies for commercial deployment.
- Test technology systems to ensure that technical and financial risks faced by U.S. industry are fewer, making technology readiness less difficult, less costly, and take significantly less time.
- Enable U.S. industry to compete more readily with foreign companies in Europe and Asia, and help determine technology readiness, allowing the U.S. to overcome vulnerabilities inherent in dependence on foreign oil, and achieving the objectives of energy security in an accelerated way.

DOE's visionary initiatives and programs are designed to accelerate the development of technologies to meet milestones for each individual technology. Developing a new electric and fuel infrastructure for the nation is a complex task requiring a systems-level approach, and many paths can lead to a successful future. Today, scientists and engineers are developing more efficient and lower-cost fuel cells; advanced vehicle designs; new methods to produce power from solar, wind, and biomass resources; gasoline and diesel alternatives from biomass.

To fully realize the benefits of EERE's Technology Programs and improve the market impact of renewable energy, DOE also needs to strengthen its engineering, design, modeling, simulation, and testing capabilities. Currently, the DOE research, development, and demonstration environment has little capability to accomplish the following critical activities:

- Integrate components into optimized systems from power generation through end use at a building-scale, community-scale, or utility-scale system.
- Test systems using flexible platforms for mixing and matching power generation and use.
- Provide technical and economic data/analyses to foster successful business opportunities.

EERE needs to increase the ability to characterize and test pre-commercial-scale integrated renewable energy and fuel cell systems to maximize the benefit of individual program funding, which is directed at individual technology development. The ability to test and evaluate integrated systems will help maximize the benefit to each technology program to accomplish the EERE mission in support of the Department's Energy Strategic Goals. This scale of testing can be done quicker and for less cost than commercial-scale demonstrations and will allow industry to try a variety of new and advanced component and system combinations quickly before deciding on which paths forward make the best economic sense to commercialize (Figure 2.3.1).

The Federal system currently lacks a facility for designing and testing engineering optimized systems, testing integrated energy technologies, and simulating and or emulating new infrastructure scenarios under the control of DOE and available to all of DOE industry partners. The lack of such a facility represents a key barrier to being able to meet DOE's solar, wind, and fuel cell goals. A new facility will allow DOE to optimize these technologies as part of a total energy system collecting both technical and economic data for business analysis and will encourage their integration into energy production and delivery systems at minimum cost and high system reliability.

In addition to supporting EERE Program requirements for Solar, Wind, Fuel Cell, Infrastructure, and Vehicle technologies, the capabilities of this new facility will also support the interconnection requirements of the Office of Electricity Program for distributed power from renewable energy technologies and the integration of EERE technologies into the electrical grid.

Industry partnership is vital to the success of new energy and transportation technologies. U.S. utilities and private sector companies are interested in partnering with DOE to achieve a successful electric and fuel cell future. However, there is currently no facility in the country that supports cooperative public-private, laboratory-controlled research at the pre-commercial engineering scale, including testing and verification of a wide variety of concepts for advanced fuel cell technologies and integrated energy systems. Also, private facilities are not equally available to all researchers involved in a national effort.

One of the goals of NREL, for which EERE is the principal secretarial office, is to manage the interface between applied R&D and the commercial marketplace to encourage the market penetration of renewable and energy efficiency technologies. Many of the existing individual engineering and testing activities supporting the goals of the Solar, Wind, Fuel Cell, and Vehicle Technology Programs described above are conducted at NREL. Fuel Cell systems development and advanced fuels technology development activities are effectively leveraged to take advantage of NREL's core expertise

and capabilities in integrating clean energy technologies such as solar, wind, and biofuels. These activities at NREL, however, have no dedicated facility.

Creating a facility to test the integrated renewable technology systems concept (energy system technology and system design, testing and performance optimization in the context of the larger energy supply, delivery, and end use systems for deployment) forms the center of DOE's energy efficiency and renewable energy capability. The Energy Systems Integration Facility (ESIF) will enable DOE and its industrial partners to assess the potential of solar, wind, and fuel cell technology options for buildings, transportation, community, and utility utilization and develop a validated engineering-scale collection and analysis of performance data for the most promising technologies and integrated energy systems. The ESIF will allow U.S. industry members to insert their individual technologies into a controlled integrated energy system platform to test and optimize the technologies for earlier market penetration. The ESIF is envisioned to be a new facility specially designed to accommodate the critical engineering, testing, optimization, and verification research needed for integrated engineering systems development for EERE Programs. It is proposed as a "first of its kind" integrated test and validation facility for new technologies being developed by the EERE Programs and industry research partners nationwide. The facility will provide support space for researchers and support staff, effectively consolidating activities currently in several different locations at NREL, some of which are currently located in leased facilities. In addition, outdoor pads will be available for testing larger equipment and systems up to the multi-megawatt scale. The facility itself will be designed to merit at least a Leadership in Energy and Environmental Design (LEED) "Gold" rating from the U.S. Green Building Council, in support of EERE's goal to demonstrate energy efficient buildings with a lower impact on the environment.

The project is being conducted in accordance with the project management requirements in DOE O 413.3A, Program and Project Management for the Acquisition of Capital Assets, and all appropriate project management requirements have been met.

A conceptual design for the project has been completed. The project has CD-1 approval and preliminary design and development of the cost, scope, and schedule baselines for validation began on June 14, 2010 and was completed on December 7, 2010. The project is expected to attain a combined CD-2/3 in the second quarter of FY2011.

5. Financial Schedule

	(dollars in thousands)		
	Appropriations	Obligations	Costs
Total Estimated Cost (TEC)			
PED			
FY2008	6,603	6,603	0
FY2009	1,648	1,648	0
FY2010	0	0	3,861
FY2011	0	0	4390
FY2012	0	0	0
FY2013	0	0	0
Total, PED	**8,251**	**8,251**	**8251**
Construction			
FY2008	47,897	47,897	0
FY2009	37,375	37,375	0
FY2010	0	0	0
FY2011	38,495	38,495	27716
FY2012	0	0	75,874
FY2013	0	0	20177
Total, Construction	**123,767**	**123,767**	**123767**
TEC [Total D&C]			
FY2008	54,500	54,500	0
FY2009	39,023	39,023	0
FY2010	0	0	3,861
FY2011	38,495	38,495	32106
FY2012	0	0	75,874
FY2013	0	0	20177
Total, TEC	**132,018**	**132,018**	**132,018**
Other Project Cost (OPC)			
OPC except D&D			
FY2008	0	0	0
FY2009	1,977	1,977	1,166
FY2010	0	0	555
FY2011	1,005	1,005	630
FY2012	0	0	482
FY2013	0	0	149
Total, OPC except D&D	**2,982**	**2,982**	**2,982**
OPC D&D			
FY2008	0	0	0
FY2009	0	0	0
FY2010	0	0	0
FY2011	0	0	0
FY2012	0	0	0

	(dollars in thousands)		
	Appropriations	Obligations	Costs
FY2013	0	0	0
Total, OPC D&D	**0**	**0**	0
Total OPC			
FY2008	0	0	0
FY2009	1,977	1,977	1,166
FY2010	0	0	555
FY2011	1,005	1,005	630
FY2012	0	0	482
FY2013	0	0	149
Total, OPC	**2,982**	**2,982**	**2,982**
Total Project Cost (TPC)			
FY2008	54,500	54,500	0
FY2009	41,000	41,000	1,166
FY2010	0	0	4,416
FY2011	39,500	39,500	32736
FY2012	0	0	76,356
FY2013	0	0	20326
Total, TPC	**135,000**	**135,000**	**135,000**

6. Details of Project Cost Estimate

	(dollars in thousands)		
	Current Total Estimate	Previous Total Estimate	Original Validated Baseline
Total Estimated Cost (TEC)			
DESIGN [PED]			
Design	7,858	8,974	TBD
Management Reserve	393	897	
Total, PED	**8,251**	**9,871**	**TBD**
CONSTRUCTION			
Site Preparation	2,136	2,135	TBD
Equipment	28,000	30,000	TBD
Other Construction	83,087	72,024	TBD
Management Reserve	4,839	10,879	TBD
DOE Contingency	3,205	0	TBD
Award Fee	2,500	2,500	
Total, Construction	**123,767**	**117,538**	**TBD**
Total, TEC	**132,018**	**127,409**	**TBD**
Management Reserve TEC	**5,232**	**11,776**	**TBD**

	(dollars in thousands)		
	Current Total Estimate	Previous Total Estimate	Original Validated Baseline
DOE Contingency	**3,205**	**0**	**TBD**
Other Project Cost (OPC)			
OPC except D&D			
Conceptual Planning/Design	1,166	1,371	TBD
Other Project-Related costs	864	1,253	TBD
Commissioning (Start-Up)	303	266	TBD
Management Reserve	649	289	TBD
Total, OPC except D&D	**2,982**	**3,179**	**TBD**
D&D			
D&D	0	0	0
Management Reserve/DOE Cont	0	0	0
Total, D&D	**0**	**0**	**0**
Total, OPC	**2,982**	**3,179**	**TBD**
Management Reserve, OPC	**649**	**289**	**TBD**
Total, TPC	**135,000**	**133,000**	**TBD**
Total, Management Reserve	**5,881**	**12,065**	**TBD**
Total DOE Contingency	**3,205**	**2,412**	**TBD**

7. Schedule of Appropriation Requests[a]

($K)

		Prior Years	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	Outyears	Total
FY 2009	TEC	93,280	0	39,500	0	0	0	0	0	132,780
	OPC	2,220	0	0	0	0	0	0	0	2,220
	TPC	95,500	0	39,500	0	0	0	0	0	135,000
FY 2011	TEC	93,523	0	38,495	0	0	0	0	0	132,018
	OPC	1,977	0	1,005	0	0	0	0	0	2,982
	TPC	95,500	0	39,500	0	0	0	0	0	135,000

8. Related Operations and Maintenance Funding Requirements

Start of Operation or Beneficial Occupancy (fiscal quarter or date)	4QFY2013
Expected Useful Life (number of years)	50
Expected Future Start of D&D of this capital asset (fiscal quarter)	4QFY2063

(Related Funding requirements)

(dollars in thousands)

	Annual Costs		Life Cycle Costs	
	Current Total Estimate	Previous Total Estimate	Current Total Estimate	Previous Total Estimate
Operations	685	1,371	34,265	68,550
Maintenance	754	876	37,726	43,800
Total, Operations & Maintenance[b]	1,439	2,247	71,991	112,350

9. Required D&D Information

Area	Square Feet
Area of new construction	175,000
Area of existing facility(s) being replaced	175,000
Area of additional D&D space to meet the “one-for-one” requirement	0

The new construction is not replacing an existing DOE owned facility. EERE has secured offset space through the Office of Engineering and Construction Management to comply with the "one-for-one" requirement.

[a] Project does not have CD-2 approval; therefore, a performance baseline has not yet been established.

[b] Estimated costs include building utilities i.e. electric, natural gas, sewer or water for common office facilities. Research utility usage is unquantifiable. Life cycle costs were analyzed using a discounted, life-cycle cost model as prescribed by OMB Circular A-94.

Name(s) and site location(s) of existing facility(s) to be replaced: Lease space will be released as soon as feasible in accordance with lease terms and operational requirements.

10. Acquisition Approach

The Acquisition Strategy will emphasize best value to the government; defined, as the balance between mission need, project performance, financial value, timeliness, and risk mitigation. The majority of the project will be executed under a design-build strategy to mitigate government risk and to deliver the best possible building.

Acquisition will be accomplished using a progressive design-build strategy in which design and construction services are performed by an integrated design/construction team. The design/construction team was selected via competition using best value contracting procedures. A Firm Fixed Price subcontract has been negotiated with the Design-Builder for preliminary design services to limit the Government's risk. A subcontract modification will be executed to complete design and construction activities following successful negotiations with the Design-Builder and Acquisition Executive approval of Critical Decision 2/3.

Weatherization and Intergovernmental Activities

Funding Profile by Subprogram

(dollars in thousands)

	FY 2010 Current Approp	FY 2012 Request
Weatherization and Intergovernmental Activities		
Weatherization Assistance Grants	210,000	320,000
State Energy Program	50,000	63,798
Tribal Energy Program	10,000	10,000
Total, Weatherization and Intergovernmental Activities	270,000	393,798

Public Law Authorizations:

P.L. 94-163, "Energy Policy and Conservation Act" (EPCA) (1975)
P.L. 94-385, "Energy Supply and Production Act" (ECPA) (1976)
P.L. 95-91, "Department of Energy Organization Act" (1977)
P.L. 95-618, "Energy Tax Act" (1978)
P.L. 95-619, "National Energy Supply Policy Act" (NECPA) (1978)
P.L. 95-620, "Power Plant and Industrial Fuel Use Act" (1978)
P.L. 96-294, "Energy Security Act" (1980)
P.L. 100-12, "National Appliance Energy Supply Act" (1987)
P.L. 100-615, "Federal Energy Management Improvement Act" (1988)
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"

Mission

The mission of the Weatherization and Intergovernmental Activities Program (WIP) is to significantly accelerate, in partnership with State and local organizations, the deployment of energy efficiency and renewable energy technologies and practices by a wide range of Government, community, and business stakeholders.

Benefits

WIP addresses both the supply and demand sides of energy security by facilitating investments in clean energy generation and energy efficiency. The Program provides a combination of financial and technical assistance to State, local, U.S. territory, and tribal governments. Grantees utilize these resources to implement a variety of projects, including the weatherization of homes, renewable energy planning, and emergency energy management, financing energy efficiency and clean energy projects and programs, and developing sustainable energy policies.

Planned WIP FY 2012 activities will build upon Recovery Act clean energy investments. WIP manages approximately 30 percent (about $11.5 billion) of DOE's appropriation from the Recovery Act (plans and progress may be viewed at: http://www.eere.energy.gov). The Recovery Act has enabled the: weatherization of hundreds of thousands of low-income residences; training of State, local and weatherization workforces for green careers; assistance to state energy offices; and implementation of approximately 2,400 Energy Efficiency and Conservation Block Grant (EECBG) programs. EECBG also supports the objectives of the multi-year Administration "Recovery through Retrofit" initiative.

Through the EECBG competitive solicitation, known as the "Better Buildings" program, approximately $450 million in resources were awarded in FY 2010 for innovative and comprehensive whole-neighborhood building energy retrofit initiatives.

These efforts and non-Recovery Act efforts are contributing to the High Priority Performance Goal (HPPG) of one million cost-effective residential energy retrofits. The FY 2012 Program reflects a significant shift in budget development incorporating an analytically based integrated planning, review, and performance assessment of EERE programs.

Through these retrofits and other efforts, the Program produces key benefits. Specifically, the Weatherization Assistance Program (WAP) reduces energy consumption while concurrently reducing energy costs for low-income families. The State Energy Program (SEP) serves as a critical force in reducing energy use and costs, developing environmentally conscious state economies, and increasing renewable energy generation. In partnership with tribal governments, Tribal Energy Activities are particularly valuable in advancing sustainable clean energy development and deployment on tribal lands.

WIP achieves reductions in greenhouse gas (GHG) emissions through the deployment of clean energy technologies and sustainable energy policies.

High Priority Performance Goal (HPPG)

WIP contributes directly to achieving the Retrofit HPPG. The performance measure for the Program contributes to the multiagency goal of retrofitting more than one million homes. Additional information on the intermediate performance critical to achievement is provided at: www.performance.gov.

Annual Performance Results and Targets

The Department is in the process of updating its strategic plan, and has been actively engaging stakeholders including Congress. The draft strategic plan is being released for public comment concurrent with this budget submission, with the expectation of official publication this spring. The draft plan and FY 2012 budget are consistent and aligned. Updated measures will be released at a later date and available at the following link http://www.mbe.doe.gov/budget/12budget/index.htm.

Weatherization Assistance Grants

Funding Schedule by Activity

(dollars in thousands)

	FY 2010 Current Approp	FY 2012 Request
Weatherization Assistance Grants		
Weatherization Assistance	176,700	220,000
Training and Technical Assistance	3,300	3,000
Innovations in Weatherization	30,000	97,000
Weatherization Assistance Grants	210,000	320,000

Benefits

The primary benefits of WAP are:

- Reduced residential energy demand through residential energy retrofits; and
- Expansion of green workforce capabilities through career development trainings and certifications.

Since 1976, the Program has helped 6.3 million American families, resulting in an estimated average energy savings of $350 per household in 2009, while increasing the comfort and safety of their homes. One dollar invested in the traditional Program is characterized by a:

- Return of $1.80 (2010) in energy-related benefits; and
- Match of $1 in non-Federal contributions.

The FY 2010, Innovations in Weatherization pilots forecasted a leveraging of $3 in non-Federal funds for each Federal grant dollar. Successful testing and scale-up of these demonstrations would result in a doubling of the energy benefits obtainable under the formula program.

States and utility companies also contribute funds for weatherization activities. A state-by-state breakout of this information is available through the Weatherization Assistance Program Training Assistance Center (WAPTAC) website (http://www.waptac.org), under the "WAP Basics" tab in the funding survey section. Information is updated in June of each year. The following table displays the current information:

Weatherization Assistance Funding

(whole dollars)

State/Territory	Source of Non-Federal Funds	FY 2012 Federal/DOE Funds	FY 2009 Non-Federal Funds[a]
Alabama	Alabama Power-Centsable Energy Program	2,338,597	350,000
Alaska	N/A	1,648,134	0
Arizona	Utility funds	1,309,094	2,600,000
Arkansas	N/A	2,013,546	0
California	N/A	6,130,013	0
Colorado	Utilities- Excel Energy	5,367,877	2,419,660
Connecticut	Utilities: WRAP, UI, SCG	2,450,911	7,500,000
Delaware	Utility funds	562,623	1,778,800
Dist. Columbia	Sustainable Energy Trust Fund	635,854	4,643,600
Florida	N/A	1,841,157	0
Georgia	GA Power Company & Atlanta Gas Light Resources	2,838,384	2,400,000
Hawaii	N/A	198,963	0
Idaho	Utility funds, landlord contributions, BPA funds	1,933,535	2,414,795
Illinois	Supplemental State LIHEAP fund	13,532,701	7,500,000
Indiana	N/A	6,404,780	0
Iowa	Utility funds	4,881,949	4,973,835
Kansas	N/A	2,471,134	0
Kentucky	N/A	4,418,740	0
Louisiana	N/A	1,661,992	0
Maine	N/A	3,004,922	0
Maryland	Utility & Regional Greenhouse Gas Initiative (RGGI)	2,589,831	1,618,054
Massachusetts	Utility & Regional Greenhouse Gas Initiative (RGGI)	6,404,392	29,000,000
Michigan	Utility funds	14,864,193	8,500,000
Minnesota	Utility funds, plus HUD/CDBG funds	9,654,204	2,000,000
Mississippi	N/A	1,599,492	0
Missouri	Ameren Electric, Ameren gas, Atmos Gas, Laclede Gas	5,862,446	2,957,892
Montana	State, Utility,	2,469,559	2,442,253
Nebraska	N/A	2,440,874	0
Nevada	N/A	815,457	0
New Hampshire	Electric Utility Efficiency Program	1,477,689	3,569,721

[a] FY 2010 non-Federal funding data not available until June 2011.

(whole dollars)

State/Territory	Source of Non-Federal Funds	FY 2012 Federal/DOE Funds	FY 2009 Non-Federal Funds[a]
New Jersey	N/A	4,982,599	0
New Mexico	Utility Funds	1,868,694	2,188,178
New York	Owner investments in larger multifamily buildings	19,704,925	10,000,000
North Carolina	N/A	4,045,768	0
North Dakota	N/A	2,447,382	0
Ohio	N/A	13,429,239	0
Oklahoma	Utility Funds	2,522,348	400,000
Oregon	BPA, ECHO	2,763,867	7,100,000
Pennsylvania	N/A	14,375,956	0
Rhode Island	Utility Funds	1,131,797	2,759,601
South Carolina	Utility - SC Electric and Gas	1,722,172	17,700
South Dakota	N/A	1,877,366	0
Tennessee	N/A	4,082,204	0
Texas	Utility Funds	5,351,056	1,082,873
Utah	State Electric Utility, Gas Utility	2,034,252	493,000
Vermont	VT Weatherization Trust Fund	1,252,104	4,593,774
Virginia	N/A	3,919,648	0
Washington	Energy Matchmakers Program and Matching Dollars	4,447,559	9,000,000
West Virginia	Utility funds	3,142,497	437,500
Wisconsin	Utility Public Benefit Funds	8,389,089	46,135,744
Wyoming	State General Fund	1,151,786	1,550,974
American Samoa	N/A	180,970	0
Guam	N/A	186,075	0
Puerto Rico	N/A	795,810	0
Northern Mariana Islands	N/A	181,937	0
Virgin Islands	N/A	189,857	0
Innovations in Weatherization	N/A	97,000,000	0
Headquarters T&TA	N/A	3,000,000	0
Total, Weatherization Assistance Funding		320,000,000	172,427,954

[a] FY 2010 non-Federal funding data not available until June, 2011

Detailed Justification

(dollars in thousands)

	FY 2010 Current Approp	FY 2012 Request
Weatherization Assistance	**176,700**	**220,000**

Weatherization service providers choose the best package of efficiency measures for each home based on a comprehensive computerized energy audit. Typical energy conservation measures include: installing insulation; sealing ducts; tuning and repairing heating and cooling systems; mitigating air infiltration; and reducing electric base load consumption. The consistent delivery of quality services is addressed through active state training and technical support programs. Grant supported training allows for the introduction of advanced assessment and installation techniques and continued professional development for workers.

Funds are allocated on a formula basis and awarded to States, U.S. Territories, the District of Columbia, and Native American tribal governments to increase the energy efficiency of homes occupied by low-income families. These agencies, in turn, contract with almost 900 local governmental or nonprofit agencies to deliver weatherization services to low-income clients in their areas. The WAP network continues to be one of the largest and most technically advanced residential energy retrofit providers.

Training and Technical Assistance	**3,300**	**3,000**

DOE directed weatherization training and technical assistance activities to improve the effectiveness and efficiency of WAP. These resources support strategic planning and analysis; program performance measurement and documentation; and facilitation of advanced techniques and collaborative strategies (e.g., publications, training programs, workshops and peer exchange). An ongoing national evaluation is assessing the overall energy savings and cost-effectiveness of the program. The WAP retrospective and Recovery Act based evaluation components are scheduled to be completed in FY 2012.

Innovations in Weatherization	**30,000**	**97,000**

The objective of Innovations in Weatherization is to demonstrate new ways to increase the number of low-income homes weatherized and lower the Federal per home cost for residential energy retrofits while also establishing a stable funding base. DOE forms partnerships with non-traditional weatherization providers such as foundations and other non-profits, labor unions, churches, private contractors, large companies, and other groups. These organizations provide leadership in leveraging financial resources and managing the home energy retrofit process. A key component is the ability of grantees to obtain $3 in non-Federal contributions for every $1 invested by DOE. This activity will build upon lessons learned from the 16 weatherization pilots funded in FY 2010.

Total, Weatherization Assistance Grants	**210,000**	**320,000**

Explanation of Funding Changes

	FY 2012 vs. FY 2010 Current Approp ($000)
Weatherization Assistance	
Additional funding will support the HPPG goal to weatherize one million homes.	+43,300
Training and Technical Assistance	
The decrease will be offset by the use of technical assistance project funds awarded in prior years.	-300
Innovations in Weatherization	
Competitively selected weatherization innovation demonstrations will create high impact, highly leveraged, and sustainable clean energy projects. The funding increase will result in approximately 10,000 additional residential energy retrofits.	+67,000
Total Funding Change, Weatherization Assistance Grants	**+110,000**

State Energy Program

Funding Schedule by Activity

(dollars in thousands)

	FY 2010 Current Approp	FY 2012 Request
State Energy Program		
State Energy Program Formula Grants	25,000	30,000
State Energy Program Competitive Grants	25,000	25,000
State Energy Program Technical Assistance	0	8,798
Total, State Energy Program	50,000	63,798

Benefits

The State Energy Program (SEP) reduces energy use and cost, increases renewable energy capacity and production, and lessens dependence on foreign oil.

The primary program benefits of the SEP are:

- Greater energy efficiency and energy conservation;
- Creation of well-paying jobs in clean energy industries;
- Expanded renewable energy capacity; and
- Positive environmental impacts, such as reduced carbon emissions.

An internal program review estimated annual leveraged energy savings of 1.103 million source Btus and $7.22 for each $1 of Federal funding[a]. Examples of supporting activities include: 1) facilitating a robust robust national renewable energy certificate trading program; and 2) managing a comprehensive partnership with utilities to put energy efficiency on an even footing with energy generation in meeting the Nation's energy needs.

Detailed Justification

(dollars in thousands)

	FY 2010 Current Approp	FY 2012 Request
	25,000	**30,000**

State Energy Program Formula Grants

Formula-based grants allow States, the District of Columbia, and U.S. Territories to advance their energy priorities through the design and implementation of renewable energy and energy efficiency programs. These grants maintain the viability of the State energy office network and support the development and maintenance of energy emergency planning at State and local levels, which provides a critical security benefit. Examples of State projects include: financing energy efficiency and renewable

[a] Source: An Evaluation of State Energy Program Accomplishments Program Year 2002 (June 2005), ORNL.

(dollars in thousands)

	FY 2010 Current Approp	FY 2012 Request

energy investments through revolving loans, appliance rebates, and performance contracting programs; adoption, training, and enforcement of upgraded building energy codes; and transportation programs that accelerate the use of alternative transportation fuels and hybrid vehicles.

State Energy Program Competitive Grants **25,000** **25,000**

SEP competitive awards focus on specific high impact market transformation and crosscutting solutions. The overall objective is for States to develop the policy and program frameworks that support investment in cost effective energy efficiency for the long-term. The most recent solicitation cycle (FY 2010) resulted in the award of $28 million in competitive financial assistance. These funds support 12 state-level projects which: 1) strengthen energy retrofit markets, or 2) stimulate planning to reduce electricity usage. Future areas of interest include encouraging: States and utilities to improve energy efficiency and renewable energy deployment; and 2) the optimization of State energy planning and protocols.

State Energy Program Technical Assistance **0** **8,798**

DOE also conducts analysis, outreach, and technical assistance to increase program efficiency and effectiveness. These resources will be used for: 1) outreach, tools development and specific technical assistance provided to States; 2) national energy initiatives and strategic partnerships; 3) development of web based reporting and monitoring systems; and 4) broader planning, analysis, and evaluation activities. The program is conducting a national evaluation, scheduled for completion in FY 2012, to improve measurement of energy and non-energy benefits. A key area of technical support is providing grantee access to: web based tools on best practices; project planning and resources; and information on a variety of renewable energy and energy efficiency initiatives. In the short-term, technical assistance provides unbiased expertise on renewable energy and energy efficiency policy and cross-cutting topic areas from DOE laboratory technical experts.

Total, State Energy Program **50,000** **63,798**

Explanation of Funding Changes

	FY 2012 vs. FY 2010 Current Approp ($000)
State Energy Program Formula Grants	
The increase will support the expansion of State capabilities to: 1) deploy energy efficiency and renewable energy technology to local governments, businesses, and consumers; and 2) facilitate the transition to lower-carbon clean energy technologies and sustainable energy policies.	+5,000
State Energy Program Competitive Grants	
No Change.	0

	FY 2012 vs. FY 2010 Current Approp ($000)
State Energy Program Technical Assistance	
The request is consistent with prior year technical assistance allocations. Technical assistance provides States with tools, resources, and assistance needed to meet their objectives, such as increasing sustainable clean energy capacity.	+8,798
Total Funding Change, State Energy Program	**+13,798**

Tribal Energy Program

Funding Schedule by Activity

(dollars in thousands)

	FY 2010 Current Approp	FY 2012 Request
Tribal Energy Program		
Tribal Energy Activities	10,000	10,000
Total, Tribal Energy Program	10,000	10,000

Benefits

Tribal Energy Activities build partnerships with tribal governments to address Native American energy needs for residential, commercial and industrial uses.

The primary benefits of the Tribal Energy activities are:

- Greater energy efficiency and energy conservation;
- Expanded renewable energy capacity; and
- Positive environmental impacts, such as reduced carbon emissions.

Sustainable energy projects also address concerns of tribal governments for energy sufficiency and economic development. For example, the Campo Band of Mission Indians received a grant in FY 2010 for pre-construction activities associated with the development of a 160 MW wind farm. When completed, the project may generate enough electricity to power 54,000 homes in San Diego County, California.

Detailed Justification

(dollars in thousands)

	FY 2010 Current Approp	FY 2012 Request
Tribal Energy Program	**10,000**	**10,000**

Tribal Energy activities are particularly valuable in advancing sustainable clean energy development and deployment on tribal lands. The program utilizes financial assistance to support the assessment and planning of sustainable energy options, renewable energy installations, and cost effective energy efficiency projects. Between FY 2002 and FY 2010, 129 tribal energy projects totaling $30.4 million were awarded on a competitive basis. These projects were leveraged by $29.1 million cost-shared by Tribes.

Tribal Energy also provides technical assistance in various forms. The key area of emphasis is on ways to better leverage existing public and private financing to accelerate the deployment of tribal energy projects. Product areas include: model contracts; sample project development documents, e.g., power purchase agreements; decision matrices, primers, and checklists; primers on business structures and tax implications; and economic and cash flow models. Tribal Energy activities hosted a national meeting in FY 2010 on business and legal models and strategies with 130 participants from Indian tribes. In FY

(dollars in thousands)

	FY 2010 Current Approp	FY 2012 Request

2012 the program will continue to improve and distribute these tools through the EERE website, webinars, and regional and national training sessions.

To improve program performance, a peer review by outside experts and program participants will be conducted in FY 2012. Continuing technical assistance efforts include: regional and national workshops on energy efficiency and renewable energy technologies; and renewable energy internships for Native American graduate students through Sandia National Laboratory.

Total, Tribal Energy Program	**10,000**	**10,000**

Explanation of Funding Changes

	FY 2012 vs. FY 2010 Current Approp ($000)
Tribal Energy Program	
No Change.	0
Total Funding Change, Tribal Energy Program	**0**

Program Direction

Funding Profile by Category

(dollars in thousands)

	FY 2010 Current Approp	FY 2012 Request
Headquarters (HQ)		
Salaries and Benefits	73,138	92,063
Travel	2,895	1,989
Support Services	9,800	12,317
Other Related Expenses	9,560	17,613
Total, Headquarters	95,393	123,982
Golden Field Office (GO)		
Salaries and Benefits	24,134	32,198
Travel	697	555
Support Services	2,424	4,315
Other Related Expenses	1,818	1,615
Total, Golden Field Office	29,073	38,683
National Energy Technology Laboratory (NETL)		
Salaries and Benefits	8,779	6,993
Travel	400	147
Support Services	6,180	5,253
Other Related Expenses	175	1,547
Total, NETL	15,534	13,940
Total Program Direction		
Salaries and Benefits	106,051	131,254
Travel	3,992	2,691
Support Services	18,404	21,885
Other Related Expenses	11,553	20,775
Total, Program Direction	140,000	176,605

Mission

Program Direction provides funding for Federal employees, contract support, and operational costs required for the overall implementation and execution of Energy Efficiency and Renewable Energy (EERE) programs. This funding allows EERE to advance the President's priorities by enabling accelerated research, development, deployment and demonstration (RDD&D) of EERE technologies that address energy security, economic stability, and the environment with unprecedented transparency, accountability and oversight.

Detailed Justification

(dollars in thousands)

	FY 2010 Current Approp	FY 2012 Request
Salaries and Benefits	**106,051**	**131,254**

EERE's current workforce is being subsidized by the Recovery Act Bridge Fund to address the residual Recovery Act project workload which extends several fiscal years. The FY 2012 budget request supports this increased workforce needed to address the significant workload in grants management and oversight, reporting and transparency requirements, risk-management, and accountability. This increased staffing level is needed to cover management and administration responsibilities for over 2,500 new financial assistance awards and more than 700 Congressionally-Directed Projects in various stages of execution. EERE requires personnel who provide expertise in implementing and integrating technology programs through comprehensive program management, technical assistance and oversight. EERE is increasing headquarters staffing, while decreasing field staffing, in order to strengthen program and project management as well as to improve communication and coordination across the EERE portfolio. This request also provides business administration expertise in personnel, budget and financial management, program evaluation, procurement, contract administration, legal services, information technology (IT) business systems, and information services management. Funding provides for promotions, within-grade-increases and relocation allowances for current and new employees. This request incorporates a pay freeze for Federal and DOE M&O contract employees. Indirect overhead funding rates associated with the reimbursable NETL staff are included in the Support Services.

Travel	**3,992**	**2,691**

Provides necessary travel for proper management and oversight of approximately 6,000 Federally-funded projects, agreements, and grants, including additional audits and on-site monitoring of new and expanding technology programs and Federal energy assistance programs. This funding allows for frequent, geographically-dispersed reviews of Weatherization Assistance and State Energy Program grants. Travel also supports expanding international activities necessary to address global climate change and supports a number of key bilateral and multilateral initiatives that further DOE's research, demonstration, and deployment goals. This request supports continued work on-site with member countries to develop the International Partnership for Energy Efficiency Cooperation and the lead of the Energy Development for the Island Nations initiative.

(dollars in thousands)

	FY 2010 Current Approp	FY 2012 Request
Support Services	**18,404**	**21,885**

This funding provides technical and administrative contract support, information technology (IT), communications 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, and accurate reports and analyses critical for decision-making. This funding also supports training, education, safety and health support, facility safeguards and security, and computer configuration, and maintenance. Additionally, this request provides for a 77 percent indirect overhead charge for reimbursable work provided by direct/technical Fossil Energy employees at 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; IT and local-area network operations.

This funding also provides for reports, oversight, and analysis, management and general administrative services for project planning, and analysis. These requirements are characterized by the increase in accountability and transparency instituted by Congress and the Administration and will provide direct support, tools, expertise and services to deliver the additional materials specified and to provide the flexibility necessary to respond rapidly, efficiently and professionally to the requirements for corporate level planning, evaluation, reporting, analysis and administrative services. This request includes a pay freeze for DOE M&O contractors.

Other Related Expenses	**11,553**	**20,775**

This request provides office space at Headquarters 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 being 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. It also includes funding for GSA rent for the Golden Field Office, as well as supplies and materials for both Golden Field Office 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.

Total, Program Direction	**140,000**	**176,605**

Explanation of Funding Changes

	FY 2012 vs. FY 2010 Current Approp ($000)
Salaries and Benefits	
The increase reflects the planned increase of Federal staff required to minimally support the projected EERE workload which will rise to more than 7,000 contracts, grants, agreements and congressionally-directed projects. The increase in the staffing level is necessary to provide the executive direction, technical expertise, and business management experience necessary to accelerate the scale and pace at which activities are implemented, executed, and closed out. This budget request does reflect a savings due to the implementation of the Federal pay freeze; however, funding is included for promotions, within-grade-increases, and relocation allowances for new employees.	+25,203
Travel	
The decrease reflects the department's anticipation that electronic media will, in large part, replace personal interface.	-1,301
Support Services	
This increase is a result of the increased contract staff and related indirect and overhead costs necessary to support the increase in the projected EERE workload. Support services funds the continued enhancement of business information, reporting, analysis, and planning systems and their support, as well as associated training, and continues the implementation of additional system security enhancements. This line includes a pay freeze for DOE M&O contractors.	+3,481
Other Related Expenses	
The increase reflects the addition of office space, utilities, security, equipment, software, licenses, communications, and other overhead necessary to support the increasing workforce.	+9,222
Total Funding Change, Program Direction	**+36,605**

Support Services by Category

(dollars in thousands)

	FY 2010 Current Approp	FY 2012 Request
Technical Support		
Feasibility of Design Considerations	740	1,198
Development of Specifications	535	1,994
System Definition	591	1,617
System Review and Reliability Analyses	994	1,138
Trade-off Analyses	994	1,132
Economic and Environmental Analyses	423	821
Surveys or Reviews of Technical Operations	944	1,709
Total, Technical Support	5,221	9,609
Management Support		
Analyses of Workload and Work Flow	472	753
Directives/Management Studies	596	342
Automated Data Processing	439	3,076
NETL Reimbursable Overhead Services	5,277	4,822
Preparation of Program Plans	895	479
Training and Education	845	1,098
Analyses of DOE Management Processes	497	385
Reports and Analyses, Mgt & Gen Admin Services	4,162	1,321
Total, Management Support	13,183	12,276
Total, Support Services	18,404	21,885

Other Related Expenses by Category

(dollars in thousands)

	FY 2010 Current Approp	FY 2012 Request
Other Related Expenses		
Rent to GSA	591	1,723
Rent to Others	0	0
Communications, Utilities, Miscellaneous	187	187
Printing and Reproduction	502	502
Other Services	917	140
Purchases from Govt Accounts	483	105
Operation and Maintenance of Equipment	551	261
Supplies and Materials	807	149
Equipment	728	208
Working Capital Fund	6,787	17,500
Total, Other Related Expenses	11,553	20,775

Strategic Programs

Funding Profile by Subprogram

(dollars in thousands)

	FY 2010[a] Current Approp	FY 2012 Request
Strategic Programs (formerly Program Support)		
Communications & Outreach (formerly Technology, Advancement & Outreach)	11,000	11,559
Innovation & Deployment (formerly Commercialization)	7,000	15,145
International	10,000	12,500
Strategic Priorities & Impact Analysis	6,000	7,000
Planning, Analysis & Evaluation	11,000	7,000
Total, Strategic Programs	45,000	53,204

Public Law Authorizations:

P.L. 95-91, "Department of Energy Organization Act" (1977)
P.L. 109-58, "Energy Policy Act of 2005"
P.L. 110-140, "Energy Independence and Security Act of 2007"

Mission

The mission of Strategic Programs is to conduct activities and analysis that are crosscutting and more efficiently undertaken on an EERE-wide basis. Most of the work is done in close collaboration with individual program offices with activities in relevant areas. The work includes: (1) conducting cross-cutting technology and policy analysis; (2) evaluating EERE RDD&D activities and impacts; (3) EERE-wide approaches to utilities, urban policy, strategies driving innovation in the economy, training and certification for green jobs, analysis of EERE-specific legislation, and other areas affecting the commercial adoption of EERE technologies; (4) strengthening research management including peer reviews and obtaining effective external advice; (5) using modern communication tools to ensure that EERE information is easily accessible to the public; and (6) collaborating with foreign partners on strategies for advancing the development and implementation of clean and efficient energy technologies.

Benefits

Analytical tools help EERE programs set priorities in research and deployment activities ensuring that resources are targeted effectively and that all important topics are covered. These activities increase the productivity of program investments especially in corporate activities and those that are common to multiple programs as well as Federal, state and local agencies and institutions. The office helps EERE technology programs track progress to determine whether goals are being met and where additional work and collaboration may be needed. It ensures that EERE programs have access to the most effective information technology resources for communicating with their diverse constituents and ensuring the transparency of EERE operations. The cross-cutting expertise in key areas includes the integration of EERE technologies into utility systems (both technical and financial/programmatic

[a] Strategic Programs (formerly Program Support) for FY 2010 only.

connections), urban policies, and international research. Strategic Programs also provides a common point of contact in EERE for other Federal agencies and international organizations interested in EERE issues. The research management of all programs benefit from the peer review strategies, teams and resources provided by Strategic Programs.

Communications and Outreach

Funding Schedule by Activity

(dollars in thousands)

	FY 2010 Current Approp	FY 2012 Request
Communications and Outreach (formerly Technology, Advancement & Outreach)	11,000	11,559
Total, Communications and Outreach	11,000	11,559

Benefits

The Office of Communications and Outreach (CO) provides strategic communications and outreach support for EERE's activities and scientific and technology achievements. CO manages and creates public engagement tools and products that keep stakeholders advised of the status of EERE programs, activities, and technologies, the impact of policy options on the development and adoption of these technologies, and the potential contribution of the adoption of emerging technologies to DOE's economic, environmental, and energy security goals. By educating the public and other stakeholders about clean energy, CO contributes to EERE's goals and E-government initiatives by helping to raise awareness, overcome barriers, and speed adoption of new technologies and practices.

Detailed Justification

(dollars in thousands)

	FY 2010 Current Approp	FY 2012 Request
Communications and Outreach	**11,000**	**11,559**

The Office of Communications and Outreach (CO) provides strategic communications and outreach support for EERE's activities and scientific and technology achievements, to help raise awareness, overcome barriers, and speed adoption of new energy efficiency and renewable energy technologies and practices. CO ensures information is available to, and actively engages with, the general public and other stakeholders through a wide variety of communication channels, including but not limited to web-based content and services, print products, displays and events, toll-free telephone services, multimedia, radio, television, and content for mobile devices. CO communicates with a range of stakeholders, including the general public, industry, students, educators and educational institutions, other federal, State, and local government and non-governmental organizations. To expand reach, CO also works with industry, State and local governments, educational institutions, NGOs, and media producers to produce and disseminate information. CO leverages public communication assets to raise public energy awareness by providing information and education to inform public and private energy decisions. CO provides timely and relevant information to help consumers make informed energy choices to reduce energy use, demand, and associated costs. Samples of CO activities include, but are not limited to the following:

- CO will manage and continually update the EERE website and expand mechanisms for electronic outreach. This includes EERE's main website, as well as its main consumer portal, EnergySavers.gov, which together attract millions of online visitors per year. CO works to deploy the latest effective electronic and online communications technologies, requiring continual investment in new server technologies and web tools.
- CO will continue to engage stakeholders online with periodic news updates and program information. This includes delivering information to more than 32,000 stakeholders that have requested to receive EERE information, as well as leveraging new media tools and online multimedia (video etc.) to further engage and inform EERE stakeholders.
- CO will continue to reach stakeholders via public service advertising methods.
- CO will continue to maintain a catalogue of thousands of EERE information products, including publications, CDs, and analytic tools, and makes that information available online.
- CO will continue to leverage the resources of other agencies to promote collaborations between Federal, State and local entities to advance renewable energy sources and energy efficiency, and provide interactive technology online to educate consumers in the use of these technologies.
- CO will continue to operate the EERE Information Center, a "one-stop," centralized information center that provides information to the general public and other stakeholders through web-based and toll-free telephone services. The Information Center currently handles approximately 28,000 phone inquiries annually, and mails and distributes more than 300,000 publications per year. These inquiries include homeowners and consumers, as well as energy managers and industry stakeholders.

(dollars in thousands)

	FY 2010 Current Approp	FY 2012 Request
▪ CO will continue to produce and disseminate documents in both English and Spanish to educate homeowners on energy savings techniques and technologies.		
Total, Communications and Outreach	**11,000**	**11,559**

Explanation of Funding Changes

	FY 2012 vs. FY 2010 Current Approp ($000)
Communications and Outreach	
No significant change, additional funds will allow for participation in additional in-person events, engaging homeowners and other stakeholders.	+559
Total Funding Change, Communications and Outreach	**+559**

Innovation & Deployment

Funding Schedule by Activity

(dollars in thousands)

	FY 2010 Current Approp	FY 2012 Request
Innovation & Deployment	7,000	15,145
Total, Innovation & Deployment	7,000	15,145

Benefits

These activities increase the effectiveness of all EERE programs by providing specialized expertise in areas like research management, deployment, green jobs training, and other areas. This reduces duplication within programs and increases the effectiveness of each program.

Detailed Justification

(dollars in thousands)

	FY 2010 Current Approp	FY 2012 Request
Innovation & Deployment	**7,000**	**15,145**

Deployment activities accelerate the in-field validation of energy efficiency and renewable energy technologies. Technical assistance is provided to areas that have traditionally relied on fossil fuels to help them transition to a reliance on cleaner energy sources. Activities also explore creative models for innovation.

Technology Information Management makes EERE information and modeling tools accessible and attractive through technology portals, tools and calculators. It increases transparency by providing easier access to EERE-funded curricula. This activity strengthens the value of individual program efforts in education and training by helping to coordinate and disseminate training materials through the effective use of information technology.

(dollars in thousands)

	FY 2010 Current Approp	FY 2012 Request
Green Job Training focuses on coordinating the education and training activities within EERE's programs to promote the sharing of best practices and to reduce the duplication of efforts. This activity also provides a common interface to agencies like the Departments of Labor, Education and Defense. It also includes an effort to integrate advanced training technologies and methods to improve EERE's response to immediate job training needs, as well as develop a future workforce. Expanded use of EERE technologies is dependent on the capacity of the U.S. to produce, install, maintain, and service these emerging advanced technologies. Activities will include partnering with universities, community and technical colleges, corporate and union training facilities to provide green job training, and helping EERE programs develop curricula that not only incorporate the latest research findings but also make use of reusable, interactive online tools that will enable the workforce to train rapidly for new jobs created by EERE technologies. The programs can achieve large savings by focusing their efforts on instructional design and content and by sharing the infrastructure and networks developed by this activity.		
Research Management identifies and enables best practices to ensure that the highest-quality and most innovative R&D projects are selected and supported by EERE. This includes robust merit review processes and tools; utilizing mechanisms, such as the EERE Federal Advisory Committee, to get expert advice on the EERE portfolio; and helping EERE Programs bridge the gap between basic and applied research to accelerate the movement of innovative technologies into the market. These efforts make effective use of high quality peer review and creative solicitation methods to ensure that the most creative and qualified minds are engaged to solve EERE research challenges.		
Utility Integration focuses on analyzing the impact of renewable energy and energy efficiency technologies on utility operations and economics. This activity also analyzes utility policies that shape and accelerate markets for energy efficiency and renewable energy technologies and accelerate the adoption of EERE technologies. This work will be closely coordinated with the Office of Electricity and include collaboration with utilities and policy-makers.		
Urban Systems helps develop a common approach to city governments that ensures effective integration of EERE goals into city policies in energy, transportation, and other areas. It will also provide connections to HUD, DOT and other agencies with large programs affecting the way cities use energy.		
Total, Innovation & Deployment	**7,000**	**15,145**

Explanation of Funding Changes

	FY 2012 vs. FY 2010 Current Approp ($000)
Innovation & Deployment	
Increase will accelerate commercial adoption of EERE technologies through improved collaboration with utilities, city governments, and education and training institutions and it will improve external reviews of EERE programs.	+8,145
Total Funding Change, Innovation & Deployment	**+8,145**

International

Funding Schedule by Activity

(dollars in thousands)

	FY 2010 Current Approp	FY 2012 Request
International	10,000	12,500
Total, International	10,000	12,500

Benefits

EERE's International Subprogram seeks to achieve three objectives:

- Accelerate the research and development of energy efficiency and renewable energy technologies through collaboration with international partners:

  Through partnerships with other countries at the cutting edge of clean energy R&D, EERE will leverage DOE resources to accelerate development and cost reductions for EE and RE technologies. These partnerships can serve as a force multiplier in more rapidly achieving EERE's research, development, and demonstration (RD&D) of technical and cost goals.

- Accelerate the deployment of energy efficiency and renewable energy technologies to help meet growing demand for energy and to reduce greenhouse gas emissions:
  Partnerships with key countries advance the deployment of clean energy technologies and can achieve substantial, measurable environmental impacts on GHG emissions and related sustainability factors. Commercialization of these technologies leads to diversification of U.S. energy supplies, thereby improving energy security. Providing access to clean energy in the developing world enhances local and regional stability through improved living standards.

- Develop global markets for clean energy solutions through policy and technology analysis, technical assistance, and training:
  EERE investments in diverse clean energy technologies set the stage for development of a robust clean energy export market in the U.S. 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 policy support, developing codes and standards, and addressing technology product reliability will help this development occur with the cleanest energy profile possible. These activities also generate market pull for EE and RE technologies, which can be met with U.S. clean energy exports.

Detailed Justification

(dollars in thousands)

	FY 2010 Current Approp	FY 2012 Request
International	**10,000**	**12,500**

The Office of Energy Efficiency and Renewable Energy (EERE) aims to accelerate clean energy innovation and the development of renewable energy and energy efficiency markets in key partner countries through cooperative RD&D, clean energy analyses and assessments, and market transformation efforts. EERE implements these activities through cooperative agreements (such as MOUs) with other countries and international institutions. The program leverages DOE's technical expertise, activities, and relationships to make a significant and sustainable impact in addressing climate change, enhancing U.S. energy security and economic vitality, and building product infrastructure knowledge necessary for the domestic economy.

In all international partnerships, EERE will collaborate regularly with other DOE offices, U.S. agencies (State, USAID, Commerce, ExIm, OPIC, etc.) and international organizations (IEA, UNEP, GEF, OAS, development banks, etc.) to ensure clear roles and responsibilities consistent with each agency's mission, and to leverage resources, expertise and ongoing activities where possible.

Research, Development, and Demonstration: EERE will continue partnering with other countries that play a lead role in RD&D of advanced EE and RE technologies and systems to leverage resources and expertise to accelerate the progress of R&D. This will include multilateral cooperation through the International Energy Agency and other bodies and bilateral partnerships with key Organization for Economic Cooperation and Development countries, Israel, and major emerging economies (e.g. China, India, Brazil). Cooperation will focus on non-competitive topics where international partnerships can serve as force multipliers to more rapidly achieve EERE's technology RD&D goals.

Specific examples of EERE bilateral relationships include:

China: Work conducted under the Strategic and Economic Dialogue (S&ED) includes cooperation on building and industrial efficiency, electric vehicles, biofuels, wind, and solar energy;

Brazil: Development of advanced biofuel technologies and methodologies for conducting economic and sustainability analyses;

India: Continued collaboration through the U.S.-India Energy Dialogue;

Canada: Cooperation under the U.S.-Canada Clean Energy Dialogue, includes joint work on energy efficiency, biomass technologies, and clean vehicles R&D; and

Israel: Collaborative research includes solar energy, electric vehicle and plug-in electric vehicle battery technologies, and biofuel production and use.

Market Transformation Partnerships with Key Developing Countries: EERE will continue to engage government agencies, technical institutes, and the private sector in China, India, Brazil, and other targeted countries to assist in the adoption of EE and RE market enabling policies and programs; implement demonstration and deployment projects; and attract investment and business partnerships. EERE will also play a lead role in key multilateral initiatives to accelerate market penetration of EE and RE technologies, such as the Major Economies Forum, the Clean Energy Ministerial and the Energy and

(dollars in thousands)

	FY 2010 Current Approp	FY 2012 Request
Climate Partnership of the Americas, the Energy Development in Island Nations initiative, and the International Partnership for Energy Efficiency Cooperation. EERE may also support regional programs to advance EE and RE use in Africa, the Middle East, newly independent states, and other countries of strategic importance. EERE will explicitly promote opportunities for export of U.S. clean energy technologies and services by incorporating outreach to the Foreign Commercial Service and American Chambers of Commerce into project plans, especially training and technical assistance, where appropriate**.**		
Total, International	**10,000**	**12,500**

Explanation of Funding Changes

	FY 2012 vs. FY 2010 Current Approp ($000)
International	
Increase will allow the subprogram to conduct more and/or larger projects within targeted bilateral partnerships with key countries, including China, India, Brazil, Canada and Russia, as well as through a variety of multilateral and regional partnerships, such as the International Partnership for Energy Efficiency Cooperation (IPEEC), the Asia-Pacific Economic Cooperation (APEC), the Energy and Climate Partnership of the Americas (ECPA), Energy Development in Island Nations (EDIN). The outcome from increased funding is expected to be accelerated global deployment of clean energy technologies.	+2,500
Total Funding Change, International	**+2,500**

Strategic Priorities and Impact Analysis

Funding Schedule by Activity

(dollars in thousands)

	FY 2010 Current Approp	FY 2012 Request
Strategic Priorities and Impact Analysis	6,000	7,000
Total, Strategic Priorities and Impact Analysis	6,000	7,000

Benefits

The Strategic Priorities and Impact Analysis (SPIA) subprogram conducts analyses to provide a clear picture of how the sum of EERE's parts, practices and policies can contribute to solutions as a whole. This subprogram enables a better understanding of how RDD&D supported by EERE can drive high levels of efficiency and renewables into the economy, strengthening economic recovery and growth, improving energy security, and reducing harmful emissions. Work is conducted across EERE programs within an integrated, credible and independent forum. A variety of independent, analytical products are developed each year to address these highly interrelated issues, which inform the alternative pathways to achieve the national and international potential of EERE's RDD&D projects. The same foundation of unbiased, quality information created and used by EERE to make decisions is made available to external stakeholders to inform policy decisions at all levels of government, as well as to facilitate private investment to promote the rapid adoption of clean energy technologies in the marketplace.

Analyses supported by Strategic Programs include assessment of lifecycle (cradle-to-cradle) carbon emissions, materials and water consumption, and other resource impacts by including their outputs as key drivers, as well as financial, market, and policy analyses. This work will provide core support for detailed strategic planning in EERE and DOE by demonstrating the possible results and impacts of various EERE research portfolios and technology policy scenarios. Additional analyses will assess innovative strategies for market adoption and demonstrate the benefits of integrated application of clean energy technologies and policies. All studies will be conducted in close collaboration with EERE technology programs, other DOE offices, and other Federal agencies. The work will be done by Federal staff working with experts at the national labs, industry, and universities, a portion of which will be awarded competitively.

(dollars in thousands)

	FY 2010 Current Approp	FY 2012 Request
Strategic Priorities and Impact Analysis	**6,000**	**7,000**

The SPIA subprogram supports the development of cutting-edge technical and analytical system models to improve strategic planning and develops multi-program cross-cutting implications and recommendations based on analyses of internal and external inputs. This work cuts across multiple technologies, programs, and offices, and thus builds upon and broadens technology-specific analyses conducted by EERE programs. The results of the work are communicated to EERE and DOE management to guide decisions, to the EERE programs to shape their work, and to external stakeholders to enable knowledge and the advancement of DOE's strategic priorities. The activities of this subprogram are essential to provide a consistent office-wide methodology for strategic technology planning and are coordinated with activities in the EERE Planning, Analysis, and Evaluation group, the Department's Office of Policy and International Affairs, other DOE Energy Offices, ARPA-E, the Office of Science, the Chief Financial Officer, National Laboratories, and other Federal agencies.

FY 2012 SPIA activities include but are not limited to the following areas:

Energy Systems Analysis: Work in FY 2012 will emphasize continuation and completion of key parts of the Energy Futures analyses started in FY 2010. The Energy Futures studies develop bottom-up technology roadmaps of RDD&D pathways to achieving drastically reduced oil consumption and carbon emissions in the power, transportation, industry, and buildings sectors by incorporating high levels of efficiency and renewables. More broadly, as the title suggests this work: examines how to combine adoption of disparate technologies from different programs into high performance energy systems; evaluates the interactions of these different technologies; and develops cutting-edge engineering and analytical models to characterize the resultant systems. For example, both wind and solar are variable generation resources, but there may be synergies between wind and solar that allows greater market penetration when both resources are introduced to the grid together. Energy Systems analysis also involves the evaluation of improved approaches to engineering design at a systems level; evaluation of engineering costing methodologies—including economies of scale, scope, and learning; and the incorporation of risk and uncertainty in systems development. For example, urban systems can be analyzed to identify integration of efficiency and renewables into city planning and management.

(dollars in thousands)

FY 2010 Current Approp	FY 2012 Request

Energy and Environmental Analysis: Energy and Environmental analysis builds on the Energy Systems analysis work above to evaluate the energy and environmental impacts of the RDD&D pathways identified in the Systems Analysis, particularly the costs and benefits of reducing oil consumption and fossil energy consumption generally on U.S. economic vitality, environmental quality, and national security. Conversely, this analysis also examines the impact of proposed energy and environmental policies, particularly climate change policies, under RDD&D and commercialization of renewable energy and energy efficiency technologies. The analytic activities and technical support for FY 2012 will expand upon previous efforts to reflect the requirements of proposed U.S. legislation and increased international engagement. This integrated multi-program analysis is carefully coordinated both internally and externally with other leading analytical institutions.

Market Analysis: The objective of market analysis is to improve the understanding of the market implications and impacts of supporting particular RDD&D pathways for efficiency and renewable technologies. Efforts include the development of uniform market reports that compile critical information about target markets for EERE technologies and the discussion of key changes in the target markets and emerging trends each year. Market analysis addresses up-to-date market data relevant to EERE's technologies. Work includes analysis of EE and RE technology financing structures; documentation of financing for large-scale projects and capital markets; identification of supply chain bottlenecks, particularly for critical materials such as rare-earths; project financing tools and assumptions; application of valuation techniques to renewable energy assets; and implementation of a renewable financing web portal. This activity also supports a systematic methodology, data, and tools for analyzing target market conditions and developing near-term technology deployment projections (up to 10 years) for EE and RE technologies, including analysis of the implications for manufacturing and supporting industries. Critical information about target markets and discussions of key recent and emerging developments in the target markets is compiled and made available with this support.

EERE Technology Policy Analysis: Energy policy analysis assesses how technology and systems characteristics interact with policy to contribute to national energy, economic, environmental, and security goals. The energy policy work incorporates inputs from DOE’s Office of Policy and International Affairs which supports model development and analysis in support of clean energy rulemaking. This task area continues to develop new, and strengthen existing, models to support near term policy analyses. This area also includes developing an understanding of the implementation and impacts of R&D based tax and other incentives and supports.

(dollars in thousands)

	FY 2010 Current Approp	FY 2012 Request

Data and Analysis Foundation and Dissemination: This work focuses on strengthening the value of EERE's cross-cutting data and analysis. This process involves engaging the analysis community in setting standards and protocols for their work; developing peer-reviewed data and modeling resources; providing access to the data and results using state-of-the-art information visualization tools; and making EERE analysis results more broadly available through publication in peer-reviewed journals and improved communication of results. It builds directly on the best-in-class: (a) bottom-up engineering analyses of energy systems; (b) energy and environmental analyses; (c) market analyses; and (d) policy analyses. This work includes synthesis and identification of key insights from analyses for various stakeholder groups and comparing analysis results to other internal/external work. The approach is based on best practices from industry and laboratory sources. Each analysis provides key insights relevant to various stakeholder groups including policymakers; identifies how results compare with and integrate the existing body of knowledge for the subject area; suggests how results could be used to inform program planning for relevant EERE programs; and recommends follow-on analysis as appropriate.

Total, Strategic Priorities and Impact Analysis	**6,000**	**7,000**

Explanation of Funding Changes

	FY 2012 vs. FY 2010 Current Approp ($000)
Strategic Priorities and Impact Analysis	
Strategic Analysis with its network of collaborating analysts will continue to provide critical guidance for program RDD&D strategy and direction. Increase reflects a focus on cross-cutting technology roadmaps.	+1,000
Total Funding Change, Strategic Priorities and Impact Analysis	**+1,000**

Planning, Analysis and Evaluation

Funding Schedule by Activity

(dollars in thousands)

	FY 2010 Current Approp	FY 2012 Request
Planning, Analysis and Evaluation	11,000	7,000
Total, Planning, Analysis and Evaluation	11,000	7,000

Benefits

PAE, in concert with the Strategic Priorities and Impact Analysis (SPIA) and the Innovation & Deployment subprograms, establishes, maintains and implements the methods, information base, and standards for portfolio planning and policy analysis, budget formulation, performance reporting, management and evaluation. The PAE subprogram provides direct expertise and management, and funds activities that provide technical, economic, performance management and policy analyses to support strategic and multi-year planning, performance and budget integration, GPRA benefit estimation, and scenario analysis for all DOE Energy Efficiency (EE) and Renewable Energy (RE) programs. The data and methods used are vetted DOE models and modeling assumptions. PAE provides estimates of integrated energy, economic, and environmental benefits generated by the EERE technology and deployment portfolio and provides means for selecting the most cost-effective technology portfolio and policy options both domestically and globally. These comparable estimates over the next two generations of potential energy generated and saved, criteria pollutants avoided and economic benefits to consumers and industry provide the substance of the benefits sections in the overview, program budget chapters, as well as in testimony and budget characterization and defense. Each activity informs decisions regarding the optimal allocation of resources within and among the EERE and related energy programs and provides key information that enables senior management and the technology programs to select portfolios and pathways that will most effectively and productively advance DOE's economic, environmental, energy security, and management excellence goals.

Detailed Justification

(dollars in thousands)

	FY 2010 Current Approp	FY 2012 Request
Planning, Analysis and Evaluation	**11,000**	**7,000**

PAE delivers management support through planning, analysis and evaluation activities by providing technical support staff that respond to external inquiries and requirements including improved analytic and performance input and transparency in all aspects of planning, analysis, performance, and reporting. PAE's planning efforts focus on developing EERE-wide approaches to strategic and multi-year program planning and portfolio analyses. A key component of PAE's efforts is to work with the programs to develop multi-year plans linking DOE's Strategic Plan to EERE's corporate goals and program's performance management and activity targets. PAE's planning and analysis activities seek to improve the understanding, methodology, treatment, representation and application of benefits, risk, and uncertainty, and to help advance Planning-Budget-Performance Integration productively within EERE.

PAE's analysis activities focus on providing multidisciplinary cross-cutting and integrated technical and market analysis to inform EERE corporate and program budget decisions while meeting GPRA requirements. PAE's approach to integrated analysis includes a focus on developing open, transparent, well-documented, peer-reviewed assumptions and analysis methods for estimating the expected energy, economic, and environmental benefits of the EERE portfolio as planned, as well as with policy, options and alternative scenarios.

EERE is continuing to work with the National Academy of Sciences (NAS), and other DOE applied R&D offices to provide comparable estimates of the potential impacts of each program's investments PAE also develops and maintains independent, objective analytical capabilities to address questions from the senior management, account for technical risk and uncertainty, and examine how outcomes change under different future technology and policy scenarios. As required by good business practices, PAE is working with EERE programs and other applied energy R&D programs to prepare benefits projections using common baselines, assumptions, and methods.

PAE's performance and evaluation component works with the programs to proactively address performance management requirements for programs and corporate management and to prepare EERE's submissions for integrated performance planning and reporting. EERE co-developed and is responsible for three of the five DOE HPPG's that represent the Department. PAE's evaluation team leads, specifies standards of practice and provides a comprehensive range of evaluation technical assistance, processes, and tools to help senior management and programs monitor and measure success, increase program effectiveness, and meet requirements for objective and independent assessment.

Total, Planning, Analysis and Evaluation	**11,000**	**7,000**

Explanation of Funding Changes

	FY 2012 vs. FY 2010 Current Approp ($000)
Planning, Analysis and Evaluation	
Decrease reflects a shift of funding for higher priority activities within the EERE portfolio. PAE will leverage collaboration with the technology programs to continue to produce critical, high caliber corporate planning, analysis and evaluation services.	-4,000
Total Funding Change, Planning, Analysis and Evaluation	**-4,000**

Congressionally Directed Projects

Funding Profile by Subprogram

(dollars in thousands)

	FY 2010 Current Approp	FY 2012 Request
Congressionally Directed Projects	292,135	0

Description

The Energy and Water Development and Related Agencies Appropriation Act, 2010 (Public Law 111-8) includes 295 Congressionally Directed Projects within the Office of Energy Efficiency and Renewable Energy. Funding for these projects was appropriated separately for individual projects although specific projects may relate to ongoing work in a specific programmatic area.

Detailed Justification

(dollars in thousands)

	FY 2010 Current Approp	FY 2012 Request
Congressionally Directed Projects		
▪ 21st Century Renewable Fuels, Energy, and Materials Initiative (MI)	1,250	0
▪ A123 Systems Large Format Nanophosphate Batteries for Solar Energy Storage (MI)	1,000	0
▪ Advanced Automotive Fuels Research, Development, & Commercialization Cluster (OH)	1,000	0
▪ Advanced Battery Manufacturing (VA)	200	0
▪ Advanced Power Cube for Wind Power and Grid Regulation Services (PA)	500	0
▪ Agri-business Energy Independence Demonstration (NY)	80	0
▪ Alabama Institute for Deaf and Blind Biodiesel Project Green (AL)	300	0
▪ Algae Biofuels Research (WA)	2,000	0
▪ Algae to Ethanol Research and Evaluation (NJ)	750	0
▪ Algal-based Renewable Energy for Nevada (NV)	800	0
▪ Alternative and Unconventional Energy Research and Development (UT)	10,000	0
▪ Alternative Energy School of the Future (NV)	1,200	0
▪ Alternative Energy Training Institute (CA)	500	0
▪ Alternative Fuel Bus Project, Schaghticoke, NY (NY)	300	0
▪ Auburn University, Biomass to Liquid Fuels and Electric Power	1,500	0

	(dollars in thousands) FY 2010 Current Approp	FY 2012 Request
Research (AL)		
▪ Bayview Gas to Energy Project (UT)	1,000	0
▪ Ben Franklin Technology Partners - Clean Technology Commercialization Initiative (PA)	500	0
▪ Bexar County Solar Collection Farm and Distribution System (TX)	1,000	0
▪ Bio Energy Initiative for Connecticut (CT)	1,500	0
▪ Biodiesel Blending (WI)	600	0
▪ Biodiesel Feedstock Development Initiative (MO)	1,000	0
▪ Biodiesel Production from Grease Waste (CA)	250	0
▪ Bioenergy/Bionanotechnology Projects (LA)	500	0
▪ Biofuel Micro-refineries for Local Sustainability (TN)	500	0
▪ Biofuels Campus for Accelerated Development (NC)	500	0
▪ Biofuels Research Laboratory (KY)	1,000	0
▪ Biofuels, Biopower and Biomaterials Initiative (GA)	1,250	0
▪ Biomass Energy Resources Center (VT)	1,000	0
▪ Bioprocesses Research and Development, Michigan Biotechnology Institute, Lansing, MI (MI)	500	0
▪ Black Hills State Heating and Cooling Plant (SD)	1,000	0
▪ Boulder SmartGridCity - Plug-In Electric Hybrid Vehicles (CO)	500	0
▪ Bridge Hydro-Turbine Study (OR)	150	0
▪ Brookston Wind Turbines Study, Brookston, IN (IN)	75	0
▪ California Polytechnic State University Center for Renewable Energy and Alternative Electric Transportation Technologies Equipment Acquisition (CA)	250	0
▪ Cellulosic Diesel Biorefinery (NJ)	1,000	0
▪ Center for Applied Alternative Energy, Sustainable & Practices (FL)	500	0
▪ Center for Biomass Utilization (ND)	7,000	0
▪ Center for Energy Storage Research (TX)	1,000	0
▪ Center for Environmental and Energy Research (NY)	250	0
▪ Center for Nanoscale Energy (ND)	5,000	0
▪ Center for Ocean Renewable Energy (NH)	750	0
▪ Central Corridor Energy District Integration Study (MN)	500	0
▪ Central Piedmont Community College (NC)	525	0
▪ Central Vermont Recovered Biomass Facility (VT)	500	0
▪ Christmas Valley Renewable Energy Development (OR)	410	0
▪ City Hall Leadership in Energy and Environmental Design (LEED) Certification (FL)	500	0

	(dollars in thousands)	
	FY 2010 Current Approp	FY 2012 Request
▪ City of Boise Geothermal Expansion to Boise State University (ID)	1,000	0
▪ City of Grand Rapids Solar Roof Demonstration Project (MI)	250	0
▪ City of Norco Waste-to-Energy Facility (CA)	750	0
▪ City of Oakdale Energy Efficiency Upgrades (MN)	400	0
▪ City of Redlands Facilities Upgrades to Improve Energy Efficiency (CA)	900	0
▪ City of Tallahassee Innovative Energy Initiatives (FL)	250	0
▪ City of Winter Garden Weatherization Demonstration Project (FL)	200	0
▪ Clean Power Energy Research Consortium (CPERC) (LA)	1,000	0
▪ Clemson University Cellulosic Biofuel Pilot Plant (SC)	1,000	0
▪ Cloud County Community College Renewable Energy Center of Excellence (KS)	750	0
▪ Coastal Ohio Wind Project: Removing Barriers to Great Lakes Offshore Wind Energy Development (OH)	1,000	0
▪ Commercial Building Energy Efficiency Demonstration (IL)	500	0
▪ Comprehensive Wind Energy Program, Purdue University-Calumet, IN (IN)	500	0
▪ Compressed Natural Gas Fueling Facility (MO)	700	0
▪ Concentrator Photovoltaic Technology (AZ)	900	0
▪ Consolidated Alternative Fuels Research (OK)	250	0
▪ Consortium for Plant Biotechnology Research (Multiple States)	3,000	0
▪ Controlled Environmental Agriculture and Energy Project (NY)	200	0
▪ Cooling, Heating and Power (Micro-CHP) and Bio-fuel Application Center (MS)	2,000	0
▪ Creighton University Training & Research in Solar Power (NE)	1,200	0
▪ Daemen College Alternative Energy/Geothermal Technologies Demonstration Program, Erie County, NY (NY)	950	0
▪ Dedham Municipal Solar Project (MA)	500	0
▪ Demonstration Plant for Biodiesel Fuels from Low-impact Crops (IL)	500	0
▪ Design and Implementation of Geothermal Energy Systems at West Chester University (PA)	300	0
▪ Development of an Economic and Efficient Biodiesel Production Process (NC)	750	0
▪ Development of Biofuels Using Ionic Transfer Membranes (NV)	1,500	0
▪ Development of High Yield Feedstock and Biomass Conversion Technology for Development of High Yield Tropical Feedstocks and Biomass Conversion (HI)	6,000	0
▪ Development of Pollution Prevention Technologies (NY)	900	0

	(dollars in thousands)	
	FY 2010 Current Approp	FY 2012 Request
▪ DRI Renewable Energy Center (REC) (NV)	500	0
▪ East Kentucky Bioenergy Capacity Assessment Project (KY)	250	0
▪ Eastern Illinois University Biomass Plant (IL)	1,000	0
▪ Energy Audit, Efficiency Improvements, and Renewable Energy Installations, Township of Branchburg, NJ (NJ)	1,000	0
▪ Energy Conservation and Efficiency Upgrade of HVAC Controls (NY)	500	0
▪ Energy Conservation Upgrades, Ingham Regional Medical Center, Lansing, MI (MI)	250	0
▪ Energy Efficiency Enhancements (AL)	250	0
▪ Energy Efficiency Repairs and Air Quality Improvements at Lyonsdale Biomass (NY)	500	0
▪ Energy Efficiency Upgrades, New Rochelle, NY (NY)	1,000	0
▪ Energy Reduction and Efficiency Improvement Through Lighting Control (PA)	120	0
▪ Energy Saving Retrofitting for the CFCC Main Campus (FL)	300	0
▪ Energy Storage/Conservation and Carbon Emissions Reduction Demonstration Project (MA)	400	0
▪ Energy Efficient Innovations for Healthy Buildings (NY)	500	0
▪ EngenuitySC Commercialization and Entrepreneurial Training Project (SC)	500	0
▪ Environmental Impact Protocols for Tidal Power (ME)	1,000	0
▪ Ethanol from Agriculture (AR)	500	0
▪ Fairbanks Geothermal Energy Project (AK)	1,000	0
▪ Fairview Department of Public Works Building and Site Improvements (NY)	500	0
▪ Fallon Paiute-Shoshone Tribe Demonstration Energy Park (NV)	200	0
▪ Farm Deployable Microbial BioReactor for Fuel Ethanol Production (AL)	800	0
▪ Fast Charging Electric Vehicle Demonstration Project in Charlottesville, Virginia (VA)	500	0
▪ Feasibility Study and Design of "Brightfield" Solar Farm (PA)	200	0
▪ Florida Renewable Energy Program (FL)	1,000	0
▪ Fluid Flow Optimization of Aerogel Blanket Process Project (MA)	300	0
▪ Fort Mason Center Pier 2 Project (CA)	2,000	0
▪ Gadsden State Community College Green Operations Plan (AL)	75	0
▪ Gas Heat Pump Cooperative Training Program (NV)	250	0
▪ Genetic Improvement of Switchgrass (RI)	1,500	0
▪ Georgetown South Commercial Park, Photovoltaic Generation Facility (TX)	100	0

	(dollars in thousands) FY 2010 Current Approp	FY 2012 Request
▪ Georgia Southern University Biodiesel Research (GA)	250	0
▪ Geothermal Development in Hot Springs Valley (MT)	491	0
▪ Geothermal Power Generation Plant at Oregon Institute of Technology (OR)	1,000	0
▪ Global Green New Orleans - Holy Cross Project (LA)	550	0
▪ Gogebic Community College (GCe) - Campus Energy Efficient and Weatherization Upgrade (MI)	300	0
▪ Great Basin College Direct-use Geothermal Demonstration Project (NV)	1,000	0
▪ Great Lakes Institute for Energy Innovation (OH)	1,000	0
▪ Great Plains Wind Power Test Facility, Texas Tech University, Lubbock, TX (TX)	2,000	0
▪ Green Building Research Laboratory (OR)	1,000	0
▪ Green Buildings/Retrofitting (VA)	350	0
▪ Green Fuels Depot (IL)	1,500	0
▪ Green Roof Demonstration Project (IN)	600	0
▪ Green Roof for the DuPage County Administration Building (IL)	250	0
▪ Greenfield Community College Hybrid Geo-thermal Project (MA)	525	0
▪ Hardin County General Hospital Energy Efficiency Upgrades (IL)	500	0
▪ Hawaii Energy Sustainability Program (HI)	6,000	0
▪ Hawaii Renewable Energy Development Venture (HI)	6,000	0
▪ Henderson, Solar Energy Project (NV)	500	0
▪ High Penetration Wind Power in Tatitlek (AK)	900	0
▪ High Speed Wind Turbine Noise Model with Suppression (MS)	1,000	0
▪ High Temperature Hydrogen Generation Systems (SC)	300	0
▪ Hospital Lighting Retrofit (IL)	500	0
▪ Housatonic River Net-Zero-Energy Building (MA)	1,000	0
▪ Hull Municipal Light Plant Offshore Wind Project (MA)	750	0
▪ Hydrogen Production and Delivery Technology (CT)	500	0
▪ HyperCAST R&D Funding for Vehicle Energy Efficiency (CO)	750	0
▪ Illinois Community College Sustainability Network (IL)	250	0
▪ Illinois Energy Resources Center at the University of Illinois at Chicago (IL)	400	0
▪ Improving Fuel Cell Durability and Reliability Initiative (CT)	2,500	0
▪ Independent Energy Community Renewable Power System (UT)	1,000	0
▪ Installation of a Solar Canopy (MA)	534	0
▪ Institute for Sustainable Energy (AL)	1,000	0

	(dollars in thousands)	
	FY 2010 Current Approp	FY 2012 Request
▪ Integrated Biomass Refining Institute (NC)	1,000	0
▪ Integrated Power for Microsystems (NY)	250	0
▪ Integrated Renewable Energy & Campus Sustainability Initiative (IA)	750	0
▪ Iowa Central Renewable Fuel Testing Laboratory (IA)	750	0
▪ Issaquah Highlands Zero Energy Affordable Housing (WA)	500	0
▪ Jenks Energy Management Equipment (OK)	250	0
▪ Juniata Hybrid Locomotive (PA)	1,000	0
▪ Kansas State University Center for Sustainable Energy (KS)	500	0
▪ La Feria Solar Lighting Initiative (TX)	500	0
▪ Lancaster Landfill Solar Facility (MA)	500	0
▪ Lane Community College Energy Demonstration Building (OR)	550	0
▪ Large-Scale Wind Training Program, Hudson Valley Community College, Troy, NY (NY)	300	0
▪ Lignocellulosic Biofuels from New Bioenergy Crops (TX)	1,000	0
▪ Long Island 50 MW Solar Initiative (NY)	1,750	0
▪ Long Island Biofuels Alliance (NY)	2,750	0
▪ Low Cost Production of Thin-Film Photovoltaic (PV) Cells (PA)	1,200	0
▪ MARET Center (MO)	1,500	0
▪ Marine Energy Technology (WA)	1,750	0
▪ Marine Renewable Energy Center (MA)	750	0
▪ Miami Children's Museum Going Green Initiative (FL)	1,000	0
▪ MidSouth/Southeast Bioenergy Consortium (AR)	1,000	0
▪ Mill Seat Landfill Bioreactor Renewable Green Power Project (NY)	1,000	0
▪ Montana Algal Biodiesel Initiative (MT)	500	0
▪ Montana Bio-Energy Center of Excellence (MT)	2,250	0
▪ Morris County Renewable Energy Initiative (NJ)	2,000	0
▪ Moving Toward an Energy Efficient Campus at Maffei College (MA)	400	0
▪ Mt. Wachusett Community College Wind Project (MA)	1,000	0
▪ Multi-Hybrid Power Vehicles with Cost Effective and Durable Polymer Electrolyte Membrane Fuel Cell and Lithium Ion Battery for Ohio University (OH)	600	0
▪ Municipal Building Energy Efficient Window Replacement Program (NJ)	180	0
▪ Municipal Complex Solar Power Project (NJ)	200	0
▪ Nanostructured Materials for Energy (NC)	1,000	0
▪ Nanostructured Materials for Improved Photovoltaics (MS)	1,000	0

	(dollars in thousands)	
	FY 2010 Current Approp	FY 2012 Request
▪ National Center of Excellence in Energy Storage Technology (OH)	1,000	0
▪ National Offshore Wind Energy Center (TX)	2,000	0
▪ National Open-Ocean Energy Laboratory (FL)	2,000	0
▪ NCMS (IL)	900	0
▪ Near Zero Carbon Footprint Energy Creation Through Thermal Oxidation (PA)	1,000	0
▪ Neighborhood Weatherization Collaborative (CO)	500	0
▪ Nevada Renewable Energy Integration and Development Consortium (NV)	3,000	0
▪ Newark Museum Alternative Energy Enhancement Program (NJ)	500	0
▪ Next Generation Composite Wind Blade Manufacturing Technologies (ME)	250	0
▪ Next Generation Wind Turbine (MA)	1,000	0
▪ NIREC - Nevada Institute for Renewable Energy Commercialization (NV)	1,000	0
▪ Northern Illinois University Transportation Energy Program (IL)	1,000	0
▪ Northern Nevada Renewable Energy Training Project (NV)	500	0
▪ Norwich Cogeneration Initiative (CT)	750	0
▪ Novel Photocatalytic Metal Oxides (NE)	250	0
▪ NTRCI Legacy Engine Demonstration Project (TN)	500	0
▪ NY State Center for Advanced Ferrite Production (NY)	300	0
▪ Oakland University Alternative Energy Education (MI)	500	0
▪ Offshore Wind Initiative (ME)	5,000	0
▪ Offshore Wind Project Study (NY)	500	0
▪ Ohio Advanced Energy Manufacturing Center (OH)	500	0
▪ Orange County Solar Demonstration & Research Facility (FL)	300	0
▪ Oregon Solar Highway - Innovative Use of Solar Technology (OR)	1,000	0
▪ OU Center for Biomass Refining (OK)	500	0
▪ Passive NOx Removal Catalyst Research, Notre Dame University, IN (IN)	900	0
▪ Peru Electrical Department Wind Turbine Generation (IL)	1,000	0
▪ Phipps Conservatory CTI Waste-to-Energy Project (PA)	500	0
▪ Phoenix Children's Hospital Central Energy Plant Expansion (AZ)	2,000	0
▪ Photovoltaic Power Electronics Research Initiative (PERI) (FL)	700	0
▪ Pittsburgh Green Innovators (PA)	1,500	0
▪ Placer County Biomass Utilization Pilot Project (CA)	1,000	0

(dollars in thousands)

	FY 2010 Current Approp	FY 2012 Request
▪ Plug-In Hybrid Initiative (MI)	750	0
▪ Port of Galveston Solar Energy Project (TX)	250	0
▪ Prototyping and Development of Commercial Nano-Crystalline Thin Film Silicon for Photovoltaic Manufacturing (NY)	500	0
▪ Purdue Solar Energy Utilization Laboratory, West Lafayette, IN (IN)	425	0
▪ R&D of Clean Vehicle Technology (OH)	1,000	0
▪ Renewable Energy Center (NC)	750	0
▪ Renewable Energy Clean Air Project (RECAP) (MN)	1,000	0
▪ Renewable Energy Demonstration (IL)	500	0
▪ Renewable Energy Feasibility Study and Resources Assessment (NV)	500	0
▪ Renewable Energy Initiative (IL)	500	0
▪ Renewable Energy Initiatives for Clark County, Nevada Parks and Recreation (NV)	1,000	0
▪ Renewable Energy/Disaster Backup System for Hawaii Red Cross Headquarters Building (HI)	240	0
▪ Research and Development of Liquid Carriers for Hydrogen Energy (WA)	500	0
▪ Research on Fuel Cell Powered by Hydrogen Production from Biomass to Provide Clean Energy for Remote Farms Away from Electric Grids (NY)	675	0
▪ Richland Community College Bioenergy Program (IL)	500	0
▪ Running Springs Retreat Center Solar Upgrade (CA)	1,000	0
▪ Saint Joseph's University Institute for Environmental Stewardship (PA)	1,000	0
▪ San Diego Center for Algae Biotechnology (SD-CAB) (CA)	750	0
▪ San Francisco Electric Vehicle Initiative (CA)	1,000	0
▪ Shenandoah Valley as a National Demonstration Project Achieving 25 Percent Renewable Energy by the Year 2025 (VA)	750	0
▪ Show Me Energy Cooperative Biomass Development (MO)	900	0
▪ Smart Energy Program (CT)	500	0
▪ Solar Compactor Energy Efficiency Research Demonstration Project (MA)	300	0
▪ Solar Electric Power for Nonsectarian Educational and Social Services Facilities (NV)	500	0
▪ Solar Energy Development (ME)	800	0
▪ Solar Energy Parking Canopy Demonstration Project (CA)	3,000	0
▪ Solar Energy Program (FL)	800	0
▪ Solar Energy Research Center Instrumentation Facility, University of North Carolina at Chapel Hill (NC)	1,000	0

	(dollars in thousands)	
	FY 2010 Current Approp	FY 2012 Request
▪ Solar Energy Zone Planning and Infrastructure for the Nevada Test Site and Adjacent Lands (NV)	1,000	0
▪ Solar Furnace Research Program, Valparaiso University, IN (IN)	500	0
▪ Solar Hot Water Project in Greenburgh, NY (NY)	169	0
▪ Solar Lighting for Artesia Parks (CA)	250	0
▪ Solar Panel Expansion Initiative (TX)	500	0
▪ Solar Panels in Municipal Owned Buildings (NJ)	1,000	0
▪ Solar Panels on Hudson County Facilities (NJ)	500	0
▪ Solar Pioneer and Solar Entrepreneur Programs (NY)	500	0
▪ Solar Power for Maywood (NJ)	300	0
▪ Solar Powered Compressed Natural Gas Refueling Station (NY)	500	0
▪ Solar Powered Lighting for Forest Preserve District of DuPage County, IL (IL)	300	0
▪ Solid Oxide Fuel Cell Systems PVL Pilot Line (OH)	1,000	0
▪ Somerset County Renewable Energy Initiative (NJ)	2,000	0
▪ South Jersey Wind Turbines (NJ)	500	0
▪ Southern Pine Based Biorefinery Center (GA)	1,000	0
▪ Southern Regional Center for Lightweight Innovative Designs (MS)	4,000	0
▪ Southwest Alaska Regional Geothermal Energy Project (AK)	2,500	0
▪ St. Luke's Miners Memorial Hospital Energy Efficiency Improvement Project (PA)	525	0
▪ St. Marks Refinery Redevelopment (OH)	350	0
▪ St. Petersburg Solar Pilot Project (FL)	1,000	0
▪ St. Petersburg Sustainable Biosolids/Renewable Energy Plant (FL)	2,500	0
▪ State Colleges' (VSC) Statewide Energy Efficiency and Renewable Energy Initiative (VT)	450	0
▪ Strategic Biomass Initiative (MS)	500	0
▪ Street Lighting Fixture Energy Efficiency Retrofit Project (CA)	500	0
▪ Sun Grant Initiative (SD)	2,750	0
▪ Sustainable Algal Energy Production and Environmental Remediation (VA)	500	0
▪ Sustainable Energy Options for Rural Nebraska (FL)	500	0
▪ Sustainable Energy Research Center (MS)	10,000	0
▪ Sweet Sorghum Alternative Fuel and Feed Pilot Project (AZ)	750	0
▪ Switchgrass Biofuel Research: Carbon Sequestration and Life Cycle Analysis (FL)	500	0
▪ Synthesis of Renewable Biofuels from Biomass (MT)	500	0
▪ The Biorefinery in New York-Bio Butanol from Biomass (NY)	400	0

	(dollars in thousands) FY 2010 Current Approp	FY 2012 Request
▪ The Boston Architectural College's Urban Sustainability Initiative (MA)	1,600	0
▪ The CUNY Energy Institute (NY)	1,550	0
▪ The Johnston Avenue Solar Project (NJ)	500	0
▪ The Solar Energy Consortium (NY)	2,250	0
▪ Thin Film Photovoltaic Research & Development (VT)	500	0
▪ Thurgood Marshall College Fund Minority Energy Science Initiative: NNSA (NC)	3,000	0
▪ Today's Leaders for a Sustainable Tomorrow: A Sustainable Energy Program (MN)	1,500	0
▪ Tucson Public Building Solar Arrays (AZ)	450	0
▪ Unconventional and Renewable Energy Research Utilizing Computer Simulations (UT)	3,500	0
▪ Union Terminal (OH)	500	0
▪ United Way of Southeastern Michigan (MI)	400	0
▪ University of Akron National Polymer Innovation Center (OH)	1,000	0
▪ University of Arkansas at Little Rock Nanostructured Solar Cells (AR)	500	0
▪ University of Detroit Mercy Energy Efficient Chemistry Building Renovations (MI)	800	0
▪ University of Louisville Research and Energy Independence Program (KY)	2,000	0
▪ University of New Haven Solar Testing and Training Lab (CT)	500	0
▪ University of North Alabama Green Campus Initiative (AL)	200	0
▪ University of South Carolina Aiken Biofuels Laboratory in Aiken, SC (SC)	456	0
▪ University of Wisconsin Oshkosh's Anaerobic Dry Digestion Facility (WI)	500	0
▪ University of Wisconsin-BaraboojSauk County Net-Zero Energy Building (WI)	500	0
▪ University of Wisconsin-Milwaukee Advanced Nanomaterials for High-Efficiency Solar Cells (WI)	500	0
▪ UNR - Biodiesel from Food Waste (I\IV) (NV)	1,000	0
▪ UNR - Great Basin Center for Geothermal Energy (I\IV) (NV)	1,000	0
▪ UNR - Mass Exchanger Technology for Geothermal and Solar Energy Systems (NV)	1,200	0
▪ UW Northwest National Marine Renewable Energy Center (WA)	880	0
▪ Vermont Biofuels Initiative (VT)	750	0
▪ Vermont Energy Investment Corporation (VT)	450	0
▪ Wallowa County Integrated Biomass Energy Center (OR)	500	0

(dollars in thousands)

	FY 2010 Current Approp	FY 2012 Request
▪ Warren Technology and Business Center for Energy Sustainability (OH)	2,700	0
▪ Washington State Biofuels Industry Development (WA)	1,000	0
▪ Washoe Wind Turbine Demonstration Project (NV)	50	0
▪ Western Iowa Tech Community College Renewable Energy Economy Corridor (IA)	500	0
▪ Western Kentucky University Research Foundation Biodiesel Project (KY)	500	0
▪ Wind Turbine Development (MT)	1,000	0
▪ Wind Turbine Infrastructure for Green Energy and Research on Wind Power in Delaware (DE)	1,000	0
▪ WSU, National Institute for Aviation Research, Advanced Materials Research (KS)	1,500	0
▪ Ypsi Civic Center (IL)	1,000	0
Total, Congressionally Directed Projects	292,135	0

Explanation of Funding Changes

	FY 2012 vs. FY 2010 Current Approp ($000)
Congressionally Directed Projects	
No funding requested.	0
Total, Congressionally Directed Projects	**0**

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, $237,717,000, to remain available until expended.

Electricity Delivery and Energy Reliability
Office of Electricity Delivery and Energy Reliability

Overview

Appropriation Summary by Program

	FY 2010 Current Appropriation	FY 2011 CR	FY 2012 Request
Electricity Delivery and Energy Reliability			
Research and Development	121,402		192,817
Permitting, Siting, and Analysis	6,400		8,000
Infrastructure Security and Energy Restoration	6,187		6,187
Program Direction	21,420		31,217
Congressionally Directed Activities	13,075		0
Subtotal, Electricity Delivery and Energy Reliability	168,484	171,982	238,221
Use of Prior Year Balances			-504
Subtotal, Electricity Delivery and Energy Reliability			237,717

Preface

The Office of Electricity Delivery and Energy Reliability (OE) leads national efforts in electric grid research and development (R&D) and electricity policy, while also serving as the Federal government's focal point in responding to energy security emergencies. OE's leadership in developing "next generation" electric grid technologies, tools, and techniques; working with stakeholders to deploy these systems and create favorable policy and regulatory structures; and enhancing the security of the nation's energy infrastructure, is essential to help achieve national energy, economic, and environmental goals.

Electric power faces a transformative opportunity: helping to strengthen the U.S. economy in the information age while addressing the preeminent energy challenge of our day – sustainable global energy development that reduces both greenhouse gas emissions and the consumption of oil. For the most part, today's electric grid was designed and constructed in the last century before cell phones, personal computers, and the internet changed how and for what electricity is needed and used. In fact, the pace of society's changing needs has pushed an aging and sometimes congested grid to its operating limits.

A modern electric grid is critical to meeting the nation's energy, environmental, and security goals. . Not only is reliable, affordable, efficient, and secure electric power delivery fundamental for the information age, it will also be central for expanding the economic recovery, protecting critical

infrastructures, and enabling the transition to low-carbon energy sources and away from the consumption of oil through electrification of transportation.

Over the next several decades, the U.S. electric power industry must address three critical needs simultaneously:

- Integrate a new class of low-carbon alternatives into the nation's fleet of power generating resources (i.e., advanced nuclear, coal with carbon capture and sequestration, and non-hydro renewable resources including, wind, solar, geothermal, and biomass);
- Meet increasing demand for electricity driven by growth in population, economic output, and electrification, including possible mass-markets for electric vehicles; and
- Accomplish these while maintaining reliability, security and affordability -- pillars of the nation's economic growth and prosperity in the information age.

Without development and deployment of "next generation" electric transmission, distribution, and customer technologies, the grid could become a barrier to the adoption of cleaner energy supplies and more energy-efficient demand-side measures. Opportunities for innovation and entrepreneurship will be lost in the electricity sector and sectors that depend on electricity – such as telecommunications, banking and finance, water, and public health and safety – will be left more vulnerable to growing cyber security threats.

OE's leadership in research and development, state and regional assistance in planning and policy, and efforts to enhance the resiliency of the energy infrastructure is critical to meeting these challenges. Across its programs, OE pursues an approach that is technology-neutral regarding generation sources and end use demands. It seeks to create a secure and reliable grid that provides maximum flexibility in the marketplace. It focuses on areas critical to achieving national energy, economic, environmental, and critical infrastructure protection goals where there is a strong need for a federal role.

Within the Electricity Delivery and Energy Reliability Appropriation, OE has four programs: Research and Development (4 subprograms); Permitting, Siting and Analysis; Infrastructure Security and Energy Restoration; and Program Direction.

The Research and Development program (R&D) pursues innovative technologies that improve the reliability, efficiency, flexibility, functionality, and security of the Nation's electricity delivery system. R&D technology areas include advanced smart grid technologies; transmission reliability and renewables integration tools; energy storage systems; advanced computational and modeling tools for the grid; grid materials, devices and systems research hub; power electronics devices; and cyber security for energy delivery systems. The Permitting, Siting, and Analysis program (PSA) works to develop and/or improve policies, state laws, and programs that facilitate the development of electric infrastructure needed to bring new clean energy projects to market, and provides technical assistance to states and regions. The Infrastructure Security and Energy Restoration program (ISER) works to enhance the reliability, survivability and resiliency of the energy infrastructure; and to facilitate recovery from disruptions to the energy supply.

Mission
OE's mission is to lead national efforts to modernize the electric grid; enhance security and reliability of the energy infrastructure; and mitigate the impact of, and facilitate recovery from, disruptions to the energy supply.

Benefits
The electric grid is a key enabler for the implementation of the Administration's commitment to a low-carbon, clean energy future. This enabling role has several key aspects: (1) facilitating greater adoption of variable and intermittent renewable resources and other clean power systems; energy efficient buildings, appliances, and industrial equipment; and low-carbon transportation alternatives such as electric vehicles; (2) improving the energy efficiency of the electric transmission and distribution system itself, with resulting reductions in power delivery losses and greenhouse gas emissions; and (3) enhancing energy security by increasing resilience to energy supply disruptions, which can result from a physical or cyber attack, a spike in demand or change in generation (e.g., from intermittent renewables), technical and/or operational failures, market manipulation, or natural disasters.

OE focuses on the full spectrum of electricity delivery system needs. It pursues applied research and development investments (mid to long-term), and technology demonstrations (short-term) aimed at bringing new and innovative technologies to maturity. OE's research and development 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.

Benefits of the research activities include:
- Strengthened stability and hardening of the electric grid and reduced frequency/duration of operational disturbances (reliability);
- Increased efficiency of the electric delivery system through reduced energy losses (energy efficiency);
- Reduced peak demand and price volatility of electricity through increased asset utilization (capacity factor of transmission and distribution);
- Improved accessibility to a variety of energy sources that generate electricity (reliability, system efficiency, and renewables integration); and
- Enhanced cyber security for control systems (reliability).

Benefits of the operational activities include:
- A hardened energy infrastructure that detects, prevents, and mitigates disruptions to the U.S. energy sector (reliability);
- Competitively priced and environmentally responsible electricity through cross-border trade with Canada and Mexico (system efficiency);
- Facilitated activities with states to develop energy security and reliability plans, and generation/demand response investment strategies (system efficiency); and
- Coordinated response for energy emergencies (resiliency).

Projects are selected as part of a broad strategy that involves partnerships with key stakeholders – particularly those who can influence and change conditions and circumstances that the Federal Government may be unable to influence and change on its own. These partnerships enable OE to leverage its resources and capabilities by conducting joint planning, information exchange, and cost-shared research, development, and demonstration projects with national laboratories, universities, the

private sector, and other Government agencies. OE plays catalytic and facilitative roles since most of the Nation's energy infrastructure is owned and operated by the private sector.

Focus of the FY 2012 Request

OE's FY 2012 request significantly expands the Department's investment in a modernized grid. The request supports the development of technologies, tools and techniques that can increase grid flexibility, enabling a range of generation resources; maintain grid reliability and security in the face of increasing complexity and demand; and increase grid efficiency to minimize cost and energy consumption. The request continues support for state and regional partners to facilitate grid modernization and new transmission, and works to enhance protection of the energy infrastructure against physical and cyber disruptions, and quickly restore energy when disruptions do occur.

The FY 2012 request provides increases to leverage the considerable investment in grid modernization made by the Recovery Act and to address the challenges of an increasingly complex electric grid facing increasingly complex demands. A key investment in FY 2012 is the establishment of a new energy innovation hub, called the Smart Grid Technology and Systems Hub. The Hub will address the total electricity system with a broad, multi-disciplinary group, covering basic science, technology, economic, and policy issues that affect our ability to modernize the grid. The Hub will focus on integrated development of 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. For example, one potential research area is the development of a self configuring substation linking the distribution system, smart grid and reactive components like transformers and switches in real time.

Other investments in FY 2012 include:

- Additional demonstrations for a new suite of cost-shared grid level energy storage projects to maintain the momentum from the American Recovery and Reinvestment Act (ARRA) investments. Energy storage can provide stability to the grid and offers a solution to integration of intermittent and variable renewable energy sources into the grid;
- Expanded research efforts in advanced modeling of the grid into other system layers to create a comprehensive, integrated modeling architecture that gives more in-depth system understanding, rather than having separate, "isolated" models that answer specific questions. Examples include the communications layer overlaying on the electric system model; and the integration of distribution models into higher-level transmission system models; and
- Expansion of interconnection studies and local, state and regional dialogues begun under ARRA by providing additional analysis and collaboration on advanced transmission system approaches, including identification of efficient ways for balancing areas to increase cooperation; evaluation of a "hardened" offshore transmission system to facilitate delivery of electricity to major population centers from remote generation facilities; and continued evaluation of the effect of the transition to a low-carbon energy future on the operation and planning of the electric system.

Accomplishments

FY 2010 accomplishments in the **Research and Development** program include:

- In the **Clean Energy Transmission and Reliability** program:

    - Developed a prototype electromechanical grid stability alarm tool that alerts operators to unwanted power oscillations on the grid;
    - Initiated university-based renewables integration research, including analysis of grid dynamics and electricity markets; and
    - Demonstrated consistent production of second generation High Temperature Superconductivity wire (greater than 300 meters-long) with 70,000 ampere-meters (A-m) critical current-length.
- In the **Smart Grid Research and Development** program:
    - Developed the Smart Grid Maturity Model for use by utilities, which measures progress and prioritizes future activities in implementing smart grid technologies;
    - Launched SmartGrid.gov and the Smart Grid Information Clearinghouse websites for outreach of smart grid information to all stakeholders;
    - Published the results of two analyses, one on the impacts of plug-in hybrid electric vehicles on the grid, and another on the reductions in energy consumption and CO_2 emissions from smart grid technologies; and
    - Supported development of commercially viable GaN-based power electronic devices for grid applications.
- In the **Energy Storage** program:
    - Initiated efforts for development of self-assembled Lithium-ion electrodes and Lithium-ion cells with potential for meeting the performance requirements for community storage; and
    - Continued development of novel lead carbon batteries with potential photovoltaic applications that show vastly increased cycle life when compared to traditional lead acid batteries.
- In the **Cyber Security for Energy Delivery Systems** program:
    - Made competitive awards for R&D of cyber attack-resilient energy delivery system computer platforms and communications networks; and
    - Developed Smart Grid security profiles that provide vendor-neutral, actionable guidance to utilities, vendors and government entities on how to build cyber security into Smart Grid components in the development stage, and how to implement those safeguards when the components are integrated into the power grid.

FY 2010 accomplishments in the **Infrastructure Security and Energy Restoration** program include:

- Responded to seven events affecting energy infrastructure, including winter storms in the Mid-Atlantic and Northeast U.S., earthquakes in American Samoa and Haiti, and the Deepwater Horizon oil spill;
- Issued a first of its kind report on the efforts taken by industry to harden their energy systems and make them more resilient to all hazards; and
- Led completion of the 2010 Energy Sector-Specific Plan (ESSP) under the National Infrastructure Protection Plan, in partnership with governmental and private sector asset owners and operators from the electricity and oil and natural gas sectors. The plan defines the strategic roadmap that lays the foundation for successful critical infrastructure protection implementation.

FY 2010 accomplishments in the **Permitting, Siting and Analysis** program include:

- Responded to requests from over 40 States for technical assistance on electricity policies, including Smart Grid deployments, and regulatory approaches to better align utility incentives with electric ratepayer-financed energy efficiency;

- Issued the second National Electric Transmission Congestion Study, which assesses transmission congestion and constraints across the country and identifies areas that are experiencing congestion-related problems;
- Processed electricity export authorizations, and permit applications for transmission facilities at the U.S. international borders; and
- Provided support to the Western Governor's Association's Western Renewable Energy Zone (WREZ) project, which began an effort to coordinate purchases of distant renewable resources between utilities and renewable project developers.

American Recovery and Reinvestment Act (Recovery Act)

The American Recovery and Reinvestment Act of FY 2009 (Recovery Act) included $4.5 billion for Electricity Delivery and Energy Reliability activities. It directed the funds be used to modernize the electric grid, enhance the security and reliability of the electric infrastructure, facilitate recovery from disruptions, and implement smart grid activities authorized under the Energy Independence and Security Act of 2007 (EISA).

Recovery funds have significantly accelerated adoption of available smart grid technologies. OE made over $4 billion in awards to utilities, manufacturers, cities and others to demonstrate and deploy smart grid technologies across the transmission and distribution system. Smart grid technologies enable real-time monitoring of energy usage to save energy and increase both stability and efficiency, while enhanced data can also enable consumers to better control their use of energy. The awards included large-scale energy storage demonstration projects that can facilitate integration of variable and intermittent renewable energy sources such as wind and solar energy into the grid. Including private investment through cost shares, these initiatives represent nearly a $10 billion investment in modernizing the electric grid.

Recovery initiatives also included awards in each of the nation's three interconnections to support regional transmission planning, a critical element of the nation's transition to a clean energy future. Recovery funds supported grants to community colleges, universities, utilities and manufactures for workforce development and training for the next generation of workers in the utility and electrical manufacturing industries; and provided assistance to state and local governments to enhance energy assurance capabilities and emergency preparedness, and to state utility commissions that regulate and oversee new electricity projects which can include smart grid, renewable energy and energy efficiency elements. The Department also provided funds to the National Institute of Standards and Technology to facilitate the development of industry-based interoperability standards to help the many different devices involved in smart grid communicate with each other in an efficient and secure manner.

By the end of FY 2010, OE completed all awards for all of its Recovery initiatives -- nearly 350 awards in all -- with more than 95 percent of the funds competitively awarded. OE will monitor progress as the projects move towards completion, and the insight gained will help inform future program decisions, building on the acceleration of deployments that the Recovery Act made possible.

The Department of Energy's Recovery website (http://www.energy.gov/recovery) contains current information on activities and highlights progress in implementing activities supported by the Recovery Act. Additional details on OE's Recovery projects can be found at http://www.oe.energy.gov.

Basic and Applied R&D Coordination

Coordination between the Department's basic research and applied technology programs is a high priority for the Secretary of Energy. The Department has a responsibility to coordinate its basic and applied research programs to effectively integrate R&D by the science and technology communities (e.g., national laboratories, universities, and private companies) that support the DOE mission. Efforts have focused on improving communication and collaboration between federal program managers and increasing opportunities for collaborative efforts targeted at the interface of scientific research and technology development to ultimately accelerate DOE mission and national goals. Coordination between the basic and applied programs is also enhanced through joint programs, jointly-funded scientific facilities, and the program management activities of the DOE Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) programs. Additionally, co-funding research activities and facilities at the DOE laboratories and funding mechanisms that encourage broad partnerships are also means by which the Department facilitates greater communication and research integration within the basic and applied research communities.

For example, OE coordinates its energy storage research with the Office of Science (SC) and the Advanced Research Projects Agency-Energy (ARPA-E), as well as the Office of Energy Efficiency and Renewable Energy (EERE). SC's Basic Energy Sciences program is supporting research at the Pacific Northwest Laboratories on Molecularly Organized Nanostructured Materials, and OE is developing self-assembled batteries with the same group. An Energy Storage Stakeholders Workshop was jointly organized by OE, ARPA-E and EERE, and the resultant recommendations are being incorporated into a DOE-wide Strategic Plan on storage research. OE and ARPA-E act as reviewers for each other's solicitations and conducted a joint Grid Scale Energy Storage program review.

Electricity Delivery and Energy Reliability
Office of Electricity Delivery and Energy Reliability

Funding by Site by Program

	FY 2010 Current Appropriation	FY 2012 Request
Argonne National Laboratory		
Research and Development	2,380	4,200
Permitting, Siting, and Analysis	600	213
Infrastructure Security and Energy Restoration	200	300
Total, Argonne National Laboratory	3,180	4,713
Brookhaven National Laboratory		
Research and Development	350	0
Total, Brookhaven National Laboratory	350	0
Chicago Operations Office		
Research and Development	100	0
Program Direction	220	0
Total, Chicago Operations Office	320	0
Golden Field Office		
Research and Development	8	0
Permitting, Siting, and Analysis	135	0
Total, Golden Field Office	143	0
Idaho National Laboratory		
Research and Development	1,581	3,165
Infrastructure Security and Energy Restoration	0	200
Total, Idaho National Laboratory	1,581	3,365
Idaho Operations Office		
Research and Development	350	0
Total, Idaho National Laboratory	350	0
Lawrence Berkeley National Laboratory		
Research and Development	3,890	7,850

	FY 2010 Current Appropriation	FY 2012 Request
Permitting, Siting, and Analysis	3,358	3,921
Total, Lawrence Berkeley National Laboratory	7,248	11,771
Los Alamos National Laboratory		
Research and Development	7,290	970
Total, Los Alamos National Laboratory	7,290	970
National Energy Technology Laboratory		
Research and Development	49,735	94,819
Permitting, Siting, and Analysis	855	2,078
Infrastructure Security and Energy Restoration	537	350
Program Direction	5,684	8,215
Congressionally Directed Activities	13,075	0
Total, National Energy Technology Laboratory	69,886	105,462
National Renewable Energy Laboratory		
Research and Development	4,000	4,000
Permitting, Siting, and Analysis	559	0
Total, National Renewable Energy Laboratory	4,559	4,000
Oak Ridge National Laboratory		
Research and Development	15,710	12,343
Permitting, Siting, and Analysis	229	899
Infrastructure Security and Energy Restoration	100	300
Total, Oak Ridge National Laboratory	16,039	13,542
Oak Ridge Operations Office		
Research and Development	2,055	0
Total, Oak Ridge Operations Office	2,055	0
Pacific Northwest National Laboratory		
Research and Development	13,240	25,845
Infrastructure Security and Energy Restoration	0	300
Total, Pacific Northwest National Laboratory	13,240	26,145

	FY 2010 Current Appropriation	FY 2012 Request
Richland Operations Office		
Infrastructure Security and Energy Restoration	450	800
Total, Richland Operations Office	450	800
Sandia National Laboratory		
Research and Development	13,799	34,203
Infrastructure Security and Energy Restoration	350	150
Total, Sandia National Laboratory	14,149	34,353
Washington Headquarters		
Research and Development	6,914	5,422
Permitting, Siting, and Analysis	664	889
Infrastructure Security and Energy Restoration	4,550	3,787
Program Direction	15,516	23,002
Total, Washington Headquarters	27,644	33,100
Total, Electricity Delivery and Energy Reliability	168,484	238,221

Major Changes or Shifts by Site

Argonne National Laboratory (ANL)
- Increase in funds reflects additional activities under Advanced Modeling Grid Research.

Brookhaven National Laboratory (BNL)
- Reduction results from close-out of activities related to High Temperature Superconductivity in Clean Energy Transmission and Reliability.

Chicago Operations Office (CH)
- Reductions results from the functions being performed at Headquarters.

Idaho National Laboratory (ANL)
- Increase reflects an increase in Cyber Security activities.

Lawrence Berkeley National Laboratory (LBNL)
- Increase in funding due to additional activites in Advanced Modeling Grid Research and Renewables Integration.

Los Alamos National Laboratory (LANL)
- Reduction in funds due to close-out of activities related to High Temperature Superconductivity in Clean Energy Transmission and Reliability.

National Energy Technology Laboratory (NETL)
- NETL's additional funding reflects new competitive awards in Advanced Modeling Grid Research, Transmission Reliability, Energy Storage, the Smart Grid Technology and Systems Hub, and Cyber Security.

Oak Ridge National Laboratory (ORNL)
- Reduction in funds due to close-out of activities related to High Temperature Superconductivity in Clean Energy Transmission and Reliability.

Pacific Northwest National Laboratory (PNNL)
- Increase supports additional activities in Clean Energy Transmission and Reliability.

Sandia National Laboratory (SNL)
- SNL's additional funds will support additional activities in Energy Storage.

Site Description

Argonne National Laboratory (ANL)

Research and Development

ANL previously performed research and development in high temperature superconductivity (HTS) under the Advanced Cables and Conductors activity. Argonne's scientific and computational resources are being utilized in support of the Advanced Modeling Grid Research activity due to their demonstrated knowledge and expertise in constructing effective modeling tools and analyzing results.

Permitting, Siting, and Analysis
ANL provides analytical support to DOE in its EPACT Sec. 368 requirement to work with the Federal agencies of Defense, Commerce, Agriculture, Interior and in consultation with the Federal Regulatory Energy Commission (FERC), states, tribes, appropriate local units of governments, affected energy industries and other interested parties, to perform any environmental reviews in order to allow the respective Federal agencies to amend their land use and resource management plans to incorporate corridors for oil, gas, and hydrogen pipelines and transmission lines on Federal lands in the eastern US. In addition, ANL assists DOE in its review of environmental assessments required for DOE issuance of permits and authorizations for cross-border transmission lines and exports of electricity.

Infrastructure Security and Energy Restoration
ANL supports the ISER program by providing energy analysis specializing in oil and natural gas, exercise and workshop support, and visualization and situational awareness capabilities.

Idaho National Laboratory (INL)

Research and Development
Funding to INL supports Cyber Security work to reduce the risk of a malicious cyber attack that could disrupt the operation of the nation's electric grid or distribution of Oil and Natural Gas to end users. Previous work in this area has focused on assessing the supervisory control and data acquisition (SCADA) and energy management systems (EMS) to identify potential cyber vulnerabilities and to identify applicable mitigation approaches. As assessments are completed on the SCADA/EMS products, attention will be directed to other parts of the electric grid, specifically substations that are judged likely to contain vulnerabilities that could be attacked to cause significant impacts on grid operation.

Infrastructure Security and Energy Restoration
INL supports the ISER program through expertise in cyber security as well as some exercise and workshop support.

Lawrence Berkeley National Laboratory (LBNL)

Research and Development
LBNL is the lead for a national laboratory/industry/university consortium that was formed to support research in power systems. These university/national laboratory/industry partnerships are being leveraged to address critical research challenges in renewable integration and advanced grid modeling.

Permitting, Siting, & Analysis
Funding to LBNL is used for analysis in support of the 2009 DOE National Transmission Congestion study and other transmission-related analysis studies undertaken by DOE. LBNL is also responsible for providing technical assistance to state electricity officials, including but not limited to state public

utility commissions, on state and regional electricity policy issues, including ratepayer-financed energy efficiency, demand response, smart grid, renewable energy, transmission, and clean coal. Additionally, LBNL provides analytical support to DOE in its facilitation with EPA of the utility industry/state electricity regulators' National Action Plan for Energy Efficiency.

Los Alamos National Laboratory (LANL)

Research and Development

LANL will support Smart Grid Research and Development in the development of a Smart Grid Technology Test Bed. LANL contributes experience with the analysis and modeling necessary for demonstration of integration of intermittent resources.

National Energy Technology Laboratory (NETL)

Research and Development
NETL will provide strategic planning, technical support, benefits analysis, and project management support to the Research and Development Program. Project management support includes commissioning solicitations and management support for financial assistance agreements awarded through these solicitations. NETL will also provide intra- and inter-departmental coordination support with other Federal Programs.

Permitting, Siting, & Analysis
NETL is used to issue grants to national and regional State-based non-profit organizations that have developed expertise in providing technical assistance in electric markets to States and regions. These groups include the National Association of Regulatory Utility Commissioners, the National Governors Association, the Western Governors Association, and the National Conference of State Legislatures.

Infrastructure Security and Energy Restoration
NETL provides analysis for special projects that emerge from various sources and incidents, such as a Gulf of Mexico oil and gas production analysis in the post-Katrina environment. Further, NETL develops Energy Information Library documents which profile key energy assets for use during emergencies as reference documents, and produces a 1-hour analysis of energy related situations showing major energy assets.

National Renewable Energy Laboratory (NREL)

Research and Development
NREL works with industry to develop a uniform national standard for interconnection of distributed power resources with the electric grid and performs research to develop related test and certification procedures. Activities will also include renewable energy grid integration to fully integrate transmission and distribution system level renewable energy technologies into the electric grid.

Oak Ridge National Laboratory (ORNL)

Research and Development

ORNL is engaged in research and development activities related to transmission reliability, renewables integration (including the effects of plug-in hybrid electric vehicles on the grid), power electronics and energy storage. ORNL operates the National Transmission Technology Research Center for testing transmission technologies. Additionally, ORNL is pursuing a baseline Smart Grid Security profile for users to approach, understand, and implement the guidance for securing smart grid systems. ORNL is part of a national laboratory/industry/university consortium that was formed to support research activities in Transmission Reliability and Renewables Integration.

Permitting, Siting, & Analysis
ORNL assists DOE in its review of environmental assessments required for DOE issuance of permits and authorizations for cross-border transmission lines and exports of electricity. Additionally, ORNL supports DOE in its analysis of material related to any emergency order issued by the Secretary of Energy concerning electricity reliability under sec. 202(c) of the Federal Power Act and any other related matter.

Infrastructure Security and Energy Restoration
ORNL provides visualization and situational awareness support to the ISER program in rapid response situations.

Pacific Northwest National Laboratory (PNNL)

Research and Development
PNNL is supporting development of communication and control architectures and technologies, situational awareness, and visualization tools. PNNL supports development of smart grid technologies for improved load/demand management while responding to market prices and electricity supply/demand conditions. PNNL is one of the leading labs in analyzing the effects of plug-in hybrid electric vehicles on the grid. They are also supporting work in renewable energy grid integration. PNNL is part of a national laboratory/industry/university consortium that was formed to support research on Transmission Reliability and Renewables Integration. PNNL conducts evaluations of the technological and institutional aspects of recent reliability events on the Nation's electric power system, and is the lead for research activities in real-time monitoring and control for the power grid. Their power system expertise and computational capabilities are also supporting the grid modeling effort.

Infrastructure Security and Energy Restoration
PNNL supports the ISER program by providing energy analysis specializing in electricity and cyber security, exercise and workshop support, and visualization and situational awareness capabilities. PNNL also offers electricity-related analytical support.

Richland Operations Office (RL)

Infrastructure Security and Energy Restoration
Funds sent to the Richland Operations office are used for the HAMMER program to support a variety of emergency response functions. Richland develops and conducts training for OE's ESF-12 Energy Restoration Team members, including conducting drills and exercises to test emergency response capabilities. During an emergency, Richland provides responders for energy emergencies, coordinates

deployment schedules, and provides lessons learned and after-action reports, detailing activities from ESF-12 deployment efforts.

Sandia National Laboratories (SNL)

Research and Development
SNL is a national leader in energy storage systems research and development. SNL is developing improved energy storage system components including power conversion electronics and modular multi-functional energy storage systems and manages joint DOE Storage Initiatives with the California Energy Commission and the New York State Energy Research and Development Authority. SNL is part of a national laboratory/industry/university consortium that was formed to support research on Transmission Reliability and Renewables Integration.

Infrastructure Security and Energy Restoration
SNL provides support for the ISER program's Global Initatives division for the majority of International reimbursable work by providing exercise and workshop capabilities.

Washington Headquarters

Research and Development
Activities include program management and administration of the Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) programs, I-Manage, and communications.

Permitting, Siting, & Analysis
Headquarters regulates international trade in electric energy. This is accomplished by authorizing exports of electric energy to Canada and Mexico and granting permits for construction and operation of electric transmission lines that cross the U.S. international border.

Infrastructure Security and Energy Restoration
Washington Headquarters funds ISER's inter-agency initiatives, analysis and technical support needs. Specifically, this support will encompass computer, technology, and visualization support for the Emergency Response Center, as well as research on critical energy infrastructure in support of the Operations and Response Area Managers.

Research and Development

Funding Profile by Subprogram

	FY 2010 Current Appropriation	FY 2012 Request
Research and Development		
Clean Energy Transmission and Reliability	37,373	60,817
Smart Grid Research and Development	31,541	45,000
Energy Storage	13,608	57,000
Cyber Security for Energy Delivery Systems	38,880	30,000
Total, Research and Development	121,402	192,817

Public Law Authorizations:
P.L. 109-58, Energy Policy Act, 2005
P.L. 110-140, Energy Independence and Security Act, 2007

Mission
The OE Research and Development (R&D) program works in partnership with industry, academia, government, and the public to advance technologies to meet America's need for a reliable, efficient, secure, and affordable electric power grid.

Benefits
A modern electric grid provides the necessary infrastructure to enable the adoption of cleaner energy supplies and more energy-efficient demand-side measures. Without it, the electric system could become a major barrier for America's clean energy future. The technologies pursued by the Office's Research and Development program will enable greater adoption of renewable resources, contribute to energy independence, and enhance economic growth by making the nation's electricity delivery system more reliable, secure, efficient, flexible, and functional.

Program activities will provide advanced technologies, tools, and techniques to:

1) Integrate low-carbon power options such as wind, solar, geothermal, biomass, advanced nuclear, and coal with carbon capture and sequestration into the electric grid;
2) Enable adoption of energy-efficient appliances and equipment, and electric transportation including plug-in vehicles;
3) Strengthen the reliability and resilience of the electric grid by enhancing visualization and situational awareness to better identify operational problems, reduce their frequency and duration, and prevent local disturbances from cascading into regional outages;
4) Reduce peak electricity use, increasing asset utilization, opening access to a wider variety of energy sources for generation and demand response, and integrating them more cost-effectively into grid planning and operations; and
5) Reduce the risk of energy disruptions from cyber events by developing advanced cybersecurity protections and controls to better detect, prevent, mitigate, and recover from cyber incidents.

Overview

OE's R&D program contributes to the Administration's goals of building a competitive, low-carbon economy through world leading science.

Each of the four subprograms of the R&D Program advance these goals by promoting the development of an efficient, "smart" electricity transmission and distribution network. This includes national leadership to develop smart grid technologies, tools, and techniques; energy storage systems and power electronics devices for grid modernization; and next-generation control systems that reduce the risk of energy disruptions due to cyber events. The Advanced Modeling Grid Research initiative will provide fundamental support to these activities and improve the ability to upgrade, extend, and replace existing grid modeling and analysis, visualization, and decision-making tools.

FY 2012 will mark the establishment of a new energy innovation hub, the Smart Grid Technology and Systems Hub, to address the basic science, technology, economic, and policy issues that affect our ability to modernize the grid. Comprised of a broad, multi-disciplinary group, the effort will focus on integrated development of 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.

An efficient, flexible, and reliable electric transmission and distribution (T&D) system reduces greenhouse gas (GHG) emissions in two important ways. First, by improving the energy efficiency of electric transmission and distribution, it reduces electrical power losses and the GHG emissions associated with the generation of the lost power. Second, it enables the integration of low-carbon energy options such as variable and intermittent renewable resources and other clean power sources; energy-efficient buildings, appliances, and industrial equipment; and transportation alternatives such as electric vehicles. Cost-effective, utility-scale energy storage technologies are critical to the adoption of large amounts of renewable resources on the grid.

Technologies that reduce peak loads will also reduce GHG emissions because energy losses are greatest during peak load when electric T&D equipment approaches thermal limits. Advanced technologies, tools, and techniques can reduce peak loads and their associated thermal loadings on electric delivery equipment and increase the energy efficiency of electric T&D. Improved sensors, control systems, and communications devices enable grid operators to "visualize" real-time power flows and allow greater use of variable generation such as wind and solar energy, demand response, energy storage, advanced metering infrastructure, and other peak load-reducing strategies. RD&D priorities include development and testing of lower-cost sensors, communications and control systems, and energy storage systems, and testing of devices, software, and analysis tools at utilities across the country.

Smart grid systems and power electronics devices make it easier and more economical to install, operate, and interconnect renewable energy and energy efficiency technologies in the electric grid in a reliable and safe manner. An electric distribution system that includes real-time controls, distributed generation and energy storage, and advanced metering infrastructure will also improve the adoption and use of energy efficient buildings, appliances, and equipment. In addition, to realize the future potential of plug-in electric and hybrid-electric vehicles, an electric distribution system is needed that can provide cost-effective charging services to consumers without adding to peak demand or causing other harmful impacts on the grid. RD&D priorities include lower-cost and more widely deployed sensors and

communications and control systems and demonstrating their performance at utilities across the country. Advanced power electronics devices will play an increasingly important role as renewables are integrated into the grid and in the full realization of a smart grid.

Inherently secure next-generation control systems and components with built-in security will enable a smart electric grid to deliver on its promise of reliability and efficiency in the face of quickly evolving, motivated, and well-resourced cyber threats. The application of digital technologies to the grid creates widely distributed communication networks and thousands of digital access points, necessitating a secure communications architecture that manages scalable, interoperable, advanced components and diverse communications media across large, complex systems. Next-generation systems will enable operators to visualize the cyber and physical security of their control system in real time; implement upgrades and patch vulnerabilities quickly; detect an attack and prioritize mitigation options; continue critical operation in a degraded state; and return to normal operations quickly. Designing resilient control systems and building security into interoperable components requires the diverse expertise and capabilities of system owners and operators, vendors and integrators, security experts, and academic and national laboratory researchers. R&D priorities include collaborative efforts with knowledgeable partners that assess and harden control system designs and develop intuitive real-time visualization capabilities; advanced threat and risk assessment; secure communications and cryptographic key management methods; capabilities to ensure trustworthy operation using untrusted components; and event detection and correlation.

Means and Strategies

The OE R&D Program uses a variety of means and strategies to achieve its goals of modernizing the electric grid and accelerating energy innovation, while recognizing that various external factors could affect the probability of success. Accordingly, the Office implements a strategy that emphasizes collaboration with external stakeholders.

The Office emphasizes projects that are vital to the electric system and its consumers, but will not be pursued by the private sector or states without federal support. Focus is placed on technology development activities that address the long-term needs of the power system but also contribute to today's critical challenges. The Office remains "technology neutral" regarding generation sources and end use demands; it seeks to create a robust, resilient, interoperable grid that provides maximum flexibility in the marketplace.

The Department will implement the following means:

- Continuing engagement with stakeholders to develop industry-driven roadmaps that identify priority R&D needs and address critical problems in transmission and distribution planning and operations.

- Development and implementation of technical plans for each research area to assess R&D needs at a more detailed level.

- Use of competitive award mechanisms, which ensure funds are given based on merit, resulting in better research results for OE R&D efforts

- Continued use of independent peer reviews to identify the effectiveness of in-progress research activities, ensuring consistent focus and technical direction and providing a forum for interested parties to learn about OE's work

- Use of stage-gate processes to quantify project performance, assess technology readiness to advance in the development cycle, and allow management to make the best decisions based on consistent, comparable data

The Department will implement the following strategies:

- Increase grid flexibility – developing better sensing, control, and decision support systems to allow greater adoption of distributed energy resources and demand-side management, as well as electricity flow control and storage. The ability to accommodate all generation and demand-side management options will enable innovation and help to ensure the efficiency and effectiveness of the energy transformation.

- Maintain grid reliability and security – by managing the increasing system complexity by protecting the power system from external threats.

- Increase grid efficiency – through technologies that increase control and enable better dynamic sensing of grid conditions. This will enable more efficient asset utilization and significant reductions in system losses.

- Accommodate customer base – by developing systems that can provide consumers with accurate, timely information about their electricity usage, encouraging them to be active participants in the electricity market. This engagement will empower consumers to make informed choices, providing additional pathways for improving the economic and energy efficiency of the power system.

- Demonstrate technologies, in all program areas, that can reduce the cost and increase performance to promote transfer and commercialization of grid modernization technologies.

- Work with the National Institutes of Standards and Technology and standards development organizations to develop interoperability and cyber security standards.

These strategies will enable the modernization and expansion of current electricity infrastructure, accelerate grid technology innovation, and lead to increased commercialization and market penetration of advanced grid technologies, driving the transformation of the Nation's energy systems.

The following external factors could affect OE's ability to achieve its strategic goal:

- Most grid assets are privately owned and technology investments must be justified within private companies.

- A constantly shifting economic and regulatory environment adds uncertainty and risk to technology investment decisions.

Partnership and collaboration with key stakeholders is a fundamental strategy that OE uses to accomplish its mission. Collaborative activities include:

- Planning, reviewing, partnering, and cost-sharing with leading U.S. companies to pursue research and development of electric transmission, distribution, and energy storage technologies;

- Consulting with utilities, Regional Transmission Organizations, and Independent System Operators on regional policies, market assessments, planning, and regulations;

- Collaborating with DOE offices and related entities, including:
    - The Office of Fossil Energy and the Office of Energy Efficiency and Renewable Energy on how to best ensure energy security with a diverse supply of reliable, affordable, and environmentally responsible energy
    - The Advanced Research Project Agency – Energy on the development of promising cutting-edge research into practical grid applications, prototyping and testing
    - The Office of Science to apply basic research and science capabilities to technological barriers involving the electric grid
    - The Energy Information Administration on market analysis
    - The Power Marketing Administrations and the Tennessee Valley Authority (TVA) on evaluating transmission-related technologies that enhance reliability and lower costs to consumers
    - DOE laboratories on planning, managing, reviewing, and completing R&D technical work with industry

- Working with other federal agencies, such as the Federal Energy Regulatory Commission, Department of Commerce, National Institute of Standards and Technology, Environmental Protection Agency, Department of Interior, and Department of Agriculture to develop policies, market mechanisms, and programs that facilitate modernization and expansion of the nation's electricity grid and development and deployment of smart grid technologies, tools, and business practices; as well as the Department of Homeland Security, the Department of State, and the Department of Defense to develop and test technologies, coordinate vulnerability and cyber security issues, and provide assessments;

- Collaborating with electric utility organizations such as the North American Electric Reliability Corporation, Electric Power Research Institute, Edison Electric Institute, American Public Power Association, and the National Rural Electric Cooperative Association along with power companies, equipment manufacturers, and IT vendors to analyze market mechanisms and develop improved approaches to grid modernization and expansion;

- Working with states and regional entities, such as regional governors' associations, the National Governors Association, National Association of Regulatory Utility Commissioners, National Association of State Energy Offices, and the National Council of State Legislators to develop policies, market mechanisms, state laws, and programs to improve the electric grid at the local, state, and regional levels; and

- Partnering with universities to develop plans and reviews, and to further research and development efforts.

Annual Performance Results and Targets

The Department is in the process of updating its strategic plan, and has been actively engaging stakeholders including Congress. The draft strategic plan is being released for public comment concurrent with this budget submission, with the expectation of official publication this spring. The draft plan and FY12 budget are consistent and aligned. Updated measures will be released at a later date and available at the following link http://www.mbe.doe.gov/budget/12budget/index.htm.

Clean Energy Transmission and Reliability

Funding Schedule by Activity

(dollars in thousands)

	FY 2010 Current Appropriation	FY 2012 Request
Clean Energy Transmission and Reliability		
Transmission Reliability and Renewables Integration	17,798	20,234
Advanced Cables and Conductors	19,575	0
Smart Grid Technology and Systems Hub	0	19,440
Advanced Modeling Grid Research	0	19,440
SBIR/STTR	0	1,703
Total, Clean Energy Transmission and Reliability	37,373	60,817

Description

One of the essential components of the Nation's electric delivery system is a robust and responsive transmission system that ties urban loads to sources of generation, and connects regions for enhanced reliability. Parts of the Nation's electric system are being operated closer to the limit than ever before and it is straining under the increasingly complex demands being placed upon it. Building additional transmission capacity is critical to maintain reliability throughout the power system. At the same time, electric system owners and operators must prepare for potentially dramatic changes in the way the system is planned and operated as the system transforms, including increases in the amount of renewable energy and electric vehicles.

Substantial expansion of renewable power generation presents the Nation's electric sector with two major challenges: judicious expansion of the Nation's transmission infrastructure; and integration of variable renewable generation into the routine operation of the power system. There is a need to expand the transmission system in order to connect remote renewable energy resources (especially utility-scale solar and wind) to demand centers such as large cities. The expansion will also require better management and visualization of the grid infrastructure, especially as variable resources are increasingly integrated with traditional baseload electricity sources.

To address these issues, the Clean Energy Transmission and Reliability (CETR) subprogram focuses on improving operational efficiency and system reliability. The CETR subprogram supports three general activities in FY 2012. Transmission Reliability and Renewables Integration supports R&D to enhance understanding of the power system, and enable responses to changing system and market conditions. It also supports activities critical for ensuring reliable and efficient grid operations under high penetration of variable generation. The Advanced Modeling Grid Research activity will significantly advance the electricity industry's analytical capability by upgrading, extending, and replacing existing grid modeling and analysis, visualization, and decision making tools. This comprehensive, integrated suite of computer simulation models and computational techniques will enhance electric system understanding needed for transmission planning, improved operations, and anticipation of the impacts of new generation on load balancing.

The third area is the establishment of a new energy innovation hub, called the Smart Grid Technology and System Hub. The Hub will address the total electricity system with a broad, multi-disciplinary group, covering applied science, technology, economic, and policy issues that affect our ability to modernize the grid. The effort will focus on integrated development of 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. For example, one potential research area is the development of a self configuring substation linking the distribution system, smart grid and reactive components like transformers and switches in real time.

Benefits

The CETR subprogram supports grid modernization through the development of advanced transmission technologies to improve grid reliability and system efficiency. It is developing and demonstrating advanced technologies, tools, capabilities and techniques that will:

- Enable integration of transmission-level, variable renewable generation (such as utility-scale solar and wind) into routine operation of the power system , and thereby reduce greenhouse gas (GHG) intensity associated with the electric grid;
- Improve situational awareness for faster response to transmission disturbances to reduce the number and spread of outages;
- Enhance sensing of and response to deteriorating grid conditions to allow the transmission system to operate closer to its loading limits, reduce operating margins, and increase utilization of existing transmission corridors; and
- Advance modeling and data analytic capabilities needed for in-depth power systems planning, operation, and investment.

University partnerships are a core element of the CETR subprogram. Recognizing that an informed and skilled workforce is as critical to transmission reliability and to achieving our Nation's energy vision as advanced technologies, tools, and policies, OE works to develop and nurture the needed scientific and engineering talent. Coupled with the strategic power engineering research that is sponsored at the national laboratories in partnership with the private sector, the subprogram draws on the most talented researchers in the power system field and provides opportunities for the Nation to position its workforce to address future electricity challenges, strengthening America's role as the world leader in science and technology.

Detailed Justification

(dollars in thousands)

	FY 2010 Current Appropriation	FY 2012 Request
Transmission Reliability and Renewables Integration	**17,798**	**20,234**

Market restructuring, greenhouse gas reductions, and new end-use technologies such as plug-in hybrid electric vehicles are redefining the way we use electricity. As the demand for higher quality electricity continues to grow, as well as the need to better integrate renewable resources, more sophisticated transmission technologies and power system understanding will be required to assure the reliability and security of the Nation's power grid. Increased grid system variability from renewable generation can be dealt with by using a number of different approaches that include increased use of real-time information for system operation; enhanced communications, controls, and robust markets that can tap

existing demand flexibility and encourage the development of new flexible resources when needed; larger (or restructured) balancing areas; and other forms of flexible generation and energy storage.

To meet these demands, the Transmission Reliability and Renewables Integration activity focuses on equipping system planners and operators with the real-time information they need to achieve the long-term goal of improving electric transmission planning and operations. It is developing advanced technologies and tools to help create a resilient electric transmission system that can better detect disturbances, accommodate a variety of generation sources, and automatically reconfigure to prevent widespread outage and/or rebalance the system. This subprogram works with electric utilities, vendors, regulators, and research organizations to expand the breadth of coverage of sensors in the transmission system and the depth of coverage in the distribution system through coordination with the Smart Grid subprogram.

Key activities include the development of a North American wide-area monitoring system (WAMS) to enhance situational awareness, and associated tools to evaluate operational performance. Advanced GPS time-synchronized sensors are intelligent electronic devices (IED) that are known as "synchrophasors" when used in a network; they are deployed primarily in substations and include phasor measurement units (PMU), digital fault recorders, and circuit breaker monitors. Other sensors that monitor dynamic line conditions (e.g., sag monitors) are deployed directly on transmission lines. They enable higher utilization of existing transmission capacity through real-time ratings.

The development of WAMS involves partnering with universities, national laboratories, vendors, and the electricity industry to develop the underlying theory, algorithms, and software for power system planning and operations applications. Market uncertainties have hindered strategic transmission investment, and have been a threat to grid reliability and the efficient, economic operation of the power system. Customer demand reduction programs will enable energy-consuming products and processes to respond to electricity market prices to balance supply and demand in specific areas to help reduce transmission congestion, and ensure system reliability.

The activity also models, simulates, and experiments with new electricity market designs and operating practices to understand and optimize the effects of new markets for energy (including zero and low-carbon generation), ancillary services, and demand response prior to actual implementation on the power system. Development of advanced analysis and control algorithms requires continued support for a multidisciplinary, geographically-diverse university collaboration seeking innovative solutions to critical challenges to electric power transmission and distribution reliability.

The CETR subprogram coordinates renewables integration activities with the Office of Energy Efficiency and Renewable Energy to develop technologies and methodologies to ensure transmission-level renewable resources can be effectively integrated into system operations. This includes development of renewables integration models and support for regional reliability studies. In FY 2012, efforts may include comprehensive human factors assessments, identification of critical operational issues, training simulations, and tool development to assist system operators and planners in handling the emerging complexities associated with integrating large penetrations of renewable resources into smart grid operations.

These activities also support efforts for overall system plans for transmission development in

coordination with the Permitting, Siting, and Analysis (PSA) program. Renewable energy resources such as wind and solar are often located far from load centers and from existing transmission lines. In addition, renewable generation is often developed incrementally over a period of years. If future generation development plans are not known or appear to be uncertain, a lower voltage transmission line may be developed for the first increment of energy that is insufficient to deliver the full build-out of potential energy resources, adding cost and complexity to the electric system. There is an increasing recognition of a need for comprehensive regional planning processes to overcome these challenges. In FY 2012, activities may also include technical analysis to support these planning processes and complement the policy-focused analysis supported under PSA.

FY 2010 accomplishments include:

- Developed a voltage angle stability prototype alarm tool and released to industry for evaluation
- Developed a prototype electromechanical grid stability alarm tool
- Launched four multi-year competitively-awarded contracts to develop advanced analysis and monitoring applications using synchrophasor data
- Developed automated reliability reporting software that was customized and installed by the Federal Energy Regulatory Commission (FERC)
- Initiated university-based renewables integration research, including analysis of grid dynamics and electricity markets

FY 2012 planned activities:

- Continue development of a prototype small signal stability monitoring tool that provides system operators with information on the amplitude and damping of characteristic grid oscillations;
- Support research and development to expand the dynamics analysis capability of a phasor measurement unit (PMU)-based network and develop techniques to counter poorly-damped power, voltage or frequency oscillations and excursions;
- Support the examination of advanced concepts for the use of phasor data to enhance system planning and operations. Includes extracting new information and understanding from phasor data to create decision support application tools that could include control, protection, and system restoration functions;
- Examine potential deployment locations for PMUs to monitor the dynamics of renewable generation sources to better integrate renewables into the grid.
- Conduct demonstration of advanced, innovative applications developed under FY 2009 awards that assess the dynamic status of the grid in real time
- Continue development of renewables integration models and support for reliability studies and technical analyses, including evaluation of innovative electricity market designs

Advanced Cables and Conductors **19,575** **0**

High temperature superconducting (HTS) wire is a key enabler for power transmission cables with three to five times the capacity of conventional underground alternating current (AC) cables and up to ten times the capacity for direct current (DC) cables.

FY 2010 accomplishments include:

- Demonstrated consistent production of second generation HTS wire (greater than 300 meters-long) with 70,000 A-m critical current-length.
- Completed preliminary characterization of ultra-high current HTS DC cable configuration for reliable and secure long distance renewable power delivery and verified Giga Watt (GW) level transmission potential.
- Continued development of low AC loss substrate using single crystal faceted fiber substrate and demonstrated new method to deposit buffer and superconducting layers. Developed model and simulation to correlate effect of wire AC loss to HTS device performance.
- Conducted comparative studies of pinning effects by using nanorods and nanoparticles to manipulate the microstructure at the nanoscale to increase performance (critical current density (Jc)). Worked with wire manufacturers to evaluate promising methods and material systems in production-like environments.
- Developed low cost solution deposition planarization process which has the potential to eliminate expensive metal polishing procedures. This could simplify the HTS wire manufacturing process, reduce hazardous waste and allow the use of lower cost metal substrates.

In FY 2011, OE will have to achieve a critical milestone in the HTS wire complex architecture and multi-step manufacturing process. At that point, the HTS wire research will have reached a termination point that provides meaningful technical value. This, in turn, has enabled an orderly closeout of OE-sponsored HTS work with laboratory and industry partners.

Smart Grid Technology and Systems Hub **0** **19,440**

If the future power grid is to fully expand its capabilities, to sense and dynamically reconfigure as necessary and achieve resiliency under multiple contingencies, then the power system must advance to the next level beyond an information technology overlay. This advancement will require a transformation of the infrastructure's foundation from static, electromechanical technologies and devices to a topology with dynamic system characteristics, giving devices and equipment the ability to adapt, respond and protect the grid.

The grid requires devices, controllers and systems that can operate at varying levels of power, temperature, and other system conditions. These components often operate in high electro-magnetic fields and interact with a medium that moves near the speed of light. Applying only advanced communications to the grid can put the system at risk if it has no ability to provide feedback via sensors and controls, so that corrective action can be executed quickly and reliably before faults occur.

This Hub would attract experts from many fields to focus on the grid's unique conditions and needs and to develop targeted solutions that can overcome the complex barriers the grid faces today. The North American electric grid operates as the world's largest and most complex machine and requires a systems-level approach to solutions. Increasing the efficiency and performance of sections and components of the grid will enable improvements across the entire system.

This foundational transformation underlies the establishment of the new Smart Grid Technology and

Systems Hub activity in FY 2012. The Hub is targeted at key devices, advanced devices, components, software, and systems to transition our current grid into a smarter and more efficient one. It will call on a diverse, multi-disciplinary group to accelerate the development and adoption of key components for improved grid performance. Potential topics include self-healing substations, self-regulating conductors, and new designs for transformers.

The grand challenges for the Smart Grid Technology and Systems Hub activity include:

- Development of cost-effective, near-term solutions using mature technologies to transition the grid from a static, command-and-control system to a more dynamic and responsive one.
- Development of advanced components and systems to increase utilization, flow control and resiliency with condition monitoring, diagnostics and reconfiguration for system evolution.
- Exploration of policy, markets, and designs for a modernized grid with layered controls and mechanisms to optimize transmission, distributed generation, microgrids, storage and demand management (building design).

The goal will be a five-year activity with research focusing on novel sensors and devices, and initiation of efforts in embedded sensor applications for system components. These applications will lead to the development of self-diagnostics of operating conditions and reconfiguration to improve efficiency and resiliency. Integrating self-diagnostics and self-optimization capabilities through broader "smart grid" communications will help asset-managers handle the growing need to replace and upgrade existing infrastructure, and to reduce catastrophic failures, maintenance costs, and improve the overall reliability of the power system.

A broad constituency of researchers in applied electronics, computation, communications, economics, electricity markets and manufacturing encompassing talent from universities, national laboratories, and industry will be engaged to address these challenges. There will be targets established for advances in designs, software, components and systems within five years from concept to demonstration, with the possibility of renewal of the Hub for those parts of the research that show exceptional progress.

Advanced Modeling Grid Research	**0**	**19,440**

The electric power system is undergoing extensive changes. The availability of more detailed data about system conditions from devices such as phasor measurement units for wide area visibility and advanced metering infrastructure for dynamic pricing and demand response can be a great benefit for improving grid planning and operations, but the scale and complexity is well beyond what is currently being considered. The purpose of the advanced modeling grid research effort is to "get ahead of the curve" by anticipating the major modeling and engineering challenges that are expected over the next decade as part of grid modernization efforts, and by then mounting an aggressive national effort to address the needs through a coordinated collaborative process with industry that engages upfront and directly the best mathematical and scientific resources. In addition, by carrying out its objectives, this program area helps establish a research base at the university level, which is critical to maintaining the human capital pipeline necessary for

developing the next-generation power engineering workforce to meet the Nation's energy challenges.

Science-based discovery needs include:

- New algorithms that are scalable and robust for efficiently solving the complex mathematical problems of the grid
- New methodologies for characterizing uncertainty in both the large volumes of data and the models themselves
- New approaches to efficiently determine relevance of data across extensive networks
- New software architectures and rapid development tools for merging legacy and new code without disrupting operation
- New human factors assessments that better align visualization platforms with operator capabilities and system needs such as accommodating large amounts of variable generation

A new research focus will begin in FY 2012 for development of methodologies for large-scale optimization addressing spatiotemporal uncertainty in weather, generation, and demand conditions, in support of operational and transmission planning activities. This will expand efforts into other system layers, such as the communications system, which are critical to fully understanding the electric system. This approach will capture, for example, the interactions and interdependencies that allow development (and validation) of new control techniques and technologies, and build strong understanding of the delicate balance at the local level between generation and load. This mathematical foundation and system understanding is necessary to support decision-making in an electric system with more uncertainty than historically experienced, allowing network topologies to be co-optimized as part of resource dispatch and enabling dynamic reconfiguration (of previously static assets) driven by technical and economic objectives.

The advanced modeling and data analytic capabilities of our universities and national laboratories, in partnership with industry, will be utilized to develop the understanding and capability needed for in-depth power systems planning, operation, and investment.

In FY 2012, planned activities include:

- Continue research on new methods to address the identified science-based discovery needs, including new algorithms and methodologies for dealing with large volumes of data, to support widespread penetration of alternative and renewable energy
- Initiate new projects to examine and model other system layers.

SBIR/STTR **0** **1,703**

In FY 2010, $961,000 and $116,000 were transferred to the SBIR and STTR programs respectively. The FY 2012 amount is an estimate for the continuation of the SBIR and STTR

	(dollars in thousands)	
	FY 2010 Current Appropriation	FY 2012 Request
programs.		
Total, Clean Energy Transmission and Reliability	**37,373**	**60,817**

Explanation of Funding Changes from 2010 Appropriation

	FY 2012 vs. FY 2010 Current Approp ($000)
Clean Energy Transmission and Reliability	
▪ **Transmission Reliability and Renewable Integration** Increase reflects expanded efforts in renewables integration and phasor tools research.	+2,436
▪ **Advanced Cables and Conductors** Decrease reflects close out of work on superconducting materials begun in FY 2010.	-19,575
▪ **Smart Grid Technology and Systems Hub** This is a new activity in FY 2012.	+19,440
▪ **Advanced Modeling Grid Research** Increase reflects expanded efforts to address modeling challenges associated with the grid, with a focus on developing modeling capability into other system layers, e.g. communications.	+19,440
Total, Clean Energy Transmission and Reliability	**+21,741**
SBIR/STTR	
▪ **SBIR/STTR** Reflects the increase in base request.	+1,703
Total, SBIR/STTR	+1,703
Total Funding Change, Clean Energy Transmission and Reliability	**+23,444**

Smart Grid Research and Development

Funding Schedule by Activity

(dollars in thousands)

	FY 2010 Current Appropriation	FY2012 Request
Smart Grid Research and Development		
Smart Grid Research and Development	31,541	34,020
Power Electronics	0	9,720
SBIR/STTR	0	1,260
Total, Smart Grid Research and Development	31,541	45,000

Description

The term "Smart Grid" refers to an electric grid that maximizes the integration of advanced information, communication, and control technologies to improve electric system operations, reliability, security, and enable expanded customer products and services. This will prepare America's electric infrastructure to meet the challenges of our 21st century economy. Along with supportive policies, smart grid technologies through two-way communication will make the electric system more reliable, empower consumers and utilities to use energy more efficiently, help manage peak demand, enable microgrids and larger scale use of renewable energy and electric vehicles, help meet America's energy diversity and climate change challenges.

The Smart Grid Research and Development subprogram focuses on system reliability and operational efficiency. The subprogram has two main goals: (1) to optimize grid operations and resources for a robust, flexible, and secure "plug-and-play" electric grid, and (2) to fully integrate demand response and consumer participation into grid resource planning and operations. The subprogram consists of two activities. One activity is Smart Grid Research and Development that focuses on integrating open architecture, standards-compliant technologies, two-way communications, and digital controls into electric distribution systems and consumer energy management to enable intelligent control over electricity use, including new end-use devices such as plug-in electric vehicles (PEVs), smart appliances, etc. The second activity is Power Electronics. Improvements in both power electronics systems and the devices on which they are based will be important components in developing a smart grid and facilitating the integration of renewable energy sources into the electric grid. Advanced power electronic devices and systems will allow for increased power flow control, and increasing the reliability of the electric power system. They will also allow for precise and rapid switching of electric power to support long-distance transmission and advanced distribution topologies.

The Smart Grid Research and Development subprogram directly supports Section 1304, Smart Grid Technology Research, Development, and Demonstration, within the Energy Independence and Security Act of 2007 (EISA 2007).

Benefits

The economic and environmental benefits of smart grid implementation are significant. A recently published report states that a savings of $130 billion annually could be realized by 2019 from successful deployment of smart grid technologies in the United States.[a] The same report further breaks down this total savings into the following: $63 billion from grid applications; $59 billion from customer applications; and $9 billion from Advanced Metering Infrastructure (AMI). The Smart Grid R&D subprogram is targeting R&D to achieve the benefits from grid and customer applications, while leveraging the buildout of smart grid technologies from the American Recovery and Reinvestment Act (ARRA) investments.

In addition, a national laboratory report estimates that smart grid technologies could directly realize a potential reduction of 12 percent in electricity consumption and CO_2 emissions by 2030, and could also indirectly contribute an additional 6 percent reduction from reinvesting cost savings into purchase of additional cost-effective energy efficiency.[b] The Smart Grid R&D subprogram supports development of needed technologies for the direct reduction mechanisms identified in the report such as conservation effect of consumer information and feedback systems, diagnostics in buildings, support of PEVs, and conservation voltage reduction and advanced voltage control.

Development of advanced devices, modules and systems underlie many requirements of the smart grid principal functionalities described above. As renewable and distributed energy sources are integrated into the electric grid, advanced power electronics will play an increasingly important role. By 2030, it is expected that 80 percent of all electric power will flow through power electronics. Advanced power electronics will be a key component in the development of a high-voltage direct-current mesh network that can transport renewable energy from where it is available to where it is needed. In addition, power electronics will enable full realization of a smart grid that can sense its state and dynamically reconfigure as necessary.

Detailed Justification

(dollars in thousands)

	FY 2010Current Appropriation	FY2012 Request
Smart Grid Research and Development	**31,541**	**34,020**

Today's electric distribution system is primarily based on a radial circuit design with one-way power flow. It employs few measuring and control devices beyond substations for situational awareness and control and most devices are capable of only one-way communication. As the distribution grid becomes increasingly decentralized with growing penetration of distributed energy resources both by 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 lack the 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. This limited consumer participation hampers the ability to achieve the market potential for energy conservation and demand response.

[a] McKinsey & Company, *McKinsey on Smart Grid*, Number 1, Summer 2010 (http://www.mckinsey.com/clientservice/electricpowernaturalgas/McKinsey_on_Smart_Grid/index.asp)

[b] Pacific Northwest National Laboratory, *The Smart Grid: An Estimation of the Energy and CO_2 Benefits*, PNNL-19112, January 2010 (http://www.pnl.gov/main/publications/external/technical_reports/PNNL-19112.pdf)

(dollars in thousands)

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Through full integration of information/communication/control technologies with the electric power system, smart grid development will enable two-way power flow, while providing two-way communications and information exchanges. Key technical challenges facing such integration exist and are identified in the Smart Grid Research & Development Multi-Year Program Plan (MYPP)[a] as follows:

- Evolving nature of foundational standards (interoperability) for the smart grid
- Customer acceptance, business models, and market designs of demand-side management solutions
- Evolving smart grid architectures to integrate distributed resources for protection coordination, operational control, and automation
- Wide scope of technologies (information, engineering, integration of information and operational technology, standards, and business analytics tools) and domains (grid operations, work and asset management, customer management and experience, value chain integration, and societal and environmental attributes)
- Integration with legacy systems for optimization of grid performance and resources
- Expected service longevity of smart grid technologies (durability, reliability, serviceability, and affordability)
- Changing communications/information technologies and regulatory policies

To overcome these challenges, the Smart Grid R&D subprogram utilizes the MYPP to implement its activities and will undertake projects in the following R&D areas in FY2012:

- **Standards & Best Practices** are needed for electrical and communications interconnection, integration, interoperability, conformance test procedures, and operating practices.
- **Technology Development** 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 operates in connection with the grid, but can disconnect and function autonomously as physical and/or economic conditions dictate. All projects involving high penetration of renewable generation and grid integration of PEVs will be closely coordinated with the EERE programs.
- **Simulation and modeling** encompasses development of tools to accurately model the behavior, performance, and cost of distribution-level smart grid assets. This work, focused on operational tool development for the distribution system, is complemented by the research supported in the Clean Energy Transmission and Reliability program, which focuses on advanced modeling and computational techniques for the electric system, especially transmission.
- **Analysis** of measured data and simulations is needed 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.

[a] The Smart Grid Research & Development Multi-Year Program Plan: 2010-2014, March 2010 (http://www.smartgrid.gov/sites/default/files/oe_mypp.pdf)

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- **Evaluation & Demonstrations** of new technologies and methods are needed for technical and economic performance as well as for conformance with emerging standards & best practices and interoperability requirements.
- **Smart Grid Communications and Outreach.** A broad-based consumer communications program is needed to increase awareness of the smart grid, its costs and benefits, and available tools for energy savings. Outreach to State regulatory bodies and national and international smart grid communities is needed to inform them of the importance and status of development as well as areas for continued development.

The MYPP was developed in March 2010 involving participation by national labs and the Smart Grid Roundtable (consisting of experts and practitioners from industry and universities) and followed by a public-comment period.

FY 2010 accomplishments include:

- Issued a competitive solicitation for industry- and university-led projects responding to three MYPP high-priority R&D needs: integrated distribution management systems for distribution automation, prognostic health monitoring of critical assets for enhanced asset utilization and reliability, and voltage regulation and protection schemes for high penetration of renewables.
- Published the analysis results on reductions in electricity consumption and CO_2 emissions from smart grid technologies.
- Published the analysis results on impacts of plug-in hybrid electric vehicles (PHEVs) to the U.S. electric distribution systems.
- Completed simulation analysis of advanced control operational benefits from a smart grid.
- Launched SmartGrid.gov and the Smart Grid Information Clearinghouse websites for outreach of smart grid information to all stakeholders.

In FY 2012, planned activities include:

- Provide the 3rd and final year of funding support to industry- and university-led projects competitively selected for award in FY 2010.
- Launch new projects on PEV/grid integration to better understand the impacts of charging and discharging electric vehicles on grid performance. They will include simulating and field demonstrating the effects of charging clusters of PEVs under varying circuit designs, charging levels, and local penetration levels.
- Continue development of smart grid architectures for high penetration of distributed resources (renewable generation, energy storage, electric vehicles). Included will be increased collaboration and support to DoD for designs and implementation of microgrids at military facilities that will allow them to increase their energy security and ensure the availability of their mission critical assets. This includes support of the SPIDERS (Smart Power Infrastructure Demonstration for Energy Reliability and Security) joint capability technology demonstration with DoD.
- Develop conformance test procedures and requirements relating to the smart grid standards, in coordination with the NIST Smart Grid Interoperability Standards Program.
- Advance development of an open-source simulation tool, via a collaborative environment, toward modeling of smart grid impacts on the bulk grid as affected by changing regulatory and

policy environments.

- Support the smart grid test bed for integration of high penetration renewables with smart grid functionalities (demand-side management and distribution automation). In addition, the microgrid testbed will be supported for integration of distributed renewable electricity sources with utility distribution systems.
- Launch a broad-based consumer communications program and a stakeholder outreach program to regulators, including continued development of SmartGrid.gov and the Smart Grid Information Clearinghouse as a communication venue.
- Produce the biennial publication of "The Smart Grid System Report" for submission to Congress, required by Section 1302, EISA 2007.

Power Electronics **0** **9,720**

For several decades, silicon-based devices in the form of insulated-gate bipolar transistors (IGBTs) and gate turn-off thyristors (GTOs) have been the dominant semiconductor switches for high power applications such as high voltage direct current converter stations and flexible alternating current transmission systems. However, these devices have not been widely deployed due to the high cost and limited performance. Power electronics enable utilities to more effectively deliver power to their customers. Benefits include increased transmission and distribution efficiency, and improved voltage and frequency regulation.

Currently, there are no high voltage high-current single silicon-based devices available for utility applications. Instead, lower-rated devices are connected in series and parallel to meet the necessary voltage and current requirements. If several silicon-based devices could be replaced with one advanced high voltage high current device, then size, complexity, and cooling reqirements would decrease and reliability would increase. All this would translate into reduced costs. Recent advances in devices based on wide bandgap semiconductors - with high voltage, high current capabilities - may make this possible. The Power Electronics activity will concentrate on the development of wide bandgap semiconductor based devices using integrated research teams composed of academia, national laboratories, and industry, including materials producers, device manufacturers, systems providers, and utilities. This approach will help focus on improvements in cost, performance, yield, and production scalability needed to achieve commercialization and insertion into the grid. The Power Electronics strategy emphasizes the development of GaN-on-Si based devices in the near term since they show significant promise in creating devices for high-power applications and the potential for transition to high-volume manufacturing processes.

The Smart Grid R&D activity included support for Power Electronics R&D in FY 2010. FY 2010 accomplishments include:

- Development of commercially viable GaN-based power electronic devices for grid applications through a partnership with Lincoln Laboratory, Massachusetts Institute of Technology, and M/A-COM Technology Solutions. This project identified and solved several device issues that currently limit performance such as electric field control, device leakage, and contact resistance. The partnership also developed new device topologies for GaN-on-Si devices to expand the current and voltage operating space for power electronics.
- Through a partnership with Oak Ridge National Laboratory and industry, conducted investigations to evaluate high-speed diamond film growth focusing on non-diamond

(dollars in thousands)

FY 2010Current Appropriation	FY2012 Request

substrates; developed a method for rapid film growth using a high flux molecular jet source; developed novel package designs capable of sustained operation under high-voltage/high-temperature conditions; and developed innovative accelerated testing approaches to determine optimum operating conditions to improve the reliability of utility-scale power electronic devices.

- Conducted research at Sandia National Laboratory to evaluate the growth of bulk GaN for next-generation power electronics. Currently, bulk GaN is not commercially available.

In FY 2012, planned accomplishments include:

- Process optimization and device reliability studies.
- Scaling the operating voltage of developed devices to more than 2000 V.
- Modeling studies of GaN-on-Si in low power utility applications.
- Research directed at epitaxial diamond film growth.
- Packaging technology development and modeling for sustained operation under high-voltage/high-temperature conditions.
- Innovative accelerated test approaches for utility-scale power electronic devices.
- Growth of Bulk GaN research.

SBIR/STTR	**0**	**1,260**

In FY 2010, $811,000 and $98,000 were transferred to the SBIR and STTR programs respectively. The FY 2012 amount shown is an estimate for the continuation of the SBIR and STTR programs.

Total, Smart Grid Research and Development	**31,541**	**45,000**

Explanation of Funding Changes from FY 2010 Appropriation

	FY 2012 vs. FY 2010 Current Approp ($000)
Smart Grid Research and Development	
▪ **Smart Grid Research and Development**	
Increase primarily reflects increased research to better understand the impacts of charging and discharging electric vehicles on grid performance and increased collaboration with DoD for designs of microgrids at military facilities.	+2,479
▪ **Power Electronics**	
Increase reflects a new focus in on developing solid state devices to replace outdated electromechanical devices for faster switching, more flexible power conversion, and better flow control.	+9,720
Total, Smart Grid Research and Development	+12,199

	FY 2012 vs. FY 2010 Current Approp ($000)
SBIR/STTR	
▪ **SBIR/STTR**	
Reflects the overall increase in funding	+1,260
Total, SBIR/STTR	+1,260
Total Funding Change, Smart Grid Research and Development	**+13,459**

Energy Storage

Funding Schedule by Activity

(dollars in thousands)

	FY 2010 Current Appropriation	FY2012 Request
Energy Storage		
Energy Storage	13,608	55,404
SBIR/STTR	0	1,596
Total, Energy Storage	13,608	57,000

Description

The Energy Storage subprogram conducts research and development efforts to lower the cost and improve the performance of stationary energy storage technologies for utility-scale applications, an area that has gained importance in the energy field as a potential answer to many of the problems being experienced on the electric grid.

Benefits

Energy storage technology has many potential applications in the electric grid. Congestion of supply, increasing penetration of variable renewable generation, increased power quality demands, the need to improve asset utilization and concern over greenhouse gas emissions are issues in the current electric infrastructure. System benefits of storage include: 1) smoothing of renewables for easier integration into grid operations, 2) shifting of load demands to avoid costly infrastructure upgrades on substations and distribution lines, and 3) providing grid services, such as voltage and frequency regulation to maintain system stability and reliability. The intermittency of electricity supply resulting from increasing renewable energy coupled with fluctuations of demand will need to be addressed to maintain system reliability. Developing cost effective technology to store electrical energy so it can be available whenever needed would represent an important breakthrough. Energy storage systems offer faster response time and significantly smaller carbon footprints than traditional thermal providers of grid reliability services, thus contributing to improved system efficiency.

Detailed Justification

(dollars in thousands)

	FY 2010 Current Appropriation	FY 2012 Request
Energy Storage	**13,608**	**55,404**

- With the increased awareness and support of energy storage as an emerging technology, crucial for the modernization of the U.S. electric grid, research and development activities in the Energy Storage subprogram fall into four general types of activities:

- **Advanced storage materials research.** This area targets research on key attributes of storage materials affecting lifetime, storage density, and cost.

- **Applied research and development of devices and systems.** These activities focus on the

(dollars in thousands)

FY 2010 Current Appropriation	FY 2012 Request

development and testing of advanced prototype devices and their integration into complete storage systems.

- **Field Validation.** Field testing evaluates first-of-a-kind systems in life-like simulations and in utility environments. This work is crucial to optimize storage devices for diverse applications such as frequency regulation, peak shifting, and renewable integration

- **Modeling and analysis of storage systems.** This area studies the use of energy storage systems, costs and benefits of energy storage, and develops tools for utility and user planning for the introduction and use of energy storage.

The subprogram is involved in a wide portfolio of technologies such as advanced batteries, flow batteries, ultracapacitors, flywheels, compressed air energy storage (CAES), and superconducting magnetic energy storage (SMES). Each of these technologies has potential for reduced cost, higher energy density, increased safety, and improved manufacturability. Application areas include frequency regulation, ramping support, energy management for peak shifting and load leveling, smoothing and integration of renewables.

In FY 2010, the Energy Storage subprogram initiated the development of a comprehensive Multi-Year Plan in coordination with the Office of Energy Efficiency and Renewable Energy, ARPA-E, and the Office of Science. Two external planning workshops, bringing together utilities, manufacturers, and researchers, were conducted to identify high priority energy storage applications, technology gaps and metrics to guide progress. Results from both workshops were incorporated into the program plans for FY 2012.

The Energy Storage subprogram also supports the monitoring of 16 projects funded with $185 million of American Recovery and Reinvestment Act funding and $585 million in cost share, representing some 530MW. Several of the projects represent a tenfold increase in capacity over previous deployments. These projects will be carefully monitored over the course of the next three years and performance data will be analyzed. A public data base will provide industry with reliable information and the program with input for future research directions.

The increased visibility of storage technologies, as a result of ARRA demonstrations, has created considerable interest among utilities and renewable developers. In FY 2012, the Energy Storage subprogram will maintain this momentum by supporting demonstrations for a new suite of cost-shared grid level storage projects, emphasizing the demonstration of promising ARPA-E projects. State energy agencies will also be encouraged to participate as cost share partners in the demonstrations. Aggressive support of storage deployment will provide the basis of commercialization and the market pull for development of more effective storage technologies.

The Energy Storage subprogram works in coordination with the Office of Science, which conducts basic research in materials and processes applicable to energy storage; with ARPA-E, which funds high risk, high payoff energy storage developments; and with EERE, which sponsors the Vehicle

Technologies Program containing a large battery development program for automotive applications. Significant advances in energy storage science and technology are possible from all of these sources. The OE Energy Storage subprogram will develop those advances for use in electric grid applications.

OE also works in cooperation with the Energy Frontier Research Centers in the Office of Science to develop innovative technologies that have the promise of significantly improving the energy storage industry, and to bring these new discoveries to the component prototype stage. Improvements are needed in the basic materials forming battery, electrochemical capacitor and flywheel systems to reduce their cost and improve energy storage and cycling capabilities. Successful cutting edge developments produced under ARPA-E will be carried to prototype and early commercial development. Lithium ion batteries developed in the DOE electric vehicle program also have the potential for use in stationary applications. Work is ongoing to develop community energy systems based on vehicle batteries (including used vehicle batteries) and to develop significantly larger lithium ion cells for stationary applications. OE has increased basic research and improved modeling capabilities of Compressed Air Energy Storage (CAES) systems to remove barriers in geologic site selection, characterization and development and to improve overall system efficiency. OE's Energy Storage subprogram will continue advanced component development and field testing of storage systems in diverse applications to bring these technologies closer to market. Benefits to the industry will include lower life cycle cost, improved performance, and easier siting due to reduced size and environmental impact. Collaborative field testing with renewable energy developers will increase collaboration in high penetration renewable applications. OE is also developing energy storage modules for existing utility grid modeling software that will aid utilities in their planning efforts to assess the impact of energy storage on renewable system integration, increasing asset utilization, improved grid management, and as an alternative to large capital expenditures.

FY 2010 Accomplishments include:

- Identified a novel air breathing battery concept with the potential to revolutionize stationary storage systems and conducted initial proof-of-principle experiments on several of the components with encouraging results.

- Successfully demonstrated the feasibility of a new class of electrolytes incorporating electrochemically active metal ions directly in the solvent for flow batteries.

- Initiated a project to develop new electrolyte chemistry and advanced electrodes for flow batteries with potential of meeting cost and performance metrics of large scale storage systems.

- Initiated efforts for development of self-assembled Lithium-ion electrodes and Lithium-ion cells with potential for meeting the performance requirements for community storage.

- Continued testing of novel lead carbon batteries under simulated solar generation operating conditions showing vastly increased cycle life when compared to traditional lead acid

batteries. Successfully conducted field tests of energy storage technologies in collaboration with utility and state energy agencies.

- Initiated modeling efforts for a compressed air energy storage (CAES) cavern as well as energy storage/grid modeling. The storage/grid modeling examined sizing and location optimizations in real grid configurations.

- Completed a major study on the value and benefits storage can provide over a variety of application areas including an upper bound of the market potential for these areas.

FY 2012 planned activities include:

- Initiate a second University solicitation for innovative energy storage applied research. Evaluate a bench scale air breathing battery.

- Expand scale of lithium battery devices for stationary use. Conduct initial design and evaluations of community energy storage systems.

- Conduct bench tests of new battery and electrochemical capacitor components developed during FY 2010. These tests will increase the scale of materials and electrolytes successfully developed in the applied research program.

- Continue collaborative modeling and testing programs with renewable energy developers and users and identify the most effective uses of energy storage in the integration of high penetration renewables.

- Continue coordination with the Energy Frontier Research Centers and ARPA-E to bring new developments in energy storage out of the lab and develop prototype components or systems of promising new technologies. The subprogram will help facilitate partnerships with commercial companies and fund the next stage of development.

- Support new solicitation for energy storage demonstrations of promising technologies identified through ARPA-E efforts, maintaining the momentum created by ARRA, through new collaborations with states, utilities, and renewable developers to deploy grid scale storage facilities on line. These demonstrations will allow optimization of storage technologies, development of operational experience, reduction of manufacturing costs, and encourage support by the financial community.

SBIR/STTR	**0**	**1,596**

In FY 2010, $350,000 and $42,000 were transferred to the SBIR and STTR programs respectively. The FY 2012 amount is an estimate for the continuation of the SBIR and STTR programs.

Total, Energy Storage	**13,608**	**57,000**

Explanation of Funding Changes from FY 2010 Appropriation

	FY 2012 vs. FY 2010 Current Approp ($000)
Energy Storage	
▪ **Energy Storage**	
Increase reflects expanded support for investigations into lithium-based batteries; research to reduce the system capital and life cycle costs; development and testing of tools for analysis, modeling; field testing with renewable energy developers and utility field tests; development of an outreach program to educate regulators and other non-technical stakeholders in energy storage. Increase also supports a new solicitation for grid-scale energy storage demonstrations that will build on ARRA momentum.	+41,796
▪ **SBIR/STTR**	
Increase reflects the increase in base budget.	+1,596
Total, Energy Storage	+43,392
Total Funding Change, Energy Storage	**+43,392**

Cyber Security for Energy Delivery Systems

Funding Schedule by Activity

(dollars in thousands)

	FY 2010 Current Appropriation	FY2012 Request
Cyber Security for Energy Delivery Systems		
Cyber Security for Energy Delivery Systems	38,880	29,160
SBIR/STTR	0	840
Total, Cyber Security for Energy Delivery Systems	38,880	30,000

Description

Cyber security for energy delivery systems has emerged as one of the Nation's most serious grid modernization and infrastructure protection issues. Intelligence reports indicate that cyber adversaries are becoming increasingly targeted, sophisticated, and better financed. The Stuxnet worm—designed to attack a specific energy control system—underscores the seriousness of targeted cyber attacks on energy control systems. The energy sector must research, develop and deploy new cyber security capabilities faster than the adversary can launch new attack tools and techniques. With so many vital services and critical infrastructures interconnected with energy systems, a large scale cyber attack could disrupt power, affecting the economy and public safety of large communities.

The goal of the Cyber Security for Energy Delivery Systems (CEDS) subprogram is to enhance the reliability and resiliency of the Nation's energy infrastructure by reducing the risk of energy disruptions due to cyber attacks. In 2005, DOE collaborated with energy owners and operators to develop an innovative technology strategy to secure energy control systems going forward. The resulting *Roadmap to Secure Control Systems in the Energy Sector* lays out a vision to research, develop, deploy and maintain energy delivery systems that can survive an intentional cyber assault without the loss of critical function.

The CEDS program is specifically designed to meet the stringent cybersecurity requirements of the energy sector. Energy 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, they require security solutions that meet unique performance requirements, design, and operational needs.

Cyber security technologies designed to protect business IT computer systems and networks can break an energy delivery control system. The computers, networks, and protocols that control our Nation's power grid are very different from those on our desks in several important ways. Energy delivery system communications must be fast. Data communications in substations require time-critical responses of less than 4 milliseconds for protective relaying, and technologies to provide wide-area situational awareness for transmission lines require data communications links with time delays of less than a second. An automated response might be able to prevent a cascading power failure by changing how power flows through the grid but this change must be executed in just a few milliseconds. Energy delivery system computers and networks must always be available. They cannot be patched or upgraded without

extensive testing and validation, normally planned weeks or months in advance, to ensure that the change does not jeopardize power system operations, and often the vendor's warranty for these systems prevents the change from being implemented at all.

Energy delivery systems have predictable communication patterns, and predictable behavior. So it makes sense to allow only expected actions and deny any others. In contrast, desktop cybersecurity measures often allow any actions not explicitly denied. Energy delivery systems require complex access controls, including secure remote access for maintenance and operations support. Multiple energy-workers need different levels of access to the same device, and these access needs can change depending on the operating mode. Most importantly, access controls must never jeopardize system availability as this could represent a safety hazard during an emergency response. Energy delivery systems have critical components that are widely distributed across extensive territories, and are, by necessity, located outside where they are vulnerable to physical tampering. Finally, control systems security involves ensuring the timely and proper operation of cyber-physical devices (e.g., opening a digital relay or changing settings on transformers). Thus, cyber attacks on control systems can cause physical damage to expensive electric grid components like generators that can take many months to replace.

Energy delivery systems also include decades-old legacy components with limited resources for computation, and limited bandwidth for communications. These legacy devices perform their function well so there is no business case to replace them, but they were designed decades ago when the internet did not exist and cybersecurity was not a central concern.

The electric power industry relies on control systems to manage and control the generation, transmission, and distribution of electric power. Similarly, the oil and gas industry uses control systems to help manage refining operations and remotely monitor and control pressures and flows in oil and gas pipelines. These systems allow operators to centrally monitor and control a large, often geographically distributed, network of sites and troubleshoot problems. Such centralized monitoring and control is indispensable for reliable and efficient management of large energy systems that may contain up to 150,000 real-time monitoring and control points.

Energy control systems include a hierarchy of networked physical and electronic sensing, monitoring, and control devices connected to a central supervisory station or control center. Control systems encompass supervisory control and data acquisition (SCADA) systems used to monitor vast, widely dispersed operations; distributed control systems (DCS) used for a single facility or small geographical area; and remote components such as remote terminal units (RTU) and programmable logic controllers (PLC) that monitor system data and initiate programmed control activities in response to input data and alerts. Figure 1 shows a typical control system configuration.

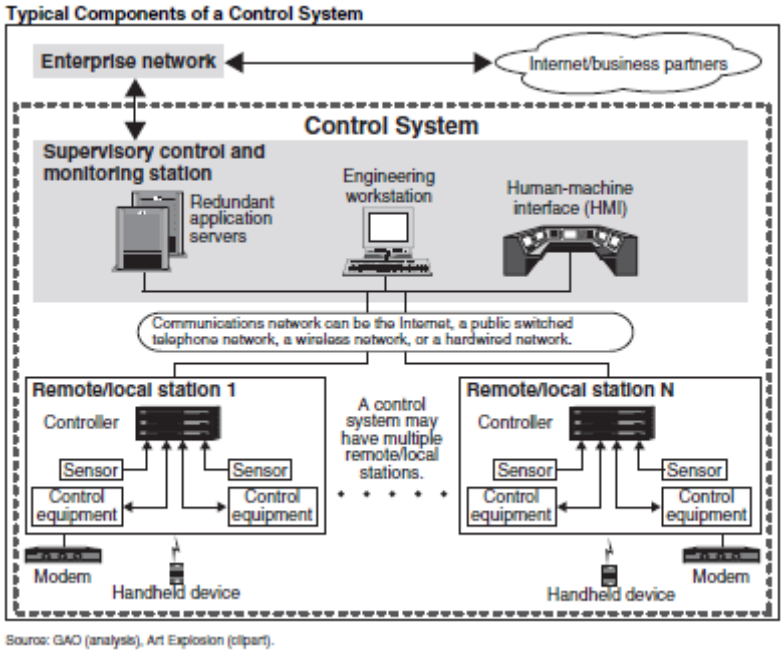


Figure 1: Typical components of a control system. Source: GAO Report GAO-04-354, "Critical Infrastructure Protection: Challenges And Efforts To Secure Control Systems".

Benefits

The CEDS subprogram will enhance the reliability and resiliency of the Nation's energy infrastructure by reducing the risk of energy disruptions due to cyber attacks. CEDS is working closely with energy sector owners and operators, system vendors, academia and other federal agencies to better secure energy communications and control systems against cyber events. The subprogram is delivering results through system testing, stakeholder training, and next-generation R&D. Key benefits include improved reliability and availability of the energy delivery system, increased adoption of renewable technologies through the application of secure Smart Grid technologies, and the development of a resilient energy infrastructure that can withstand cyber attacks without loss of critical services.

Detailed Justification

(dollars in thousands)

	FY 2010 Current Appropriation	FY 2012 Request
Cyber Security for Energy Delivery Systems	**38,880**	**29,160**

The CEDS Subprogram will pursue the development of resilient communications and control systems that detect and prevent cyber infiltration, inform operator response decisions, and enable power systems to continue operating during a disturbance, as well as conduct integrated risk analyses that prioritize effective cyber security resource allocation and raise awareness of the real and evolving cyber-threat. CEDS builds collaborations comprised of the DOE national laboratories, academia, and the private sector to address the rapidly advancing capabilities of the adversary, and proactively manage and reduce the risk of energy disruptions due to cyber attacks in the energy sector.

The CEDS subprogram collaborates with the entire research community, including government,

industry and academia to enhance energy delivery system cyber security capabilities in the following area

High-risk/high-payoff research for energy-sector cybersecurity: CEDS supports national laboratory and academic collaborative research in quantum information science for cryptographic protection of energy delivery systems; innovative mathematical methods and advanced computer science such as bio-inspired lightweight, mobile agents—digital ants—whose correlated activities produce emergent behavior that can raise early awareness to cyber-attack; trust anchors, independent monitoring and control devices that sit at the lowest levels of a computer and can detect the deceptive malicious actions of a cyber-attack for securing legacy energy delivery systems; and novel intrusion detection tailored to the unique constraints of energy delivery control systems.

CEDS is working closely with academic and industry partners through the Trustworthy Cyber Infrastructure for the Power Grid (TCIPG), which is a University-led public-private research partnership supported by the DOE, DHS and industry for high-risk/high-payoff research to develop resilient and secure smart grid systems. TCIPG leverages and expands upon previous research funded primarily by the National Science Foundation. Key activities include an automated intrusion detection and response system; new mathematical methods that quantify economic benefits of investment in energy-sector cyber security technologies in terms of risk mitigation; self-configuring resilient energy delivery control systems network architectures; and research that enhances distributed power system algorithms and integrates these with secure data sharing protocols.

Transition R&D to the energy-sector: CEDS transitions research from academia and the national laboratories into next-generation technologies that will strengthen our Nation's critical energy infrastructure against cyber-attack. Industry-led project teams funded through the 2010 competitive solicitation include academic or national laboratory partners, and in most cases have both, and many are building on cutting-edge research previously funded by OE. Key projects include:

- Development of cybersecurity technology that allows only expected communications content and patterns from central control system computers, and raises an alarm upon detecting unexpected behavior. The central control system computers at an energy utility provide supervisory control and use a local network to communicate with each other, exchanging messages with predictable content and pattern that can be monitored.

- Research to develop technology that prevents unexpected cyber-activity on substation computers. This research is designed to address Stuxnet-like cyber-attacks.

- Development of cybersecurity technology that protects field device communications and alarms from physical tampering. The field devices used by substations to control grid operations are widely distributed across large territories and are often found in metal boxes on the top of poles in populated areas where they are vulnerable to physical tampering.

- Research to build a tightly-secured communications gateway for utility-to-utility

communication. Central control systems communicate with each other to share situational awareness of power grid operations over wide geographical regions. Consequently, compromise of these communications could jeopardize power grid operations over wide areas.

- Development of a near-real-time cyber-physical security situational awareness capability that includes an operator training simulator, and uses power system engineering to inform operator response decisions, and controls that allow only the access needed to do the work at hand.

Smart Grid cybersecurity solutions: CEDS research supports innovative fast encryption and decryption techniques to protect high-speed Smart Grid data and to develop adaptive hybrid spread-spectrum modulation formats that will provide superior resistance to multipath, noise, interference, and jamming to secure Smart Grid wireless communications.

In addition, research for secure and resilient Smart Grid architectures becomes increasingly important as modernization of the Nation's power grid accelerates. The Advanced Security Acceleration Project for the Smart Grid (ASAP-SG) is a public-private partnership that accelerates the development of Smart Grid security requirements through development of security profiles used by power grid asset owners, operators, and vendors, for the secure design, deployment and operation of resilient Smart Grid network architectures and systems.

Consumer confidence in the protection of privacy for energy-usage data is of utmost importance for the success of the Smart Grid. CEDS supports research to secure data traveling across multi-party Smart Grid networks, to develop a cryptographic key management capability to secure communications for millions of smart meters, and to secure Smart Grid communication protocols.

Research to discover and mitigate SCADA vulnerabilities: CEDS conducts vulnerability research using the National SCADA Test Bed (NSTB) that partners with control system vendors in the electric, oil, and natural gas sectors to identify and mitigate energy delivery control system vulnerabilities in fielded systems. Many energy-sector communication protocols were developed decades ago when cybersecurity was not the central concern that it is today. CEDS is conducting research to identify and mitigate energy-sector communication protocol vulnerabilities and is developing technologies that enforce secure communications.

Integrated risk analysis: National laboratory integrated risk analyses that evaluate threat, vulnerability and consequences, and keep current and comprehensive awareness of the real and evolving cyber-threat to our nation's energy-sector. This includes research to address supply chain integrity that protects energy-sector cyber-components from malicious modification during design, manufacture and procurement.

FY 2010 accomplishments include:

- Transitioned the Secure SCADA Communications Protocol (SSCP) to the energy-sector to

secure serial communications between remote devices and control centers. The SSCP has been accepted as the basis for IEEE Standard P1711 that provides cyber security for serial communication links.

- Transitioned interoperable Virtual Private Network (VPN) configuration profile that secures routable network communications to the energy-sector. This technology has been accepted as the basis for an OpenSG (Smart Grid) Security Working Group Task Force.
- Developed audit files that describe optimal security configurations for energy delivery systems. More than 200 organizations subscribe.
- Developed Smart Grid security profiles that provide vendor-neutral, actionable guidance to utilities, vendors and government entities on how to build cyber security into Smart Grid components in the development stage, and how to implement those safeguards when the components are integrated into the power grid.
- Academic collaboration research accomplishments include more than a dozen publications at prestigious conferences and in journals, presentations and keynotes at conferences and Smart Grid meetings, development of several software and hardware cyber security tools for energy delivery systems, field-testing of a cyber security toolkit with partner energy utilities, establishment of a data sharing agreement with a partner utility for synchrophasor data used for wide-area situational awareness, and establishment of a prominent External Advisory Board.
- Initiated competitively awarded projects to advance cyber security of energy delivery systems. R&D topics include next-generation technologies that harden energy delivery system platforms, hardware and communication networks, including Smart Grid devices, against cyber-attack; advanced technology to mitigate supply chain risk; energy delivery system physical and cyber security situational awareness data collection, correlation, analysis and visualization capability that informs operator response decisions; next-generation technologies that secure remote access to energy delivery system assets; and highly-scalable, centralized cryptographic key management that addresses the challenge of securing communications for millions of Smart Grid intelligent meter devices.

FY 2012 planned activities include:

- Provide final year of funding for research and development projects awarded in FY 2010 to enhance cyber security of energy delivery systems.
- Continue national laboratory integrated risk analysis, and research of vulnerability and mitigation techniques.
- Continue the Trustworthy Cyber Infrastructure for the Power Grid (TCIPG).
- Issue competitive solicitation that will foster cutting edge research with the vision to transition this high-risk/high-payoff research into the energy-sector.

SBIR/STTR	**0**	**840**

In FY 2010, $1,000,000 and $120,000 were transferred to the SBIR and STTR programs respectively. The FY 2012 amount is an estimate for the continuation of the SBIR and STTR programs.

Total, Cyber Security for Energy Delivery Systems	**38,880**	**30,000**

Explanation of Funding Changes

	FY 2012 vs. FY 2010 Current Approp ($000)
Cyber Security for Energy Delivery Systems	
▪ Reduction reflects the one-time funding for the National Energy Sector Cyber Organization in FY 2010, as well as the successful completion of several industry-led projects.	-9,720
Total, Cyber Security for Energy Delivery Systems	-9,720
SBIR/STTR	
▪ **SBIR/STTR**	
Reflects the increase in base funding.	+840
Total, SBIR/STTR	+840
Total Funding Change, Cyber Security for Energy Delivery Systems	**-8,880**

Permitting, Siting, and Analysis

Funding Profile by Subprogram

(dollars in thousands)

	FY 2010 Current Appropriation	FY 2012 Request
Permitting, Siting, and Analysis		
Permitting, Siting, and Analysis	6,400	8,000
Total, Permitting, Siting, and Analysis	6,400	8,000

Public Law Authorizations:
P.L. 95-617, Public Utilities Regulatory Policy Act, 1978
42 U.S.C. 8301 Powerplant and Industrial Fuel Use Act of 1978 (FUA), as amended
P.L. 109-58, Energy Policy Act, 2005
P.L. 110-140, Energy Independence and Security Act, 2007
Executive Order 10485, as amended by Executive Order 12038
Federal Power Act, section 202(e), 16 U.S.C. 824a(e)

Mission

The mission of the Permitting, Siting, and Analysis Division (PSA) is to support modernization of the nation's electric grid by: (1) providing technical assistance to states and regions on electricity policy design to support the enhancement of the electricity infrastructure; (2) implementing the statutory obligations for permitting electric transmission facilities and electricity exports between the United States and foreign countries; and (3) contributing to the development of electricity policy at the Federal and state level.

Benefits

PSA supports efforts to develop and/or improve policies, state laws, and programs that facilitate the development of electric infrastructure in order to increase access to reliable, affordable, and sustainable energy sources, which are critical to the foundation of regional and local economies. PSA guides and funds activities by experts to aid state policy makers and the electric power industry in dealing with major new challenges facing electricity planners, such as understanding the implications of smart grid technologies for future electricity demand. These PSA activities are key to development of the advanced electric grid infrastructure needed to enable the continued growth and reliable integration of renewables and other clean energy resources, and thus support the Administration's goals of clean, secure energy supplies.

Overview

The Permitting, Siting and Analysis division supports building a competitive, low-carbon economy to secure America's energy future by supporting the modernization of the nation's electric grid. A modernized electric grid is critical for the development of and access to low-carbon electricity

generating sources. PSA's contribution to this mission is measured by the implementation of three distinct activities:

- State and regional technical assistance regarding electricity policies
- Implementing transmission provisions of the Energy Policy Act of 2005 (EPAct)
- International Electricity Regulatory Program

Means and Strategies

The PSA program implements electricity provisions of various Federal laws including Executive Order 10485 (regarding permitting electricity transmission facilities between the United States and a foreign country), the FPA, EPAct, FUA, and EISA.

The Department will implement the following means:

- Providing technical assistance to states and regions on best practice-based electricity policies including but not limited to demand response, renewables, clean coal, distributed generation, ratepayer-funded energy efficiency, regional electricity planning/coordination, smart grid, and transmission siting.

The Department will implement the following strategies:

- Providing technical assistance to states and regions on an as-requested basis, as well as providing that assistance in a neutral, unbiased manner, so as to comply with the rules and regulations that govern Federal interaction with state and local governments on policy matters.

- Authorizing electricity exports and issuing Presidential permits for cross-border transmission facilities.

The following external factors could impact OE's ability to achieve its strategic goal:

- The number of states that request technical assistance.

In carrying out the program's mission, PSA performs the following collaborative activities:

- Provides technical assistance to state public utility commissions, governor's staffs, state legislatures, state energy offices, Tribal governments and various Federal offices.
- Works with national and regional state-based organizations who seek to help their members to modernize the electricity infrastructure at the state, regional and national levels. These groups include the National Association of Regulatory Utility Commissioners, National Council of State Legislatures, National Governors Association, National Association of State Energy Officials, and regional groups such as the Western Governors Association.
- Consults with electric utilities and their national associations, North American Electric Reliability Corp, Electric Power Research Institute, and regional transmission organizations and independent system operators on various electricity-related topics.

- Consults and collaborates with other DOE and non-DOE Federal entities, including:
    - DOE's Office of Energy Efficiency and Renewable Energy, Office of Fossil Energy, Office of Nuclear Energy, Office of Policy and International Affairs, Loan Guarantee Office, and the Federal Power Marketing Administrations.
    - Department of the Interior, Department of Agriculture, U.S. Army Corps of Engineers, Department of Defense, Federal Energy Regulatory Commission, Environmental Protection Agency, National Institute of Standards and Technology, and the Tennessee Valley Authority.

Annual Performance Results and Targets

The Department is in the process of updating its strategic plan, and has been actively engaging stakeholders including Congress. The draft strategic plan is being released for public comment concurrent with this budget submission, with the expectation of official publication this spring. The draft plan and FY12 budget are consistent and aligned. Updated measures will be released at a later date and available at the following link http://www.mbe.doe.gov/budget/12budget/index.htm.

Detailed Justification

	(dollars in thousands)	
	FY 2010Current Appropriation	FY 2012 Request
Permitting, Siting, and Analysis	**6,400**	**8,000**

PSA provides technical assistance to states, tribal governments, and regional entities that wish to develop policies that facilitate development of the electricity infrastructure required to access clean energy resources, and/or improve reliability. In authorizing electricity exports and granting permits for international transmission lines, PSA ensures the reliable operation of the U.S. electric power supply system and that new facilities are constructed in an environmentally responsible manner, consistent with U.S. foreign policy.

PSA assists states and regions with their electricity policies by continuing to provide expert technical assistance, on an as-requested basis, to state public utility commissions, state legislatures, regional state associations, and Governors' offices. Topics requiring assistance or analysis include: electricity resource planning; regional transmission planning; transmission siting; energy efficiency; renewable energy policies and portfolio standards; demand-response; smart grid; and coal with carbon capture and sequestration. Emphasis continues on encouraging the development of regional institutions and regional thinking among states on these and related topics that help modernize the grid and meet the needs of the Nation's 21st Century economy and environmental concerns. PSA also provides assistance to states to implement, in collaboration with EERE and the U.S Environmental Protection Agency, the State Energy Efficiency Action Network, which helps states achieve higher levels of both ratepayer and non-ratepayer energy efficiency.

In FY 2012, PSA will use funds to expand on existing interconnection studies and local, state and regional dialogues initiated under the 2009 American Recovery and Reinvestment Act by providing additional analysis and collaboration on advanced transmission system approaches. Topics may include identification of efficient ways for balancing areas to increase cooperation and the requisite operational tools needed to maintain regional situational awareness and to highlight potential synergies; design and evaluation of a "hardened" offshore transmission system to facilitate delivery of electricity to major coastal population centers from offshore, remote generation facilities; and continued evaluation of what effect the transition to a low-carbon energy future will have on the operation and planning of the electric system, especially the regulatory (electricity policy) perspective.

PSA's electricity-related responsibilities under Energy Policy Act (EPAct) include the following mandated activities:
Section 1221 of EPAct added section 216(h) to the Federal Power Act, which requires that DOE act as the lead agency for purposes of coordinating all applicable Federal authorizations and related environmental reviews required to site an electric transmission facility. In October 2009, DOE and eight other Federal agencies entered into a *Memorandum of Understanding on Early Coordination of Federal Authorizations and Related Environmental Reviews Required in Order to Site Electric Transmission Facilities*. In FY 2009, PSA published interim final regulations and a notice of proposed rulemaking for the substantive portion of its section 216(h) responsibilities, and has established a publicly available website to track all critical elements in the Federal review process for transmission projects.

(dollars in thousands)

FY 2010Current Appropriation	FY 2012 Request

Section 1221 of EPAct also requires DOE to issue a National Transmission Congestion Study every three years, and the next study is scheduled for 2012. The Congestion Study is coupled with a possible recommendation on designation of national interest electric transmission corridors and conducting environmental and technical analysis needed for coordination of all Federal authorizations required for siting transmission projects.

Leading up to the 2012 National Transmission Congestion Study, the Department will monitor the progress that is being made to relieve known congestion problems using both transmission and non-transmission alternatives, continue a transparent process that includes interactions with interested parties and consultation with affected states, and perform technical analyses as required.

Section 1252 of EPAct requires DOE to provide technical assistance on demand response and related topics to states and regional entities such as regional transmission operators and independent system operators.

In its second major area of work required under the Federal Power Act, PSA also executes the Department's International Electricity Regulatory program. The International Electricity Regulatory Program processes applications for new projects from project sponsors. Before rendering any regulatory decisions, the environmental impacts of the proposed action are assessed pursuant to the requirements of the National Environmental Policy Act (NEPA). In most instances, compliance with NEPA for issuing Presidential permits requires preparation of an environmental impact statement (EIS). Since DOE-wide median time required to prepare an EIS is 26 months, processing of Presidential permit applications typically extends through more than one fiscal year. Before issuing a Presidential permit, PSA must also analyze the operation of the U.S. electric power supply system to determine that the issuance of a Presidential permit or an electricity export authorization will not adversely affect the reliability of the U.S. electrical grid.

Significant FY 2010 accomplishments include:

- Issued the second Electric Transmission Congestion Study.
- Responded to requests from over 40 states for technical assistance on various electricity policies including topics such as decoupling and other regulatory means of better aligning utility incentives with electric ratepayer-financed energy efficiency.
- Responded to significant new requests for help from states on the smart grid.
- Processed 11 electricity export authorizations and 5 Presidential permit applications for transmission facilities at the U.S. international borders.
- Provided continued support to the Western Governor's Association's Western Renewable Energy Zones (WREZ). The WREZ project issued its Phase I report in June 2009 that maps concentrated high quality renewables in the West that may need new transmission to reach distant markets. The Western Governors Association began work on a WREZ Phase II effort to coordinate purchases of distant renewable resources between utilities and renewable project developers. Phase III and IV of the WREZ are being funded separately with Recovery Act funds devoted to interconnection-wide transmission and resource planning.

	(dollars in thousands)	
	FY 2010Current Appropriation	FY 2012 Request

Planned FY 2012 activities include:

- Drafting the 2012 National Transmission Congestion Study.
- Responding to new requests from public utility commissions, tribes and other state agencies, such as governors' offices and state legislatures, for technical assistance on electricity policies.
- Processing electricity export authorizations and Presidential permit applications.
- Providing coordination for siting of transmission facilities.
- Providing assistance to state officials on other electricity topics, such as renewable energy, transmission and clean coal, which have come to the forefront as a result of ARRA initiatives.
- Expand on existing interconnection studies and local, state and regional dialogues initiated under the 2009 Recovery Act by providing additional analysis and collaboration on advanced transmission system approaches.

Total, Permitting, Siting, and Analysis	**6,400**	**8,000**

Explanation of Funding Changes from 2010 Appropriation

	FY 2012 vs. FY 2010 Current Approp ($000)
Permitting, Siting, and Analysis	
▪ **Permitting, Siting, and Analysis**	
This increase reflects expanded analytical and collaborative efforts to build on interconnection-level studies and local, state and regional dialogues initiated under the 2009 Recovery Act; advanced transmission system approaches, such as the balancing areas' effect on renewables integration; and off-shore resources and the system requirements to integrate them.	
	+1,600
Total, Permitting, Siting, and Analysis	+1,600
Total Funding Change, Permitting, Siting, and Analysis	**+1,600**

Infrastructure Security and Energy Restoration

Funding Profile by Subprogram

	FY 2010 Current Appropriation	FY 2012 Request
Infrastructure Security and Energy Restoration		
Infrastructure Security and Energy Restoration	6,187	6,187
Total, Infrastructure Security and Energy Restoration	6,187	6,187

Public Law Authorizations:
P.L. 109-58, Energy Policy Act, 2005
P.L. 110-140, Energy Independence and Security Act, 2007

Mission
The mission of the Infrastructure Security and Energy Restoration (ISER) program is: (1) to enhance the reliability, survivability and resiliency of the energy infrastructure; and (2) to facilitate recovery from disruptions to the energy supply.

Benefits
ISER supports methods, tools, and technology to protect against physical and cyber disruptions, reduces the impact of disruptive events, and facilitates the rapid restoration of energy after disruptions occur. These services are vital to the economy and public safety and people have come to expect and rely on them.

In view of the current all-hazards threat environment, support for ISER's activities from OE's Research and Development (R&D) and Permitting, Siting and Analysis (PSA) programs and from DOE national laboratories' world-class science and technology capability is increasingly important. For instance, in the area of visualization, tools such as VERDE were developed by OE's R&D Division and later deployed by ISER. Further, ISER has established close relationships with private industry owners and operators of the energy infrastructure, as well as state and local governments, to address new and evolving threats, understand their perspectives on protection, mitigation, and response options and to quickly deploy the best available technology in a tailored, systems approach. This places ISER in a unique role of defining the science and technology needs of the energy infrastructure sector, helping discover potential technical solutions, identifying suppliers of the required technology, and leading the deployment of new science and technology into the energy sector. ISER has a long, successful history of supporting U.S. energy infrastructure restoration efforts in times of disruptive events.

Overview

The U.S. energy infrastructure, both physical and cyber, comprises a diverse set of global energy sources and distribution systems. Therefore, assuring the reliability, survivability, and resiliency of the domestic energy infrastructure is essential to U.S. energy and national security.

All ISER activities are aligned under one of four focus areas: 1) *Emergency Preparedness, Response, and Restoration*; 2) *Analysis and Situational Awareness*; 3) *Physical and Cyber System Assurance*; and 4) *Global Energy Assurance*. All activities – regardless of focus area - are facilitated by effective coordination with key partners to leverage complimentary efforts resulting in true collaboration.

Means and Strategies

OE ISER uses various means and strategies to achieve its mission. 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:

- ISER analyzes the potential impacts of disruptions, identifies critical nodes, and collaborates with stakeholders to develop optimized strategies to prevent or mitigate disruptions.

- ISER maintains a cadre of trained emergency responders dedicated to the ten regional offices of the Federal Emergency Management Agency (FEMA) to organize and coordinate emergency response activities. These responders rapidly deploy under national emergency declarations to areas where the energy infrastructure has been severely damaged. This established team of responders applies market-ready technology, expertise from the national labs, experience from the power marketing administrations, and knowledge of DOE program offices to meet any challenge facing the US energy systems.

- Upon request, ISER will conduct an initial engineering assessment to provide expert advice to key energy producing allies on securing their critical energy infrastructure. Any support beyond this initial assessment, will be provided on a cost reimbursable basis.

The Department will implement the following strategies:

- ISER will implement a strategy to expand its infrastructure reliability activities by applying a robust systems analysis process designed to identify critical assets and key interdependencies within energy systems. This process serves as a compliment to ISER's Energy Preparedness, Response and Restoration responsibilities by incorporating scientific applications to improve current methodologies and enhance analytical techniques. This will also improve situational awareness and response capabilities through advancements in power outage and restoration visualization and modeling.

- OE compliments DOE's international efforts by providing a senior energy advisor to every Combatant Command headquarters; these advisors are funded by Department of Defense through interagency agreements.

The following external factors could affect OE's ability to achieve its goals:

- The intensity and frequency of the natural and/or man made disasters.

In carrying out the program's mission, OE performs the following collaborative activities:

- DOE collaborates with DHS to enhance ISER's ability to execute both DOE's Energy-Sector Specific Agency responsibilities and its National Response Framework-Emergency Support Function 12 responsibilities. ISER also executes significant responsibilities under the recently signed DOE-Department of Defense (DoD) Memorandum of Understanding (MOU) *Concerning Cooperation in a Strategic Partnership to Enhance Energy Security.*

Annual Performance Results and Targets

The Department is in the process of updating its strategic plan, and has been actively engaging stakeholders including Congress. The draft strategic plan is being released for public comment concurrent with this budget submission, with the expectation of official publication this spring. The draft plan and FY12 budget are consistent and aligned. Updated measures will be released at a later date and available at the following link http://www.mbe.doe.gov/budget/12budget/index.htm.

Detailed Justification

(dollars in thousands)

	FY 2010Current Approp	FY 2012 Request
Infrastructure Security and Energy Restoration	**6,187**	**6,187**

The ISER program defines "infrastructure security" as a reliable, survivable, and resilient energy infrastructure. Responsibilities include the identification and prioritization of critical energy infrastructure in order to prevent, deter, and mitigate the effects of deliberate efforts or natural events that could destroy, incapacitate, or exploit them. ISER is also responsible for collaboration with all relevant Federal departments and agencies, state, tribal and local governments, and private sector asset owners and operators.

The increasing complexity and interdependency of our Nation's energy infrastructure in conjunction with rising energy market globalization, and catastrophic natural disasters or deliberate efforts are significant energy challenges. ISER's infrastructure security and reliability efforts include the development and implementation of a system-wide analytical process designed to provide insightful, in-depth analysis of energy infrastructure networks. This effort provides a baseline for ISER's analytical products, some of which are used to support National Special Security Events, such as the 2010 Nuclear Security Summit, as well as a multitude of ad-hoc requests to support improvements in the resiliency of domestic energy infrastructure.

ISER also has a role in cybersecurity, focusing on industrial control systems, situational awareness and information sharing between the Federal government and industry. ISER also participates in cyber-related exercise planning and implementation.

DOE (through ISER) works collaboratively with the two Energy Sector Coordinating Councils (SCCs), one for electricity and one for oil and natural gas, and leads the Energy Government Coordinating Council (GCC), composed of members within DOE and across the Federal community, concerned with maintaining energy security and reliability.

(dollars in thousands)

FY 2010Current Approp	FY 2012 Request

In its role as the Energy Sector-Specific Agency, ISER, on behalf of DOE, serves to implement the risk management framework established by the National Infrastructure Protection Plan (NIPP). The broad scope of the NIPP risk management framework includes protecting physical assets and cyber systems. Implementation of the framework involves close coordination with other government agencies and the private sector.

Both at DOE headquarters through our coordination with other DOE program offices and at the Combatant Command (COCOM) headquarters through our COCOM Energy Advisors, ISER conducts extensive collaboration with Department of Defense on a wide variety of domestic and international energy security issues.

When energy infrastructure fails, ISER responds by working with the energy industry, Federal, State and local governments to coordinate actions in restoring energy supplies and systems. ISER accomplishes this mission by providing technical expertise and coordinating within the Department to plan for, protect against, and minimize the effects of energy supply disruptions. This responsibility includes facilitating the restoration of damaged energy systems and components that result from acts of terrorism, natural disasters and other emergencies requiring a coordinated Federal response. ISER's role is articulated in the National Response Framework (NRF) and described within its Emergency Support Function (ESF) #12 Annex. These activities also support national counterterrorism priorities.

In carrying out emergency support responsibilities, ISER undertakes preparedness, response, recovery, and mitigation activities with other Federal agencies, states and local governments. ISER maintains a cadre of trained emergency responders who rapidly deploy under national emergency declarations to areas where the energy infrastructure has been severely damaged. This established team of responders applies market ready technology, expertise from the national labs, experience from the power marketing administrations, and knowledge of DOE program offices to meet any challenge facing the U.S. energy systems. ISER's staff of energy infrastructure analysts provides situational awareness (i.e., reports, briefings, press releases, etc.) during emergency responses. ISER has also assigned dedicated personnel to the ten regional offices of the Federal Emergency Management Agency (FEMA) to organize and coordinate these activities.

ISER works directly with state and local governments, and private sector entities, to improve their emergency planning and response capabilities. These efforts include providing guidance for developing, improving and implementing energy assurance plans. They also include training and outreach initiatives. Educational opportunities, such as table-top exercises (simulating energy disruptions), forums, workshops, and web-based training are conducted for Federal, state, and local-government energy officials to create awareness about the energy infrastructure and the effects of supply disruptions, in addition to critical infrastructure protection and security issues.

ISER has been leading a unique energy assurance planning initiative with states and selected cities across the country. Funded under the American Recovery and Reinvestment Act, this initiative will enhance the emergency preparedness capability of states and localities when responding to energy

disruptions. The end result will be a National level uniform, comprehensive energy assurance approach that will provide for a more resilient energy sector. While states and localities will address current energy sector portfolios contained in their plans, such as petroleum, electricity, and natural gas, they are also required to incorporate new portfolios, such as wind, biofuels, and other renewables, smart grid technologies and cyber security. This effort focuses on building collaborative, regional energy assurance partnerships.

In an effort to improve communications during energy emergencies, ISER has also developed and continues to maintain the Energy Emergency Assurance Coordinators (EEAC) System, a communications protocol offering state and local governments a common platform to share information and technical advice. The EEAC contains over 180 state and local energy officials from across the country who have expertise in electricity, oil, and natural gas, and who can be contacted during an emergency.

ISER also organizes workshops that are designed to allow energy stakeholders to compare and contrast current plans, policies, and procedures used to prepare for and respond to a widespread, catastrophic events in the United States and to test coordination, communication, and resource management between utility owners and operators and government stakeholders.

ISER uses an integrated systems approach to encourage development of electrification that is clean, efficient, secure, reliable and resilient. Moreover, ISER supports restoration activities by sharing its years of disaster response and restoration experience to improve contingency planning, training, and response capabilities. ISER provides technical assistance in conducting comprehensive risk assessments of critical energy sites, developing conceptual designs for improving security, and training in security methodologies and system operation.

FY 2010 accomplishments include:

Emergency Preparedness, Response and Restoration:

- Activated the DOE Energy Response Center (ERC) to respond to seven separate events: winter storms in both the Mid-Atlantic and Northeast U.S., Tropical Storm Ida in the Gulf, earthquakes in American Samoa and Haiti, the Deepwater Horizon oil spill, and Hurricane Alex. Resolved a number of local, regional, and national issues in conjunction with our energy industry partners to maximize the availability of utilities and fuel and mitigate impacts on the national economy.
- Developed an innovative new web-based platform in lieu of a more traditional classroom format, enabling ISER to conduct eight ESF-12 training sessions for 85 DOE emergency response personnel. The new platform has not only proven to be a convenient and user-friendly approach to training, but a highly effective and cost-saving option as well.
- Conducted three conferences, two workshops, and an exercise that greatly enhanced the energy emergency response and situational awareness capabilities of state and local governments, industry officials, and policy and decision makers.

(dollars in thousands)

FY 2010Current Approp	FY 2012 Request

Analysis and Situational Awareness:

- Developed modeling and visualization capabilities that will allow DOE to examine disruptions in electricity delivery and improve DOE's situational awareness and response capabilities through the advancements in power outage tools; electricity visualization tools; and near-real time reporting capabilities on the electric sector.
- In cooperation with the North American Electric Reliability Corporation, sponsored two workshops and a report on High Impact Low Frequency Event Risk to the North American Bulk Power System and a joint technical report with the Federal Energy Regulatory Commission and the DHS on the effects of electromagnetic induced currents on the electricity grid.
- Published the report, the "Hardening and Resiliency: US Energy Industry Response to Recent Hurricane Seasons." This was a first of its kind report which provides information to Federal, State and local governments and the private sector, as well as the general public about the efforts taken by industry to harden and make their energy systems more resilient.

Physical and Cyber System Assurance:

- Homeland Security Presidential Directive-7 and the National Infrastructure Protection Plan designated DOE as the Energy Sector-Specific Agency, responsible for enhancing the protection of our Nation's critical energy infrastructure and key resources from all threats and hazards.
- Accomplishments related to these responsibilities include:
  - Led the completion of the 2010 Energy Sector-Specific Plan with governmental and private sector asset owners and operators from both the electricity and oil and natural gas sectors to replace the 2007 plan.
  - Prepared the DOE Energy Sector Critical Infrastructure Protection Annual Report which included contributions from all major energy sector partners with a focus on activities currently underway in the sector to meet Energy Specific Plan Goals and Milestones. This partnership has increased industry sharing of best practices and enhanced voluntary cooperation, significantly increasing ISER's ability to obtain critical information from sector partners during emergencies.
  - Completed petroleum and natural gas systems analysis studies that identified clusters of critical energy infrastructure and their impact to the U.S. economy if disrupted. The studies provide a baseline for other analytical efforts.
  - Participated in a National Level Exercise (NLE) in June 2010, focused on coordination and information sharing between government and industry during a nuclear attack.
- Concluded analysis of a pilot effort with select oil and gas industries. This was a voluntary effort to gather sufficient information to assess system-wide vulnerabilities. Areas assessed included: cyber systems, SCADA, physical protection, emergency preparedness, resiliency, training business continuity, and communications.
- Developed CyberCap, an online catalogue of National Laboratory cyber security capabilities. Deliverables include both the content and a user-friendly web-based interface for both industry and other government agencies.
- Co-sponsored Secure Grid '10 with DOD and DHS to examine security gaps in the electrical grid system and the capability of the public and private sector to respond to such an event. The event,

(dollars in thousands)

FY 2010Current Approp	FY 2012 Request

hosted by Northern Command, was a non-public, official-use only strategic exercise to work through key issues in physical and cyber security, simulating a domestic cyber attack on the electric grid.

Global Energy Assurance:

- Deployed DOE Combatant Command (COCOM) Energy Advisors to Central Command and Southern Command, both in Florida, and European Command in Germany. These COCOM Energy Advisors, fully funded by DOD, improve the effectiveness of U.S. energy security initiatives and capacity building efforts.

FY 2012 Planned Activities include:

- *Emergency Preparedness, Response and Restoration:* Train 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.
- *Analysis and Situational Awareness:* Improve 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.
- *Physical and Cyber System Assurance:* Develop internal and external relationships and the appropriate mechanisms (e.g., Memorandum of Understanding) to receive notice of physical/cyber threats from all relevant sources.
- *Global Energy Assurance:* Develop and document a strategic analytical framework for identifying and modeling critical foreign energy infrastructure that if disrupted would negatively impact U.S. energy security.

Total, Infrastructure Security and Energy Restoration	**6,187**	**6,187**

Explanation of Funding Changes

	FY 2012 vs. FY 2010 Current Approp ($000)
Infrastructure Security and Energy Restoration	
▪ **Infrastructure Security and Energy Restoration**	
No Change	+0
Total, Infrastructure Security and Energy Restoration	+0
Total Funding Change, Infrastructure Security and Energy Restoration	**+0**

Program Direction
Funding Profile by Category

	FY 2010 Current Appropriation	FY 2012 Request
Chicago Field Office		
Salaries and Benefits	52	0
Travel	2	0
Support Services	157	0
Other Related Expenses	9	0
Total, Chicago Field Office	220	0
Full Time Equivalents	1	0
National Energy Technology Laboratory		
Salaries and Benefits	3,738	5,584
Travel	231	372
Support Services	1,281	1,842
Other Related Expenses	434	417
Total, National Energy Technology Laboratory	5,684	8,215
Full Time Equivalents (non-add)*	(19)	(31)
Headquarters		
Salaries and Benefits	8,623	15,087
Travel	617	998
Support Services	4,387	4,273
Other Related Expenses	1,889	2,644
Total, Headquarters	15,516	23,002
Full Time Equivalents	60	87
Total Program Direction		
Salaries and Benefits	12,413	20,671
Travel	850	1,370
Support Services	5,825	6,115
Other Related Expenses	2,332	3,061
Total, Program Direction	21,420	31,217
Total, Full Time Equivalents (non-add)*	61 (19)	87 (31)

* As Fossil Energy employees at NETL funded by OE, FTEs are reported and counted in Fossil Energy Budget.
** Totals adjusted for rounding.

Detailed Justification

(dollars in thousands)

	FY 2010Current Approp	FY 2012 Request
Salaries and Benefits	**12,413**	**20,671**

Funds a total of 118 FTEs that provide the executive management, program oversight, analysis, and information required for the effective implementation of the Office's program. Of these, 87 FTEs are planned for Headquarters, and 31 FTEs are planned at NETL. While the 31 FTEs at NETL are funded in OE's budget, they are counted in the Fossil Energy Budget. Therefore, the 31 FTEs are non-add in the OE budget.

This request continues to support the staff that were previously funded by the American Recovery and Reinvestment Act of 2009. These FTEs provide critical technical oversight and monitoring of Recovery Act grants and cooperative agreements.

Staff oversees finances and performance of over 100 R&D electric transmission projects as well as Recovery Act project awards; contributes to the development and implementation of electricity policy at the Federal and State levels; issues authorization for electricity exports and Presidential permits for cross-border transmission lines; works to enhance security and reliability of the grid infrastructure; and facilitates recovery from disruptions to the energy supply.

Headquarters personnel work in one of three programs (Research and Development; Permitting, Siting, and Analysis; and Infrastructure Security and Energy Restoration) or in the support element, Corporate Business Operations.

The personnel in the Research and Development subprogram manage a portfolio of research, development, field testing, and technology demonstration projects, including development and implementation of technology visions and roadmaps, multi-year program plans, budget materials, program evaluations and metrics, public-private partnerships, technology transfer and commercialization plans, and outreach strategies. They also monitor and evaluate progress toward milestones, and hold research performers and others who receive funds accountable for their performance. The R&D functions previously performed at Chicago Operations Office will be performed at Headquarters in FY 2012.

The personnel in the Permitting, Siting, and Analysis subprogram lead the formulation and implementation of the Department's policies and programs to implement the Department's electricity policy-related provisions of EPAct; to assist States and regional organizations on best practices for various electricity-related policies and programs; and to issue Presidential permits for new electric transmission lines that cross U.S. international borders and authorizations for electricity exports.

The personnel in the Infrastructure Security and Energy Restoration subprogram represent the Department in its role as the Sector Specific Agency for the Energy Sector in support of the Department of Homeland Security, responsible for implementing the national strategy for the physical and cyber protection of critical infrastructure and key assets, and performing energy restoration support functions under the National Response Plan. They also work through State and local

	(dollars in thousands)	
	FY 2010Current Approp	FY 2012 Request

governments, and with private industry, to coordinate the Federal government's efforts to ensure secure and reliable energy for America's homes, industries, public service facilities, and the transportation system. Working with government and industry leaders, they analyze physical and cyber vulnerabilities of the national energy infrastructure to find solutions to correct or minimize system vulnerabilities. Finally, they work with the R&D Division to develop, implement, and maintain a cyber security program to assist the Nation's energy sector, including Supervisory Control and Data Acquisition systems.

Staff in Corporate Business Operations provide the administrative, budgetary, financial, logistical, and communications support that allows the Office to achieve its mission and goals in the most strategic and cost effective manner.

Travel	**850**	**1,370**

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 local organizations with regard to planning needs and issues, policies, siting protocols and new energy facilities; carry out the international infrastructure security program; 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	**5,825**	**6,115**

Support Services comprises energy technology specific support on critical science, engineering, environmental, and economic issues that benefit strategic planning program and project effectiveness; technology and market analysis to improve strategic and annual goals; environmental analyses required to process an increased number of Presidential permit applications; development of management tools and analyses to improve overall Office performance, effectiveness, and efficiency; assistance with communications and outreach to enhance the Office's anticipatory stance and responsiveness to public needs and 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.

Other Related Expenses	**2,332**	**3,061**

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, training, and other needs not identified in the above categories.

Total, Program Direction	**21,420**	**31,217**

Explanation of Funding Changes

	FY 2012 vs. FY 2010 Current Approp ($000)
Salaries and Benefits	+8,258
The increase reflects the cost of thirty-eight new FTEs, plus promotions and within-grade increases for the existing eighty FTEs. Twenty-six of these new FTEs are primarily associated with management of ongoing Recovery Act grants and cooperative agreements, while the other new FTEs provide new technical expertise and capabilities needed to manage the expanded responsibilities in non-Recovery Act workloads. This increase is offset by the freeze on cost of living increases.	
Travel	+520
The increase supports the additional FTEs.	
Support Services	+290
The increase supports the additional FTEs and is offset by the planned reductions in the use of advisory and assistance services.	
Other Related Expenses	+729
The increase supports the additional FTEs.	
Total Funding Change, Program Direction	**+9,797**

Support Services by Category

	(dollars in thousands)	
	FY 2010 Current Appropriation	FY 2012 Request
Technical Support		
Feasibility of Design Considerations	0	0
Development of Specifications	0	0
System Definition	0	0
System Review and Reliability Analyses	0	0
Trade-off Analyses	0	0
Test and Evaluation	0	0
Surveys Or Reviews of Technical Operations	0	0
Total, Technical Support	0	0
Management Support		
Analyses of Workload and Work Flow	0	0

	(dollars in thousands)	
	FY 2010 Current Appropriation	FY 2012 Request
Directives Management Studies	0	0
Automated Data Processing	0	0
Manpower Systems Analyses	0	0
Preparation of Program Plans	0	0
Training and Education	105	231
Analyses of DOE Management Processes	0	0
Reports and Analyses Management and General Administrative Services	5,720	5,884
Total, Management Support	5,825	6,115
Total, Support Services	5,825	6,115

Other Related Expenses by Category

	(dollars in thousands)	
	FY 2010 Current Appropriation	FY 2012 Request
Other Related Expenses		
Communications, Utilities, and Miscellaneous Charges	12	37
Other Services	408	574
Supplies and Materials	135	181
Equipment	27	35
Working Capital Fund	1,750	2,234
Total, Other Related Expenses	2,332	3,061

Congressional Directed Projects

Funding Profile by Subprogram

(dollars in thousands)

	FY 2010 Current Appropriation	FY 2012 Request
Congressionally Directed Projects	**13,075**	**0**

Detailed Justification

(dollars in thousands)

	FY 2010Current Appropriation	FY 2012 Request
Congressionally Directed Projects		
▪ AK - National Center for Reliable Electric Transmission	500	0
▪ AL - Western Baldwin County, AL Grid Interconnection	500	0
▪ AZ - University of Arizona Compressed Air Energy Storage	500	0
▪ CA - Smart Grid Initiative	500	0
▪ FL - Adaptive Supervisory Control and Data Acquisition (SCADA) Technology for Infrastructure Protection	750	0
▪ ND - Energy Development and Reliability	325	0
▪ ND - North Dakota Energy Workforce Development	1,900	0
▪ ND - Red River Valley Research Corridor Technology Development	300	0
▪ NJ - Automated Remote Electric Water Meters in South River	500	0
▪ NM - Energy Technologies Research and Education Initiative	750	0
▪ NM - Navajo Electrification Demonstration	1,750	0
▪ NY - Oswego County BOCES Wind Turbine Model Project	200	0
▪ NY - Watkins Glen, Schuyler County Gas Storage Project	500	0
▪ OH - Energy Transmission and Infrastructure Northern Ohio	1,100	0
▪ TX - Development of a Smart MicroGrid Testbed	500	0
▪ TX - Microgrids for Colonias	550	0
▪ VT - Institute for Energy and the Environment at Vermont Law School	450	0
▪ VT - UVM Smart Energy Grid Research	500	0
▪ WA - Power Grid Reliability & Security	1,000	0
Total, Congressionally Directed Projects	**13,075**	**0**

Explanation of Funding Changes

	FY 2012 vs. FY 2010 Current Approp ($000)
Congressionally Directed Projects	
No Funding Requested	-13,075
Total, Congressionally Directed Projects	**-13,075**

Energy Transformation Acceleration Fund

Energy Transformation Acceleration Fund

Table of Contents

Energy Transformation Acceleration Fund
Advanced Research Projects Agency – Energy

Proposed Appropriation Language

For necessary expenses in carrying out the activities authorized by section 5012 of the America COMPETES Act (Pub. L. No. 110-69), as amended, $550,011,000, to remain available until expended.

Energy Transformation Acceleration Fund
Advanced Research Projects Agency – Energy

Overview

Appropriation Summary by Program

	FY 2010 Current Appropriation	FY 2011 CR	FY 2012 Request
Advanced Research Projects Agency – Energy (ARPA-E)			
Energy Transformation Acceleration Fund			
ARPA-E Projects	—	—	521,943
Program Direction	—	—	28,068
Subtotal, Energy Transformation Acceleration Fund	—	—	550,011
Wireless Innovation Fund[a]	—	—	100,000
Total , Advanced Research Projects Agency – Energy (ARPA-E)	—	—	650,011

Preface

The Advanced Research Projects Agency – Energy (ARPA-E) is devoted exclusively to funding specific high-risk, high payoff, game-changing research and development projects to meet the nation's long-term energy challenges.

In 2005, a bipartisan group of Members of Congress requested that the National Academies "identify the most urgent challenges the United States faces in maintaining leadership in key areas of science and technology."[b] In response, the National Academies authored a report entitled *Rising Above the Gathering Storm* in which was expressed grave concerns about the state of U.S. economic and technological competitiveness. Among the many recommendations in the *Gathering Storm* report enacted into law was the creation of ARPA-E.

Initially funded in FY 2009, ARPA-E is at the forefront of the Department of Energy's efforts to accelerate the pace of innovation. ARPA-E fulfills a critical need for transformational energy technologies. Given the recent surge in energy investments overseas, and unparalleled growth in the global demand for energy resources, the next few decades must be the most innovative period of U.S. history in order to remain competitive in the energy economy of the future. ARPA-E will play a key role in fostering that innovation. The magnitude of this challenge is enormous, as is the opportunity.

[a] The Wireless Innovation Fund is a separate legislative proposal for mandatory spending.

[b] National Research Council, Committee on Prospering in the Global Economy of the 21st Century, *Rising Above the Gathering Storm: Energizing and Employing America for a Brighter Economic Future* (2007), page 244.

Encouraging American innovation and maintaining our leadership in research and technology is a high priority for the Administration. In his State of the Union Address President Obama called this, "Our generation's Sputnik moment," adding, "We've begun to reinvent our energy policy. We're not just handing out money. We're issuing a challenge. We're telling America's scientists and engineers that if they assemble teams of the best minds in their fields, and focus on the hardest problems in clean energy."[a] To meet this challenge, the Director of ARPA-E will administer funds to projects that promise a high impact on the ARPA-E mission, and will create new and game-changing global business opportunities.

Within the Energy Transformation Acceleration Fund, the ARPA-E program currently has two programs, ARPA-E Projects (funding for research and development), and Program Direction (providing support and scrutiny to projects).

Mission

The mission of ARPA-E is to overcome the long-term and high-risk technological barriers in the development of energy technologies. To achieve this mission, ARPA-E will pursue the following goals: First, ARPA-E aims to enhance the economic security of the United States through the development of energy technologies. Second, ARPA-E aims to ensure that the United States maintains a technological lead in developing and deploying advanced energy technologies.

Benefits

ARPA-E is responsible for funding high-risk and high-payoff game-changing research and development projects to meet the nation's long-term energy challenges. ARPA-E identifies and promotes early-stage transformational research and development projects in areas that industry by itself cannot and will not support because of technical and financial uncertainty. ARPA-E pursues opportunities that have the promise to make revolutionary advances in breakthrough sciences, translate scientific discoveries and cutting-edge inventions into technological innovations, accelerate transformational technological advances, and ensure U.S. competitiveness and technical lead in developing and deploying advanced energy technologies.

Coordination between the Department's basic research and applied technology programs is a high priority for the Secretary of Energy. ARPA-E takes great care to ensure that its projects do not overlap with other DOE programs, but instead complement them in multiple ways. ARPA-E focuses on creating breakthrough energy technologies that do not exist in today's energy market, but if they did, these breakthrough technologies would make today's approaches obsolete and have huge commercial market impact. ARPA-E works in close coordination with DOE's basic science and applied research programs to avoid duplicative research and ensure a balanced research portfolio across the DOE. ARPA-E also seeks to bridge traditionally stove-piped DOE programs and proactively reaches out to form partnerships to transition successful projects to deployment. This coordination occurs at the senior DOE leadership level and the Program Director and staff level with regular and ad hoc planning meetings. In addition, other DOE programs are involved from beginning to end in ARPA-E's program development process—providing technical consultation, co-hosting technical workshops, and serving as reviewers for ARPA-E concept papers and full applications.

ARPA-E is set up to be a lean and agile organization. ARPA-E has special hiring authority to bring on Program Directors and other program leadership, enabling it to recruit and rotate the best and brightest

[a] http://www.whitehouse.gov/the-press-office/2011/01/25/remarks-president-state-union-address

minds in the energy research fields. ARPA-E brings in top scientists and engineers to serve as Program Directors for limited terms and empowers them to make technical and programmatic decisions for the projects they oversee. The quality of the performers is important as well and ARPA-E strives to bring in world-class scientists and engineers in high-potential teams with the technical knowledge and motivation to succeed. ARPA-E also seeks to attract new researchers to focus on critical energy-related issues, and to push researchers currently in the field to produce transformational results.

ARPA-E has adopted several processes to expedite the program development and project selection process without compromising quality or integrity, while ensuring operational and mission success within rigid time constraints. For example, ARPA-E utilizes a program development process that includes extensive up-front technical research and technical workshops co-hosted with other DOE program offices, both with a great deal of technical community engagement. ARPA-E also employs a thorough peer review process. Further, ARPA-E has embedded dedicated procurement and legal teams, allowing ARPA-E to achieve exceptional speed and efficiency (usually two to three months) for processing awards from announcement to signing contracts.

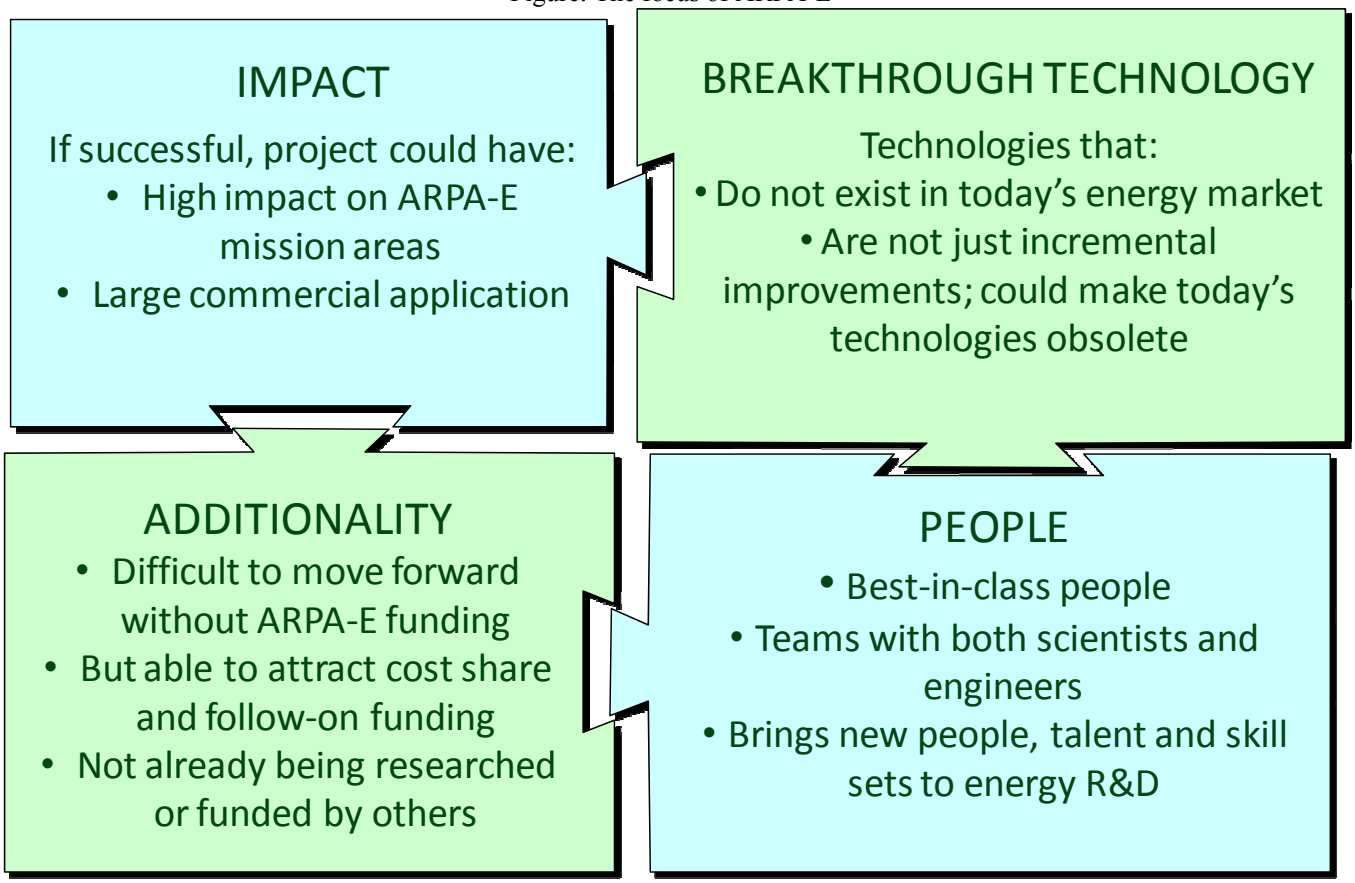
The inherent risk associated with the types of projects ARPA-E will fund means the agency fully expects a large number of projects to not fully achieve their prescribed technical milestones and deliverables. Indeed, ARPA-E embraces the possibility of failure with an entrepreneurial spirit and the strong belief that, "…fear of technology failure should not paralyze strategic investments in innovation, since some amount of failure is inevitable and essential to such a disruptive and non-linear process."[a] Given the transformational nature of the technologies, even a small percentage of successful projects would yield a payoff that will result in the flow of new ideas that will fuel the economy, create new jobs, provide security, and enhance the quality of life.

As shown in the figure below, ARPA-E's focus is on:

- High-risk, high-impact projects;
- Disruptive applied technologies that don't now exist but have a large potential application;
- Breakthrough science that can transform a field with revolutionary technical advances;
- Projects in need of rapid and flexible experimentation and/or engineering;
- Attracting the next generation of energy researchers and entrepreneurs; and
- Merging technological opportunities with mission gaps that are not being addressed.

[a] American Enterprise Institute (AEI), Brookings Institution, and the Breakthrough Institute, *Post-Partisan Power: How a Limited and Direct Approach to Energy Innovation Can Deliver Clean, Cheap Energy, Economic Productivity and National Prosperity* (2010), page 7.

Figure: The focus of ARPA-E



Energy Transformation Acceleration Fund
Advanced Research Projects Agency - Energy

Funding by Site by Program

(dollars in thousands)

	FY 2010 Current Approp	FY 2012 Request
Washington Headquarters		
ARPA-E Projects	—	521,943
Program Direction	—	28,068
Total, Washington Headquarters	—	550,011
Total, Energy Transformation Acceleration Fund	—	550,011

Major Changes or Shifts by Site

Washington Headquarters
ARPA-E Projects

- ARPA-E requests $521.9 million in FY 2012 to fund new projects. There are no major changes, simply an increase in the number of projects ARPA-E plans to fund.

Program Direction

- In FY 2012 the Program Direction element ARPA-E's request at $28.1 million will accommodate the hiring of federal employees and support service contractors, and commensurate increases in information technology purchases and costs for leased space, to allow ARPA-E to fulfill the mission of the program.

Site Description

Washington Headquarters

In support of the Energy Transformation Acceleration Fund and the Advanced Research Projects Agency – Energy (ARPA-E) subprograms, the Washington Headquarters site provides management and leadership of ARPA-E, oversight of the Fund, and also administers funding agreements with the award recipients, support services contracts, and all other financial/funding agreements associated directly with ARPA-E.

Advanced Research Projects Agency – Energy (ARPA-E)

Funding Profile by Subprogram

(dollars in thousands)

	FY 2010 Current Appropriation	FY 2012 Request
ARPA-E Projects		
Stationary Power	—	130,000
Electrical Infrastructure	—	80,000
End Use Efficiency	—	105,000
Embedded Efficiency	—	60,000
Transportation Systems	—	115,000
Seedlings/Broad Funding Announcement	—	17,329
SBIR/STTR	—	14,614
Total, ARPA-E Projects	—	521,943

Public Law Authorizations:

P.L. 95-91, "Department of Energy Organization Act" (1977)
P.L. 109-58, "Energy Policy Act of 2005"
P.L. 110-69, "America COMPETES Act" (2007)
P.L. 111-358, "America COMPETES Reauthorization Act of 2010" (2010)

Mission
ARPA-E Projects will identify and promote early-stage research and development projects with the promise to make revolutionary advances in breakthrough sciences, translate scientific discoveries and cutting-edge inventions into technological innovations, and accelerate transformational technological advances in areas that industry by itself cannot and will not support because of technical and financial risk and uncertainty.

Benefits
To accomplish its mission, ARPA-E will draw upon the nation's strengths of having the best R&D infrastructure in the world, an unparalleled innovation ecosystem in business and entrepreneurship, and the American enthusiasm for pioneering and taking risks. ARPA-E itself performs no research, but rather funds early-stage transformational energy research and development projects that are conducted by teams from universities, small businesses, large businesses, non-profits, national laboratories, and other federally funded research and development centers.

ARPA-E finds energy technologies at an early stage in their development and funds the most promising projects at a point when they are considered too high-risk to receive investment from private investors or other public sources.

Beyond providing funds to projects, ARPA-E's scientists, engineers, and entrepreneurs actively work with the project performers to help solve problems and keep projects on track. By supporting integrated teams of scientists and engineers, ARPA-E maintains continuous feedback loops to increase the speed of innovation. ARPA-E provides crucial financial, technical, and commercialization assistance to a selected portfolio of projects for a limited period, promoting their rapid development toward a point where interested private or public investors are willing to commit funds and bring them to market scale.

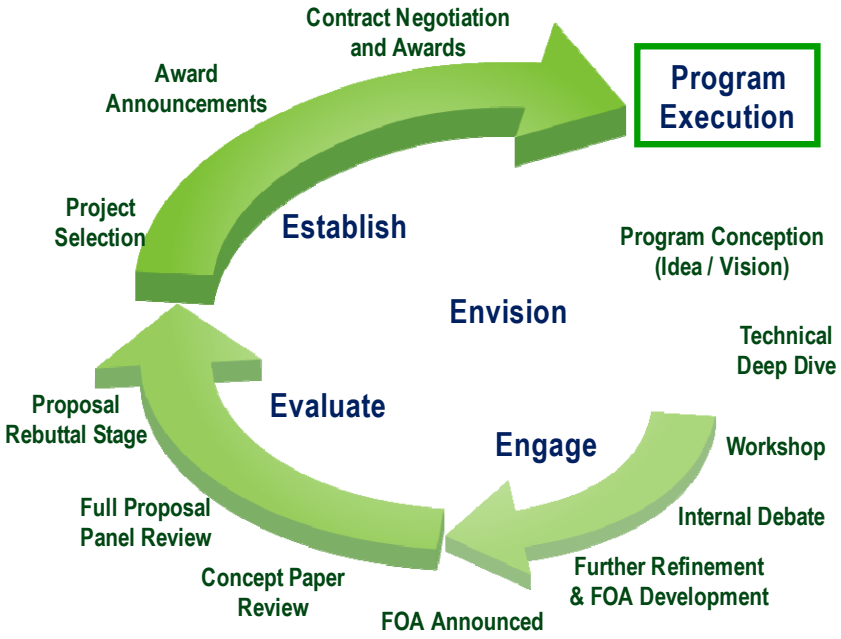
ARPA-E is organized and administered in ways that enable the program to be lean, effective, and agile and strives to be a model of excellence for a small agency. In its short existence of less than two years, ARPA-E has implemented several key business process innovations that have earned it recognition as an organization to emulate.

As noted in a 2010 report from the President's Council of Advisers in Science and Technology (PCAST), "Although the ultimate success of the research funded by ARPA-E is unknown, as evidenced by the solicitations managed by ARPA-E, that they have been successful in their peer review of proposals, quick negotiation of contracts, and rapid hiring of high-caliber personnel."[a] Some of the core ARPA-E innovations are described in more detail below.

<u>ARPA-E's program development process includes distinctive and desirable features</u>
ARPA-E implemented a novel process for the development and creation of programs that features extensive technical community engagement, topical workshops, a three-stage peer review process that allows for rebuttals to reviewer comments, and rapid contract negotiation, as shown in the figure below. Despite its depth of engagement and multi-stage evaluation, this model affords a timeline from conception to execution that is greatly accelerated—ARPA-E's timeline is typically only six to eight months. This in turn allows ARPA-E to respond rapidly to newly emerging technological discoveries and geo-political events in its creation of new programs.

[a] Executive Office of the President, President's Council of Advisers on Science and Technology, *Report to the President on Accelerating the Pace of Change in Energy Technologies Through and Integrated Energy Policy* (2010), page viii.

Figure: ARPA-E's Program Development Process



The first two phases of the program development process serve to refine a good idea into an actual Funding Opportunity Announcement (FOA) in an area where ARPA-E's limited funding will have substantial impact in the long term. The third phase utilizes a novel peer review process to choose the projects that have the most potential to produce transformational and disruptive technologies. The fourth phase features the negotiation of contracts in only two to three months—a pace that is uncommon in the public sector.

The process begins with the idea or vision for a potential program. ARPA-E staff engages the technical community and performs extensive background research and a technical "deep dive" that seeks to state the problem, define the current state of the art, identify revolutionary advances in breakthrough sciences, and propose preliminary focus areas. ARPA-E staff concurrently engages DOE colleagues and others to identify the gaps in the current research portfolios for ARPA-E to fill. This also serves to leverage DOE knowledge to accelerate the development of a potential program and to eliminate redundancy.

In the second phase, Program Directors are required to hold a workshop in order to engage the scientific community, both within DOE and at large, to help ARPA-E determine the state of the art in a given field, to discuss solutions to the critical challenges identified, and determine performance targets the technical community thinks are aggressive yet reachable. If after a workshop ARPA-E determines to issue a FOA, the technical community is involved extensively again in the peer review process.

The third phase, ARPA-E's peer review process, is a key component of the program's success. Engaging the leading experts in the technical community at every turn is very important to ARPA-E. Program Directors and staff solicit input both formally and informally during the conceptualization phase and the workshops, but is perhaps most significant during the peer review process. The involvement of world-class scientists and engineers and leaders from the technical community brings to the process unparalleled expertise and knowledge. ARPA-E taps dozens of the leading experts in the world in a particular field. ARPA-E has them review concept papers and full applications over several weeks, and then brings them together for a Merit Panel Review. ARPA-E's evaluation process includes

another facet that is common for things such as journal articles, but rather distinctive among federal research and development programs – the opportunity for the applicant to read reviewers comments and to provide a rebuttal. This aspect of the ARPA-E process has been extremely well received in the technical community. In additional to the recognition from the PCAST report, the DOE Office of the General Counsel has circulated a summary of the ARPA-E review process to the rest of DOE as a template for all the applied research programs.

The final phase, the quick negotiation of cooperative agreements, is another key business innovation and is a hallmark of the ARPA-E process. A defining feature of this innovation is that ARPA-E has embedded dedicated procurement and contracting teams. Another example of ARPA-E striving to eliminate traditional bureaucratic stovepipes that hinder innovation and efficiency, this arrangement allows ARPA-E to achieve an unprecedented pace of transferring awards from announcement to signing cooperative agreements—usually about two to three months. This speed and efficiency of process is instrumental to ARPA-E's success and reputation.

During this final phase, the general cost and performance metrics developed for the FOA are negotiated with specificity for each selected performer. ARPA-E's cost and performance metrics are particularly aggressive, another characteristic of the program, and seek not to advance prevailing technology along existing learning curves, but rather to establish entirely new learning curves. These cost and performance metrics become technical deliverables and milestones for the selected projects and are codified in the final funding agreement.

ARPA-E Program Directors are world-class scientists and engineers, and are term-limited

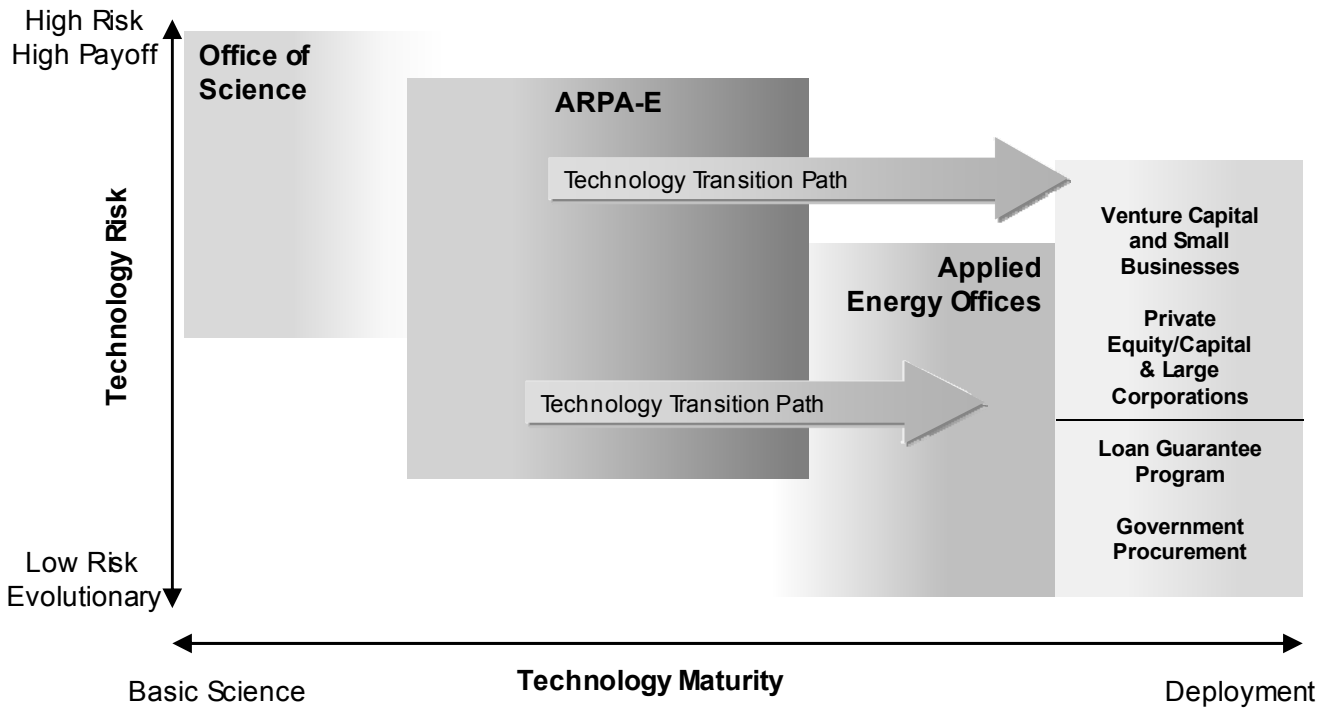
The rapid hiring of high-caliber personnel is one more notable feature of ARPA-E. ARPA-E has special hiring authority to bring on Program Directors and other program leadership for terms limited to three years. In turn, some of the best and brightest minds in the energy field have been attracted to come to ARPA-E to serve their nation for a few years and then return to the technical community. ARPA-E's Program Directors are the top scientists and engineers in the world and have significant experience in bridging science, technology and business with multidisciplinary teams. ARPA-E Program Directors lead topic programs and work directly with the award recipient project teams. They are expected to know all of the scientific details of the projects they manage. This enables technical brainstorming and sharing of knowledge that significantly shortens the technology development pipeline. ARPA-E Program Directors practice active hands-on risk management for each project, including at least two site visits per year, two program reviews, and go/no go technical milestones. Program Directors limited appointments last only the duration of the projects they support. Rotating program leadership in this way provides fresh perspective and enthusiasm to each round of funding for projects, and also leads to speed and a sense of urgency since Program Directors have only three years to deliver a technology and make an impact with the projects they fund.

ARPA-E is a catalyst for coordination within DOE

An additional benefit enjoyed by ARPA-E that is not related to an internal business process innovation has been ARPA-E's role in bringing together the traditionally stove piped DOE program offices. As noted in the overview, ARPA-E works in close coordination with DOE's basic science and applied research programs to avoid duplicative research and ensure a balanced research portfolio across the DOE. ARPA-E proactively reaches out to form partnerships to transition successful projects to deployment. Along with technical coordination within DOE, it is important for ARPA-E to coordinate with other stakeholders. The figure below charts the relationship between ARPA-E and DOE's Office of Science and Applied Offices as it relates to technology maturity and risk. The figure also illustrates the technology transition path for ARPA-E projects as they increase in technological maturity—either a

direct path to the investment community, DOE's Loan Guarantee Program, or other Government Procurement, or in some cases a hand-off to a DOE Applied Office for further development before going on to deployment.

Figure: ARPA-E Coordination within DOE and with Other Stakeholders



To facilitate senior management level coordination within DOE, the ARPA-E Director created the Panel of Senior Technical Advisors (PASTA), a group of technical leaders within DOE spanning the Office of Science, the Office of Fossil Energy, the Office of Nuclear Energy, the Office of Energy Efficiency and Renewable Energy, the Office of Electricity Delivery and Energy Reliability, and others from senior DOE leadership positions. The intent of the PASTA meetings is to share information, avoid duplication, and engender coordination, cooperation, and collaboration among all of the DOE research programs.

Below the senior management level, ARPA-E Program Directors frequently coordinate with their counterparts in other DOE program offices. In addition to maintaining regular contact, other DOE officials serve as ARPA-E concept paper and full application reviewers. ARPA-E works closely in collaboration with other DOE basic and applied research offices to identify gaps in their research portfolios ("white space") as well as through co-hosting topical workshops in the development of programs.

Coordinating with other DOE offices on workshops is an essential way to avoid duplicative research and ensure a balanced research portfolio across the DOE. This also serves to inform all parties of each other's ongoing research activities to facilitate the transition of successful ARPA-E projects to other DOE programs. A few examples of workshops follow:

- Grid Scale Energy Storage Workshop: ARPA-E and the Office of Electricity Delivery and Energy Reliability co-hosted a workshop as a complement to the Department of Energy-sponsored Electrical Energy Storage Applications and Technology Conference 2009 (EESAT 2009). ARPA-E used information from this workshop to shape the scope and focus of its funding opportunity announcement of the GRIDS program.

- Advanced Building Energy Technologies Workshop: ARPA-E and the Office of Energy Efficiency and Renewable Energy (EERE) held a workshop on the topic of advanced building energy technologies. The objective of this workshop was to gain a deeper understanding of those areas and technologies that have the highest potential to meet DOE's goal of developing the technical foundations necessary to enable massive reductions in energy consumption in buildings. ARPA-E used the information from this workshop to shape the scope and focus of its funding opportunity announcement of the BEETIT program.

It is important to note that not all workshops necessarily lead to programs.

Currently Funded Programs

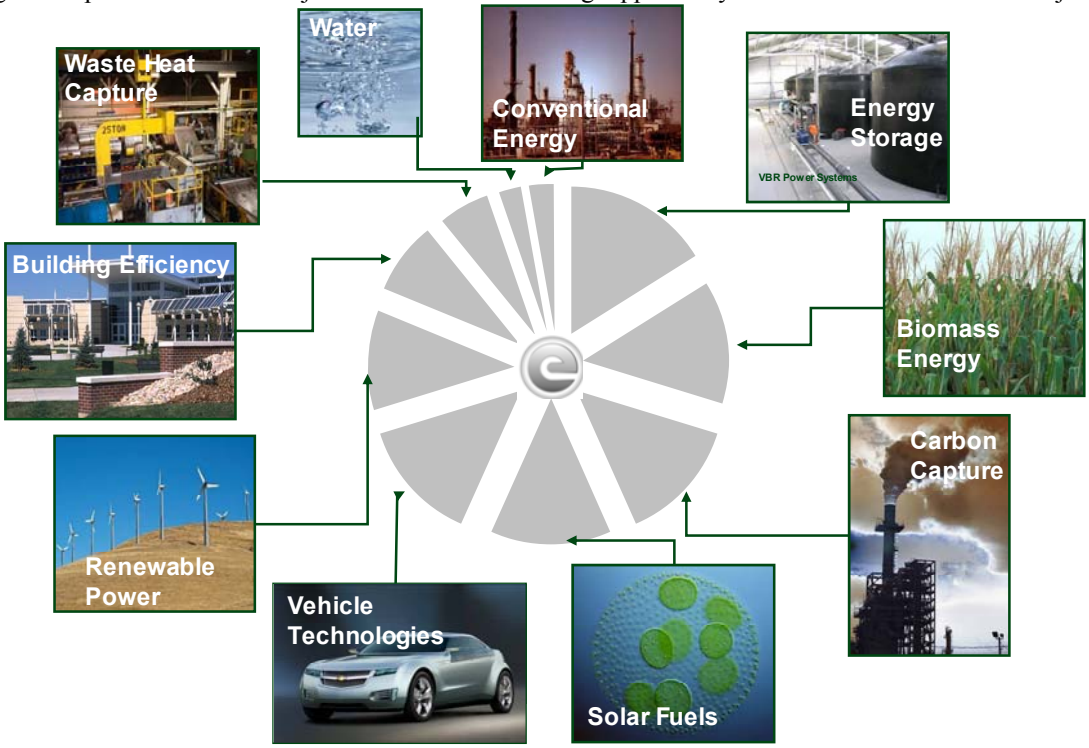
Since April 2009, ARPA-E has issued seven Funding Opportunity Announcements (FOAs) and received an overwhelming response from the technical community. ARPA-E has reviewed 4,786 concept papers and 688 full proposals, from which 121 projects were selected for funding.

ARPA-E was substantially oversubscribed, and many projects which showed potential to be truly transformational could not be funded. ARPA-E elected to give these non-selected but high-potential projects exposure by including them on the ARPA-E website. These projects teams are also invited to the ARPA-E summit and afforded the opportunity to showcase their technologies. This provides them exposure to other ARPA-E teams for potential partnerships and to potential investors.

ARPA-E selected projects with extraordinary potential, but because of their high-risk nature of the research involved not all of them will be successful. If just a fraction of the projects funded by ARPA-E are successful in reaching the marketplace, the U.S. will benefit greatly by creating new industries and jobs, making energy technologies substantially more efficient and profitable, and accelerating the timeframe for achieving energy and security goals.

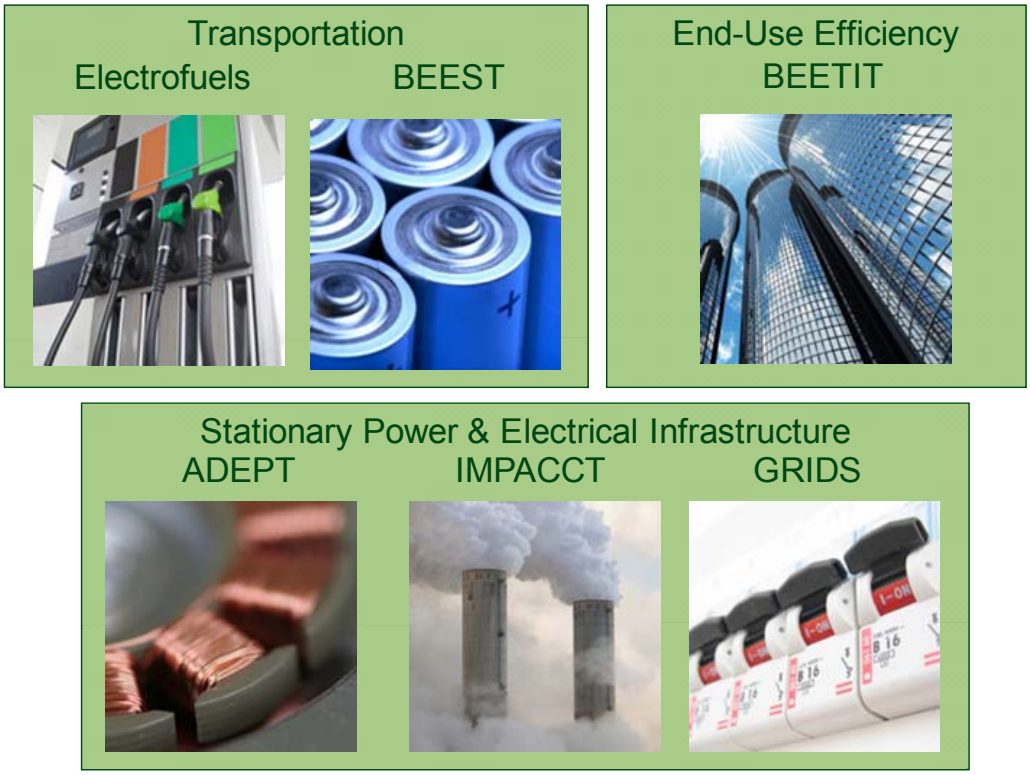
ARPA-E's inaugural FOA did not seek a specific technological goal. Rather, this FOA was open to all energy ideas and technologies, but focused on applicants who already had well-formed research and development plans for potentially high-impact concepts or new technologies. Projects spanning ten topic areas were selected based on impact on ARPA-E's mission, innovative technical approaches, high-performance teams, and opportunities for the U.S. to gain leadership, as well as to pursue technologies that are underserved by other parts of DOE and the private sector (see figure below for details). If successful, these technologies could be game-changing and launch new opportunities for American businesses and jobs.

Figure: Topics of ARPA-E Projects from the first Funding Opportunity Announcement and Other Projects



ARPA-E's subsequent FOAs targeted specific topics, in contrast to the open approach of the initial funding opportunity. These programs fund competitive approaches, setting market-relevant and aggressive cost and performance metrics as ends for performers to achieve while allowing performers to determine the specific technological means to do so. These six FOAs are described in detail below.

Figure: ARPA-E Topical Funding Opportunity Announcements (FOAs) by Primary Focus and Programs



Electrofuels

New and advanced liquid fuel technologies are needed to address the challenges associated with reliance on oil. While domestically-produced biofuels increase the nation's energy security, there remains a considerable need for next-generation renewable fuels that are compatible with today's fuel refining and distribution infrastructure. To address this need, the Electrofuels program is exploring ways that have never been tried before to produce renewable liquid transportation fuels—without using petroleum or biomass—by using microorganisms to harness chemical or electrical energy to convert carbon dioxide into liquid fuels. Theoretically such an approach could be 10 times more efficient than current photosynthetic-biomass approaches to liquid fuel production.

Batteries for Electrical Energy Storage in Transportation (BEEST)

The BEEST program aims toward making a new generation of ultra-high energy density, low-cost battery technologies for long-range (300 to 500 miles) plug in hybrid electric vehicles (PHEVs) and electric vehicles (EVs). Successful development of these types of batteries will make PHEVs and EVs more useful to more people and will put more cars on the road that run on U.S.-generated electricity rather than imported oil. ARPA-E investments in this area run from moderately risky projects to take lithium ion batteries (the current industry standard) to the next level, to pushing the boundaries of batteries by using lithium air systems that can hold as much energy as a tank of gasoline in the same volume. Other projects in the BEEST program are looking at new ways to safely store energy that will provide cars with energy for up to a 500 mile range and be able to fully charge in minutes. ARPA-E is funding research efforts that will promote U.S. leadership in the emerging EV battery market.

Building Energy Efficiency Through Innovative Thermodevices (BEETIT)

The BEETIT program seeks to develop energy-efficient building cooling technologies that will reduce energy consumption from: (a) overall cooling and (b) refrigerants used in vapor compression systems. Project teams are developing the most efficient cooling technologies that are also cost-competitive with current methods. These more advanced technologies will be suitable for both warm and humid climates (e.g. Florida) and hot and dry climates (e.g. Arizona). Further, it is planned that these technologies could be retrofitted into existing buildings. The U.S. demands technologies that will retrofit into current cooling systems, while developing economies, because of new construction, can readily incorporate new cooling technologies. Developing these technologies significantly increase the U.S. technological lead in rapidly-emerging clean energy industries.

Agile Delivery of Electrical Power Technology (ADEPT)

The ADEPT program seeks to create microelectronic circuits that incorporate transistors able to handle high voltages and advanced magnetic materials for much smaller power transformers and inductors. These investments could potentially leapfrog existing power converter performance and reduce costs. The result of improved efficiency of electric power conversion will then be seen in applications such as the lamp drivers commonly used for LED lighting. These improved lamp drivers will be ten times smaller and will reduce the amount of heat loss. Additionally, improved electrical power efficiency could result in smaller personal computers and computer servers, and produce lightweight chargers for electric vehicles. In total, these advanced transistors will enable miniaturization, increased efficiency, and reduced costs. The ADEPT program also focuses on creating high-voltage transistors for utility power networks that can allow for the controlled movement of electricity by selective routing through transmission lines to avoid congestion and overloading. Innovations in power electronics could significantly reduce costs, which would promote U.S. businesses through technological leadership.

Innovative Materials and Processes for Carbon Capture Technologies (IMPACCT)
The IMPACCT program seeks to reduce the cost of carbon capture significantly by revolutionizing the technologies used to capture carbon dioxide—through a combination of new materials, improvements to existing processes, and demonstration of new capture processes. ARPA-E seeks to complement existing DOE efforts in the field of carbon capture, led by the Office of Fossil Energy and National Energy Technology Laboratory, by accelerating promising ideas from the basic research stage towards large-scale demonstrations and, ultimately, commercialization. IMPACCT is pushing the boundaries of carbon capture research through technologies such as new liquid chemistries that dissolve carbon dioxide and a capture system inspired by jet engines that transforms carbon dioxide from a gas into pellets of dry ice. If successful, the IMPACCT program will allow the continued use of America's coal infrastructure without further increases in carbon dioxide emissions.

Grid-Scale Rampable Intermittent Dispatchable Storage (GRIDS)
The GRIDS program seeks to develop new technologies that enable widespread use of cost-effective grid-scale energy storage. While valuable applications for grid-scale storage exist, this program focuses on technologies that balance the short-duration variability in renewable generation. Investing in these technologies will position the U.S. as the technology and manufacturing leader of the emerging, and potentially massive, global market for stationary electricity storage infrastructure. The GRIDS program seeks to develop revolutionary modular storage systems that provide the energy, cost, and lifecycle of pumped hydropower, and can be widely implemented across the power grid. Specifically, GRIDS considers two areas: 1) proof–of-concept storage-component projects focused on validating new, over-the-horizon, electrical energy storage concepts, and 2) advanced system prototypes that address critical shortcomings of existing grid-scale energy storage technologies. Ultimately, technologies developed through this program will be scalable to megawatt and megawatt-hour levels of power and energy capacity. GRIDS will complement other DOE grid-scale energy storage efforts by focusing on technology prototyping and proof-of-concept research and development.

Potential Future Programs
As noted in the section above describing ARPA-E's program development process, topical workshops engaging the leading experts in DOE and in the technical community at large are a key component of ARPA-E's success. The workshops serve as a forum for ARPA-E to determine the state of the art in a given field, to discuss solutions to the critical challenges identified, and determine performance targets the technical community thinks are aggressive yet reachable. While not all workshops necessarily lead to ARPA-E programs, they do inform the direction of the program in particular energy technology areas. A listing of recent ARPA-E workshops is below. Summary reports from all ARPA-E workshops are available on the ARPA-E website (http://arpa-e.energy.gov/EventsWorkshops/PastEvents.aspx).

- $1/W Workshop (August 2010) – To complement the Office of Energy Efficiency and Renewable Energy's (EERE) highly-productive photovoltaic (PV) program, ARPA-E co-hosted with EERE a workshop explored the possibility of developing products and processes that would enable PV facilities priced at $1 per watt, fully-installed.

- Applied Biotechnology for Transportation Fuels Workshop (December 2010) – This workshop brought together thought leaders from distinct science and engineering communities to develop new ideas and identify practical approaches toward increasing the efficiency of light collection by biological systems and the conversion of that energy into liquid forms of chemical energy that can be used for transportation. Focus was directed towards the production of high-energy content fuel molecules by photosynthetic systems rather than processes that convert lignocellulose or other sources of biomass to usable fuels.

- Critical Materials Technology Workshop (December 2010) – The importance of critical materials in the energy sector has been highlighted by the mismatch between the rapidly growing demand relative to the limited global supply of rare earth materials. The goal of the workshop was to bring together thought-leaders from across scientific and engineering disciplines to identify transformational, early-stage applied research and development approaches to address the technical challenges related to the potentially limited availability of critical materials in the energy sector. Technology solutions focused on both the supply side and demand side of critical materials challenges are of interest. Specifically, ARPA-E was interested in exploring potentially disruptive (not incremental) technology solutions.

- Green Electricity Network Integration Workshop (December 2010) – This workshop addressed the challenges and opportunities associated with incorporating renewable energy sources into the nation's power grid. The goal of the workshop was to develop new ideas and identify the most promising research and development pathways to better accommodate the alternatives to traditional electricity generation and the use of plug-in hybrid electric vehicles while improving the reliability, controllability, and performance of the power grid. Specifically, ARPA-E examined grid control in a highly variable environment for electricity generation, islanding and microgrids, flexible A/C transmission systems (FACTS) devices, and high-voltage direct current (HVDC) transmission.

- High Density Thermal Energy Storage Workshop (January 2011) – Thermal energy transport and conversion play a very significant role in more than 90% of energy technologies. Approximately two thirds of thermal energy is wasted. Thermal energy storage can significantly reduce this waste and enhance the efficiency of energy delivery and consumption. Applications range from low temperature cold storage to high temperature nuclear reactors. Efficient storage of thermal energy can lead to grid power profile balancing, an increase in building envelope thermal mass, efficient use of heat in combined heat and power systems, less intermittent and more cost-effective solar thermal power plants, and the use of nuclear energy for meeting seasonal as well as hourly variation in electricity demand. This workshop brought together a diverse community of scientists (e.g. chemists, materials scientists, and physicists) and engineers (e.g. mechanical, thermal, chemical) to develop new ideas and identify the most promising R&D pathways for thermal energy storage.

- Power Electronics in Photovoltaic Systems Workshop (February 2011) – ARPA-E co-hosted a follow-up to the $1/W workshop with EERE's Solar Energy Technologies Program focusing on power electronics in photovoltaic (PV) systems. One part of the workshop addressed the challenges and opportunities associated with incorporating advanced power electronics into photovoltaic sources of electricity generation, while the other part focused on system related issues such as grid-integration. The workshop brought together some of the world's foremost experts in PV technology as well as leaders from industry, academia, and government with diverse perspectives to discuss the challenges and opportunities related to the generation of solar power.

ARPA-E programs generally fall into two categories:

- New Areas of Science and Technology—for example, ARPA-E's current Electrofuels program the goal of which is to create a biological non-photosynthetic process to produce liquid fuels. This is not being done anywhere else and, if successful, could create an entirely new industry.

- New Generation Technology—for example, ARPA-E's current program called Batteries for Electrical Energy Storage in Transportation, or BEEST. While DOE and most outside R&D is focused on lithium batteries, ARPA-E is looking for other battery chemistries that, if successful, would yield batteries that are less expensive and provide longer range and storage capabilities than today's approaches.

ARPA-E continues to improve its internal strategic vision for the future direction of the agency. This internal strategic plan, formally titled Strategic Vision Roadmap, is still being developed; but the broad strokes of the plan are codified in an updated matrix organization structure, shown in the figure below, that hones in on the broad strategic areas in which ARPA-E will seek to fund projects.

Building on the matrix organization structure that ARPA-E has in place already, the "Applied Science and Technologies" columns remain the same but the "Integrated Energy Systems" rows have been regrouped to reflect the program's internal strategic thinking on the focus of future projects. Additionally, relative to the matrix in the FY 2011 budget request, ARPA-E has shifted the contents of some cells to indicate where the current projects and planned future FOAs should now be considered to fall; as well as to show other refinements to ARPA-E's strategic thinking. This updated matrix now reflects ARPA-E's best estimates as to the areas of focus for ARPA-E currently and in FY 2012.

The five broad thematic strategic direction areas, shown in the bulleted list below, are explored more deeply in the detailed justification section that follows. Described therein are areas of technical interest that ARPA-E will explore at the requested funding level. Technical flexibility and empowerment of Program Directors is a key aspect of ARPA-E. Before starting a program ARPA-E will do in-depth research, market studies, have discussions with experts from the technical community, and hold a technical workshop to determine if an area of interest is ready for an ARPA-E program.

- Stationary Power

- Electrical Infrastructure

- End Use Efficiency

- Embedded Efficiency

- Transportation Systems

ARPA-E is required by statute to provide 5% of appropriated funds for technology transfer and outreach. These activities will be funded within the programs below.

Figure: ARPA-E's Updated Matrix Organization Structure

APPLIED SCIENCES AND TECHNOLOGIES							
Marketing & Decision Science	Information Science & Device Engineering	Electronic & Structural Materials Science & Device Engineering	Thermal Science & Device & Process Engineering	Chemical & Biological Science & Process Engineering		FY 2012	
		ADEPT, GRIDS, & BAA $1/W Solar	**IMPACCT** Thermal Battery	**IMPACCT**	**Carbon-Free Power (Nuclear, Solar, Wind, Hydroelectric, & Geothermal)** **Carbon Dioxide Capture & Utilization**	**Stationary Power** **FY 2012 $130M**	INTEGRATED ENERGY SYSTEMS
	Grid Security Optimization	**ADEPT & GRIDS**			**Transmission & Distribution**	**Electrical Infrastructure** **FY 2012 $80M**	
BAA Performance Measurement, Education	Systems Integration, Control, and Optimization for Energy Use		**BEETIT** Thermal Battery		**Buildings & Appliances (Homes, Buildings, Data Centers)**	**End Use Efficiency** **FY 2012 $105M**	
		BAA Biological Chemical Precursors	**BAA**	**BAA**	**Industrial Power Generation & Use (Cement, Metals, Glass, Paper)** **Water & Agriculture**	**Embedded Efficiency** **FY 2012 $60M**	
		BEEST, & BAA	**BAA**	**Electrofuels** Natural Gas Generation and Storage	**Transportation** **Fuels Synthesis**	**Transportation Systems** **FY 2012 $115M**	

Shaded cells show topic areas (Current Projects or potential future FOA) for ARPA-E funding

IN BOLD: FOA title, or Broad Agency Announcement (BAA), ongoing and fully funded
UNDERLINED: focus of potential upcoming FOAs

FY 2012 funding levels shown represent broad categories of ARPA-E's strategic focus and will guide hiring of future Program Directors, workshops, and FOAs

Annual Performance Results and Targets

The Department is in the process of updating its strategic plan, and has been actively engaging stakeholders including Congress. The draft strategic plan is being released for public comment concurrent with this budget submission, with the expectation of official publication this spring. The draft plan and FY12 budget are consistent and aligned. Updated measures will be released at a later date and available at the following link http://www.mbe.doe.gov/budget/12budget/index.htm.

Detailed Justification

(dollars in thousands)

	FY 2010 Current Approp	FY 2012 Request
Stationary Power	**—**	**130,000**

ARPA-E is investing in transformational R&D in a number of power generation technologies, and coordinating that investment with basic energy sciences and the applied programs to identify programs with potential for game changing developments to meet the ARPA-E mission. To date, ARPA-E activities relating to stationary power have focused on improving the economics and performance of conventional wind turbine through new designs based on jet engine technology, novel ways to tune and optimize blades that are much simpler to manufacture, and airborne wind turbines at modest altitudes; novel fabrication processes for solar technology that reduces the cost of manufacturing silicon substrates; new drilling technology, allowing vastly more economical access to deep under- ground thermal reservoirs; and innovative materials and processes to reduce the cost of carbon capture.

Given the increasing reliance on an overwhelming percentage of the nation's electricity that comes from stationary power sources, ARPA-E will continue to make strategic investments in this sector. ARPA-E is developing specific future focus areas for programs that employ novel approaches, materials, devices, and processes to make revolutionary advances in the way we capture and utilize energy from a portfolio of diverse renewable and other power sources.

ARPA-E's goal is to create a diverse portfolio of technological options for low-cost power generation from traditional and renewable sources. This will make US the world leader in these technologies and thereby lead to economic prosperity and American jobs. These include:

- Electricity generation from solar, wind, natural gas, nuclear, clean coal and other sources to meet base load and peak power at levelized cost of electricity is 5-6 cents/kWh.
- Integrated energy supply systems for distributed supply of heating, cooling, and power in optimal ways.

Potential areas of investment are identified below.

As renewable and distributed generation technologies are added to the electric generation mix, energy flow changes from a unidirectional flow – from supply to demand – to a complex bidirectional supply/demand optimization problem. The U.S. is committed to installing low-cost, clean, renewable energy resources and, as a result, needs to develop an intelligent system capable of balancing the needs and demands of each building. ARPA-E, in coordination with other DOE offices engaged in complimentary activities, will investigate novel operating system/sensor pairings that effectively balance the use of renewable energy sources to maximize both utilization and efficiency and minimize the use of non-renewable energy sources.

The salt concentration gradient where freshwater rivers reach saltwater oceans can be harnessed to create electricity. While this technology has the potential to generate gigawatts of clean, renewable energy, the concept is still largely theoretical, and membrane performance is far from what is needed. ARPA-E will consider programs in advanced membranes and osmotic power generation strategies to simultaneously produce electricity and improve desalination efficiency.

(dollars in thousands)

FY 2010 Current Approp	FY 2012 Request

Natural gas (methane) currently provides 25% of U.S. energy, and is a clean, low carbon, energy source. The use of natural gas could be expanded for both stationary power and as a transportation fuel. Additionally, methane generated in a renewable fashion could serve as a zero-carbon fuel. ARPA-E will investigate methods to produce methane via approaches that would transform natural gas from a non-renewable to a renewable clean fuel.

Solar technologies such as photovoltaics have received extensive federal and private support. Still, high efficiency, low-cost solar solutions do not exist. ARPA-E is considering a radically different approach to solar power generation, specifically the storage of incident sunlight as chemical energy that could be released on exposure to a catalyst. This novel concept would facilitate solar storage in such a fashion that renewable energy could be harvested when available and harnessed as needed.

Conventional power generation facilities – both nuclear and fossil-fuel fired – present extraordinarily harsh conditions under which construction materials must survive and perform. As a result, high temperature, radiation-hard, and corrosion-resistant materials have been the focus of intense study. While numerous advances have been made in areas such as nickel-based superalloys, improved efficiency remains out-of-reach due to materials limitations. ARPA-E will consider high-risk programs in advanced coolants, computationally-guided discovery of high temperature metal alloys, and advanced manufacturing processes. ARPA-E will focus on the manufacture and integration of high-temperature materials (e.g. those that can withstand 1300 degrees Celsius) for low-cost power generation (e.g. Brayton cycle) through high-efficiency engines. In addition, ARPA-E will coordinate with other DOE offices to investigate radically new molding and manufacturing techniques for jointless radiation-hard, high-temperature materials for advanced nuclear reactors.

Stationary Power is a new subprogram for FY 2012.

Electrical Infrastructure **— 80,000**

The U.S. electric grid is undergoing a technical renaissance through the deployment of initial smart-grid technologies, catalyzed significantly through U.S. federal support. This technical renaissance is motivated by the need to modernize the grid for the 21st century: supporting a diverse mix of renewable, efficient, and clean generation; providing greater flexibility and control of electricity for the consumer; greater reliability and security in the delivery of electricity; and a sustainable electric energy foundation for our information-intensive economy.

The US grid is many decades old and often running at maximum capacity, making it vulnerable to outages and security threats. Meanwhile, other nations such as China are investing heavily in those technologies that will leap frog and create the most advanced grid.

While the first generation of smart-grid technology is being deployed as a high-speed information network in parallel with the energy network, ARPA-E looks forward to developing technologies that can realize the full vision of a smart grid. Leveraging the smart grid information network provides a platform for new energy technologies: from widespread deployment of breakthrough approaches to

energy storage; to highly distributed, efficient, and modular approaches to energy generation; to more efficient and secure approaches to controlling the cyber-physical transmission grid system.

ARPA-E's goal is to develop those next generation technologies that will make today's approaches obsolete, and would truly revolutionize the grid for secure, stable, and reliable transmission and distribution of electrical power and maximize the capacity of today's infrastructure. These technologies could be sold globally, thus leading to American jobs and economic prosperity. Some broad goals are as follows:

- Low-cost electrical storage to increase utilization of renewable resources such as wind and solar.
- Advanced, low-cost and smart components for high-efficiency power transmission, conversion and management at ultrahigh voltages for transmission and medium-to-low voltages for distribution networks.
- Technologies for system-level stability, security, high capacity and reliability for the whole US transmission-distribution system.

Potential areas of investment are identified below.

Renewable sources of electricity such as wind and solar offer clean power, but their intermittent nature complicates consistent deployment of base-load power. Grid-scale energy storage technologies buffer variation in renewable generation and ensure stability of the electric grid. The ARPA-E Grid-scale Renewable Intermittent Dispatchable Storage (GRIDS) program is currently developing low-cost grid-scale energy storage technologies. Future ARPA-E investment in this area will integrate novel technologies developed in the GRIDS program into full systems that can be scaled for use on the electric grid, as well as storage strategies effective over longer time-frames. Future programs may explore other approaches to grid-scale energy storage, such as reduced transmission line congestion.

To harness new renewable sources of electricity such as wind, solar, and geothermal, the nation's network of electricity transmission lines must be expanded. Such deployment can take years to secure new "rights of way" for electricity transmission projects, and routes through densely-populated areas are often closed indefinitely to development. Although the U.S electric grid includes hundreds of thousands of miles of transmission lines, less than 1000 miles of new interstate transmission were added during the last decade. To address this problem, ARPA-E will explore technologies that permit transmission of larger amounts of electricity through existing corridors, including devices that enable the operation of transmission systems at 1000 kV (one million volts) and above.

Today's electric grid includes a complex network of power lines, transformers, and substations that relay power from the high voltage transmission system to the homes and businesses in which it is used. Known as the "distribution grid," this network is largely "dumb:" it provides little information to either operators or users. ARPA-E will consider increasing the intelligence of the distribution network to increase the efficiency and reliability of this critical portion of the electric grid. ARPA-E will explore technologies that complement existing smart grid technologies (such as residential "smart meters") and enable more efficient routing of electricity, more efficient operation of transformers and substations, and more effective diagnosis of and rapid response to system faults, including the use of wireless

technology.

Electrical Infrastructure is a new subprogram for FY 2012.

End Use Efficiency **— 105,000**

Energy efficient technologies for buildings, both commercial and residential, offer a tremendous opportunity to reduce energy demand and green house gas emissions. Buildings consume 40 percent of energy in the U.S., while the industrial sector consumes 30 percent. 72 percent of the nation's electricity and 55 percent of natural gas is used in buildings. The cooling and heating of buildings consumes 30 percent of the total energy used in buildings; which corresponds to 30 percent of CO2 emissions. This translates into 12 percent primary energy use and 12 percent CO2 emissions in the U.S. To date, activities in ARPA-E in energy efficiency have focused mainly on buildings.

ARPA-E will continue to invest in the buildings sector to develop high-efficiency energy technologies, including an expansion of the current BEETIT program and new technologies for energy measurement systems and integrated building operations, as well as a novel way to light a room.

ARPA-E's goal is to develop those technologies that do not exist today, but if they did they would lead to substantial life-cycle monetary savings by increasing the efficiency of how energy is used in buildings and industry. Some of the program's broad goals include:

- Reduction of energy consumption by 50% with a pay-back period of less than 5 years by highly efficient and smart use of heating, cooling and electrical power in homes and commercial buildings
- Advanced and alternative technologies to provide industrial goods and services with substantial reduction in energy consumption and a pay-back period of less than 5 years

Potential areas of investment are identified below.

Lighting is among the greatest consumers of electricity. To produce light when the sun is below the horizon, electricity is transformed into light. ARPA-E will investigate technologies that *directly* store photons during the day and emit light on demand, significantly reducing the electric demand for electricity for lighting.

Thermal imaging of buildings and real time monitoring of power use on an outlet by outlet basis can detect hidden energy losses. On the other hand, measurement systems necessary to facilitate such monitoring are both crude and expensive. Residential and commercial buildings consume approximately one third of all the energy in the U.S. and reduction in energy lost through inefficient power management would make a significant reduction in the nation's total energy consumption. ARPA-E will investigate ways to dramatically improve building efficiency through innovative technologies that identify energy losses without the need for expensive system retrofitting, including wireless technology.

(dollars in thousands)

FY 2010 Current Approp	FY 2012 Request

The integration of individual building systems such as lighting, air conditioning, etc. into a single, "smart" building-wide system has the potential to dramatically reduce energy consumption and improve both quality of life (residential) and worker productivity (commercial). However, such systems do not yet exist. ARPA-E will consider programs, building off the successes of the ADEPT program as well as in new areas, that reduce the energy consumption through the development of a building operating system, minimizing losses due to unnecessary power usages, the detection and correction of building "faults," a decrease in installation costs with integrated wireless modules, and reduction of electrical losses due to standby power consumption via power management, including the use of wireless technology.

Heating, ventilation, and air conditioning (HVAC) is the largest contributor to building energy use. ARPA-E has created a program, BEETIT, to improve air conditioning efficiency, which will lead to transformational improvements through reduction in air conditioner loads. ARPA-E is considering building on the success of the BEETIT program both through the expansion of promising technology areas, including thermoelastic cooling, membranes for dehumidification, and reverse osmosis refrigeration cycle, as well as consideration of approaches not currently represented.

ARPA-E will investigate integrated electrothermal energy systems integrated with electrothermal storage to match electrical and thermal energy supply and demand for building at the seasonal, weekly and daily basis. Through such a program ARPA-E expects to cut the primary energy consumption by more than 20% even if existing energy service technologies such as lighting, air-conditioning, etc. are used. Combined with the other programs on improvement of energy service technologies mentioned above, further significant reduction will be achieved in buildings.

End Use Efficiency is a new subprogram for FY 2012.

Embedded Efficiency **— 60,000**

On the demand side of our energy economy, energy is consumed primarily in three sectors—buildings, transportation and industry. Buildings consume approximately 40 percent of our primary energy, transportation about 28 percent, and industry about 32 percent. In the case of buildings and transportation, energy is used predominantly for the direct benefit of the people enjoying the services provided by that energy. Energy use in the industrial sector primarily goes into the creation of products and materials such as chemicals, cement, steel, aluminum, glass, etc, which are then used in consumer goods, buildings, and transportation. Energy consumption in the industrial sector, therefore, is embedded in the materials and goods that are produced and used in other parts of our economy. Reduction of energy consumption in the industrial sector is essential to ARPA-E's mission and will be achieved through "embedded efficiency" programs.

Another example of embedded efficiency is the use of water in agriculture, power generation, natural gas production, etc. Unchecked use of water in industrial processes can lead to shortages of potable water, which then necessitates consumption of significant energy to produce clean water. Hence, sustainable and low-energy pathways of reusing water and producing drinkable water are within the realm of ARPA-E's emphasis on embedded efficiency.

(dollars in thousands)

FY 2010 Current Approp	FY 2012 Request

In the first round of funding, ARPA-E funded one project on desalination of water through novel carbon nanotube based membranes that consume less energy than traditional reverse-osmosis membranes. As part of the FY 2012 budget, ARPA-E will consider developing programs in Embedded Efficiency that will fall within the industrial energy or water sectors.

ARPA-E's goal is to focus on the industrial sector with the aim to develop cost-competitive technologies and industrial processes to significantly reduce energy consumption and emissions. Some of the program's broad goals include:

- Advanced and alternative technologies to provide industrial goods and services with substantial reduction in energy consumption and a pay-back period of less than 5 years
- Utilization of waste heat from industry and other uses in intelligent ways to reduce primary energy consumption.

Potential areas of investment are identified below.

Over 97 percent of the earth's water is salty; for agriculture and other human needs, salt must be removed. In many areas of the United States fresh water is already a limiting resource, and this shortage will increase in coming years. Current desalination techniques are prohibitively energy intensive, which limits the deployment of large scale desalination plants. Revolutionary advances in desalination would expand those regions of the world amenable to human settlement, and vastly increase the fraction of the world's landmass capable of supporting agriculture. In coordination with ongoing DOE efforts, ARPA-E will investigate advanced technologies for both centralized and decentralized desalination applications.

The manufacturing of important building materials such as steel, cement, and glass is highly energy-intensive, in large part because the processes to manufacture these materials operate at high temperatures. Industry consumes one third of all energy used in the United States, and much of that energy is lost as waste heat in exhaust and waste streams. ARPA-E will develop programs designed to dramatically increase the fraction of waste heat captured from industrial manufacturing, massively increasing the energy efficiency of such plants, and look at alternative processes with a dramatically reduced need for thermal energy inputs.

Embedded Efficiency is a new subprogram for FY 2012.

Transportation Systems **— 115,000**

In 2008, the U.S. consumed 19.5 million barrels of petroleum per day, 57 percent of which was imported from foreign sources. The U.S. transportation sector represents nearly 70 percent of U.S. petroleum consumption and accounts for roughly 30 percent of U.S. CO2 emissions. Broadly speaking, reduction in fuel consumption and energy-related emissions can be achieved through advances in fuel/propulsion, vehicles, and driver behavior. To date, activities at ARPA-E in the transportation sector have focused largely on fuels. ARPA-E will continue to invest in the transportation sector, in both fuels

and vehicles.

ARPA-E is focusing to create a diverse portfolio of technological options that would reduce our dependence on oil, and instead rely on the efficient use of domestic sources of energy for transportation, while addressing the other statutory goals mentioned above. Some broad goals follow:

- Development of those batteries and systems that would make electric vehicles have a range of 300-500 miles and be less expensive than cars based on internal combustion engines. This would enable electric vehicles to be market competitive without government subsidies.
- Development of sustainable and market-competitive transportation fuels using domestic resources such as natural gas or a combination of carbon dioxide and hydrogen, that have 5-10 times less land and water use than that of biomass or algae based biofuels. This would be especially attractive for long-haul trucks and air transport where electrification is unlikely to make an impact.
- Novel uses of information technology to reduce fuel consumption, avoid traffic congestion, and optimize use of existing transportation resources.
- Novel cost-effective power generation or propulsion systems that have significantly higher efficiency than today's internal combustion engines, and thereby maximize the use of transportation fuels.

Potential areas of investment are identified below.

Development of those batteries and systems that would allow electric vehicles to have a range of 300-500 miles, and be less expensive than cars based on internal combustion engines, would enable electric vehicles to be market-competitive. ARPA-E will expand its support of electric vehicle technologies, which will enable the United States to simultaneously reduce its dependence on petroleum. While remaining cognizant of other DOE activities in these areas in order to avoid duplication, future ARPA-E programs will support the design and development of advanced battery systems based on the high-capacity battery cells developed in the existing Batteries for Electrical Energy Storage in Transportation (BEEST) program. These battery systems may target high energy and power densities by combining batteries and ultracapacitors with lightweight structural packaging materials and appropriate thermal management. The goal is overcome "range anxiety" (>300 miles driving range) and simultaneously delivery sufficient power for acceleration. Low-cost, high-efficiency, user-friendly vehicle charging technology will also be developed, including "fast charging" systems that provide sufficient power for >80 miles of driving range in less than 15 minutes of charging time, without degrading battery life or adversely impacting the electric grid. While much current investment is focused on vehicle development, ARPA-E will also consider allied technologies required to ensure successful deployment of a mass-market product.

ARPA-E will continue and expand support for novel approaches to energy-dense, infrastructure-compatible fuels, which will simultaneously reduce the nation's dependence on foreign petroleum and reduce greenhouse gas emissions. Future programs will build on the ARPA-E Electrofuels Program, which considers non-photosynthetic approaches to convert renewable energy resources and carbon dioxide directly into fuel. Successful Electrofuels approaches will be improved to increase conversion

efficiency and lower cost, subject to rigorous techno-economic analysis to ensure cost-effective deployment, and scale-up to de-risk commercial investment.

Development of sustainable and market-competitive transportation fuels using domestic resources such as natural gas or a combination of carbon dioxide and hydrogen, that have 5-10 times less land and water use than that of biomass or algae based biofuels, would directly reduce foreign imports of oil, and will be especially attractive for long-haul trucks and air transport where electrification is unlikely to make an impact. ARPA-E will develop unique approaches for the conversion of natural gas into energy-dense, infrastructure-compatible liquid fuels for transportation. This effort will leverage the nation's remarkable reserves of natural gas to displace imported petroleum in the transport sector without modification to the millions of vehicles currently in service. Although natural gas can be converted to diesel through Fischer–Tropsch processes, CAPEX demands largely preclude widespread commercial deployment. ARPA-E will support exploration of methanotroph-based conversion protocols that convert natural gas to gasoline and diesel cleanly, efficiently, and at a cost equal to or less than petroleum fuels.

ARPA-E will support development of novel information technology systems for the transportation sector, including wireless technology. ARPA-E will coordinate with the U.S. Department of Transportation's Intelligent Transportation Systems (ITS) program, administered by the Research and Innovative Technology Administration (RITA), to develop technologies which aim to decrease congestion and increase the efficiency of existing transport networks, leading to lower petroleum usage and costs, as well as emissions in the transportation sector. Future programs may include development of advanced systems that allow vehicles to communicate with both roadways and other vehicles, and new network monitoring and optimization tools that dynamically reroute traffic and alter traffic signals. While some technology development is occurring in all of these areas, the ARPA-E effort will aim to optimize large portions of the existing transportation network in ways that are distinct from ongoing efforts.

ARPA-E will investigate novel cost-effective power generation or propulsion systems that have significantly higher efficiency than today's internal combustion engines, and thereby maximize the use of transportation fuels. ARPA-E will support the development of high-efficiency vehicle propulsion systems so efficient and inexpensive that they could replace the conventional internal combustion engine. The engines in our cars and trucks waste over half of the available energy in each gallon of gasoline they consume; more efficient technologies would reduce our dependence on foreign petroleum and lower emissions. Future programs will support the development of radically new volumetric fuel cells that generate electricity more efficiently than combustion processes. While today's fuel cell systems are too expensive for deployment and have a limited lifespan, ARPA-E will explore novel designs that lower cost and increase available power by expanding the reaction site.

Transportation Systems is a new subprogram for FY 2012.

Seedlings/Broad Funding Announcement	**—**	**17,329**

The focus of the Seedlings/Broad Funding Announcement line is to provide funding for innovative projects that happen to fall outside the boundaries of a specific topic area FOAs. ARPA-E believes it is important to capture any truly innovative projects that may be out there and to foster an inclusive community that demonstrates ARPA-E is open to funding projects that are outside of the specific focus topic areas FOAs. In FY 2012, ARPA-E plans to have at least one Broad Funding Announcement.

Seedlings/Broad Funding Announcement is a new subprogram for FY 2012.

SBIR/STTR	**—**	**14,614**

The FY 2012 amount shown is the estimated requirements for the continuation of the mandated SBIR and STTR programs.

Total, ARPA-E Projects	**—**	**521,943**

Explanation of Funding Changes

	FY 2012 vs. FY 2010 Current Approp ($000)
Stationary Power The increase is due to this being a new subprogram for FY 2012.	+130,000
Electrical Infrastructure The increase is due to this being a new subprogram for FY 2012.	+80,000
End Use Efficiency The increase is due to this being a new subprogram for FY 2012.	+105,000
Embedded Efficiency The increase is due to this being a new subprogram for FY 2012.	+60,000
Transportation Systems The increase is due to this being a new subprogram for FY 2012.	+115,000
Seedlings/Broad Funding Announcement The increase is due to this being a new subprogram for FY 2012.	+17,329
SBIR/STTR	+14,614

	FY 2012 vs. FY 2010 Current Approp ($000)
The increase is due to the increased amount of the request for new funds for ARPA-E Projects in FY 2012.	
Total Funding Change, ARPA-E Projects	**+521,943**

Program Direction

Funding Profile by Category

(dollars in thousands)

	FY 2010 Current Approp	FY 2012 Request
Headquarters		
Salaries and Benefits	—	8,493
Travel	—	1,500
Support Services	—	15,575
Other Related Expenses	—	2,500
Total, Headquarters	—	28,068
Full Time Equivalents	—	38
Total Program Direction		
Salaries and Benefits	—	8,493
Travel	—	1,500
Support Services	—	15,575
Other Related Expenses	—	2,500
Total, Program Direction	—	28,068
Total, Full Time Equivalents	—	38

Detailed Justification

(dollars in thousands)

	FY 2010 Current Approp	FY 2012 Request
Salaries and Benefits	**—**	**8,493**

ARPA-E federal staff will provide leadership and management for ARPA-E in both the administrative and program management functions. Administrative functions include the Director's office, contract management, general counsel, financial management, and human capital management. Program Directors will establish research and development goals, solicit applications for specific technology areas of particular promise, build research collaborations, select projects to be supported under the program, monitor the progress of those projects, and recommend program restructure or termination of research partnerships or whole projects. The Director will ensure, to the maximum extent practicable, that the activities of ARPA-E are coordinated with, and do not duplicate the efforts of, programs and laboratories within the Department, or other relevant research agencies.

Travel	**—**	**1,500**

The request funds travel by ARPA-E staff to carry out the activities supported under the program. The amount requested includes all costs of transportation of persons, subsistence of travelers, and incidental travel expenses in accordance with federal travel regulations which are directly chargeable to ARPA-E. ARPA-E Program Directors and staff travel to award recipient locations to conduct first-hand monitoring and evaluation of progress towards technical deliverables and milestones. This travel is essential to assessing the performer's research efforts and informing any decision to stop targeted programs on the basis of performance.

Support Services	**—**	**15,575**

The ARPA-E Support Services subprogram provides funds for non-federal contractor support functions, defined as advisory and assistance services acquired by contract from non-governmental services, necessary to carry out the activities supported under the program. Included under this element for FY 2012 are technical support, program management support, information technology and computer system operations support, and administrative and clerical support.

Other Related Expenses	**—**	**2,500**

The Other Related Expenses subprogram includes costs for building leases, and other related expenses (communications, utilities, computer and video support, training, printing and graphics, photocopying, postage, supplies, and common administrative services) not covered by the Working Capital Fund. The request funds training for ARPA-E Program Directors and staff. ARPA-E will have a relatively limited number of federal employees who will require training on policies and procedures for both DOE and the federal government, since many hired staff will be new to the federal government. Other Related Expenses provides ARPA-E's contribution to the Department's Working Capital Fund (WCF) for common administrative services at HQ, 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 Working Capital Fund business lines per the Department's new policy being implemented in FY 2012. In addition, WCF services assessed to and used by HQ, OSTI, and the Field include online training, the Corporate Human Resource Information System, payroll processing, and the Project Management Career Development Program.

	(dollars in thousands)	
Total, Program Direction	**—**	**28,068**

Explanation of Funding Changes

	FY 2012 vs. FY 2010 Current Approp ($000)
Salaries and Benefits The increase is due to the fact that ARPA-E received no funding in FY 2010, and will accommodate the employment of an estimated 38 federal employees in FY 2012.	+8,493
Travel The increase is due to the fact that ARPA-E received no funding in FY 2010. ARPA-E performs significant oversight and diligence on its performers with multiple site visits per year by the program director, as well as performer community meetings which bring together performers from similar or complimentary technology areas for collaboration.	+1,500
Support Services The increase is due to the fact that ARPA-E received no funding in FY 2010.	+15,575
Other Related Expenses The increase is due to the fact that ARPA-E received no funding in FY 2010.	+2,500
Total Funding Change, Program Direction	**+$28,068**

Support Services by Category

(dollars in thousands)

	FY 2010 Current Approp	FY 2012 Request
Technical Support		
Management and Technical Services	—	7,825
Total, Technical Support	—	7,825
Management Support		
Administrative Services	—	7,750
Total, Management Support	—	7,750
Total, Support Services	—	15,575

Other Related Expenses by Category

(dollars in thousands)

	FY 2010 Current Approp	FY 2012 Request
Other Related Expenses		
Rent to Others	—	900
Communications, Utilities, Misc.	—	250
Printing and Reproduction	—	100
Other Services	—	50
Purchases from Gov. Accounts	—	25
Supplies and Materials	—	50
Equipment	—	125
Training	—	250
Working Capital Fund	—	750
Total, Other Related Expenses	—	2,500

Wireless Innovation Fund
Advanced Research Projects Agency - Energy

(dollars in thousands)

	FY 2010 Current Approp	FY 2012 Request
Wireless Innovation Fund	—	100,000
Total, Wireless Innovation Fund	—	100,000

Detailed Justification

(dollars in thousands)

	FY 2010 Current Approp	FY 2012 Request
Wireless Innovation Fund	**—**	**100,000**

The President's Wireless Innovation and Infrastructure Initiative proposes to reallocate a total of 500 megahertz of Federal agency and commercial spectrum bands over the next 10 years in order to increase Americans access to wireless broadband. Repurposing spectrum will greatly facilitate access for smart phones, portable computers, and innovative technologies that are on the horizon. This effort will also enhance Americas public safety, infrastructure, and competitiveness by investing some of the expected auction receipts in the creation of a broadband network for public safety, expanding access to wireless broadband in rural America, and a Wireless Innovation (WIN) Fund to help develop cutting edge wireless technologies. As part of this initiative, ARPA-E will participate in the WIN Fund by supporting clean energy activities.

An additional $100 million in mandatory funding is proposed from the Wireless Innovation Fund for ARPA-E to develop cutting-edge wireless technologies. In FY 2012, ARPA-E plans to utilize funds available from the Wireless Innovation Fund on projects related to wireless information technology, as outlined in the detailed justification of the projects section, particularly in Electrical Infrastructure, End Use Efficiency, and Transportation Systems.

Explanation of Funding Changes

	FY 2012 vs. FY 2010 Current Approp ($000)
Wireless Innovation Fund	+100,000

The increase is due to this being a new one-time source of funding for ARPA-E, available in FY 2012.

Fossil Energy Research and Development

Fossil Energy Research and Development

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Fossil Energy Research and Development
Office of Fossil Energy

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), $452,975,000, to remain available until expended: Provided, 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.

Note.--A full-year 2011 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. 111-242, as amended). The amounts included for 2011 reflect the annualized level provided by the continuing resolution.

Fossil Energy Research and Development
Office of Fossil Energy

Overview

Appropriation Summary by Program

	FY 2010 Current Appropriation	FY 2011 CR	FY 2012 Request
Fossil Energy Research and Development			
Coal	393,485		291,358
Natural Gas Technologies	17,364		0
Unconventional Fossil Energy Technologies	19,474		0
Program Direction	158,000		159,233
Plant and Capital Equipment	20,000		16,794
Fossil Energy Environmental Restoration	10,000		7,897
Cooperative R&D	4,868		0
Special Recruitment Programs	700		700
Congressional Directed Projects	35,879		0
Subtotal, Fossil Energy Research and Development	659,770		475,982
Use of prior-year balances	0		-23,007
Total, Fossil Energy Research and Development	659,770	672,383	452,975
Strategic Petroleum Reserve			
Facilities Expansion	25,000		0
Facilities Development	218,823		192,704
Use of prior year balances	0		-71,000
Total, Strategic Petroleum Reserve	243,823	243,823	121,704
Northeast Home Heating Oil Reserve	11,300		10,119
Northeast Home Heating Oil Cancelation	0		-79,000
Naval Petroleum & Oil Shale Reserves	23,627		14,909
Total, Fossil Energy	938,520[a]	951,133	520,707

Public Law Authorizations:

[a] Total was reduced by $12,676,000 that was transferred to the Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) programs.

Preface

Secure, affordable, and environmentally acceptable energy sources are essential to our Nation's security and economic prosperity. The Fossil Energy Research and Development (FER&D) appropriation advances technologies related to the reliable, efficient, affordable, and environmentally sound use of fossil fuels.

The FER&D appropriation implements several key Research, Development and Demonstration (RD&D) programs. To advance Carbon Capture and Storage (CCS) technologies, the CCS Demonstration program manages a portfolio of commercial-scale projects that demonstrate advanced clean coal technologies, and build and operate near-zero atmospheric emissions power plants which capture and store carbon dioxide (CO_2). The Carbon Capture sub-program is focused on emerging technologies that separate CO_2 in both pre-combustion and post-combustion systems. The Carbon Storage sub-program is focused on the science of long-term geologic storage of CO_2, including small- and large-scale CO_2 injection tests across the Nation to improve our understanding of CO_2 behavior in the subsurface. Advanced Energy Systems sub-program focuses on improving the efficiency of coal-based power systems, enabling affordable CO_2 capture, increasing plant availability, and maintaining the highest environmental standards. The Cross-cutting Research activity serves as a bridge between basic and applied research by fostering the development and deployment of innovative systems.

Mission

The FER&D Program creates public benefits by enhancing U.S. economic, environmental, and energy security. The program carries out three primary activities: (1) managing and performing energy-related 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.

Benefits

On February 3, 2010, President Obama established an Interagency Task Force on Carbon Capture and Storage composed of 14 Executive Departments and Federal Agencies. As stated in the August 2010 Task Force report:

> "While CCS can be applied to a variety of stationary sources of CO_2, its application to coal-fired power plant emissions offers the greatest potential for GHG [Greenhouse Gas] reductions. Coal has served as an important domestic source of reliable, affordable energy for decades, and the coal industry has provided stable and quality high-paying jobs for American workers. At the same time, coal-fired power plants are the largest contributor to U.S. greenhouse gas emissions, and coal combustion accounts for 40 percent of global CO_2 emissions from the consumption of energy. EPA and Energy Information Administration assessments of recent climate and energy legislative proposals show that, if available on a cost-effective basis, CCS can over time play a large role in reducing the overall cost of meeting domestic emissions reduction targets. By playing a leadership role in efforts to develop and deploy CCS technologies to reduce GHG emissions, the United States can preserve the option of using an affordable, abundant, and domestic energy resource, help

improve national security, help to maximize production from existing oil fields through enhanced oil recovery, and assist in the creation of new technologies for export."

Elaborating further on the potential global significance of CCS, the Task Force report states that:

"Globally, CCS can play a major role in reducing GHG emissions, with 20–40 percent of global emissions from electric power (IPCC, 2005). The early development of a robust domestic industry in advanced CCS technology would further the Administration's goals for continued leadership in the global market for innovation. American firms could become leading exporters of advanced CCS technology."

The FER&D Program supports CCS Task Force recommendations and DOE's mission to achieve national energy security in an economic and environmentally sound manner through the development of the technical capability to dramatically reduce carbon emissions to achieve near-zero atmospheric emissions power production. To achieve this goal, the program is focused on developing and demonstrating advanced power generation and CCS technologies for existing facilities and new fossil-fueled power plants, to increase overall system efficiencies and reduce CCS capital costs.

Performance

The mission of the **Fossil Energy Research and Development** (FER&D) program is to create technology and technology-based policy options for public benefit by enhancing U.S. economic, environmental, and energy security. This mission is achieved by developing technologies to enhance the clean use of domestic fossil fuels and to reduce emissions from fossil-fueled electricity generation plants to achieve near-zero atmospheric emissions power production.

The **CCS Demonstration** program, including the Clean Coal Power Initiative (CCPI), FutureGen 2.0, and Industrial CCS Demonstrations funded by the Recovery Act, enables and accelerates the deployment of advanced carbon capture and storage (CCS) technologies to ensure clean, reliable, and affordable electricity for the United States. The three major component of the CCS Demonstration Program are cost-shared partnerships between the government and industry to develop and demonstrate advanced coal-based power generation and industrial technologies at the commercial scale.

The **Carbon Capture & Storage (CCS) and Power Systems** program directly supports the mission of FER&D by conducting and supporting long-term, high-risk R&D to significantly reduce coal power plant emissions (including CO_2) and substantially improve efficiency to reduce carbon emissions, leading to a viable near-zero atmospheric emissions coal energy system and supporting carbon capture and storage.

- The **Carbon Capture** sub-program is focused on the development of post-combustion and pre-combustion CO_2 capture technologies for new and existing power plants. Post-combustion CO_2 capture technology is applicable to pulverized coal (PC) power plants, which is the current standard industry technology for coal-fueled electricity generation. Pre-combustion CO_2 capture is applicable to gasification-based systems such as IGCC, a potential technology for future generation of electricity from coal-fueled plants.

- The **Carbon Storage** sub-program advances safe, cost effective, permanent geologic storage of CO_2. Activities in this area were previously funded under the Carbon Sequestration activities. The technologies developed and large-volume injection tests conducted through this sub-program will be used to benefit the existing and future fleet of fossil fuel power generating facilities by developing tools to increase our understanding of geologic reservoirs appropriate for CO_2 storage and the behavior of CO_2 in the subsurface. No funding is provided for reforestation or other terrestrial carbon sequestration.

- The **Advanced Energy Systems** sub-program focuses on improving the efficiency of coal-based power systems, enabling affordable CO_2 capture, increasing plant availability, and maintaining the highest environmental standards. The program supports gasification-related R&D to convert coal into synthesis gas (syngas) that can in turn be converted into electricity, chemicals, hydrogen, and liquid fuels. In addition, this sub-program advances hydrogen turbine designs to improve the performance of pre-combustion capture systems and supports the development of Advanced Combustion Systems through research focused on new high-temperature materials and the continued development of oxy-combustion technologies.

- The **Cross-cutting Research** sub-program serves as a bridge between basic and applied research by fostering the development and deployment of innovative systems for improving efficiency and environmental performance through the research and development of instrumentation, sensors, and controls targeted at enhancing the availability of advanced power systems while reducing costs of Advanced CCS and Power Systems. This program area also develops computation, simulation, and modeling tools focused on optimizing plant design and shortening developmental timelines. The Cross-cutting Research activity also addresses advanced and cross-cutting issues, including plant optimization technologies, environmental and technical/economic analyses, coal technology export, and integrated program support.

The **Natural Gas Technologies** R&D program developed technologies to produce gas hydrate resources. Consistent with Administration policy to phase out inefficient fossil fuel subsidies, the program is requesting no funding in FY 2012 for R&D to increase hydrocarbon production.

Safeguards and Security

Total Office of Fossil Energy contributions in support of the Safeguards and Security program mission is $28.2M in FY 2010 and $28.9M in FY 2012. These amounts are the compilation of cross-cuts from the following FE program elements: Strategic Petroleum Reserve FY 2010 $24.1M; FY 2012 $24.4M; Naval Petroleum Reserve FY 2010 $.8M; FY 2012 $.6M and Fossil Energy Research and Development FY 2010 $3.3M; FY 2012 $3.9M.

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.

Direct-Funded Maintenance and Repair

	FY 2010 Current Approp.	FY 2012 Request
National Energy Technology Laboratory	11,679	12,390
Total, Direct-Funded Maintenance and Repair	**11,679**	**12,390**

Fossil Energy Research and Development

Office of Fossil Energy

Funding by Site by Program

(dollars in thousands)

	FY 2010 Current Appropriation	FY 2012 Request
Ames National Laboratory		
Coal	1,390	1,460
Total, Ames	1,390	1,460
Argonne National Laboratory (East)		
Coal	3,135	200
Natural Gas Technologies	128	0
Total, Argonne National Laboratory (East)	3,263	200
Idaho National Engineering and Environmental Laboratory		
Coal	170	850
Natural Gas Technologies	30	0
Total, Idaho National Engineering and Environmental Laboratory	200	850
Lawrence Berkeley National Laboratory		
Coal	3,191	1,600
Natural Gas Technologies	410	0
Total, Lawrence Berkeley National Laboratory	3,601	1,600
Lawrence Livermore National Laboratory		
Coal	425	1,183
Total, Lawrence Livermore National Laboratory	425	1,183
Los Alamos National Laboratory		
Coal	674	1,298
Total, Los Alamos National Laboratory	674	1,298
National Energy Technology Laboratory		
Coal	371,241	274,804
Natural Gas Technologies	16,369	0
Program Direction	125,150	127,386

(dollars in thousands)

	FY 2010 Current Appropriation	FY 2012 Request
Fossil Energy Environmental Restoration	8,310	6,477
Cooperative Research and Development	4,818	0
Unconventional Fossil Energy Technologies	18,540	0
Total, National Energy Technology Laboratory	544,428	408,667
Oak Ridge National Laboratory		
Coal	3,761	675
Total, Oak Ridge National Laboratory	3,761	675
Pacific Northwest Laboratory		
Coal	6,350	0
Natural Gas Technologies	50	0
Total, Pacific Northwest Laboratory	6,400	0
Sandia National Laboratories		
Coal	0	160
Natural Gas Technologies	161	0
Total, Sandia National Laboratories	161	160
Washington Headquarters		
Coal	3,364	9,128
Program Direction	32,850	31,847
Fossil Energy Environmental Restoration	1,690	1,420
Plant and Capital Equipment	20,000	16,794
Cooperative Research and Development	50	0
Special Recruitment Programs	700	700
Unconventional Fossil Energy Technologies	934	0
Congressionally Directed Projects	35,879	0
Total, Washington Headquarters	95,467	59,889
Subtotal Fossil Energy Research and Development		475,982
Use of Prior Year Balances		-23,007
Total, Fossil Energy Research and Development	659,770	452,975

Site Description

Ames National Laboratory

The Ames National Laboratory is located in Ames, Iowa.

Coal
Ames National laboratory conducts advanced research on virtual simulations and high-temperature materials.

Argonne National Laboratory (East)

The Argonne National Laboratory (ANL), located in Argonne, Illinois, is a major multi-program laboratory managed and operated for the U.S. Department of Energy (DOE) by the University of Chicago under a performance-based contract.

Coal
ANL research supports the following: concepts for various technologies supporting FutureGen 2.0; DOE strategies to capture CO_2 from existing and advanced fossil fuel conversion systems in Carbon Capture and Storage; DOE strategies to develop non-destructive testing examination of materials and mineral reaction kinetics in the Cross-cutting Research; and the core technology program in the Solid Oxide Fuel Cells program.

Idaho National Engineering and Environmental Laboratory

The Idaho National Engineering and Environmental Laboratory (INEEL) is located outside of Idaho Falls, Idaho.

Coal
Research conducted at INEEL supports the following: concepts for various technologies for central systems; research on breakthrough concepts to separate and capture CO_2; and research and development on materials development in Advanced Research.

Natural Gas Technologies
Research conducted at INEETL supported microbiological studies in Gas Hydrates and energy resources system development in Effective Environmental Protection.

Lawrence Berkeley National Laboratory

The Lawrence Berkeley National Lab (LBNL) is located in Berkeley, California.

Coal
LBNL conducts research in the following areas: concepts for various technologies for central systems and research and development on geologic storage approaches and measurement, monitoring, and verification protocols in geologic carbon storage.

Natural Gas Technologies
Research conducted at LBNL supported the modeling of hydrate production, lab study of hydrate flow characteristics, and climate modeling in Gas Hydrates.

Lawrence Livermore National Laboratory

The Lawrence Livermore National Lab (LLNL) is located in Livermore, California.

Coal
Research will focus on carbon capture and storage approaches.

Los Alamos National Laboratory

The Los Alamos National Laboratory (LANL) is located in Los Alamos, New Mexico.

Coal
Research supports the following: (1) concepts for various technologies for central systems; (2) research and development in the area of Carbon Capture and Storage (CCS) to lower the costs of CO_2 capture, provide fundamental scientific information on engineered geologic storage approaches, and develop advanced instrumentation to measure and validate geologically stored carbon; and (3) research and development in the area of Cross-cutting Research to model mineral storage and develop hydrogen separation membranes.

National Energy Technology Laboratory

The National Energy Technology Laboratory (NETL), located in Morgantown, West Virginia, Pittsburgh, Pennsylvania, Albany, Oregon, Houston, Texas, and Fairbanks, Alaska is a multi-purpose laboratory, owned and operated by the U.S. Department of Energy. NETL conducts and implements science and technology development programs for the Department in energy and energy-related environmental systems. NETL's key functions are to shape, fund, and manage extramural (external) RD&D projects, conduct on-site science and technology research, and support energy policy development and best business practices within the Department.

Coal
Scientists and engineers at NETL conduct basic and applied research and development in to the Coal programs. In-house research in the coal gasification area involves advanced materials testing, gas-stream pollutant removal, sorbents development, and membrane separations. NETL researchers are also working to improve the next generation of hydrogen turbines, solid oxide fuel cells, and coupled turbine-fuel cell systems. Research in CCS science studies the scientific basis for CCS options for large stationary sources of CO_2. Finally, research in computational energy science is being conducted to utilize advanced simulation techniques to improve and speed the development of cleaner, more efficient energy devices and plants.

Natural Gas Technologies
In the natural gas technology area work involved gas hydrate field, lab and modeling studies.

Program Direction and Management Support
This activity provides funding for salaries, benefits and overhead expenses for management of the Fossil Energy (FE) program at the National Energy Technology Laboratory (NETL), with sites in Morgantown, WV, Pittsburgh, PA, Albany, OR, Houston, TX, and Fairbanks, AK.

Fossil Energy Environmental Restoration
Activities are to ensure protection of workers, the public, and the environment in performing the mission of the National Energy Technology Laboratory (NETL) at the Morgantown, West Virginia, Pittsburgh, Pennsylvania, Houston, Texas, and Albany, Oregon sites.

Oak Ridge National Laboratory

The Oak Ridge National Laboratory (ORNL) is located in Oak Ridge, Tennessee.

Coal
The Oak Ridge National Laboratory conducts research in the following areas: (1) advanced materials that are applicable to advanced coal based power generation systems in CCS and Power Systems; Carbon Capture and Storage to further geologic storage concepts, including measurement, monitoring and verification; and Cross-cutting Research to develop materials.

Natural Gas Technologies
The Oak Ridge National Laboratory conducted research in the area of formation and dissociation of gas hydrates.

Pacific Northwest Laboratory

The Pacific Northwest Laboratory (PNNL) is located in Richland, Washington.

Coal
The Pacific Northwest Laboratory conducts research and development in the areas of Advanced Research to perform materials research and environmental analyses and Fuel Cells in support of the DOE-Solid State Energy Conversion Alliance (SECA) program.

Natural Gas Technologies
The Pacific Northwest Laboratory conducted research in the areas of kinetics of Gas Hydrates.

Sandia National Laboratories

The Sandia National Laboratory (SNL) is located in Albuquerque, New Mexico, and Livermore, California.

Coal
The SNL conducts research and development in the area of CCS on injection of CO_2 into depleted oil and gas formations, and advanced monitoring methodologies based on advanced seismic concepts. SNL also conducts research and development in the area of Cross-cutting Research to develop hydrogen separation membranes and conduct fundamental combustion research.

Washington Headquarters

Coal
This funding provides program support and technical support for each of the programs within the Coal Program.

Natural Gas Technologies

This funding provided program support and technical support for each of the programs within the Natural Gas Technologies Program

Program Direction
This activity provides funding for salaries, benefits, and overhead expenses for management of the Fossil Energy (FE) program at Headquarters.

Fossil Energy Environmental Restoration
The funding provides program support and technical support.

Coal

Funding Profile by Subprogram

	FY 2010 Current Appropriation	FY 2012 Request
Coal		
Clean Coal Power Initiative	0	0
Fuels and Power Systems	393,485	0
Carbon Capture and Storage (CCS) and Power Systems	0	291,358
Total, Coal	**393,485**[a]	**291,358**

Mission

The Coal Program will ensure the availability of near-zero atmospheric emissions, abundant, affordable, domestic energy to fuel economic prosperity, strengthen energy security, and enhance environmental quality.

Fuels and Power Systems Budget Structure Change

The proposed budget structure change reflects the increased focus of the program on Carbon Capture and Storage (CCS) technologies. The new budget structure aligns the existing work of the Clean Coal program with four key sub-program research areas: Carbon Capture Carbon Storage, Advanced Power Systems, and Cross-cutting Research. In addition to re-aligning the current activities with the new structure, several key changes have been made to increase the transparency of the research and development being conducted by the Office of Fossil Energy:

Innovations for Existing Plants (IEP)

In recent years, the capture of CO_2 from the flue-gas of coal-fired power plants has become a major focus of the IEP sub-program. This program historically has included post-combustion capture systems as well as oxy-combustion systems. To better realize the synergies of research and development activities, post-combustion research will be conducted under the Post-Combustion line item of the Carbon Capture sub-program and oxy-combustion research and high temperature materials research (formerly a component of the Advanced Research sub-program) will now be conducted under the Advance Combustion line item of the Advanced Power Systems sub-program.

Carbon Sequestration

[a] Total was reduced by $10,578,000 that was transferred to the Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) programs.

In addition to the Regional Carbon Sequestration Partnerships, this line item has explored advances in pre-combustion capture, modeling and simulation of sub-surface storage opportunities, monitoring, verification and assessment of stored CO_2, and applications for the beneficial use and re-use of CO_2. As the Office of Clean Coal has shifted focus towards these topics, the Carbon Sequestration program has grown considerably. The creation of five separate line items from the previous Greenhouse Gas Control line item will increase the transparency of the research and development being conducted. The new line items include: Pre-Combustion Capture (a component of the Carbon Capture sub-program), Geologic Storage, Regional Carbon Sequestration Partnerships, Carbon Use and Reuse, and Monitoring, Verification, Accounting and Assessment. With the exception of Pre-Combustion Capture, all of these activities are conducted under the new Carbon Storage sub-program.

Advanced Power Systems

Under the previous budget structure, the Office of Clean Coal conducted research of technologies with the common goal to increase the efficiency, and thereby decrease greenhouse gas emissions intensity (tones of CO_2 per MWh), of new or repowered coal-fueled, baseload power plants under multiple sub-programs. To maximize the synergy of these research activities, the new budget structure consolidates Gasification, Turbines, Solid Oxide Fuel Cells, Hydrogen production, and Advanced Combustion research as line items under the Advanced Energy Systems sub-program.

Cross-cutting Research

Multiple technologies and research methods have been previously grouped under the Advanced Research line. The new structure keeps many of the same programs; however the title change to "Cross Cutting Research" indicates the wide-ranging nature of this research. The primary activity conducted under Cross-Cutting research is advanced computer modeling and simulation work that addresses all aspects of CCS from advanced power block and capture methods to simulating the various mechanisms for geologic storage of CO_2 and examining the integration of all the components in between.

In addition to Coal Utilization Science, the cross-cutting research line also includes many smaller programs, which have now been grouped by topic area. These new topic areas include; Plant Optimization Technologies, Energy Analyses, International Activities, and University Training and Research. Of particular note is the movement of Fine Particulate Control / Air toxics, as well as Byproducts / Water Management from the former Innovations for Existing Plants sub-program into the new Plant Optimization Technologies line item.

CCS Demonstrations

Commercial-scale demonstration of CCS technologies is a key step to generate data and expand our knowledge of how these systems work when integrated with an operating power plant. The Department is focused on successfully implementing four selected CCPI Round III demonstration projects,

FutureGen 2.0, and three Industrial CCS demonstration projects funded through the American Reinvestment and Recovery Act. These demonstrations are critical for proving integrated operation and safe and effective long-term storage at-scale. The R&D focus is on developing advanced technologies to improve cost competitiveness. Continued progress on these CCS demonstration projects will provide important information to help guide future budgetary decisions.

Energy Systems Simulation

Modeling and simulation lie at the core of many of DOE's research activities. One of two areas where the Department will focus its initial modeling efforts to enhance simulation investment that could yield significant results is optimizing the integration of carbon capture and storage systems. New and evolving technologies begin their life either in a lab or at pilot-scale facilities, and slowly and incrementally grow into demonstration projects before being commercialized, a processes that could take 10-30 years. Simulation, which can speed the screening of materials and devices to identify the most promising concepts to pursue, will be an essential capability in reducing the development time of CCS. This initiative will foster collaboration between Office of Science and Fossil Energy.

Benefits

There is a growing consensus that steps must be taken to significantly reduce greenhouse gas (GHG) emissions from energy use at a pace consistent with climate stabilization goals, and that carbon dioxide (CO_2) capture and geologic storage (CCS) is a promising option to help address this challenge. FE RD&D is a major component of the global activities needed if coal power plants with cost-effective CCS (coal with CCS) are to be widely deployed in a timeframe consistent with climate stabilization goals. Regarding these activities:

- Coal with CCS allows the U.S. to obtain continued economic benefits and energy security from large domestic coal resources under significant CO_2 emission constraints.
- Coal with CCS is not currently cost-effective; however FE RD&D could considerably reduce costs of CO_2 capture. Most cost-reduction opportunities are in the area of CO_2 capture.
- Barriers to CO_2 storage include validating safety, permanence, and geologic storage capacity. Considerable progress in these areas has been made under FE's Regional Carbon Sequestration Partnership (RCSP) program. The RCSPs are beginning to implement nine large-scale CO_2 storage tests in locations throughout the U.S. and Canada.
- A significant number of demonstration projects carried out under the Clean Coal Power Initiative (CCPI) program are intended to prove the commercial viability of a suite of coal with CCS technology options.
- CCS may be ready for commercial deployment in selected applications by 2020.

Annual Performance Results and Targets

The Department is in the process of updating its strategic plan, and has been actively engaging stakeholders including Congress. The draft strategic plan is being released for public comment concurrent with this budget submission, with the expectation of official publication this spring. The draft plan and FY12 budget are consistent and aligned. Updated measures will be released at a later date and available at the following link http://www.mbe.doe.gov/budget/12budget/index.htm.

Means and Strategies

Fossil Energy will use various means and strategies to achieve its program 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:

Fossil Energy will engage the scientific, academic and industrial communities, and other public sector entities, including the states, to identify research needs and opportunities; technology strategies for addressing the highest priority needs; and the appropriate government roles in meeting those needs. The program will be implemented through competitively solicited, cost-shared public-private partnerships. The Department will implement the following strategies:

- It will employ a systematic approach to monitor the spectrum of R&D needs to better select and plan activities with a clear governmental role. Such an approach will ensure better planning and execution. Periodic external reviews will be conducted to ensure that the program maintains its focus and terminates projects that industry can fund.

These strategies will accelerate the commercial availability of cost-effective, lower emission coal utilization technology that will save consumers money, improve the environment, and enhance security through the use of an abundant, domestic energy resource.

The following external factors could affect FE's ability to achieve its strategic goal:

- The benefits of some of FE's R&D, such as CCS, are dependent on future domestic and global actions that strongly incentivize reduction of greenhouse gas emissions.
- Program results may also be affected by world prices for competitive feedstocks and energy technologies; new and evolving environmental regulations or new legislation; industry restructuring/deregulation issues and uncertainties; and technology advances in the private sector.

In carrying out the program's mission, FE performs the following collaborative activities:

- Leveraging R&D activities in partnership with universities, state and local governments, industry, foreign governments and research organizations, and other stakeholders; using cost-shared projects and diverse technology paths to improve chances of success, and to create a direct technology transfer component; seeking synergy with the capabilities of multiple governmental agencies and industry, including the unique capabilities of National Laboratories; collaborating with other agencies to effectively promulgate revolutionary energy technologies; investing jointly with other groups in promising technologies for target areas; conducting field demonstrations in collaboration with industry, academia, and others; and transferring technologies in cooperation with state and industry organizations.

Clean Coal Power Initiative (CCPI)

Funding Schedule by Activity

	FY 2010 Current Approp	FY 2012 Request
Clean Coal Power Initiative (CCPI)		
Clean Coal Power Initiative (CCPI)	0	0
Total, Clean Coal Power Initiative (CCPI)	0	0

Mission

The Clean Coal Power Initiative (CCPI) enables and accelerates the deployment of advanced carbon capture and storage (CCS) technologies to ensure clean, reliable, and affordable electricity for the United States. The CCPI is a cost-shared partnership between the government and industry to develop and demonstrate advanced coal-based power generation technologies at the commercial scale.

The 2012 Budget request does not provide any demonstration funds because these projects are already strongly supported through the 2009 American Recovery and Reinvestment Act (ARRA). ARRA provided $3.4 billion for CCS, of which $800 million supported CCPI demonstration projects.

Benefits

CCPI demonstrations address the reliability and affordability of the Nation's electricity supply from coal-based generation. CCPI demonstrations will meet technical requirements set forth in the Energy Policy Act (EPAct) of 2005. By enabling advanced technologies to overcome technical risks involved with scale-up and bringing them to the point of commercial readiness, CCPI accelerates the development of both advanced coal generation technologies and the integration of CCS with both new and existing generation technologies. The CCPI also facilitates the movement of technologies into the market place that are emerging from the core research and development activities.

Round 1 of the CCPI focused on advancing coal technologies for efficiency, environmental, and economic improvements compared to the state-of-the-art. Eight projects were selected under Round 1. From Round 1, three projects have been successfully completed, two projects withdrew, two projects were discontinued during project development, and DOE ceased negotiations prior to award on another. Round 1 is now considered complete.

Round 2 of the CCPI focused on advanced gasification technology and advanced clean-up systems (including mercury control). Four projects were selected under Round 2. One project

withdrew, one project has been successfully completed, and two projects remains active, i.e., Excelsior/Mesaba project and the Southern Company/Transport Gasifier project. The NEPA Record of Decision for the Southern project was issued in 2010 and construction was initiated. Pre-construction site permits were issued in 2010 and the project is seeking to obtain other necessary permits.

In FY 2008, the Round 3 Funding Opportunity Announcement (FOA) focusing on projects that utilize CCS technologies and/or beneficial reuse of carbon dioxide was issued, and proposals were received in January 2009. Two Round 3 projects were selected in July 2009: Hydrogen Energy California (HECA) and Basin Electric Power Cooperative. CCPI Round 3 was extended in June 2009 using ARRA funds, with proposals due in August 2009. Three projects were initially selected under the second closing of Round 3: AEP/Mountaineer, Southern Company/Plant Barry, Summit/Texas Clean Energy Project (TCEP). However, Southern later withdrew their application, and NRG/ W.A. Parrish was subsequently selected. With the exception of Basin Electric, which is still in negotiations, all Round 3 projects are currently underway.

Detailed Justification

	(dollars in thousands)	
	FY 2010 Current Approp.	FY 2012 Request
Clean Coal Power Initiative	**0**	**0**

For FY 2012, construction of Southern Company's IGCC plant will continue. Excelsior will focus on obtaining the necessary environmental permit for the IGCC plant. For Round 3 projects, efforts will focus on completing environmental permitting and detailed design of the facilities. Site preparation and ordering of long lead equipment will be initiated.

For FY 2010, continue ongoing CCPI Round 1 and Round 2 projects, completing operations for currently active Round 1 projects. Efforts will focus on completion of National Environmental Policy Act (NEPA) procedures and initiation of design and construction activities for Round 2 CCPI projects. DOE will announce project selections from the second closing date from Round 3, initiate Round 3 projects through award of cooperative agreements, and initiate/complete NEPA procedures for Round 3 projects. Based upon project selections and fact finding, CCPI anticipates awards to assemble the initial portfolio of advanced technology systems that capture carbon dioxide for geologic storage or beneficial reuse.

Total, CCPI	**0**	**0**

Explanation Of Change

	FY 2012 vs. FY 2010($000)
CCPI	
No funding was requested for the CCPI program in FY 2012, as Round 3 of the CCPI program was sufficiently funded by the American Recovery and Reinvestment Act (ARRA) of 2009.	*0*
Total Funding Change, CCPI	**0**

Annual Performance Results and Targets

The Department is in the process of updating its strategic plan, and has been actively engaging stakeholders including Congress. The draft strategic plan is being released for public comment concurrent with this budget submission, with the expectation of official publication this spring. The draft plan and FY12 budget are consistent and aligned. Updated measures will be released at a later date and available at the following link: http://www.mbe.doe.gov/budget/12budget/index.htm.

CCS and Power Systems

Funding Schedule by Activity (Non-Comparable, or as Appropriated Structure)

	FY 2010 Current Appropriation	FY 2012 Request
Fuels and Power Systems		
Innovations for Existing Plants (IEP)	50,630	0
Advanced Integrated Gasification Combined Cycle (IGCC)	61,341	0
Advanced Turbines	31,158	0
Carbon Sequestration	149,944	0
Fuels	24,341	0
Fuel Cells	48,683	0
Advanced Research	27,388	0
CCS and Power Systems		
Carbon Capture	0	68,938
Carbon Storage	0	115,477
Advanced Energy Systems	0	64,193
Cross Cutting Research	0	42,750
Total, CCS and Power Systems	393,485	291,358

Budget Structure Funding Crosswalk

FY 2010 Funding

	FY 2012 Budget Structure - Carbon Capture			
FY 2010 Budget Structure		**Post-Combustion Capture Systems**	**Pre-Combustion Capture Systems**	**Total**
IEP				
CO2 Carbon Capture and Storage		33,105	-	33,105
Sequestration				
Greenhouse Gas Control		-	15,579	15,579
Total		33,105	15,579	48,683

FY 2012 Funding Request				
	FY 2012 Budget Structure - Carbon Capture			
FY 2010 Budget Structure		**Post-Combustion Capture Systems**	**Pre-Combustion Capture Systems**	**Total**
IEP				
CO2 Carbon Capture and Storage		55,535	-	55,535
Sequestration				
Greenhouse Gas Control		-	13,403	13,403
Total		55,335	13,403	68,938

	FY 2010 Funding					
	FY 2012 Budget Structure - Carbon Storage					
FY 2010 Budget Structure	**Regional Carbon Sequestration Partnerships**	**Geologic Storage**	**Monitoring, Verification, Accounting, and Assessment**	**Carbon Use and Reuse**	**Focus Area for Carbon Sequestration Science**	**Total**
Sequestration						
Greenhouse Gas Control	76,237	31,157	9,737	3,603	-	120,734
Focus Area for Computational Energy Science	-	-	-	-	13,631	13,631
Total	76,237	31,157	9,737	3,603	13,631	134,365

FY 2010 Budget Structure Sequestration	FY 2012 Funding					
	FY 2012 Budget Structure - Carbon Storage					
	Regional Carbon Sequestration Partnerships	Geologic Storage	Monitoring, Verification, Accounting, and Assessment	Carbon Use and Reuse	Focus Area for Carbon Sequestration Science	Total
Greenhouse Gas Control	83,257	14,978	6,738	778		105,750
Focus Area for Computational Energy Science					9,726	9,726
Total	83,257	14,978	6,738	778	9,726	115,477

FY 2010 Budget Structure	FY 2010 Funding						
	FY 2012 Budget Structure – Advance Energy Systems						
	Advanced Combustion Systems	Gasification Systems	Hydrogen Turbines	Hydrogen from Coal	Coal and Coal-Biomass to Liquids	Solid Oxide Fuel Cells	Total
IEP							
CO2 Carbon Capture and Storage	11,684	0	0	0	0	0	11,684
IGCC							
Gasification Systems Technology	0	57,056	0	0	0	0	57,056
Adv. Turbines							
Hydrogen Turbines	0	0	31,158	0	0	0	31,158
Fuels							
Hydrogen From Coal	0	0	0	17,330	0	0	17,330
Coal and Coal Biomass to Liquids	0	0	0	0	7,011	0	7,011
Fuel Cells							

Innovative System Concepts/SECA	0	0	0	0	0	48,683	48,683
Adv. Research							
High Performance Materials	8,860	0	0	0	0	0	8,860
Total	20,544	57,056	31,158	17,330	7,011	48,683	181,782

FY 2010 Budget Structure	**FY 2012 Funding Request**						
	FY 2012 Budget Structure – Advance Energy Systems						
	Advanced Combustion Systems	**Gasification Systems**	**Hydrogen Turbines**	**Hydrogen from Coal**	**Coal and Coal-Biomass to Liquids**	**Solid Oxide Fuel Cells**	**Total**
IEP							
CO2 Carbon Capture and Storage	9,726	0	0	0	0	0	9,726
IGCC							
Gasification Systems Technology	0	38,905	0	0	0	0	38,905
Adv. Turbines							
Hydrogen Turbines	0	0	14,589	0	0	0	14,589
Adv. Research							
High Performance Materials	973	0	0	0	0	0	973
Total	10,699	38,905	14,589	0	0	0	64,193

FY 2010 Budget Structure	FY 2010 Funding					
	FY 2012 Budget Structure – Cross Cutting Research					
	Plant Optimization Technologies	Coal Utilization Science	Energy Analyses	University Training and Research	International Activities	Total
IEP						
Fine Particulate Control/Air Toxics	1,947	0	0	0	0	1,947
By Products/Water Management	3,895	0	0	0	0	3,895
IGCC						
Systems Analysis/Product Integration	0	0	4,285	0	0	4,285
Adv. Research						
(CUS) – Sensors and Controls – Novel Innovations	7,887	0	0	0	0	7,887
(CUS) – Computational System Dynamics	0	2,726	0	0	0	2,726
Coal Technology Export	0	0	0	0	650	650
Biomimetics	0	0	50	0	0	50
Environmental Activities	0	0	450	0	0	450
Technical & Econ Analyses	0	0	500	0	0	500
International Prog Support	0	0	0	0	700	700
Focus Area for Computational Energy Science	0	2,400	0	0	0	2,400
University Coal Research	0	0	0	2,337	0	2,337
HBCU's, Education, and Training	0	0	0	828	0	828
Total	13,729	5,126	5,285	3,165	1,350	28,655

FY 2010 Budget Structure	FY 2012 Funding					
	FY 2012 Budget Structure – Cross Cutting Research					
	Plant Optimization Technologies	Coal Utilization Science	Energy Analyses	University Training and Research	International Activities	Total
IEP						
Fine Particulate Control/Air Toxics	0	0	0	0	0	0

By Products/Water Management	0	0	0	0	0	0
IGCC Systems Analysis/Product Integration	0	0	4,000	0	0	4,000
Adv. Research (CUS) – Sensors and Controls – Novel Innovations	8,000	0	0	0	0	8,000
(CUS) – Computational System Dynamics	0	11,800	0	0	0	11,800
Coal Technology Export	0	0	0	0	650	650
Biomimetics	0	0	0	0	0	0
Environmental Activities	0	0	450	0	0	450
Technical & Econ Analyses	0	0	500	0	0	500
International Prog Support	0	0	0	0	700	700
Focus Area for Computational Energy Science	0	13,400	0	0	0	13,400
University Coal Research	0	0	0	2,400	0	2,400
HBCU's, Education, and Training	0	0	0	850	0	850
Total	8,000	25,200	4,950	3,250	1,350	42,750

Description

The Carbon Capture & Storage (CCS) and Power Systems program provides research to significantly reduce coal power plant emissions (including CO_2) and substantially improve efficiency to reduce carbon emissions, leading to a viable near-zero atmospheric emissions coal energy system and supporting carbon capture and storage.

Background

The Department is developing advanced clean coal technology with a goal of deploying high efficiency coal power plants achieving near-zero atmospheric emissions. The Office of Fossil Energy's CCS and Power Systems program is leading efforts to make possible greater utilization of the Nation's most abundant commercially available energy resource (coal) in an environmentally sensitive way. The core Research and Development (R&D) efforts of the CCS and Power Systems program focuses on a variety of carbon capture and storage technologies for pulverized coal, oxy-combustion, and gasification plants: post-combustion carbon capture for new and existing plants, improved gasification technologies, development of stationary power fuel cells, improved turbines for future coal-based combined cycle plants, and creation of a portfolio of technologies that can capture and permanently store greenhouse gases.

In addition to the funding levels reflected in the CCS and Power Section, Program Direction accounts for NETL Program Specific Activities supporting CCS and Power Systems. This funding supports Federal staff directly associated with conducting research activities specific to CCS and Power Systems in Carbon Capture, Carbon Storage, Advanced Energy Systems and Crosscutting Research.

Detailed Justification

(dollars in thousands)

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Carbon Capture

The Carbon Capture activity is focused on the development of post-combustion and pre-combustion CO_2 capture technology for new and existing power plants. Post-combustion CO_2 capture technology is applicable to pulverized coal (PC) power plants, which is the current standard industry technology for coal-fueled electricity generation. Pre-combustion CO_2 capture is applicable to gasification-based systems such as IGCC, a potential technology for future generation of electricity from coal-fueled plants.

- **Post-Combustion Capture Systems** **33,105** **55,535**

  This activity focuses specifically on developments related to advanced technologies that achieve 90 percent CO_2 capture at no more than a 35 percent increase in levelized cost of electricity (LCOE) of post-combustion capture for new and existing conventional coal-fired power plants. Given the energy penalties associated with currently available CO_2 capture technologies, significant improvements in both cost and energy efficiency will be required to achieve this goal.

(dollars in thousands)

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Critical R&D objectives include the continuation of systems and computational simulation analyses of advanced oxycombustion and chemical looping systems and bench through pilot-scale testing of combustion system support components (such as oxycombustion/chemical looping combustion materials of construction, advanced air separation/boiler integration, back end CO_2 purification) by 2016.It is anticipated that successful progression from laboratory- to large-scale demonstration will result in several of these advanced technologies being available for commercial deployment sometime between 2020 and 2030.

In FY 2012, continue work initiated under a previous Funding Opportunity Announcement (FOA) for bench-scale and slipstream development and testing of the following advanced post-combustion CO_2 capture technologies: solvents, sorbents, membranes and hybrid systems. Research initiated under an FY 2010 FOA directed at laboratory and bench-scale research in the areas of membranes, advanced solvents and sorbents (post-combustion) will also continue. *Participants include: American Air Liquide, Inc., Gas Technology Institute, 3H Company, LLC, Akermin, Inc., ION Engineering, LLC, University of Illinois, URS Group, Membrane Technology and Research, Inc., Siemens Energy, Inc., ADA-ES, Inc., NETL, TBD.*

- **Pre-Combustion Capture Systems** **15,579** **13,403**

This activity focuses on development of advanced technologies that achieve 90 percent CO_2 capture at no more than a 10 percent increase in LCOE for pre-combustion applications such as IGCC. 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.

In FY 2012, the pre-combustion CO_2 capture activity will continue research projects awarded through a FY 2009 Funding Opportunity Announcement (FOA) directed at novel concepts and bench-scale projects in an effort to reduce the cost associated with capturing CO_2 for geologic storage. The activity will look for opportunities to advance promising technologies to the next scale of development as well as solicit ideas for novel concepts in pre-combustion. *Participants include: SRI, Southern Company, Univ. of Illinois, Univ. of Minnesota, Pall Corporation, Arizona State University, TDA Research, URS Group, Gas Technology Institute, Membrane Technology Research, New Jersey Institute of Technology, NETL, LANL, TBD.*

Total, Carbon Capture **48,683** **68,938**

Carbon Storage

The overall goal of the Carbon Storage activity is safe, cost effective, permanent geologic storage of CO_2. Activities in this area were previously funded under the Greenhouse Gas Control activities. The technologies developed and large-volume injection tests conducted through this sub-program will be used to benefit the existing and future fleet of fossil fuel power generating facilities by developing tools to increase our understanding of geologic reservoirs appropriate for CO_2 storage and the behavior of CO_2 in the subsurface. No funding is provided for reforestation or other

(dollars in thousands)

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terrestrial carbon sequestration.

- **Regional Carbon Sequestration Partnerships** **76,237** **83,257**

The Regional Carbon Sequestration Partnerships (RCSP) initiative consists of seven Regional Partnerships and has been implemented in 3 Phases: I) Characterization phase; II) Validation phase and III) Development phase. Phase I focused on characterizing regional opportunities for carbon capture and storage, identified CO_2 sources, and identified priority opportunities for field tests. Phase II has focused on the small scale field tests in a variety of geological storage sites in the US and Canada. Phase III, commenced in FY 2008, will help the development on a large scale of CO_2 capture, transportation, injection, and storage such that it can be achieved safely, permanently, and economically. Regulatory compliance and public outreach and education have been an important component of each of these phases.

By FY 2012, several of the large scale injection projects are planned to be injecting CO_2 at the initial sites for large volume geologic storage tests. These field tests will have completed the first stage of the projects consisting of site selection and characterization, NEPA, pre-injection monitoring, and permitting. One project will have concluded its injection of over 1 million tons of CO_2 and will be conducting post injection monitoring at the site. Field projects will begin efforts to test storage in high priority reservoir classes not being tested by the RCSPs and smaller projects covering a wider range of classes that are regionally important to validate that safe and effective storage opportunities are available throughout the United States. The injection phase is different for each project and is dependent on the source and availability of CO_2 at the project site and is planned to require between three to five years of operation. Over the injection period, a significant cumulative volume of CO_2 should be injected at several sites at a rate of 1 Mte/yr/site. By the end of FY 2012, the program plans to inject and store a cumulative total of 3.0 MteCO_2 since 2009 at all operational large-volume geologic storage sites. These large-volume injections are needed to demonstrate the formations selected for storage are capable and have the capacity to store supercritical carbon dioxide. These injections are also needed for the development of technology that can safely and economically store carbon dioxide from coal-based energy systems.

Experience and lessons learned through the small and large field tests and other research and development of associated technologies will be captured in a series of Best Practices Manuals (BPMs). Five of the six BPMs have been completed and the sixth and final BPM will be completed in FY2011. The BPMs will be updated in the future as more data and experience is gained from the geologic field tests. *Participants include: Illinois Geological Survey, Montana State University, UNDEERC, Battelle, SSEB, New Mexico Institute of Mining and Technology, California Energy Commission, NETL, LANL, LBNL, INEEL, TBD.*

- **Geologic Storage Technologies** **31,157** **14,978**

Geologic storage is focused on five types of formations: deep saline formations, depleted oil and gas reservoirs, unmineable coal seams, oil and gas-rich shales, and basalts. The goal of DOE research in geologic storage is to develop technologies that safely, permanently, and cost

(dollars in thousands)

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effectively store CO_2 in geologic formations and monitor its movement and behavior. This involves developing an improved understanding of CO_2 flow and trapping mechanisms within the geologic formations that can support the development of improved and novel technologies for site construction, reservoir engineering, and well construction.

In FY 2012, projects selected from an FY 2010 FOA that looked at technologies for geologic storage will continue their efforts. These projects are focused on efforts to improve our understanding of the science behind CO_2 and co-contaminants flow and reactions in the formation rocks and seals; protocols for CO_2 field management are necessary to optimize storage capacity and injectivity; construction materials for wells, and methods are needed to ensure safe long-term storage; and mitigation protocols and technologies are needed to mitigate any risks for CO_2 leakage from storage formations. These projects will provide technologies that will reduce the costs associated with storage, improve the integrity of storage operations, better understand the fate of the injected CO_2 over millennia, and conduct risk assessments associated with geologic CO_2 storage activities. *Participants include: Advanced Resources International, Inc., Stanford University, Battelle, Clemson University, Colorado School of Mines, Consol, Fusion Petroleum Technologies, Inc., GoldSim Technology, Headwaters Clean Carbon Services, Missouri University, Montana State University, New Mexico Institute of Mining and Technology, Paulsson, Inc., Princeton University, Columbia University, Indiana University, University of Texas, University of Kansas, University of Wyoming, Yale University, NETL, BNL, LANL, LLNL, LBNL, INEEL, PNNL, TBD.*

In FY 2012, work on carbon storage will continue to be coordinated between the U.S. and China with the aim of leveraging each country's investment and accelerating carbon storage technology deployment through sharing of experiences; this coordination will be done under a U.S.-China Clean Energy Research Initiative.

- **Monitoring, Verification, Accounting and Assessment** **9,737** **6,738**

Monitoring, Verification, Accounting, and Assessment (MVAA) is an important part of making geologic sequestration a safe, effective, and acceptable method for greenhouse gas control. MVAA of geologic storage sites is expected to serve several purposes, including addressing safety and environmental concerns; inventory verification; project and national accounting of greenhouse gas emissions reductions at geologic storage sites; and evaluating potential regional, national, and international greenhouse gas reduction goals.

In FY 2012, projects will be continuing from a FY 2009 FOA that focused on development of innovative, advanced technology and protocols for: (1) monitoring, verification, and accounting (MVA) of CO_2 storage in geologic formations; and (2) simulating the behavior of geologically-stored CO_2. The projects will improve the ability to monitor the movement of CO_2 into, through, and out of the targeted geologic storage area; verify the location of CO_2 that has been placed in geologic storage; and account for the entire quantity of CO_2 that has been transported to geologic storage sites. Developing these technologies will help in proving the permanence of CO_2 storage

(dollars in thousands)

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in geologic formations and the ability to assess the risks and reduce them should they be present. *Participants include: Columbia University, Montana State University, Univ. of California – San Diego, University of Miami, Stanford University, Schlumberger Carbon Services, Petroleum Technology Research Centre, Planetary Emissions Management, University of Wyoming, West Virginia University Research Corp., University of Texas, NETL, LANL, SNL, LLNL, LBNL, PNNL, ORNL, INEEL, TBD.*

- **Carbon Use and Reuse** **3,603** **778**

The Carbon Use and Reuse activity focuses on pathways and novel approaches for reducing CO_2 emissions by developing beneficial uses for the CO_2, such as the conversion of CO_2 to useable products and fuels, and other breakthrough concepts that will mitigate CO_2 emissions.

In FY 2012, projects selected from a FY 2010 FOA focused on CO_2 utilization will continue to pursue research to find opportunities to convert CO_2 to useful commodities. These projects are focused on converting CO_2 to products such as chemicals, fuels, cements, and inert building products. These projects offer opportunities to reduce the costs of mitigating CO_2 emissions to the atmosphere from coal fired power plants by consuming CO_2 in the production of a valuable and useful commodity which improves the economics of CO_2 mitigation while eliminating the need for storage. These projects are considered novel approaches that may have a niche market for the commodities produced from these processes. . *Participants include: Research Triangle Institute, CCS Materials, Inc., Massachusetts Institute of Technology, University of Delaware, Brown University, McGill University, PhosphorTech Corporation, NETL.*

- **Focus Area for Carbon Sequestration Science** **13,631** **9,726**

In FY 2012, the Geological and Environmental Sciences research at NETL will continue its applied research to support the Carbon Storage Program. This includes complementary research support for Phase III field efforts from the Regional Carbon Sequestration Partnerships and research addressing needs for (1) estimating capacity/injectivity; (2) ensuring seal integrity; (3) monitoring of geochemical processes to verify prediction and to ensure protection of groundwater systems; (4) monitoring of geophysical processes quantitatively; (5) managing and assessing geospatial data (including use, maintenance, and development of NatCarb); and (6) improving the ability to predict multiscale, multiphase flow in various geologic media (especially fractured media); (7) developing the science base for predicting the fate and potential impacts of CO_2 in the subsurface over time. *Participants include: NETL, West Virginia University, University of Pittsburgh, Penn State University and Carnegie Mellon University.*

Total, Carbon Storage **134,365** **115,477**

Advanced Energy Systems

The **Advanced Energy Systems** sub-program focuses on improving the efficiency of coal-based power systems, enabling affordable CO_2 capture, increasing plant availability, and maintaining the highest environmental standards. The program supports gasification-related R&D to convert coal into synthesis gas (syngas) that can in turn be converted into electricity chemicals, hydrogen, and liquid

(dollars in thousands)

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fuels . Advanced gasification configurations create high pressure syngas with concentrated carbon, and is the technical basis for program-supported R&D expected to achieve relatively low-cost CO_2 capture. In FY 2012, the Gasification Systems program will continue to develop technologies for gas stream purification to achieve near-zero atmospheric emission goals and to meet synthesis gas quality requirements for use with fuel cells and conversion processes; to enhance process efficiency and availability; to reduce costs for producing oxygen; and to develop advanced gasification technologies.

- **Advanced Combustion Systems**

  This activity focuses specifically on development of advanced oxy-combustion and chemical looping technology components and processes that are capable of >90 percent CO_2 capture at less than a 35 percent increase in levelized cost of electricity (LCOE) for new and repowered coal-fired power plants. Given the significant economic penalties associated with application of these technologies at current state of the art, significant improvements in both cost and energy efficiency will be required to achieve this goal. Critical R&D objectives include the continuation of systems and computational simulation analyses of advanced oxy-combustion and chemical looping systems and bench through pilot-scale testing of combustion system support components (such as oxy-combustion/chemical looping, materials of construction, advanced air separation/boiler integration, and back end CO_2 purification) by 2016. By 2020, up to a 10 MWe 2nd generation oxy-combustion or chemical looping pilot system will be initiated that demonstrates achievement of program goals. It is anticipated that successful progression from pilot- to large-scale demonstration will result in one or more of these advanced technologies being available for commercial deployment sometime between 2025 and 2030.

  In FY 2012 continue pilot scale testing of advanced chemical looping and oxy-combustion CO_2 capture systems initiated in FY 2008.

  - **Oxy-Combustion and Chemical Looping** **11,684** **9,726**

    In FY 2012, initiate a competitive funding opportunity announcement for continued bench through pilot-scale development of oxy-combustion and chemical looping components including but not limited to: next-generation oxy-boiler design, air separation/oxy-boiler designs, atmospheric and high pressure circulating fluidized oxy-combustion systems, oxy-combustion materials of construction for high temperature, high pressure CO_2 rich combustion zones and computational simulation of oxy-combustion boilers and complete systems.

  - **High Performance Materials** **8,860** **973**

    In FY 2012, use computational techniques to design and develop materials for use in advanced combustion systems. These will include developing chemistries that will form either protective chromia oxide scales or alumina oxide scales, depending upon application environment and requirements. Work will also continue on the 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

(dollars in thousands)

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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. Work will continue the mechanical testing and microstructural analyses that is necessary to prove the performance of the nickel based alloy Haynes 282 that has not previously been used in pulverized coal-fired power generation plants. The results of this testing will be used for the code qualification of this material. *Participants include NET, ORNL.*

Subtotal, Advanced Combustion Systems	**20,544**	**10,699**

- **Gasification Systems** **57,056** **38,905**

This activity focuses specifically on technology developments that will increase gasification efficiency, reduce capital and operations costs, and increase availability. The program will focus on developing the following technologies:

- Ion transport membrane (ITM) technology for oxygen production
- Warm CO_2 capture and syngas cleanup
- Improving efficiency, including the high pressure, solids feed system, and real time sensors
- Improving availability, including longer refractory and sensor life
- Improving performance using models from reaction kinetics to plant simulations

To drive cost reductions, process improvements, and environmental advances across all gasification sub-systems, the Gasification program supports the National Carbon Capture Center (NCCC) in Wilsonville, Alabama, the preeminent test facility in the United States for the testing and evaluation of advanced oxy-, pre-, and post-combustion carbon capture technologies. The NCCC provides a large-scale test platform for evaluating components critical to the evolution of gasification technologies.

In FY 2012, the NCCC will continue to operate the transport gasifier to provide synthesis gas and shifted synthesis gas for pre-combustion CO_2 capture. Projects will be selected dependent upon FY 2011 project results, potential collaborations, and NETL and SCS assessment of the value of new technologies.

The 100 ton per day (tpd) ITM test facility will be commissioned and commercial-scale ITM modules will be tested in a commercially relevant configuration – the ITM technology is anticipated to reduce the capital cost of oxygen production by 25 – 33 percent, and increase system availability.

The high pressure, solids fuel pump performance tests will be completed, and testing and analysis of using the pump for low rank coal and transport gasifier particle sizes will be completed.

The solid fuel pump will enable high pressure feed without the use of a water slurry, and may

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enable the use of low rank coal in new configurations where it is currently unsuitable due to the energy penalty inherent in a slurry fed system.

Detailed design and construction of the 250 lbs/day hydrogen membrane development unit will be completed.

Design work, cost estimating and permitting efforts will continue on the RTI warm gas cleanup (WGCU) 50 MWe tests facility. This test facility will operate on a slip-stream of the commercial GE gasifier operated by TECO.

Refractory and slag analysis development will continue, with the emphasis on increasing gasifier availability, and on developing no-chromium refractory suitable for coal-biomass mixed feed.

Participants include: NETL, SCS, APCI, RTI, Eltron, PWR, VPI, GTI, TECO, Eastman, Ceramatec and WVU.

- **Hydrogen Turbines** **31,158** **14,589**

The Hydrogen Turbines activity is designed to enable the cost effective implementation of carbon capture and storage technology. The focus is on creating the technology base for turbines that will permit the design of near-zero atmospheric emission IGCC plants (including CO_2 capture and storage). Key technologies are needed to enable the development of advanced turbines that will operate with near-zero atmospheric emissions and higher efficiency when fueled with coal-derived hydrogen fuels.

In FY 2012, the Hydrogen Turbines activity will be implementing projects that will enable efficient, clean and cost effective hydrogen fueled turbines for coal-based integrated gasification combined cycle (CC) power systems that capture and store CO_2. The program will continue work with leading utility-scale gas turbine manufactures to realize goals for cost and performance. This work will produce systems and subsystems that will demonstrate premixed hydrogen combustion with single digit NOx emissions, higher turbine inlet temperatures, reduced interstage leakage via improved sealing designs, optimized airfoil heat flux with reduced cooling flows, improved material architectures for higher temperature operation and superior airfoils for more efficient expansion with higher throughput. Through component-scale testing 2 – 3 percentage points efficiency increase and 30 percent power increase above the base line hydrogen fueled CC power block will be demonstrated. This effort will be supported by national laboratories, universities and small businesses to help provide the fundamental understanding and resolution of technical issues associated with hydrogen combustion, materials and turbine related designs. *Participants include: GE, Siemens Energy, Clean Energy Systems, NASA, NETL-University Turbine Systems Research, Ames Lab, LBNL, ORNL and NETL.*

- **Hydrogen from Coal** **17,330** **0**

(dollars in thousands)

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In FY 2012, continue the design, fabrication and testing of engineering scale (100+ lbs/day hydrogen production level) precious metal hydrogen separation membranes for testing in coal derived syngas streams. Continue laboratory-scale development of non-precious metal hydrogen separation membranes and advanced water-gas-shift catalysts and processes for process intensification with the hydrogen membranes under development. *Participants include: Eltron Research, Inc., Worcester Polytechnic Institute, Praxair, Western Research Institute, United Technologies, Southwest Research Institute, Research Triangle Institute, University of Florida, Colorado School of Mines, University of Texas at Dallas, Ceramatec, University of Nevada Reno, NETL, KeyLogic Systems, URS Corporation, Booz Allen Hamilton, TBD.*

- **Coal and Coal-Biomass to Liquids** **7,011** **0**

In FY 2011, no new work will be initiated.

In FY 2010, continue systems engineering analyses and computation science activities and continue research activities in coal and biomass to liquids processing to gauge technical performance and increase knowledge base. *Participants include: GE, Idaho National Laboratory, Southern Research Institute, TDA Research, Inc., Research Triangle Institute, Iowa State University, Louisiana State University, University of Kentucky Center for Applied Energy Research, NETL, ANL, ORNL, KeyLogic Systems, URS Corporation, Booz Allen Hamilton, TBD*

- **Solid Oxide Fuel Cells** **48,683** **0**

In FY 2012, SECA Core Technology R&D will complete existing work - no new Core Technology effort shall be initiated in 2012. Industry Team work on fuel cell stack technology to enable low cost, >50 percent efficiency, 99 percent carbon capture power generation systems will continue under previously appropriated funds. Work will focus on improving fuel cell stack reliability and endurance and on preparing for manufacturing of a 250+ kW fuel cell system module. Demonstration and testing of this system module, which represents a building block of future multi-MW coal-based power plants, will be delayed from 2013 to 2015. Development and demonstration of commercial-scale fuel cell systems, as a CCS transformational technology, can still remain on schedule for 2020, dependent upon future program funding. *Participants include: FuelCell Energy/ Versa Power (one team), United Technologies/Delphi (one team), Rolls-Royce, General Electric, NETL, PNNL, ANL, LBNL, ORNL, and universities and small businesses.*

Total, Advanced Energy Systems **181,782** **64,193**

Cross-cutting Research

The Cross-cutting Research sub-program serves as a bridge between basic and applied research by fostering the development and deployment of innovative systems for improving efficiency and environmental performance through the research and development of instrumentation, sensors, and controls targeted at enhancing the availability of advanced power systems while reducing costs of Advanced CCS and Power Systems. This program area also develops computation, simulation, and modeling tools focused on optimizing plant design and shortening developmental timelines. Through the new multi-laboratory carbon capture and storage modeling and risk

(dollars in thousands)

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initiative, post-combustion capture, risk assessment, and integrated multi-scale physics-based simulations, designed to leveraging existing expertise has been initiated through a joint collaborative effort at several of the National Laboratories. These collaborative efforts will accelerate CCS development and will support the goal enabling commercial deployment of CCS technologies by 2020.

In addition, the Cross-cutting Research program area supports science and engineering education in minority colleges and universities.

- **Plant Optimization Technologies**
  - **Sensors and Controls** **7,887** **8,000**

    Sensors and Controls are an essential and enabling technology for power generation that directly contributes to a system's safe, efficient, and environmentally benign operation.

    In FY2012, continue the development of new classes of sensors that are capable of monitoring key parameters in harsh environment conditions of fossil energy systems and expand the utilization of sensors through the development of artificially intelligent sensor networks and advanced process control for near zero emission power plants. Projects include fiber-based gas sensors utilizing nanomaterials, micro sensors, and modified sapphire fiber sensors. The design and analysis sensor networks for the creation of self organizing networks with embedded intelligence will be pursued. The development of model based process control for gasification and chemical looping processes will be demonstrated virtually. Fundamental, novel, and innovative technologies that contribute directly to the environmentally benign utilization of coal will be considered and investigated. *Participants include: NETL, Alstom, GE, VPI, Siemens, New Mexico Tech, SNL, Ames Lab, and ANL*.

  - **Water Management** **3,895** **0**

    In FY2012, no new work will be initiated.

    In FY 2010, per Senate direction, energy-water R&D was continued in collaboration with Federal laboratories and research institutions in the following areas: Non-traditional Sources of Process and Cooling Water, Innovative Water Reuse and Recovery and Advanced Cooling Technology.

  - **Fine Particulate Control / Air Toxics** **1,947** **0**

    In FY2012, no new work will be initiated.

    In FY 2011, no new work will be initiated.

    In FY 2010, per Senate direction, fundamental and pilot-scale mercury control research to address the following will be continued: challenges associated with mercury removal in the

presence of SO_3; balance of plant issues with regards to mercury control such as an increase in fine particulate release, multi-pollutant control for selenium, and the impact of mercury control on by-product materials; and the demonstration of sorbent enhancement additives for mercury control.

Subtotal Plant Optimization Technologies **13,729** **8,000**

- **Coal Utilization Science**

  - **Computational System Dynamics** **2,726** **11,800**

    Computational system dynamics will develop the capability to utilize immersive, interactive, and distributed visualization technology in the design of next-generation advanced power systems. The developed technology will make use of advanced, distributed computer aided design tools for virtual design groups. System tools developed will allow the integrated use of information technology in next-generation advanced fossil power systems design including carbon capture. This program will also initiate a new multi-laboratory carbon capture and storage modeling effort National Risk Assessment Partnership (NRAP). NRAP is a multi-year effort that harnesses the breadth of capabilities across the U.S. Department of Energy (DOE) national lab system into a mission-focused platform in order to develop a defensible, science-based quantitative methodology for determining risk profiles (and, hence, residual risk) at carbon dioxide (CO_2) storage sites. These three collaborative efforts will accelerate CCS development and will support the goal to enable commercial deployment of CCS technologies by 2020.

    In FY 2012, Advanced modeling and simulation will focus on optimizing plant design and performance, informing R&D investment, and shortening developmental timelines and supports Carbon Capture and Storage focused multi-lab partnership. Projects are coupled with the common goal of developing models and simulations of near zero emission power plants. Steady state simulations, dynamic simulations, the framework that supports the simulations, reduced order model development, and multiphase flow model development and validation will be conducted. Integration of the co-simulator models with the virtual engineering plant walk-through environment will continue. Investigations will be conducted on combustion and gasification chemistry that underpins the mechanisms affecting emissions behavior or coal conversion in advanced combustion/gasification cycles and use the information for validation purposes. These collaborative efforts will accelerate CCS development and will support the goal to enable commercial deployment of CCS technologies by 2020.

    All work is intended to lead to a suite of products capable of representing the operation of near zero emission power plants, like gasification and oxy-combustion, which are based on validated models and highly detailed representations of equipment and processes. *Participants include: Alstom, Tech4Imaging, SNL, CMU, Fluent, University of Colorado,*

(dollars in thousands)

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Ames Lab, ORNL, LANL, LBNL, PNNL, LLNL and TBD.

- **Computational Energy Science** **2,400** **13,400**

  Computational Energy Science develops science-based models of the physical phenomenon occurring in fossil fuel conversion processes and develops multi-scale, multi-physics simulation capabilities. The models 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 focuses on post-combustion capture, risk assessment, and integrated multi-scale physics-based simulations, designed to leveraging existing expertise and funding. The multi national laboratory collaborative efforts will accelerate CCS development and will support the goal to enable commercial deployment of CCS technologies by 2020.

  In FY 2012, continue to provide high-performance computational modeling and simulation research into advanced energy plants and CCS technology. Research focuses on developing a set of complex but flexible computational tools that will allow more rapid and efficient scale-up of new subsystems, devices, and components, and reduce the need for large and expensive demonstration-scale testing of integrated energy systems. The *Carbon Capture Simulation Initiative* (CCSI) is a partnership among national laboratories, industry and academic institutions that will develop and deploy state-of-the-art computational modeling and simulation tools to accelerate the commercialization of carbon capture technologies from discovery to commercial deployment. In essence, it provides simulation, modeling, and computational resources to FutureGen 2.0 and carbon capture and efforts, expediting development and reducing the costs of new technology development. In collaboration with partners, activities will result in the creation of a dynamic plant simulator for testing advanced technologies. *Participants include: NETL, CMU, West Virginia University, State of West Virginia, Penn. Supercomputing Center and University of Pittsburgh, LANL, LBNL, LLNL, PNNL and TBD.*

Subtotal, Coal Utilization Science **5,126** **25,200**

- **Energy Analyses**
  - **Environmental Activities** **450** **450**

    In FY 2012, continue analysis of issues associated with air and water quality, solid waste disposal, and global climate change. These analyses include the potential impact on health and climate change of particulates and linkages to fossil fuel use, barriers to and environmental impacts of large-scale deployment of CCS, and life cycle environmental emissions analysis for existing and advanced fossil fuel technologies. *Participants include: ANL, ICF, TMS, ORNL, LANL, and PNNL.*
  - **Technical and Economic Analyses** **500** **500**

    In FY 2012, continue analyses that crosscut FE programs and support multi-year program and

(dollars in thousands)

	FY 2010 Current Approp.	FY 2012 Request

strategic planning. It includes critical studies to identify 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 strategic benefits of fossil fuel technology long-term, integrated modeling analysis of the potential impact of CCS technologies, technical and economic studies carried out through the International Energy Agency Greenhouse Gas Program, and analysis of dispatchability of advanced CCS technology in U.S. regions. *Participants include: ANL, ICF, EIA, Resource Dynamics, and TMS.*

- **Systems Analysis/Product Integration** **4,285** **4,000**

  In FY 2012, work will continue on assessing the technical viability and economics of advanced process concepts to support the development and deployment of near-zero atmospheric emissions plants, including CO_2 capture. Conduct a workshop for state environmental and economic regulators and energy officials to assist in providing state-or-the-art information for use in permitting advanced energy plants and developing state policies and international policies *Participants include: NETL, TBD*

- **Biomimetics** **50** **0**

  In FY 2012 no new work will be initiated.

  In FY 2011 no new work will be initiated.

  In FY 2010, this program will investigate options for biological methods and systems found in nature to design advanced engineering systems and modern technology with the goal of reducing and mitigating processing emissions and effluents from advanced coal power systems. *Participants include: NETL and TBD.*

Subtotal, Energy Analyses **5,285** **4,950**

- **University Training and Research**
  - **University Coal Research** **2,337** **2,400**

    In FY 2012, the University Coal Research (UCR) Program will continue to support grants at U.S. colleges and universities by emphasizing longer-term research for achieving Fossil Energy's strategic objectives. Key research areas that will be supported include advanced power systems including near-zero emission power plants; hydrogen from coal; global climate change; development of advanced high performance materials, sensors and controls; fuel cells; and the development of advanced coal systems. The program will continue to solicit applications submitted from individual universities. Selected projects will be eligible for funding of approximately $300,000 for a three-year period. About seven or eight competitively selected grants are anticipated to be awarded. Each participating university will be required to provide at least one outstanding student with grant support.

(dollars in thousands)

	FY 2010 Current Approp.	FY 2012 Request
▪ **HBCU's Education & Training**	**828**	**850**

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 for achieving Fossil Energy's strategic objectives. Research proposals can span virtually the entire spectrum of fossil fuel topics, from advanced ways to use coal cleanly to new methods for recovering and processing oil and natural gas, and innovations in fuel cell technology. Recently, the focus has been on sensors and controls; computational energy sciences; and advanced materials for power generation and for hydrogen separation and storage. Funding will be used to conduct Fossil Energy research activities at these institutions and to support an HBCU/OMI annual technology transfer symposium. Participants are determined by an open financial opportunity announcement on research topics that are of highest priority to Fossil Energy's programs.

In FY2012, about four awards are expected to be made. The maximum grant value is limited to $200,000.

Subtotal, University Training and Research	**3,165**	**3,250**

- **International Activities**

▪ **Coal Technology Export**	**650**	**650**

In FY 2012, continue creating U.S. jobs by working with international organizations to facilitate exporting of U.S. climate technology and energy services to the developing world. Continue the momentum for carbon capture and storage (CCS) in multilateral organizations including International Energy Agency IEA), United Nations, World Energy Council (WEC), and the Carbon Sequestration Leadership Forum and bilaterals with key countries such as China and India. Generate international support for CCS and work with the WEC to mitigate climate change. Ensure that U.S. policy is reflected in IEA support for G8 initiatives on highly efficient coal-fired power generation and CCS technology. Provide global outreach on advanced clean coal technology and CCS for climate change mitigation and energy security in multilateral forums including: The IEA, United Nations, WEC, and bilaterals with key countries such as China and India.

▪ **International Program Support**	**700**	**700**

In FY 2012, continue funding the activity of the International Energy Agency Clean Coal Center (IEACCC). Enhance the competitiveness and adoption of US environmental technology in China and utilize specific initiatives to protect local and global environments through the use of U.S. Clean Coal Technologies in targeted countries. Continue support of Fossil Energy's commitment to the International Energy Agency (IEA) program effort. Preserve and enhance active relationships with national and international organizations. Focus on expanding cleaner energy technology power systems activities globally. Determine

(dollars in thousands)

	FY 2010 Current Approp.	FY 2012 Request
opportunities for cleaner power systems and clean fuels from coal in targeted countries.		
Subtotal International Activities	**1,350**	**1,350**
Total, Crosscutting Research	**28,655**	**42,750**
Total, CCS and Power Systems	**393,485**	**298,358**

Explanation of Funding Changes

	FY 2012 vs. FY 2010 Current Approp ($000)
Carbon Capture	
▪ **Post-Combustion Capture** The increase in funding will fund slip stream testing of a larger number of advanced technology systems and will shorten the time required for development of systems ready for commercial application.	+22,432
▪ **Pre-Combustion Capture** The decrease in funding level represents program prioritization on post-combustion capture technology development.	-2,176
Total, Carbon Capture	**+20,256**
Carbon Storage	
▪ **Regional Carbon Sequestration Partnerships** An increase in the funding for the Regional Carbon Sequestration Partnerships validation and development field projects to ensure that the projects can maintain their schedule for completing site characterization and injection operations.	+7,019
▪ **Geologic Storage Technologies** The decrease in funding maintains existing project activities and shifts support to the Regional Carbon Sequestration Partnerships validation and development field projects to ensure these projects maintain their schedule for completing site characterization and injection operations.	-16,179
▪ **Monitoring, Verification, Accounting and Assessment** The requested funding level is sufficient to maintain existing project activities. No new activities are planned.	-2,999

	FY 2012 vs. FY 2010 Current Approp ($000)
▪ **Carbon Use and Reuse** The requested funding level is sufficient to maintain existing project activities. No new activities are planned.	-2,825
▪ **Focus Area for Carbon Sequestration Science** The requested funding level is sufficient to maintain existing project activities and focuses efforts on geologic storage of carbon dioxide.	-3,905
Total, Carbon Storage	**-18,889**

	FY 2012 vs. FY 2010 Current Approp ($000)
Advanced Energy Systems	
▪ **Advanced Combustion Systems**	
▪ **Oxy-combustion and Chemical Looping** The requested funding level is sufficient to support current R&D efforts related to work conducted under Pre-Combustion Capture.	-1,958
▪ **High Temperature Materials** The decrease in funding represents the shift in focus toward technologies that have potential benefits to both existing and new fossil-fueled power plants.	-7,887
▪ **Gasification Systems** The decrease in funding represents the shift in focus toward technologies that have potential benefits to both existing and new fossil-fueled power plants. In addition, recently obligated Recovery Act funding will ensure that development of gasification technologies will continue to advance on or ahead of schedule..	-18,151
▪ **Hydrogen Turbines** The decrease in funding represents the shift in focus toward technologies that have potential benefits to both existing and new fossil-fueled power plants. In addition, recently obligated Recovery Act funding will ensure that development of hydrogen turbine technologies will continue to advance on or ahead of schedule.	-16,569
▪ **Hydrogen from Coal Research** The decrease in funding represents the shift in focus toward technologies that have potential benefits to both existing and new fossil-fueled power plants. In addition, recently obligated Recovery Act funding will ensure that development of gasification technologies will continue to advance on or ahead of schedule.	-17.330
▪ **Coal to Coal Biomass to Liquids** All projects involving Coal to Coal Biomass to Liquids will be suspended.	-7,011

	FY 2012 vs. FY 2010 Current Approp ($000)
▪ **Fuel Cells** The program has prioritized near-term CCS technologies available for demonstration in the 2015 timeframe. As a result, 2012 funding for longer-term Fuel Cell technologies has not been requested. SECA Core Technology R&D will complete existing work - no new Core Technology effort shall be initiated in 2012. Industry Team work on fuel cell stack technology to enable low cost, >50 percent efficiency, 99 percent carbon capture power generation systems will continue under previously appropriated funds. Work will focus on improving fuel cell stack reliability and endurance and on preparing for manufacturing of a 250+ kW fuel cell system module. Demonstration and testing of this system module, which represents a building block of future multi-MW coal-based power plants, will be delayed from 2013 to 2015. Development and demonstration of commercial-scale fuel cell systems, as a CCS transformational technology, can still remain on schedule for 2020, dependent upon future program funding.	-48,683
Total, Advanced Energy Systems	**-117,589**
Crosscutting Research	
▪ **Plant Optimization Technologies**	
▪ **Fine Particle Control / Air Toxics** No new work will be initiated. All project involving Fine Particle Control / Air Toxics will be suspended.	-1,947
▪ **By Products / Water Management** No new work will be initiated. All project involving By Products / Water Management will be suspended.	-3,895
▪ **Sensors and Controls** The increase will balance out shortfall in last year's mortgages.	113
Total, Plant Optimization	
▪ **Coal Utilization Science**	**-5,729**
▪ **Computational System Dynamics** The increase in funding will enable a multi-year effort that harnesses the breadth of capabilities across the U.S. Department of Energy (DOE) national lab system into a mission-focused platform in order to develop a defensible, science-based quantitative methodology for determining risk profiles (and, hence, residual risk) at carbon dioxide (CO_2) storage sites.	+9,074

	FY 2012 vs. FY 2010 Current Approp ($000)
▪ **Computational Energy Science** Increase in funding will enable the *Carbon Capture Simulation Initiative* (CCSI) and its partnership among national laboratories, industry and academic institutions to develop and deploy state-of-the-art computational modeling and simulation tools to accelerate the commercialization of carbon capture technologies from discovery to development, demonstration, and ultimately the widespread deployment to hundreds of power plants.	+11,000
Total, Coal Utilization	
▪ **Energy Analyses**	**+20,074**
▪ **Biomime**tics All projects involving Biomimetics of coal will be suspended.	-50
▪ **System Analysis / Product Integration** A reduction in the number of active projects will require marginally less funding for engineering analyses and program support.	-285
Total, Energy Analyses	
▪ **University Training and Research**	**-335**
▪ **University Coal Research** The increase funds additional university research grants to address FE's most critical research priorities.	+63
▪ **HBCUs, Education and Research** The increase funds additional university research grants to address FE's most critical research priorities.	+22
Total, University Training and Research	**+85**
Total, Crosscutting Research	**+14,095**
Total Funding Change, CCS and Power Systems	**-102,127**

Natural Gas Technologies

Funding Profile by Subprogram

	FY 2010 Current Appropriation	FY 2012 Request
Natural Gas Technologies	17,364	0
Total, Natural Gas Technologies	**17,364**	**0**

Mission

The Natural Gas Technologies program developed scientific information and advanced technologies to increase environmentally responsible supplies of natural gas through research and development.

Benefits

Consistent with Administration policy to phase out inefficient fossil fuel subsidies, the program is requesting no funding in FY 2012 for R&D to increase hydrocarbon production.

Means and Strategies

No funds are being requested in FY 2012.

Natural Gas Technologies

Funding Schedule by Activity

(dollars in thousands)

	FY 2010 Current Approp.	FY 2012 Request
Natural Gas Technologies	17,364	0
Total, Natural Gas Technologies	**17,364**	**0**

Description

The Natural Gas Technologies program focused on science and technology to find and produce gas hydrates, mitigate any environmental impact of production, and to understand their role in nature. Support for Natural Gas R&D will be completed in FY2012.

Consistent with Administration policy to phase out inefficient fossil fuel subsidies, the program is requesting no funding in FY 2012 for R&D to increase hydrocarbon production.

Detailed Justification

(dollars in thousands)

	FY 2010 Current Approp.	FY 2012 Request
Natural Gas Technologies	**17,364**	**0**

In FY 2012, no activity is proposed in Natural Gas Technologies R&D.

In FY 2010, plan for and perform supporting laboratory and numerical modeling studies in preparation for long-term tests of multiple arctic production technologies including CO_2 sequestration. Conduct geological/geophysical prospecting and evaluation of data recovered in FY 2009 to identify locations for potential FY 2012 drilling and coring in the Gulf of Mexico. Complete construction of a new pressure-coring system. Expand research into the environmental impacts of potential production, including geo-mechanical and subsidence issues, methane release, and water production issues. Participants will include: *Chevron JIP, BPXA, ConocoPhillips, USGS, NETL, National Labs, Rice University, Georgia Tech, U Texas, Scripps Institute, UCSB, UAF, U. Chicago, Baylor University, University of Delaware, TAMU, UNEP, and TBD.*

SBIR/STTR (non-add)	**0**	**0**
In FY2010, $469,000 was transferred to the SBIR/STTR Program.		
Total, Natural Gas Technology	**17,364**	**0**

Explanation of Funding Changes

	FY 2012 vs. FY 2010 ($000)
Natural Gas Technology	
• Consistent with Administration policy to phase out inefficient fossil fuel subsidies, the program is requesting no funding in FY 2012 for R&D to increase hydrocarbon production.	-17,364
Total Funding Change, Natural Gas Technology	**-17,364**

Unconventional FE Technologies

Funding Profile by Subprogram

	FY 2010 Current Appropriation	FY 2012 Request
Unconventional FE Technologies	19,474	0
Total, Unconventional FE Technologies	19,474	0

Mission

The Unconventional Fossil Energy Program supports a comprehensive research, development and deployment (RD&D) strategy for the development of unconventional oil, gas and coal resources.

Consistent with Administration policy to phase out inefficient fossil fuel subsidies, the program is requesting no funding in FY 2012 for R&D to increase hydrocarbon production.

Benefits

No activity is proposed in FY 2012.

Means and Strategies

As directed by Congress in FY2010, the Unconventional Fossil Energy Program is developing a report outlining the domestic resource opportunities as well as technology applications for unconventional oil, gas, and coal. No activity is proposed in FY 2012.

Annual Performance Results and Targets

The Department is in the process of updating its strategic plan, and has been actively engaging stakeholders including Congress. The draft strategic plan is being released for public comment concurrent with this budget submission, with the expectation of official publication this spring. The draft plan and FY12 budget are consistent and aligned. Updated measures will be released at a later date and available at the following link http://www.mbe.doe.gov/budget/12budget/index.htm.

Unconventional FE Technologies Program

Funding Schedule by Activity

(dollars in thousands)

	FY 2010 Current Approp.	FY 2012 Request
Unconventional FE Technologies Program		
Unconventional FE Technologies	19, 474	0

SBIR/STTR	0	0
Total, Unconventional FE Technologies	19,474	0

Description

The Unconventional Fossil Energy Technologies Program supports a comprehensive research, development and deployment (RD&D) strategy for the development of unconventional oil, gas and coal resources.

Consistent with Administration policy to phase out inefficient fossil fuel subsidies, the program is requesting no funding in FY 2012 for R&D to increase hydrocarbon production.

Detailed Justification

(dollars in thousands)

	FY 2010 Current Approp.	FY 2012 Request
Unconventional FE Technologies	**19,474**	**0**
No activity in FY 2012		
No activity in FY 2011		

In FY 2010, DOE funding for technology solutions focused on comprehensive research, development and deployment (RD&D) strategy for the development of unconventional oil, gas, and coal resources. The Unconventional FE Technologies Program portfolio focused on multiple areas related to reservoir characterization of oil-prone fractured shale and Arctic heavy oil, enhanced oil recovery using carbon dioxide, chemical flooding, and alkaline-surfactant-polymer flooding in mature fields, stripper well technology development, water resources/oil shale, regulatory streamlining, advanced simulation and visualization, unconventional gas, and carbon dioxide enhanced oil recovery technology. *Participants include: Colorado School of Mines, Ground Water Protection Council, Lumedyne,, University of Alaska, University of Illinois, University of Kansas Center for Research, University of North Dakota, UT Austin/MIT, The Penn State University, Chevron, UNDEERC, PTTC, NETL, other National Labs, and TBD.*

SBIR/STTR	**0**	**0**

In FY 2010, $526,000 was transferred to the SBIR and STTR programs.

Total, Unconventional FE Technologies	**19,474**	**0**

Explanation of Funding Changes

	FY 2012 vs FY 2010 ($000)
Unconventional FE Technologies	

	FY 2012 vs FY 2010 ($000)
Consistent with Administration policy to phase out inefficient fossil fuel subsidies, the program is requesting no funding in FY 2012 for R&D to increase hydrocarbon production.	-19,474
Total Funding Change, Unconventional FE Technologies program	**-19,474**

Program Direction

Funding Profile by Category

	FY 2010 Current Appropriation	FY 2012 Request
Indirect Program Direction		
Headquarters Indirect		
Salaries and Benefits	18,163	17,084
Travel	1,000	1,000
Support Services	80	85
Other Related Expenses	11,688	11,562
Total, Headquarters Indirect	30,931	29,731
Full Time Equivalents	122	110
NETL Indirect		
Salaries and Benefits	50,600	48,160
Travel	1,673	2,400
Support Services	25,000	21,746
Other Related Expenses	18,990	20,049
Total, NETL Indirect	96,263	92,355
Full Time Equivalents	387	350
Total Indirect Program Direction		
Salaries and Benefits	68,763	65,244
Travel	2,673	3,400
Support Services	25,080	21,831
Other Related Expenses	30,678	31,611
Total, Indirect Program Direction	127,194	122,086
Full Time Equivalents	509	460
NETL Coal Research and Development Direct Program Direction		
Salaries and Benefits	23,025	29,260
Travel	543	1,172
Support Services	5,319	4,599
Total, NETL Coal Research and Development Direct Program Direction	28,887	35,031
Full Time Equivalents	180	204
Import/Export Authorization		
Salaries and Benefits	1,360	1,437
Travel	21	22
Other Related Expenses	538	657
Total, Import/Export Authorization	1,919	2,116
Full Time Equivalents	14	10

	FY 2010 Current Appropriation	FY 2012 Request
Total Program Direction		
Salaries and Benefits	93,148	95,941
Travel	3,237	4,594
Support Services	30,399	26,430
Other Related Expenses	31,216	32,268
Total, Program Direction[a]	158,000	159,233
Total, Full Time Equivalents	703	674

Mission

Program Direction and Management Support function provides the Federal staff with resources that assist the Office of Fossil Energy in carrying out its goals. These resources are allocated and the costs are generated based on the goals, strategic directions, priorities, and plans that have been pre-established.

- The Headquarters staff is responsible for providing overall guidance and direction for the program offices. In addition to the Headquarters staff, the NETL performs the day-to-day project management functions of the FE programs. NETL is also responsible for developing project budgets, implementing procurement plans, and other program and site support activities necessary to achieve their program objectives. The program is also responsible for increased projects and reporting requirements related to Recovery Act activities.

- The NETL staff is also directly associated with conducting in-house research activities for the Coal Research and Development program (the NETL Coal Research and Development Direct Program Direction activity).The Office of Import/Export Authorization manages the regulatory review of natural gas imports and exports. The 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.

Fossil Energy performs functions that directly support the mission of the Department. These functions focus on technological investigations and research concerning the use of fossil energy substances.

[a] NETL was provided $10M for program direction activities as a result of the American Recovery and Reinvestment Act (ARRA) for FY2009 and FY2010.

Detailed Justification

	(dollars in thousands)	
	FY 2010 Current Approp.	FY 2012 Request
Indirect Program Direction	**127,194**	**122,086**
Headquarters Indirect	**30,931**	**29,731**
Salaries and Benefits	**18,163**	**17,084**

The funding supports 110 FTEs in FY 2012 and 122 FTEs in FY 2010 at Headquarters. Headquarters staff is responsible for implementing and communicating DOE policy to the field offices, which includes NETL. The staff also sets program objectives, develops program plans, and evaluates alternative strategies. In addition, they are responsible for developing budgets, approving procurement plans, and overseeing the progress of the activities with regard to the efficient and effective use of resources and the associated costs.

Travel	**1,000**	**1,000**

Provide funds for both domestic and international travel in support of Fossil Energy business. Travel includes costs and transportation of persons, subsistence of travel, and incidental travel expenses in accordance with Federal travel regulations. Enables HQ staff to effectively manage a broad spectrum of Fossil Energy projects at geographically dispersed locations, and attend project and program reviews.

Support Services

▪ **E-Government Initiatives**	**80**	**85**

The requested funding will provide for the costs associated with Government-wide E-Government initiatives and all associated business lines.

Other Related Expenses	**11,688**	**11,562**
▪ **Technical and Management Support Services**	4,200	3,162

Provide for technical and management contractual services that are generic to the entire FE program.

▪ **Computer Systems and Support**	1,040	1,000

The Headquarters information technology investment includes costs associated with general information technology infrastructure support including LAN, internet and intranet networking, cyber security, desktop support, televideo, information architecture planning and systems support.

▪ **Working Capital Fund**	**6,448**	**7,400**

The request provides support to HQ for office space, utilities, building/equipment maintenance,

mail services, LAN connections, supplies and other services and equipment. Also included is FE's annual contribution for operation and maintenance of the iMANAGE corporate financial systems and DOEnet corporate network.

NETL Indirect	**96,263**	**92,355**
Salaries and Benefits	**50,600**	**48,160**

The funding at this level will support 350 FTEs in FY 2012 and 387 in FY 2010. Activities of the staff include project management, product development, contract management, and other activities related to program and administrative activities. It is anticipated that 175 NETL FTEs in FY 2010 and FY 2012 will be paid via reimbursable agreements from other fund sources. Therefore, the salaries and benefits and the associated FTEs for this reimbursable staff are not included in the budget estimate.

Travel	**1,673**	**2,400**

Supports travel necessary to conduct Fossil Energy business. Travel includes costs and transportation of persons, subsistence of travel, and incidental travel expenses in accordance with Federal travel regulations. Enables NETL staff to effectively manage a broad spectrum of Fossil Energy projects at geographically dispersed locations, and to attend project and program reviews. The number of projects has increased and will require additional travel to support enhanced project monitoring efforts. In addition, there is still significant ARRA activity ongoing that will require significant effort that may not be met by bridge funding.

Support Services	**25,000**	**21,746**

This budget line includes all costs associated with site support contractors that assist in the operation and maintenance of the Lab. The support provided includes facility operations, maintenance, grounds and janitorial services, finance, information technology/automation services, security, administrative and technical support.

Other Related Expenses	**18,990**	**20,049**

Provide supplies/materials and other services funding for facility operations. Other Related Expenses also funds the NETL information technology investment, which includes general information technology infrastructure support such as LAN, internet and intranet networking, cyber security, desktop support, televideo, telecom, information architecture planning, and systems support. The funding also supports rents, communications, utilities, maintenance agreements, and training.

NETL Coal Research and Development Direct Program Direction	**28,887**	**35,031**
Salaries and Benefits	**23,025**	**29,260**

Provide funds for 204 FTEs in FY 2012 and 180 FTEs in FY 2010 such as technicians, engineers, and scientists that support of the NETL Office of Research and Development (in-house research and development). Activities include in-house research in support of the following program areas:

(dollars in thousands)

	FY 2010 Current Approp.	FY 2012 Request
Integrated Gasification Combined Cycle, Turbines, Carbon Sequestration, Fuels, Fuel Cells, and Advanced Research.		
Travel	**543**	**1,172**
Provide funds for both domestic and international travel in support of the activities that support the in-house research and development mission of FE along with training and outreach activities.		
Support Services	**5,319**	**4,599**
Provide funding for supplies/materials, equipment and contractor support for the in-house research and development functions.		
Import/Export Authorization	**1,919**	**2,116**
Salaries and Benefits	**1,360**	**1,437**
Provides for 10 FTEs in the Office of Import/Export Authorization (OIEA).		
Travel	**21**	**22**
Provide funds for both domestic and international travel in support of the activities that support the mission of FE.		
Other Related Expenses	**538**	**657**
Provide funds for contractual services in support of the OIEA.		
Total, Program Direction	**158,000**	**159,233**

Explanation of Funding Changes

	FY 2012 vs. FY 2010 ($000)
Indirect Program Direction	
Headquarters Indirect	
Salaries and Benefits	
The decrease in salaries and benefits reflects a change in FTEs from FY 2010 (122 FTEs) to FY 2012 (110 FTEs). This change also reflects a mandatory civilian pay freeze.	-1,079
Support Services	
The increased in funding for support services is due to costs associated with inflation.	+5

	FY 2012 vs. FY 2010 ($000)
Other Related Expenses	
This decrease reflects administrative cost savings to support the Accountable Government Initiative.	-126
Total, Headquarters Indirect	**-1,200**
NETL Indirect	
Salaries and Benefits	
The decrease in funding for salaries and benefits is the result of a reallocation of funds from Indirect Program Direction to Direct Program Direction. The reallocation was done to more effectively balance direct in-house R&D labor to indirect management.	-2,440
Travel	
The number of projects has increased and will require additional travel to support enhanced project monitoring efforts. In addition, there is still significant ARRA activity ongoing that will require significant effort that may not be met by bridge funding.	+727
Support Services	
This decrease reflects administrative cost savings to support the Accountable Government Initiative.	-3,254
Other Related Expenses	
This reflects an increase in costs related to contractual services. Due to the implementation of an increased project management effort, additional costs will be associated with software and system analysis.	+1,059
Total, NETL Indirect Program Direction	**-3,908**
Total, Indirect Program Direction	**-5,108**
NETL Coal Research and Development Direct Program Direction	
Salaries and Benefits	
The increase in funding is primarily the result of a reallocation of funds and FTEs from Indirect Program Direction to Direct Program Direction. The reallocation was done to more effectively balance direct in-house research and development labor to indirect	+6,235

	FY 2012 vs. FY 2010 ($000)
management. The increase is also associated with promotions, within grade increases, performance awards, health care costs, and other related personnel costs.	
Travel	
The increase in travel is a result of escalation, enhanced mission and additional FTEs. This increase will provide funds for the research staff to travel for training, and to support new initiatives with an ARRA award for computer simulation and a Regional University Alliance collaboration. The ARRA award is a partnership with national laboratories and regional universities that requires extra travel beyond that for past fiscal years. Also, the Regional University Alliance will require extensive travel for researchers visiting and performing research collaboration at all of the various laboratory sites that comprise the Alliance.	+629
Support Services	
This decrease reflects administrative cost savings to support the Accountable Government Initiative.	-720
Total, NETL Coal Research and Development Direct Program Direction	**+6,144**
Import/Export Authorization **Salaries and Benefits**	
The increase in funding for salaries and benefits is due to promotions, within grade increases, performance awards, health care costs, and other related costs.	+77
Travel	
The increase in travel funding is a result of an escalation in travel costs per trip.	+1
Other Related Expenses	
The increase in funding will support special studies and additional requirements resulting from an increased level of liquid natural gas applications to non-free trade agreement countries. This increase will provide funding to update regulations in 10 CFR 590.	+119
Total, Import/Export Authorization	**+197**

	FY 2012 vs. FY 2010 ($000)
Non-Add	
Civilian Pay Freeze	
The civilian pay freeze is reflected in the budget.	-3,940
Administrative Savings	
This decrease reflects administrative cost savings to support the Accountable Government Initiative.	-8,908
Total Non-Add	**-12,848**

Support Services by Category

(dollars in thousands)

	FY 2010 Current Appropriation	FY 2012 Request
Technical Support		
Surveys Or Reviews of Technical Operations	500	500
Economic and Environmental Analysis	925	925
Test and Evaluation Studies	3,500	2,800
Total, Technical Support	4,925	4,225
Management Support		
Management Studies	650	650
ADP Support	6,710	6,500
Administration Support Services	18,114	15,055
Total, Management Support	25,474	22,205
Total, Support Services	30,399	26,430

Other Related Expenses by Category

(dollars in thousands)

	FY 2010 Current Appropriation	FY 2012 Request
Other Related Expenses		
Other Services	18,903	18,368
Operations and Maintenance of Equipment	1,940	2,000
Working Capital Fund	6,448	7,400
Training	550	700
Rental Space	625	900
Software Procurement/Maintenance Activities/Capital Acquisitions	2,750	2,900
Total, Other Related Expenses	31,216	32,268

Congressionally Directed Projects

Funding Profile by Subprogram

	FY 2010 Current Appropriation	FY 2012 Request
Congressionally Directed Projects	35,879	0

Description

The FY 2010 Appropriation included Congressionally directed projects within the Office of Fossil Energy. Funding for these projects was appropriated as a separate funding line although specific projects may relate to ongoing work in a specific programmatic area. Prior year funding for a specific project will be noted in the table below as a non-additive column entry.

Detailed Justification

	(dollars in thousands)	
	FY 2010 Current Appropriation	FY 2012 Request
Congressionally Directed Projects		
Center for Zero Emissions Technology, Montana State University, Clean Coal Technologies	2,921	0
North Dakota Energy and Environmental Center, Grand Forks, ND, Fossil Fuel Cooperative Research & Development	3,895	0
North Dakota Energy and Environmental Center, Grand Forks, ND, National Center for Hydrogen Technology	2,921	0
Gulf of Mexico Hydrates Research Consortium at the University of Mississippi, MS	1,169	0
Methanol Economy (CA)	730	0
University of Kentucky Strategic Liquid Transportation Fuels Derived from Coal (KY)	1,947	0
Shale Oil Upgrading Utilizing Ionic Conductive Membranes Ceramatec, Inc (UT)	1,704	0
The Center for Advanced Separation Technology, University of Kentucky, (KY)	487	0
Utah Center for Ultra Clean Coal Utilization & Heavy Oil Research (UT)	7,789	0
Long Term Environmental and Economic Impacts of the Development of a Coal Liquefaction Sector in China, WVU	1,217	0
Shallow Carbon Sequestration Pilot Demonstration, Missouri	2,337	0
Center for Renewable Energy, Science, and Technology	973	0

	(dollars in thousands)	
	FY 2010 Current Appropriation	FY 2012 Request
(CREST)(TX)		
Design and Test of an Advanced SOFC Generator in PA	973	0
Hydrogen Fuel Dispensing Station (WV)	1,169	0
Innovations for Low-Cost Gasification Systems (PA)	730	0
Innovations in Control Technologies for Synthesis Gas Combustion (OH)	292	0
Montana ICTL Demonstration (MT)	1,217	0
Oklahoma University Enhanced Oil Recovery Design Center (OK)	487	0
Research and Development of Fuel Cells for Electricity from Fossil and Bio-Based Fuels (OH)	487	0
Utah Coal and Biomass to Fuel Pilot Plant (UT)	2,434	0
Total, Congressionally Directed Projects	**35,879**	**0**

Explanation of Funding Changes

	FY 2012 vs. FY 2010 Current Approp ($000)
Congressionally Directed Projects	
No funding requested	-35,879
Total, Congressionally Directed Projects	**-35,879**

Plant and Capital Equipment

Funding Profile by Subprogram

	FY 2010 Current Appropriation	FY 2012 Request
Plant and Capital Equipment		
General Plant Projects	20,000	16,794
Total, Plant and Capital Equipment	20,000	16,794

Mission

The Plant and Capital Equipment program creates, improves, and maintains the 119 facilities and infrastructure making up the National Energy Technology Laboratory (NETL). NETL has about 119 facilities and related infrastructure located in Morgantown, West Virginia; Pittsburgh, Pennsylvania; and Albany, Oregon.

Benefits

FY 2012, 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.

Detailed Justification

	(dollars in thousands)	
	FY 2010 Current Appropriation	FY 2012 Request
General Plant Projects	**20,000**	**16,794**

FY 2012, Request will be used to conduct projects which will reduce energy, environmental, safety/health risks and liabilities posed by an aging infrastructure and to comply with building standards.

FY 2010 Request is being used to conduct projects at the three NETL field sites to reduce environmental, safety, health risks and liabilities posed by aging infrastructure and more stringent energy and building standards.

Total, Plant and Capital Equipment	**20,000**	**16,794**

Explanation of Funding Changes

	FY 2012 vs. FY 2010 Current Approp ($000)
General Plant Projects	
The decrease in GPP funding is the result of NETL re-prioritizing the planned projects detailed in the 10 Year Site Plan and will initiate only the key/most significant projects that meet the Fossil Energy programmatic objectives and that comply with the standards established by the Energy Policy Acts (EPAct) of 2005 and 2007 and Executive Orders 13514 and 13423.	-3,206
Total Funding Change, Plant and Capital Equipment	**-3,206**

The NETL shall prioritize planned projects detailed in the 10 Year Site Plan and initiate the projects that meet key Fossil Energy programmatic objectives and that comply with the standards established by the Energy Policy Acts (EPAct) of 2005 and 2007 and Executive Orders 13514 and 13423.

Fossil Energy Environmental Restoration

Funding Profile by Subprogram

	FY 2010 Current Appropriation	FY 2012 Request
Fossil Energy Environmental Restoration		
CERCLA[a] Remedial Actions	1,155	200
RCRA[b] Remedial Actions	3,105	1,697
Other ES&H Actions	5,740	6,000
Total, Fossil Energy Environmental Restoration	10,000	7,897

Mission

Fossil Energy (FE) Environmental Restoration activities ensure protection of workers, the public, and the environment in performing the FE mission of the National Energy Technology Laboratory (NETL) at the Morgantown (MGN), West Virginia; Pittsburgh (PGH), Pennsylvania; Houston, Texas; Fairbanks, Alaska; and Albany (ALB), Oregon sites.

Benefits

Execution of this program's mission will follow the Secretary's priorities/guidelines and the strategic themes of the Department.

Detailed Justification

(dollars in thousands)

	FY 2010 Current Appropriation	FY 2012 Request
CERCLA Remedial Actions	**1,155**	**200**
Rock Springs Sites	**550**	**200**

In FY2012, continue groundwater stabilization period for Sites 4, 6, 7, and 12. Conduct periodic ground water sampling events at Sites 4, 6, 7, 9, and 12 to evaluate contaminant removal and to assess progress toward meeting regulatory requirements set forth by the Wyoming Department of Environmental Quality (WDEQ). If remediation goals are met and following WDEQ approval, plug and abandon ground water monitor wells at Sites 4, 5, 6, 7, and 12. Contour and seed disturbed areas with seed mixtures approved by WDEQ. *Participants include: U.S. Army Corps of Engineers,*

[a] Comprehensive Environmental Response, Compensation and Liability Act (of 1980)
[b] Resource Conservation and Recovery Act (of 1976)

(dollars in thousands)

	FY 2010 Current Appropriation	FY 2012 Request

HydroGeoLogic Consultants and URS (NETL site support contractor).

In FY2010, operated and maintained the air sparge remediation system at Rock Springs Site 9 to remove organic contaminants from the Tipton aquifer ground water, as required by the WDEQ. Continued the groundwater stabilization period for Sites 4, 6, 7, and 12. After a three year stabilization period, received approval to begin active air sparging. Conducted periodic ground water sampling events at Sites 4, 6, 7, 9, and 12 to evaluate contaminant removal and to assess progress toward meeting regulatory requirements set forth by the WDEQ. Prepared and submitted a project review report as required by the WDEQ. *Participants include: U.S. Army Corps of Engineers, HydroGeoLogic Consultants and URS (NETL site support contractor).*

- **Hoe Creek Site** **450** **0**

In FY2012, following approval from WDEQ, plug and abandon all remaining ground water monitor wells. Continue removal of all surface facilities (buildings, air sparge lines, office trailer) and contour and seed all disturbed areas with seed mixtures approved by the WDEQ.

In FY2010, continued the 2-year ground water stability period at the Hoe Creek III Site. Conducted quarterly ground water sampling events to verify ground water quality parameters have stabilized and ground water can be considered restored to baseline conditions by the WDEQ. *Participants include: U.S. Army Corps of Engineers, Cape Environmental Associates*

- **Hanna Site Revegetation** **5** **0**

In FY2012, assuming release of the reclamation bond and permit termination, all activities at the site should be completed. There will be no funding assigned to this activity. Any interim monitoring will be covered under "Other ES&H Activities" funding.

In FY2010, resubmitted updated version of the revegetation assessment to the WDEQ, which is required before reclamation bond release. The approval of this report is necessary before the reclamation performance bond can be released.

- **NETL Preliminary Site Investigations** **25** **0**

In FY2012, no funding will be needed for this activity.

In FY2010, investigate/support two sites where NETL may have current and/or future environmental liabilities (e.g., typically associated with property disposition issues due to environmental contamination at off-site locations) as determined through EPA and state environmental agency interactions. *Participants include: U.S. Army Corps of Engineers.*

- **NETL Site Remediation** **10** **0**

(dollars in thousands)

	FY 2010 Current Appropriation	FY 2012 Request
▪ **CERCLA Potentially Responsible Party (PRP) Response Activities**	**115**	**0**

In FY2012, no funding will be needed for this activity.

In FY2010, conduct remedial investigations, feasibility studies, and address environmental claims for one or two sites found to be contaminated and requiring cleanup under Federal CERCLA and state cleanup standards.

RCRA Remedial Actions	**3,105**	**1,697**
▪ **NETL On-Site Remediation**	**1,605**	**352**

In FY2012, continue RCRA-related on-site regulatory, corrective, preventive, and improvement activities, such as asbestos and lead abatement and waste minimization and pollution prevention activities.

In FY2010, implement chemical- and pollutant-related environmental management plans under NETL's ISO-14001 program; continue NETL RCRA-related on-site regulatory, corrective, preventive, and improvement activities, such as asbestos and lead abatement and waste minimization and pollution prevention activities; perform activities to ensure compliant wastewater treatment plant operations in order to address past notices of violations; and fund RCRA-related risk management and maintenance activities. Continue retrofit of heating and cooling systems with acceptable refrigerants to meet Federal requirements by 2010.

▪ **Albany On-Site Remediation**	**1,500**	**1,345**

In FY2010-2012, continue Albany RCRA cleanup actions, including abating lead and asbestos exposures; resolving chemical storage and labeling issues; monitoring soil and ground water; upgrading ventilation and air pollution systems; and improving air emission management, materials handling, and waste disposal activities. Continue regulatory ground water monitoring activities in conjunction with the Oregon Department of Environmental Quality. Continue investigation and risk assessment activities for the specific trichloroethylene (TCE) ground water contamination issue and identify the most appropriate path forward for remediation.

(dollars in thousands)

	FY 2010 Current Appropriation	FY 2012 Request
Other ES&H Actions	**5,740**	**6,000**
Other ES&H Actions at NETL	**5,665**	**5,925**

In FY2010-2012, 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). Implement actions in support of correcting ES&H deficiencies associated with infrastructure (e.g., ventilation systems, waste pads, and gas cylinder storage areas). Implement actions in support of achieving DOE's pollution prevention and energy management goals. Maintain indoor air quality and ventilations systems, walking/working surfaces, personal protective equipment, and conduct facility seismic evaluations. Implement actions in support of personnel security, operational security, export/import controls, and the foreign national visitor and assignment programs.

Program Support	**75**	**75**

Fund technical and program management support

Total, Fossil Energy Environmental Restoration	**10,000**	**7,897**

Explanation of Funding Changes

	FY 2012 vs. FY 2010 Current Approp ($000)
CERCLA Remedial Actions	
The Hoe Creek and Rock Springs remedial actions are scheduled to be completed and released by the Wyoming DEQ after FY2012. Activities at the sites will be correspondingly reduced by the end of 2012.	-955

	FY 2012 vs. FY 2010 Current Approp ($000)
RCRA Remedial Actions	
The beryllium remediation at the Albany site was completed in FY2010, and much of the asbestos and lead abatement activities and the pollution prevention work at NETL are being completed. The only significant driver of costs in this activity remains the remediation of the groundwater contamination at the Albany site	-1,408
Other ES&H Actions	
From the savings in the CERCLA budget, more funds will be available to provide for the increasing costs related to improving and sustaining environmental, safety, and health programs at NETL.	+260
Total Funding Change, Fossil Energy Environmental Restoration	**-2,103**

Special Recruitment Programs

Funding Profile by Subprogram

	FY 2010 Current Appropriation	FY 2012 Request
Special Recruitment Programs		
Special Recruitment Programs	700	700
Total, Special Recruitment Programs	700	700

Mission

FE has developed the Mickey Leland Energy Fellowship (MLEF) Program to help attract minority and other highly qualified technical and engineering students working in the development of fossil fuels.

The FE Technical Pipeline Program collaborates with top earth science and engineering universities to provide a "pipeline" of employees who are mentored to become FE's successor managers and technical scientists of the future.

The MLEF program is a ten-week summer internship program that offers women and under-represented minority students majoring in math, science, and engineering an opportunity to learn about FE programs and initiatives. In addition, Fossil Energy works closely with and encourages these MLEF students who are studying academic disciplines related to the Fossil Energy mission to pursue careers in Fossil Energy fuel research ensuring clean, affordable energy.

Benefits

The Special Recruitment Programs support the Secretary's Priority of developing and nurturing science and engineering talent and provides a succession of scientists and engineers.

Detailed Justification

	(dollars in thousands)	
	FY 2010 Current Appropriation	FY 2012 Request
Special Recruitment Programs	**700**	**700**

In FY 2012, applicants will continue to be recruited and selected to participate in the Fossil Energy Technical Pipeline Program and the Mickey Leland Energy Fellowship Program.

Total, Special Recruitment Programs	**700**	**700**

Explanation of Funding Changes

	FY 2012 vs. FY 2010 Current Approp ($000)
Special Recruitment Programs	
No significant change in level of effort from FY 2010 to FY 2012.	+0
Total Funding Change, Special Recruitment Programs	**+0**

Cooperative Research and Development

Funding Profile by Subprogram

	FY 2010 Current Appropriation	FY 2012 Request
Cooperative Research and Development		
Cooperative Research and Development	4,868	0
Total, Cooperative Research and Development	4,868	0

Mission

The Cooperative Research and Development program supports activities of federal/industry/research institute endeavors and federal/state/industry partnerships. It was originally created in FY 1989 and provided the federal share of support for Jointly Sponsored Research Programs (JSRP) at the Western Research Institute (WRI) and the University of North Dakota Energy and Environmental Research Center (UNDEERC).

Detailed Justification

(dollars in thousands)

	FY 2010 Current Appropriation	FY 2012 Request
Cooperative Research and Development	**4,868**	**0**

In 2012, the Department anticipates that these centers will compete successfully for Fossil Energy funding through the competitive solicitation process.

In FY2010, the Department funded cooperative research programs at WRI and UNDEERC, which are 50-50 cost-shared with non-federal partners. Funding was split evenly between the two participants.

SBIR/STTR	**0**	**0**
Total, Cooperative Research and Development	**4,868**	**0**

Explanation of Funding Changes

	FY 2012 vs. FY 2010 Current Approp ($000)
Cooperative R&D	
In FY2012, the Department anticipates that these centers will compete successfully for Fossil Energy funding through the competitive solicitation process.	-4,869
Total Funding Change, Cooperative R&D	**-4,869**

Naval Petroleum & Oil Shale Reserves

Naval Petroleum & Oil Shale Reserves

Naval Petroleum and Oil Shale Reserves

Proposed Appropriation Language

For expenses necessary to carry out naval petroleum and oil shale reserve activities, $14,909,000, 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 Changes
This decrease is in support of discontinuing production operations and all cost-shared testing operations at Naval Petroleum Reserve No. 3 (NPR-3). Only those wells associated with produced water needed for geothermal testing will be operated. A plan for sale or other disposition of NPR-3 will be developed.

Naval Petroleum and Oil Shale Reserves

Overview

Appropriation Summary by Program

(dollars in thousands)

	FY 2010 Current Appropriation	FY 2011 CR	FY 2012 Request
Naval Petroleum and Oil Shale Reserves			
Naval Petroleum and Oil Shale Reserves	23,627	23,627	14,909
Total, Naval Petroleum and Oil Shale Reserves	23,627	23,627	14,909

Preface

The Naval Petroleum and Oil Shale Reserves (NPOSR) program manages a number of legal agreements that were executed as part of the 1998 sale of Naval Petroleum Reserve No. 1 (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 Department also operates the Naval Petroleum Reserve No. 3 (NPR-3) and the Rocky Mountain Oilfield Testing Center (RMOTC), co-located near Casper, Wyoming. RMOTC provides opportunities for field testing and demonstration of low-temperature geothermal technologies and other renewable energy technologies having oilfield application. Since production costs are expected to exceed oil revenues, production operations at NPR-3 are no longer economic and will be discontinued except for incidental oil production associated with produced water needed for geothermal testing. Accelerated environmental remediation will continue consistent with the 2007 Environmental Liabilities Study and restructuring activities will commence. A plan will be developed for the sale or disposition of NPR-3. Any revenues generated through the sale of incidental oil produced during technology testing are deposited into the U.S. Treasury.

Mission

The NPOSR mission encompasses finalizing the Government's equity interests in NPR-1; releasing the DOE from its environmental liabilities resulting from the 1998 sale of NPR-1; phasing out activities associated with NPR-3 production operations and RMOTC testing; and continuing remediation activities per the 2007 NPR-3 Environmental Liability Study.

Benefits

The NPR-1 program continues work to close out the remaining environmental findings, as required by the 2008 agreement between DOE and the California Department of Toxic Substance Control (DTSC). NPR-3 production operations will be discontinued except for incidental oil production associated with produced water needed for geothermal testing. RMOTC provides opportunities through 100% funds-in agreements and fully funded EERE projects for field testing and demonstration of low-temperature geothermal technologies and other renewable energy technologies having oilfield application.

Annual Performance Results and Targets

The Department is in the process of updating its strategic plan, and has been actively engaging stakeholders including Congress. The draft strategic plan is being released for public comment concurrent with this budget submission, with the expectation of official publication this spring. The draft plan and FY12 budget are consistent and aligned. Updated measures will be released at a later date and available at the following link http://www.mbe.doe.gov/budget/12budget/index.htm.

Facilities Maintenance and Repair

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

Direct-Funded Maintenance and Repair

(dollars in thousands)

	FY 2010 Current Appropriation	FY 2012 Request
Naval Petroleum and Oil Shale Reserves		
NPR-3/RMOTC	200	400
Total, Direct-Funded Maintenance and Repair	200	400

Naval Petroleum and Oil Shale Reserves
Office of Fossil Energy

Funding by Site by Program

(dollars in thousands)

	FY 2010 Current Appropriation	FY 2012 Request
Naval Petroleum and Oil Shale Reserves		
NPR Wyoming	15,895	9,179
Washington Headquarters	7,732	5,730
Total, Naval Petroleum and Oil Shale Reserves	23,627	14,909

Site Description

Naval Petroleum Reserve - Wyoming
The Naval Petroleum Reserve in Wyoming (NPR-3) is located in Casper, Wyoming. The President must authorize continued production every three years, with production currently authorized through April 5, 2012. NPR-3 will phase out activities associated with NPR-3 production operations. Oil production from most wells will be discontinued, and any revenues generated from incidental oil production associated with low-temperature geothermal testing will be deposited to the U.S. Treasury. RMOTC will support technology testing through 100% funds-in agreements and fully funded EERE projects for field testing and demonstration of low-temperature geothermal technologies and other renewable energy technologies having oilfield application. Environmental remediation will be continued and a plan will be developed for the sale or disposition of NPR-3.

Washington Headquarters
The headquarters office located in Washington, DC supports NPR-1 remediation closeout as well as Elk Hills equity finalization activities and reports on unconventional fuels activities under EPACT 2005. Also, the headquarters office supports the independent evaluation/recommendation of final equity at Elk Hills. There are geologic, petro-physical and reservoir engineering services required to prepare and support the Government's equity position before the DOE Office of Hearings and Appeals, the United States Court of Federal Claims, and the Assistant Secretary for Fossil Energy.

The National Defense Authorization Act for Fiscal Year 1996 (P.L. 104-106) required the sale of the Government's interest in Naval Petroleum Reserve No. 1 (NPR-1). To comply with this requirement, the Elk Hills field in California was sold to Occidental Petroleum Corporation in 1998. Subsequently, the Department transferred two of the Naval Oil Shale Reserves (NOSR-1 and NOSR-3), both of which are in Colorado, to the Department of the Interior's (DOI) Bureau of Land Management. In January 2000, the Department returned the NOSR-2 site to the Northern Ute Indian Tribe. The Energy Policy Act of 2005 transferred administrative jurisdiction and environmental remediation of Naval Petroleum Reserve 2 (NPR-2) in California (with the exception of eight small plats of vacant land know as the Ford City Drill Sites) to the Department of the Interior.

Naval Petroleum and Oil Shale Reserves

Funding Profile by Subprogram

(dollars in thousands)

	FY 2010 Current Appropriation	FY 2012 Request
Naval Petroleum and Oil Shale Reserves		
Production and Operation	14,166	5,480
Management	9,461	9,429
Total, Naval Petroleum and Oil Shale Reserves	23,627	14,909

Public Law Authorizations:
P.L. 94-258, "Naval Petroleum Reserves Production Act" (1976)
P.L.109-58, "Energy Policy Act of 2005"

Mission

The NPOSR mission includes environmental remediation and equity finalization at NPR-1, phasing out activities associated with NPR-3 production and cost-shared testing operations, and continuing remediation activities at NPR-3 per the 2007 Environmental Liability Study.

Benefits

The NPR-1 program continues work to close out the remaining environmental findings, as required by the 2008 agreement between DOE and the California Department of Toxic Substance Control (DTSC). RMOTC provides the Geothermal Technology Program with a low-temperature geothermal testing facility to demonstrate and validate geothermal technologies. NPR-3 production operations will be discontinued except for incidental oil production associated with produced water needed for geothermal testing. RMOTC provides opportunities through 100% funds-in agreements and fully funded EERE projects for field testing and demonstration of low-temperature geothermal technologies and other renewable energy technologies having oilfield application.

Means and Strategies

NPOSR will use various means and strategies to continue its mission and achieve its program goals. The program continues ongoing activities to attain release from remaining environmental findings related to the sale of NPR-1, as is required by the agreement between DOE and the California Department of Toxic Substance Control (DTSC). Restructuring activities associated with discontinuing a large portion of NPR-3 production and testing operations will be implemented. Environmental remediation will be continued per the 2007 NPR-3 Environmental Liabilities Study.

Production and Operations

Funding Schedule by Activity

(dollars in thousands)

	FY 2010 Current Appropriation	FY 2012 Request
Production and Operations		
NPR-1 Closeout	4,000	2,480
NPR-3 Operations	3,866	0
NPR-3 Environmental Remediation	3,000	3,000
Rocky Mountain Oilfield Testing Center	3,300	0
Total, Production and Operations	14,166	5,480

Benefits

NPR-1 - Environmental remediation and cultural resource activities 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. Current activities encompass execution of the technical baseline, interim measures, environmental sampling and analysis, corrective measures, waste removal and disposal, confirmatory sampling, and request for release from further corrective action.

NPR-3/RMOTC – Provides the Geothermal Technology Program with a low-temperature geothermal testing facility to demonstrate and validate geothermal technologies. As a validation facility for low temperature and co-produced geothermal technologies, RMOTC will aide in the development and application of this alternate energy source which will reduce the carbon footprint of electricity generation. At RMOTC, renewable and fossil energy technologies are integrated in an operating oil field with the goals of decreasing dependence on oil and allowing oil and gas to be produced in a more environmentally friendly manner. Those facilities that are not useful for geothermal or other renewable energy technology testing will be environmentally remediated. Wells that are needed for geothermal testing purposes will remain on production; revenue from these wells will be deposited into the U.S. Treasury.

Detailed Justification

(dollars in thousands)

	FY 2010 Current Appropriation	FY 2012 Request
NPR-1 Closeout	**4,000**	**2,480**

The former NPR-1 Closure Project has transitioned from baseline development to field remediation of the 131 Areas of Concern identified in the Corrective Action Consent Agreement executed between DOE and the State of California Department of Toxic Substances Control. Environmental remediation will be conducted for those sites exceeding human health risk levels. Extensive confirmatory sampling will be conducted following remediation in order to support DOE's request for release from further corrective action.

NPR-3 Operations	**3,866**	**0**

No funding is being requested for FY 2012. NPR-3 is a stripper oilfield at the end of its productive life. Since production costs are expected to exceed oil revenues, production operations at NPR-3 are

(dollars in thousands)

FY 2010 Current Appropriation	FY 2012 Request

no longer economic and will be discontinued except for incidental oil production associated with produced water needed for geothermal testing

FY 2010 funding supported the operation and maintenance of 120 producing wells. Performed maintenance to key production facilities, and support infrastructure buildings, electrical distribution system, roads and produced wastewater facility. Efforts focused on repairs and preventative maintenance activities that were necessary to keep equipment from being damaged and personnel from being harmed. Production averaged 185 barrels of oil per day, resulting in $4.4 million of revenues deposited to the U.S. Treasury. The 2007 Environmental Liabilities Study of NPR-3 and the Rocky Mountain Oilfield Testing Center addresses closeout and associated timeline issues estimating a total liability of site closure and environmental remediation between $113 and $166 million (2006 dollars).

NPR-3 Environmental Remediation **3,000** **3,000**

FY 2012 funding continues restoration activities including the plugging and abandonment of wells in compliance with State of Wyoming Oil and Gas Conservation Commission (WYOGCC) regulations. Remediation activities will focus on wells and facilities identified in the 2007 Environmental Liabilities Study with the greatest potential for negative impacts. A plan for the sale or disposition of NPR-3 will be developed. As part of the plan, disposition strategies will be analyzed including transfer to the Department of Interior and working with GSA for final disposition of the site. In addition, a Title I or II Engineering design will be conducted to more precisely determine environmental restoration costs and schedules.

In FY 2010, funding continues to support restoration activities identified in the Environmental Liabilities Study that are no longer of value to either production operations or RMOTC testing operations. Among those facilities that have little or no potential use for testing projects are idle wells routinely tested per WYOGCC requirements that are found to be damaged and uneconomic, the Gas Processing Plant, roads and electrical lines that no longer serve any facilities, and oil and water processing pits that are no longer operational. Approximately 10 wells will be plugged and abandoned. Well sites will be reviewed to verify that they would not present an environmental risk or have a beneficial use for RMOTC testing partners. The Gas Plant and other associated facilities will be decommissioned.

Rocky Mountain Oilfield Testing Center **3,300** **0**

The program is requesting no funding for RMOTC testing in FY 2012. FY 2012 testing will be comprised only of projects that are funded through 100% fully reimbursable (funds-in) arrangements or fully funded by EERE's Geothermal Technology Program to validate co-produced, geopressured, and low-temperature geothermal technologies. RMOTC will continue its collaboration with EERE to continue to provide a testing center in support of the Low-Temperature and Co-Produced Geothermal (LTCG) program.

FY 2010 funding supports core in-house contractor staff and maintenance and operation of testing facilities and equipment used to partner with industry, universities and other government entities seeking to use the facility for development and demonstration of advanced oil and gas technologies.

	(dollars in thousands)	
	FY 2010 Current Appropriation	FY 2012 Request
RMOTC will identify and analyze options for becoming a self-sustaining user facility.		
Total, Production and Operations	**14,166**	**5,480**

Explanation of Funding Changes

	FY 2012 vs. FY 2010 Current Approp ($000)
Production and Operations	
▪ **NPR-1 Closeout**	
The decrease is due to the balancing of limited resources among the program components.	-1,520
▪ **NPR-3 Operations**	
Since production costs are expected to exceed oil revenues production operations at NPR-3 are no longer economic and will be discontinued, except for incidental oil production associated with produced water needed for geothermal testing; thus this decrease is in support of discontinuing production operations.	-3,866
▪ **RMOTC**	
This decrease is due to discontinuing all cost-sharing testing operations.	-3,300
Total Funding Change, Production and Operations	**-8,686**

Program Direction

Funding Profile by Category

(dollars in thousands/whole FTEs)

	FY 2010 Current Appropriation	FY 2012 Request
NPR - Wyoming		
Salaries and Benefits	2,075	2,315
Travel	100	100
Support Services	0	0
Other Related Expenses	500	780
Total, NPR- Wyoming	2,675	3,195
Full Time Equivalents	17	14
Washington, Headquarters		
Salaries and Benefits	1,544	1,080
Travel	55	50
Support Services	161	75
Other Related Expenses	232	45
Total, Washington, Headquarters	1,992	1,250
Full Time Equivalents	11	6
Total Program Direction		
Salaries and Benefits	3,619	3,395
Travel	155	150
Support Services	161	75
Other Related Expenses	732	825
Total, Program Direction	4,667	4,445
Total Full Time Equivalents	28	20

Mission

Program Direction provides the Federal Staffing resources and associated costs required to provide overall direction and execution of the Office of Naval Petroleum and Oil Shale Reserves.

Detailed Justification

(dollars in thousands)

	FY 2010 Current Appropriation	FY 2012 Request
Program Direction	**4,667**	**4,445**

Provides salaries, travel, contractor support services and other related expenses to support the management and execution of the NPOSR program.

- **Salaries and Benefits** **3,619** **3,395**
  Staff of 20 FTEs performs policy and planning, equity determination, petroleum engineering, financial management, procurement, environment and safety, IT/ADP, project management, accounting, property control, and administration of reimbursable work programs.
- **Travel** **155** **150**
  Provides travel for resolution of NPR-1 equity issues and closeout activities, and for travel required to coordinate and accomplish the NPOSR mission**.**
- **Support Services** **161** **75**
  Provide analytic support for policy decisions, ensure that the DOE safety programs are administered in accordance with OSHA policy and ensure environmental reporting is maintained, and provide information technology support.
- **Other Related Expenses** **732** **825**
  Provides travel for resolution of NPR-1 equity issues and closeout activities, and for travel required to coordinate and accomplish the NPOSR mission.

Equity **1,140** **1,000**

DOE and Chevron currently are engaged in the finalization of equity ownership interests at Elk Hills. The Secretary of Energy is required to finalize the equity interests of the known oil and gas zones at Elk Hills under section 3412(b) of the Act. Of the four applicable zones, the Dry Gas Zone and Carneros Zone are finalized. To this end, DOE is currently engaged in mediation discussions with Chevron to settle equity in the Stevens Zone and the Shallow Oil Zone. If the mediator's proposed settlement in not accepted as fair for the Department, there will be no settlement with Chevron and the Federal judge will likely proceed with her decision.

Business Management & Support **3,654** **3,984**

Continue payments for post-employment medical and dental benefits to former Management & Operating (M&O) contractor employees. Maintain the level of effort and staffing levels and services in support of environmental, safety, security, quality assurance, property control, accounting, and administrative support at the Casper office to support NPR-3 environmental remediation.

Total, Management	**9,461**	**9,429**

Explanation of Funding Changes

	FY 2012 Request vs. FY 2010 Current Approp ($000)
Management	
▪ **Program Direction**	
The slight decrease is a result of increases in salary, travel, support services and other related expenses at NPR-3 and Washington (Headquarters) being more than offset by retirements at Washington.	-222
▪ **Equity**	
The decrease is related to a possible conclusion of the work associated with the finalization of equity. DOE is currently engaged in mediation discussions with Chevron to settle equity.	-140
▪ **Business Management Support**	
The increase is required for post-employment medical and dental benefits to former NPR-1 Management & Operating (M&O) contractor employees.	+330
Total Funding Change, Management Support	**-32**

Other Related Expenses by Category

(dollars in thousands)

	FY 2010 Current Appropriation	FY 2012 Request
Other Related Expenses		
Rent to GSA	0	0
Rent to Others	189	450
Communications, Utilities, Misc.	77	100
Printing and Reproduction	0	0
Other Services	383	205
Purchases from Gov. Accounts	0	0
Operation and Maintenance of Equipment	5	5
Supplies and Materials	78	65
Equipment	0	0
Working Capital Fund	0	0
Total, Other Related Expenses	**732**	**825**

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.), $121,704,000, to remain available until expended. Of the funds appropriated in Public Law 110-161 under this heading for new site land acquisition activities, $14,493,000 are hereby permanently cancelled. Of the funds appropriated in Public Law 110-329 under this heading for new site expansion activities, beyond land acquisition, $31,507,000 are hereby permanently cancelled. Of the funds appropriated in Public Law 111-85 under this heading, $25,000,000 are hereby permanently cancelled. For an additional amount for "Strategic Petroleum Reserve," $71,000,000, to remain available until expended

Explanation of Change

Decrease is attributable to the degas site modification construction at West Hackberry that occurred in FY 2010; reduced costs associated with the Bayou Choctaw replacement cavern; and, a reduction in power charges.

Strategic Petroleum Reserve
Office of Fossil Energy

Overview

Appropriation Summary by Program

(dollars in thousands)

	FY 2010 Current Appropriation	FY 2011 CR	FY 2012 Request
Strategic Petroleum Reserve			
Strategic Petroleum Reserve	243,823	243,823	192,704 [a]
Cancellation	0	0	-71,000
Total, Strategic Petroleum Reserve	243,823	243,823	121,704

[a] FY12 Program Level of $192.7 million assumes cancellation of $71 million in balances from prior years appropriated for 1 billion barrel expansion at Richton, MS site and use of these balances to partially fund operations and management activities.

Preface

The Strategic Petroleum Reserve, created by Congress in 1975, is a National Security program providing an emergency stockpile of petroleum to assure United States energy and economic security. The Strategic Petroleum Reserve appropriation provides resources necessary to ensure and enhance the operational readiness and responsiveness of the Strategic Petroleum Reserve to continue protecting the Nation against potential disruptions in its foreign and domestic petroleum supplies.

Within the Strategic Petroleum Reserve appropriation, there are three subprograms:
- Facilities Development and Operations
- Management
- Expansion (Introduced in FY 2008 Budget)

Mission

The Strategic Petroleum Reserve (SPR) protects the U.S. from future 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.

Benefits

The mission of the SPR program is in direct support of the Department of Energy's "Energy Security" mission. The SPR benefits the Nation by providing:

- Insurance Policy against interruption in U.S. petroleum supplies (i.e., international events, hurricanes, accidents or terrorism).
- Provides a Deterrent to hostile threats of cutoff of oil supplies.
- Protects the Economic Security of the country

- Avails the U.S. of worldwide Emergency Assistance through International Energy Agency (IEA) alliance.

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. The U.S. imports approximately 57% 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 significant deterrent to hostile threats of cutoffs of petroleum supplies. The SPR, with current crude oil stocks equal to 75 days of imports in underground storage, provides a strong deterrent to hostile efforts. The sale of approximately 6 million barrels of oil has been proposed in FY 2012 to provide for operational purposes. The sale will reduce the crude oil stocks to 74 days. The SPR protects the economic security of the country. 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. The SPR provides energy security until alternatives are developed to improve energy independence.

Annual Performance Results and Targets

The Department is in the process of updating its strategic plan, and has been actively engaging stakeholders including Congress. The draft strategic plan is being released for public comment concurrent with this budget submission, with the expectation of official publication this spring. The draft plan and FY12 budget are consistent and aligned. Updated measures will be released at a later date and available at the following link http://www.mbe.doe.gov/budget/12budget/index.htm.

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 2010 Current Appropriation	FY 2012 Request
Strategic Petroleum Reserve	39,012	33,133
Total, Direct-Funded Maintenance and Repair	39,012	33,133

Strategic Petroleum Reserve
Office of Fossil Energy

Funding by Site by Program

(dollars in thousands)

	FY 2010 Current Appropriation	FY 2012 Request
Strategic Petroleum Reserve		
Bayou Choctaw Site, LA	44,214	11,425
Big Hill Site, TX	22,744	20,968
Bryan Mound Site, TX	19,517	16,925
National Energy Technology Laboratory	982	1,415
Oak Ridge National Laboratory	361	390
Richton, MS (Expansion)	25,000	0
Sandia National Laboratory	2,976	3,342
SPR Program Office, Washington, DC	4,879	5,987
SPR Project Management Office, New Orleans, LA	93,499	111,183
West Hackberry Site, LA	29,651	21,069
Total, Strategic Petroleum Reserve	243,823	192,704

Major Changes or Shifts by Site

Bayou Choctaw Site, LA
- In FY 2012, complete the construction activities (water/brine/oil piping, instrumentation and testing) and transfer the oil from the existing cavern into the replacement cavern.

West Hackberry, LA
- In FY 2010, site modifications/foundations prepared the site for installation of the degas plant when it is moved from the Bryan Mound to the West Hackberry. In FY 2012, degas operations begin at the West Hackberry site.

Site Description

Bayou Choctaw Site, LA
Twelve miles southwest of Baton Rouge, LA. The site has storage capacity of 76 million barrels**.**

Big Hill Site, TX
Twenty-six miles southwest of Beaumont, TX. The site has storage capacity of 170 million barrels.

Bryan Mound Site, TX
Three miles southwest of Freeport, TX. The site has storage capacity of 254 million barrels.

National Energy Technology Laboratory

Located in Morgantown, WV, Pittsburgh, PA, Pittsburgh, and other locations, is a multipurpose laboratory, owned and operated by the U.S. Department of Energy. NETL conducts detailed analysis on selected oil samples of crude oil streams, caverns and storage cavern composites to ascertain the quality of stored oil on selected oil samples. These measurements include the vapor pressure and gas-oil ratio.

Oak Ridge National Laboratory
Located in Oak Ridge, TN, provides analytic support to the SPR by documenting SPR analysis models; assisting in the development of SPR oil valuation and bid analysis tools; evaluating potential applications of the DIS-Risk model approach related to energy policy issues; and evaluating SPR planning alternatives.

Richton Site, MS
The Richton site in Perry County, MS was selected in February 2007 to be a new storage facility for the SPR expansion to 1.0 billion barrels. This site has no storage capacity.

Sandia National Laboratory

The Sandia National Laboratory, located in Albuquerque, NM provides technical, comprehensive, site-specific engineering research and development support for the planning, design, development, and monitoring of SPR crude oil storage facilities.

SPR Program Office
The Program Office, located in Washington, DC, is responsible for establishing the overall policy and program(s) necessary to carry out the mission of the SPR as set forth in the EPCA. The Program Office provides the long-range planning, program direction and financial management for the SPR program.

SPR Project Management Office
The SPR Project Management Office, located in New Orleans, LA, is responsible for operations oversight and management, facilities design and construction, and overall contractor management at the four storage facilities.

West Hackberry Site, LA
Twenty-five miles southwest of Lake Charles, LA. The site has storage capacity of 227 million barrels.

Strategic Petroleum Reserve

Funding Profile by Subprogram

(dollars in thousands)

	FY 2010 Current Appropriation	FY 2012 Request
Strategic Petroleum Reserve		
Facilities Development and Operations	199,732	170,914
Management	19,091	21,790
Expansion	25,000	0
Total, Strategic Petroleum Reserve	243,823	192,704

Mission

The Strategic Petroleum Reserve (SPR) program mission is in direct support of the Department of Energy's "Energy Security" mission. 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 days 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. The Expansion subprogram was introduced in FY 2008 to fund activities associated with the expansion of the SPR to 1 billion barrels as called for in the Energy Policy Act (EPAct) of 2005.

Benefits

The SPR benefits the Nation by providing an insurance policy against interruptions in U.S. petroleum supplies whether originating from international supply problems, hurricanes, accidents or terrorist activities. The SPR serves as a significant deterrent to hostile threats of cutoffs of petroleum supplies. The SPR protects the economic security of the country. A release of crude oil 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.

Annual Performance Results and Targets

The Department is in the process of updating its strategic plan, and has been actively engaging stakeholders including Congress. The draft strategic plan is being released for public comment concurrent with this budget submission, with the expectation of official publication this spring. The draft plan and FY12 budget are consistent and aligned. Updated measures will be released at a later date and available at the following link http://www.mbe.doe.gov/budget/12budget/index.htm.

Means and Strategies

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. The sale of $500 million (approximately 6 million barrels) of oil is being proposed in FY 2012 to provide for operational purposes, which will reduce the inventory to 721 million barrels. To ensure that the SPR program is environmentally responsible and fully responsive to the needs of the Nation and the public, the FY 2012 request proposes to complete the construction activities and transfer the oil from the existing cavern into the replacement cavern.

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 is completed, efforts will begin to move the plant to the West Hackberry site. In FY 2010, modifications/foundations at the West Hackberry site were made in preparation for relocation of the degas plant to the site. In FY 2012, degas operations will begin at the West Hackberry site.

Program performance can be affected by several external factors including:

- Changing petroleum consumption and import dependence levels
- Petroleum market conditions, and
- Developments in the commercial distribution system (i.e., pipelines, and terminals)

Facilities Development and Operations

Funding Schedule by Activity

(dollars in thousands)

	FY 2010 Current Appropriation	FY 2012 Request
Facilities Development and Operations		
Security	20,817	20,895
Power	6,221	4,516
Operations and Maintenance	169,773	142,125
Support Services	2,921	3,378
Total, Facilities Development and Operations	199,732	170,914

Benefits

This 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.

Detailed Justification

(dollars in thousands)

	FY 2010 Current Appropriation	FY 2012 Request
Security	**20,817**	**20,895**

Budget reflects a cost effective security program providing an essential level of security services during all security conditions. Assures that the protection of SPR personnel, crude oil operations, classified matter, equipment, and facilities is consistent with the Site Security Plan and drawdown implementation. The major security effort is managed by the Management and Operating contractor with a subcontractor for the security protection force.

FY 2012 reflects full funding for the protection force subcontract (190 FTEs), as well as acquisition and maintenance of weapons and detection systems, conducting tactical training, and management of security and emergency operations.

Power	**6,221**	**4,516**

Includes power costs at all sites for operational readiness, degas operations, and oil fill. Includes requirements for Non-Hydro Renewable Power per Executive Order 13423.

FY 2012 includes power for degas operations at the West Hackberry site.

Operations and Maintenance	**169,773**	**142,125**

The request supports oil movements, oil accountability, cavern integrity testing, corrosion control, and site subsidence surveys. Preventive, corrective, predictive, and facilities maintenance ensure the functionality and reliability of operational systems. Maintenance construction projects involving engineering, procurement, construction, fabrication, installation, and testing are

(dollars in thousands)

	FY 2010 Current Appropriation	FY 2012 Request

scheduled to prolong the life of buildings, structures, and physical systems. Major system test exercises are conducted (pipelines and piping, emergency power, recovery systems, security systems, and cavern integrity) to demonstrate drawdown capability and verify mission-readiness. Vapor pressure mitigation continues as well as safety and health activities, fire protection, quality assurance, property management, data systems and environmental support to ensure the SPR maintains compliance with laws, rules, regulations, and requirements.

FY 2010 funds tasks for security enhancement construction projects for drawdown critical areas and upgrades to the ADAS and site security detection systems at SPR sites. FY 2012 provides for replacement of the anhydrite pond liner at Big Hill and Tank BMT-2 roof demolition at Bryan Mound.

FY 2010 provides for the purchase of a commercial storage cavern to replace an existing Bayou Choctaw site cavern that presents a major environmental risk with continued use. FY 2012 provides funding toward completion of the replacement cavern.

Support Services	**2,921**	**3,378**

The request supports funding requirements for technical support across all sites in the areas of configuration management, scheduling, audits of oil inventories and facilities revenue. Funding supports subcontractor headcount (25.8 FTEs) to support these activities.

Total, Facilities Development and Operations	**199,732**	**170,914**

Explanation of Funding Changes

	FY 2012 vs. FY 2010 Current Approp ($000)
Facilities Development and Operations	
▪ **Security**	
The increase is due to escalation.	+78
▪ **Power**	
The decrease is due to a reduction in process and hotel fees (power usage charges).	-1,705
▪ **Operations and Maintenance**	
The decrease is due to:	
➢ Degas site modification construction at West Hackberry occurred in FY 2010 (-7,073k); and	
➢ Reduced costs associated with the Bayou Choctaw Cavern Replacement project (-20,575k).	-27,648
▪ **Support Services**	
The increase reflects escalation and an increase in IT support services.	+457
Total, Facilities Development and Operations	**-28,818**

Capital Operating Expenses and Construction Summary

Capital Operating Expenses

(dollars in thousands)

	FY 2010 Current Appropriation	FY 2012 Request
ADAS System Upgrade (BH-MM-550)	1,070	0
ADAS System Upgrade (WH-MM-552)	1,043	0
Replace RWIS Bar Rack and Traveling Screen Framing (BM-MM-698)	300	0
Heat Exchanger Isolation Valves (BC-MM-618)	0	0
Upgrade Site Security Detection Systems (NO-MM-718)	0	0
Upgrade Communication/Control System to BDWs (BC-MM-575)	0	0
ADAS System Upgrade (NO-MM-716)	0	0
Anhydrite Pond Liner Replacement (BH-MM-746)	0	1,000
Rework 42-Inch CO Pipeline Mainline Valves (WH-MM-659)	0	900
Repair Timber Pipe Supports (BC-MM-768)	0	754
Repair Erosion Problem at RWIS (BH-MM-373)	0	632
Capital Equipment	6,999	6,624
Total, Capital Operating Expenses	9,412	9,910

Construction Projects

(dollars in thousands)

	Total Estimated Cost (TEC)	Prior-Year Appropriations	FY 2010 Current Appropriation	FY 2012 Request	Unappropriated Balance
Site Building Upgrades (All sites) (BC-MM-669, BM-MM-671, WH-MM-672)	5,831	0	0	0	0
Expanded Site-Wide Card Access Systems (NO-MM-731)	386	0	0	0	0
HSPD-12 PIV-II Logical Access (all sites) (BC-MM-707, BH-MM-708, BM-MM-709, NO-BM-710, WH-MM-711)	1,065	0	0	0	0
Site Building Upgrades (BC-MM-673 and BH-MM-670)	2,274	0	0	1,601	0
Total, Construction	9,556	0	0	1,601	0

Major Items of Equipment (MIE) *(TEC $2 million or greater)*

(dollars in thousands)

	Total Project Cost (TPC)	Total Estimated Cost (TEC)	Prior-Year Appro-priations	FY 2010 Current Approp	FY 2012 Request	Completion Date
Site Modifications/ Foundation for Degas Plant (WH-MM-419)		8,505	0	6,828	0	FY 2011
Upgrade Site Security Detection Systems (WH-MM-589)		4,888	0	3,442	0	FY 2011
Upgrade Site Security Detection Systems (BH-MM-587)		3,424	0	2,411	0	FY 2010
Security Enhancements for Drawdown Critical Areas (BH-MM-728)		2,313	0	1,629	0	FY 2011
Security Enhancements for Drawdown Critical Areas (WH-MM-730)		2,053	0	1,446	0	FY 2011
Heat Exchanger Isolation Valves (BM-MM-614)		2,556	0	0	0	FY 2012
Heat Exchanger Isolation Valves (WH-MM-615)		2,130	0	0	0	FY 2012
Cavern 102 - Cavern/Well LLE and Construction		14,379	0	0	0	FY 2012
Cavern 102 - Surface Facilities Construction		3,708	0	0	0	FY 2012
Tank BMT-2 Roof Demolition (BM-MM-740A)		2,996	0	0	2,110	FY 2013
Total, Major Items of Equipment		46,952	0	15,756	2,110	

Management
Funding Profile by Category

(dollars in thousands/whole FTEs)

	FY 2010 Current Appropriation	FY 2012 Request
Washington Headquarters		
Salaries and Benefits	3,475	3,913
Travel	179	194
Support Services	928	1,430
Other Related Expenses	658	840
Total, Washington Headquarters	5,240	6,377
Full Time Equivalents	27	27
Strategic Petroleum Reserve (SPR) Project Management Office		
Salaries and Benefits	12,156	13,184
Travel	398	668
Support Services	0	0
Other Related Expenses	1,297	1,561
Total, SPR Project Management Office	13,851	15,413
Full Time Equivalents	95	96
Total Program Direction		
Salaries and Benefits	15,631	17,097
Travel	577	862
Support Services	928	1,430
Other Related Expenses	1,955	2,401
Total, Program Direction	19,091	21,790
Total, Full Time Equivalents	122	123

Mission

Program Direction provides the Federal staffing resources and associated costs required to provide overall direction and execution of the SPR.

Detailed Justification

(dollars in thousands)

	FY 2010 Current Appropriation	FY 2012 Request
Salaries and Benefits	**15,631**	**17,097**
Funds salaries and benefits for 123 full time equivalent employees (FTEs) to assure achievement of Level 1 Performance criteria for drawdown and distribution. Provides for support and oversight of the management and operations contractor and subcontractor activities and program operations.		
Travel	**577**	**862**
Provides travel to assure capability to achieve Level 1 Performance criteria for drawdown and distribution and planned reconfiguration of the Reserve.		
Support Services	**928**	**1,430**
Provide analytic support for SPR development, fill and distribution policy decisions. Includes distribution modeling maintenance.		
Other Related Expenses	**1,955**	**2,401**
Major elements are communications, building lease, and electric power for DOE-occupied space (New Orleans, Louisiana). Includes training, small purchases, personal computer hardware/software, supplies, and materials for federal staff.		
Total, Management	**19,091**	**21,790**

Explanation of Funding Changes

	FY 2012 vs. FY 2010 Current Approp ($000)
Management	
The increase is due to escalation, for one (1) additional FTE to meet field procurement responsibilities, and increased technical support and other related expenses.	+2,699
Total, Management	+2,699

Support Services by Category

(dollars in thousands)

	FY 2010 Current Appropriation	FY 2012 Request
`Technical Support		
Economic and Environmental Analyses	928	1,430
Total, Support Services	928	1,430

Other Related Expenses by Category

(dollars in thousands)

	FY 2010 Current Appropriation	FY 2012 Request
Other Related Expenses		
Rent to Others	604	522
Communications, Utilities, Misc.	76	100
Other Services	1,046	1,497
Supplies and Materials	134	137
Equipment	95	145
Total, Other Related Expenses	1,955	2,401

Expansion

Funding Schedule by Activity

(dollars in thousands)

	FY 2010 Current Appropriation	FY 2012 Request
Expansion		
Richton, MS	25,000	0
Total, Expansion	25,000	0

Description

In 2005, the Energy Policy Act (EPAct) of 2005 directed the DOE to expand the SPR to its authorized level of one billion barrels, as expeditiously as practical, without incurring excessive cost or appreciably affecting the price of petroleum products to consumers.

Benefits

The mission of the SPR program is in direct support of the Department of Energy's "Energy Security" mission. The SPR benefits the Nation by providing an insurance policy against interruptions in U.S. petroleum supplies whether originating from international supply problems, hurricanes, accidents or terrorist activities.

Detailed Justification

(dollars in thousands)

	FY 2010 Current Appropriation	FY 2012 Request
Richton, MS	**25,000**	**0**
The request shows the FY 2010 appropriated amount of $25 million associated with the development of the Richton oil storage site. Request proposes cancellation of $71 million in balances from prior years appropriated for billion barrel expansion at Richton, MS site and the use of these balances to partially fund SPR non-Expansion operations and maintenance activities.		
Total, Expansion	**25,000**	**0**

Explanation of Funding Changes

	FY 2012 vs. FY 2010 Current Approp ($000)
Expansion	
Richton, MS	
In FY 2012, no funding is requested.	-25,000
Total, Expansion	**-25,000**

Project Number: BC-SP-760
Title: Bayou Choctaw Cavern 20 Replacement
Location: Bayou Choctaw Site
Project Data Sheet is for PED/Construction

1. Significant Changes

The most recent DOE O 413.3A approved Critical Decision (CD) is CD-1.

A PMCDP Level II Certified Federal Project Director has been assigned to this project.

This PDS is for PED/Long Lead Equipment (LLE).

2. Design, Construction, and D&D Schedule

(fiscal quarter or date)

	CD-0	CD-1	PED Complete	CD-2	CD-3a	CD-4	D&D Start	D&D Complete
FY 2012	07/21/2009	03/09/10	2nd Qtr 2011	3rd Qtr 2011	3rd Qtr 2011	4th Qtr 2012		

CD-0 – Approve Mission Need
CD-1 – Approve Alternative Selection and Cost Range
CD-2 – Approve Performance Baseline
CD-3 – Approve Start of Construction
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

***Schedules are to be determined.**

3. Baseline and Validation Status

	TEC, PED	TEC, Construction	TEC, Total	OPC Except D&D	OPC, D&D	OPC, Total	TPC
FY 2012	1,933	70,682*	72,615	TBD	TBD	TBD	TBD

* **Costs are to be determined. Major funding in FY 2010 is for storage cavern and land acquisition ($36,450).**
**** No construction funds, except for approved long lead procurement, will be used until the project performance baseline has been validated and CD-3 has been approved.**

4. Project Description, Justification, and Scope

Sonar testing has identified Cavern 20, at the Bayou Choctaw storage, as having a high risk of integrity failure. Cavern 20 is one of only two sweet crude caverns at this site. The SPR is able to maintain a rate of 300,000 barrels per day during a drawdown with two sweet crude caverns. The drawdown rate would

drop to roughly 90,000 barrels per day with only one cavern operational; the SPR could not fully perform its mission.

Bayou Choctaw Cavern 102, to be used for crude oil storage, will be integrated into the site mechanical, electrical, control and security systems.

Key Performance Parameters include:

1. The SPRPMO will purchase Bayou Choctaw Cavern 102 (BC-102), an existing cavern owned by a private entity, to replace Bayou Choctaw Cavern 20 (BC-20).
2. The SPRPMO will drill a second cavern well into Cavern 102.
3. The SPRPMO will connect BC-102 to the rest of the Bayou Choctaw site infrastructure systems (piping, roads, electrical, instrumentation, security, fire water, etc.).

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.

*413.3B states that if CD-2 is going to be approved within 1 year of the budget cycle, the program may include construction funds for the project.

5. Financial Schedule

(dollars in thousands)

	Appropriations	Obligations	Costs
Total Estimated Cost (TEC)			
PED			
FY 2010	1,297	1,297	665
FY 2011	636	636	1,268
Total PED	1,933	1,933	1,933
Land Acquisition			
FY 2010	36,450	0	34
FY 2011	0	0	36,416
Total Land Acquisition	36,450	36,450	36,450
Construction			
FY 2010	0	0	0
FY 2011	21,057	21,057	2,748
FY 2012	13,175	13,175	31,484
Total, Construction	34,232	34,232	34,232
TEC			
FY 2010	37,747	37,747	699
FY 2011	21,693	21,693	40,432
FY 2012	13,175	13,175	31,484
Total, TEC	72,615	72,615	36,165
Other Project Cost (OPC)			
OPC except D&D			
FY 2009	0	0	0
FY 2010	175	175	175

	(dollars in thousands)		
	Appropriations	Obligations	Costs
FY 2011	TBD	TBD	TBD
FY 2012	TBD	TBD	TBD
Total, OPC except D&D	TBD	TBD	TBD
D&D			
FY	N/A	N/A	N/A
Total, D&D	N/A	N/A	N/A
OPC			
FY 2010	175	175	175
FY 2011	TBD	TBD	TBD
Total, OPC	175	175	175
To Be Determined (TBD)			
FY 2010	37,922	37,922	874
FY 2011	21,693	21,693	40,432
FY 2012	13,175	13,175	31,484
Total, TBD	72,790	72,790	72,790

6. Details of Project Cost Estimate

	(dollars in thousands)		
	Current Total Estimate	Previous Total Estimate[a]	Original Validated Baseline
Total Estimated Cost (TEC)			
Design (PED)			
Design	1,933	1,072	
Contingency	0	200	
Total,PED	1,933	1,272	
Land Acquisition	36,450	30,783	
Construction			
Surface Construction	5,924	2,747	TBD
Long Lead Equipment	3,917	4,020	TBD
Drilling/Well Construction	6,280	9,052	TBD
Construction Management	889	1,196	TBD
Project Support	2,524	6,926	TBD
Contingency	14,698	16,619	TBD
Total, Construction	34,232	40,560	TBD
Total, TEC	72,615	72,615	TBD
Contingency, TEC	14,698	16,819	TBD
Other Project Cost (OPC)			
OPC except D&D			
Conceptual Design	175	175	TBD

[a] Previous Total Estimate is from FY BY-1 PDS.

(dollars in thousands)

	Current Total Estimate	Previous Total Estimate[a]	Original Validated Baseline
Conceptual Planning	0	0	TBD
Start-up	0	0	TBD
Contingency	0	0	TBD
Total, OPC except D&D	175	175	TBD
D&D			
D&D	TBD	TBD	TBD
Contingency	TBD	TBD	TBD
Total, D&D	TBD	TBD	TBD
Total, OPC	175	175	TBD
Contingency, OPC	TBD	TBD	TBD
Total, TBD	72,790	72,790	TBD
Total, Contingency	14,698	16,819	TBD

7. Funding Profile History

($K)

Request		Prior Years	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	Outyears	Total
FY 2012	TEC	0	37,747	21,693	13,175					72,615
	OPC	0	175	TBD	TBD					TBD
	TPC	0	37,922	TBD	TBD					TBD

8. Related Operations and Maintenance Funding Requirements

Construction funds will be requested when CD-3B is approved. The cavern is being replaced in-kind, so there are no additional costs to operate and maintain the cavern. The project ends when construction is complete.

Start of Operation or Beneficial Occupancy (fiscal quarter or date)

Expected Useful Life (number of years)

Expected Future Start of D&D of this capital asset (fiscal quarter)

(Related Funding requirements)

(dollars in thousands)

Annual Costs		Life Cycle Costs	
Current	Previous	Current	Previous

	Total Estimate	Total Estimate	Total Estimate	Total Estimate
Operations				
Maintenance				
Total, Operations & Maintenance				

9. Required D&D Information

Not applicable.

Area	Square Feet
Area of new construction	
Area of existing facility(s) being replace d	
Area of additional D&D space to meet the “one-for-one” requirement	

Name(s) and site location(s) of existing facility(s) to be replaced:

10. Acquisition Approach

The acquisition approach will use existing and new contracts described in the Table below. The acquisition approach was selected because the most efficient method to accomplish the project is to utilize existing contracts when possible.

Project Activity	**Contract Type**	**Contractor**
Environment Assessment	Cost Plus Performance Fee	Existing M&O Contractor
Land Acquisition	Interagency Agreement	US Army Corps of Engineers
Engineering Design	Cost Plus Performance Fee	Existing Architect/Engineering (A/E) Contractor
Construction Management	Cost Plus Performance Fee	Existing Construction Management Services (CMS) Contractor
Construction	Firm Fixed Price Contracts	Subcontracted Through Existing CMS Contractor
LLE	Firm Fixed Price Contracts	Subcontracted Through Existing Management and Operating (M&O) Contractor
Drilling Management/Drilling	Firm Fixed Price/Day Rate	Subcontracted Through Existing M&O Contractor
Geotechnical	Interagency Agreement	Sandia National Laboratories

SPR Petroleum Account

Proposed Appropriation Language

Notwithstanding sections 161 and 167 of the Energy Policy and Conservation Act of 1975 (42 U.S.C.6241, 6247), the Secretary shall sell $500,000,000 in petroleum products from the Reserve in this fiscal year, and shall deposit any proceeds from such sales in the General Fund of the Treasury: Provided, That paragraphs (a)(1) and (2) of section 160 of the Energy Policy and Conservation Act of 1975 (42 U.S.C. 6240(a)(1) and (2)) are hereby repealed: Provided further, That unobligated balances in this account shall be available to cover the costs of any sale under this Act.

Explanation of Change

A non-emergency sale of $500 million of SPR oil (approximately 6 million barrels) is proposed to provide for operational purposes. The Budget also proposes repeal of authorities related to the use of the Department of the Interior's royalty in-kind oil for the purpose of providing oil to the SPR. Finally, the Budget proposes authority to use balances in the account for the costs of the $500 million oil sale.

SPR Petroleum Account

Office of Fossil Energy

Overview

Appropriation Summary by Program

(dollars in thousands)

	FY 2010 Current Appropriation	FY 2011 CR	FY 2012 Request
SPR Petroleum Account			
Sale of Crude Oil	0	0	0[a]
Offset to be returned to Treasury	0	0	0[b]
Total, Strategic Petroleum Reserve	0	0	0

[a] The FY 2012 budget proposes a $500 million non-emergency sale of SPR oil.
[b] The receipts from the sale will be deposited into the receipt account for the SPR asset sale. The receipts from this account automatically go to Treasury.

Preface

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.

Mission

The mission of the SPR Petroleum Account is to fund all SPR petroleum inventory acquisitions, associated transportation and customs duties, and terminal throughput charges.

Benefits

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.

Detailed Justification

In FY 2012, a non-emergency sale of $500 million of oil (approximately 6 million barrels) is being proposed to provide for operational purposes. The non-emergency sale will provide the spare storage capacity required for maintenance activities.

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, $10,119,000, to remain available until expended: Provided, That amounts net of the purchase of 1 million barrels of petroleum distillates in fiscal year 2011; related transportation, delivery, and storage costs; and sales of petroleum distillate from the Reserve under the provisions of the Energy Policy and Conservation Act of 1975 (42 U.S.C. 6201 et seq.) are hereby permanently cancelled.

Explanation of Change
The program plans to sell 1,984,253 barrels of Heating Oil in FY 2011 and use budget authority created by the sale receipts to purchase 1 million barrels of Ultra low sulfur (ULS) distillate in FY 2011 to comply with the requirement to convert Heating Oil to ULS distillate to meet new state legislation. Remaining net balances from the sale are proposed for cancellation in FY 2012.

Northeast Home Heating Oil Reserve
Office of Fossil Energy

Overview

Appropriation Summary by Program

(dollars in thousands)

	FY 2010 Current Appropriation	FY 2011 CR	FY 2012 Request
Northeast Home Heating Oil Reserve	11,300	11,300	10,119
Cancellation	0	0	-79,000 [a]
Total, Northeast Home Heating Oil Reserve	11,300	11,300	-68,881

[a] Estimated difference between the sale of heating, purchase of 1 MB of ULSD and incidental costs.

Preface

The Energy Policy Act of 2000 amended the Energy Policy and Conservation Act (EPCA) of 1975 and authorized establishment of up to a two-million-barrel Northeast Home Heating Oil Reserve (NEHHOR) assuring a supply for the northeast states if there is a severe energy supply interruption. Two million barrels is sufficient to supplement commercial stocks for approximately 10 days, the time required for ships to carry heating oil from the Gulf of Mexico to New York Harbor.

Mission

NEHHOR's mission is to provide a short-term supplement to the Northeast systems' private supply of heating oil in the event of an actual or imminent supply interruption.

Benefits

The two million barrels are in commercial terminals, and can be sold and delivered quickly. The Northeast is serviced by the Colonial Pipeline, refineries in New Jersey and Pennsylvania, and imports from Canada, the Caribbean, and Europe. NEHHOR was created to offset temporary logistics problems with any of these sources.

Northeast Home Heating Oil Reserve

Funding by Site by Program

(dollars in thousands)

	FY 2010 Current Appropriation	FY 2012 Request
Northeast Home Heating Oil Reserve		
Hess (Woodbridge NJ)	4,800	TBD[a]
Morgan Stanley (New Haven, CT)	3,496	TBD[a]
Hess (Groton, CT)	1,092	TBD[a]
Sites to be determined[a]	0	9,744
Washington Headquarters	1,912	375
Cancellation	0	-79,000
Total, Northeast Home Heating Oil Reserve	11,300	-68,881

[a]Funding by site will be available when storage contracts are awarded in FY 2011 for FY 2012**.**

Major Changes or Shifts by Site

Northeast Home Heating Oil Reserve

- New contracts for the Northeast Home Heating Oil Reserve (NEHHOR) will be competed in FY 2011.
- In FY 2011, the program plans to sell 1,984,253 barrels of Heating Oil and use budget authority created by the receipts to purchase 1 million barrels of ULS distillate to comply with the requirement to convert Heating Oil to ULS distillate to meet new states' legislation.

Site Description

To Be Determined

The sites of the FY 2012 storage contracts will be determined when the contracts are awarded in FY 2011.

Washington Headquarters

The headquarters office located in Washington, DC handles development and maintenance of the Northeast Home Heating Oil Reserve sales bid platform and other technical and management support to maintain readiness. The headquarters office also administers the quality and management surveillance support from Defense Energy Support Center (DESC).

Northeast Home Heating Oil Reserve

Funding Profile by Subprogram

(dollars in thousands)

	FY 2010 Current Appropriation	FY 2012 Request
Northeast Home Heating Oil Reserve	11,300	10,119
Cancellation	0	-79,000
Total, Northeast Home Heating Oil Reserve	11,300	-68,881

Public Law Authorizations:
P.L. 107-63, Department of the Interior and Related Agencies (2001)

Mission
The Northeast Home Heating Oil Reserve stores petroleum distillate to provide energy security against severe heating oil supply disruptions throughout the Northeast.

Benefits
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 large enough to assist the heating oil industry in mitigating short term supply interruptions, but small enough so as to not dissuade industry from responding to increasing prices as a signal that more supplies are required.

Annual Performance Results and Targets

The Department is in the process of updating its strategic plan, and has been actively engaging stakeholders including Congress. The draft strategic plan is being released for public comment concurrent with this budget submission, with the expectation of official publication this spring. The draft plan and FY12 budget are consistent and aligned. Updated measures will be released at a later date and available at the following link http://www.mbe.doe.gov/budget/12budget/index.htm.

Means and Strategies
The Northeast Home Heating Oil Reserve 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 Heating Oil 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.

In FY 2011, the Department will sell 1,984,253 barrels of high sulfur heating oil in the Reserve and purchase one million barrels of ULS distillate to serve New England and comply with the states' new legislation. In FY 2012, remaining net balances from the sale are proposed for cancellation.

Northeast Home Heating Oil Reserve

Funding Schedule by Activity

(dollars in thousands)

	FY 2010 Current Appropriation	FY 2012 Request
Northeast Home Heating Oil Reserve		
Commercial Storage Leases	9,496	9,744
Information Technology Support	229	300
Quality Control & Analysis	75	75
Heating Oil Acquisition	1,500	0
Cancellation	0	-79,000
Total, Northeast Home Heating Oil Reserve	11,300	-68,881

Benefits

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.

Detailed Justification

(dollars in thousands)

	FY 2010 Current Appropriation	FY 2012 Request
Commercial Storage Leases	**9,496**	**9,744**
Continues operation of the Reserve, including lease of commercial storage space.		
Information Technology Support	**229**	**300**
Provides computer support. Conducts mock sales with industry participation to test and evaluate the sales process, procedures, and on-line sales system.		
Quality Control & Analysis	**75**	**75**
FY 2012 activities include monthly quality surveillance of three commercial storage sites by the Defense Logistics Agency-Energy.		
Purchase of Heating Oil		
The FY 2010 unobligated balance of $1.5M will partially fund the projected increase in storage contract costs in FY 2011.	**1,500**	**0**
Cancellation		
This is the difference from converting approximately two million barrels of heating oil to ULS distillate and other associated selling costs.	**0**	**-79,000**

	(dollars in thousands)	
	FY 2010 Current Appropriation	FY 2012 Request
Total, Production and Operations	**11,300**	**-68,881**

Explanation of Funding Changes

	FY 2012 vs. FY 2010 Current Approp ($000)
Northeast Home Heating Oil Reserve	
▪ **Commercial Storage Leases** The increase is due to the higher cost of the new storage contracts.	+248
▪ **Information Technology Support** The increase is due to modifications of the on-line system and increased service support costs.	+71
▪ **Purchase of Heating Oil** FY 2010 funding originally planned for repurchase of remaining barrels to a 2 million barrels inventory level proposed for use with new BA to fund the new storage contracts.	-1,500
▪ **Cancellation** The decrease is due to selling approximately two million barrels of heating oil in FY 2011 and buying one million barrels of ULS distillate and using the difference to offset FY 2012 budget with the remaining balance proposed for cancellation.	-79,000
Total Funding Change, Northeast Home Heating Oil Reserve	**-80,181**

Ultra-Deepwater Unconventional Natural Gas

Ultra-Deepwater Unconventional Natural Gas

Ultra-Deepwater and Unconventional Natural Gas and Other Petroleum Research Fund

Overview

Appropriation Summary by Program

	FY 2010 Current Appropriation	FY 2012 Request
Ultra-Deepwater and Unconventional Natural Gas and Other Petroleum Research Fund		
Ultra-Deepwater and Unconventional Natural Gas and Other Petroleum Research Fund	50,000	50,000
Receipts Ultra-Deepwater and Unconventional Natural Gas and Other Petroleum Research Fund	-50,000	-50,000
Repeal Ultra-Deepwater and Unconventional Natural Gas and Other Petroleum Research Fund	0	-50,000
Repeal Receipts Ultra-Deepwater and Unconventional Natural Gas and Other Petroleum Research Fund	0	50,000
Total, Ultra-Deepwater and Unconventional Natural Gas and Other Petroleum Research Fund	0	0

Mission

The Ultra-Deepwater and Unconventional Natural Gas and Other Petroleum Research Fund was established in Subtitle J of the Energy Policy Act of 2005 (Public Law 109-58) and is funded by royalties paid by industry producers.

Background

The Ultra-Deepwater and Unconventional Natural Gas and Other Petroleum Research Fund was funded from Federal revenues from oil and gas leases in Fy2008, FY2009, and FY2010. The FY2012 Budget proposes to repeal the program through a legislative proposal. Consistent with Administration policy to phase out inefficient fossil fuel subsidies, the program is requesting no funding in FY 2012 for R&D to increase hydrocarbon production.

Ultra-Deepwater and Unconventional Natural Gas and Other Petroleum Research Fund

Funding Schedule by Activity

(dollars in thousands)

	FY 2010 Current Appropriation	FY 2012 Request
Ultra-Deepwater and Unconventional Natural Gas and Other Petroleum Research Fund		
Consortium-Ultra Deepwater	35,625	0
NETL Ultra Deepwater	14,375	0
Receipts Ultra-Deepwater and Unconventional Natural Gas and Other Petroleum Research Fund	-50,000	0
Total, Ultra-Deepwater and Unconventional Natural Gas and Other Petroleum Research Fund	0	0

Detailed Justification

(dollars in thousands)

	FY 2010 Current Appropriation	FY 2012 Request
Ultra-Deepwater and Unconventional Natural Gas and Other Petroleum Research Fund	**50,000**	**0**

The Ultra-Deepwater and Unconventional Natural Gas and Other Petroleum Research Fund program is a public/private partnership designed to increase domestic natural gas and oil resource base through cost reduction and efficiency improvement. A portion of the funding will be directed towards cost-shared research partnerships, while another portion will be used to carry out complementary R&D. Three program elements included in the cost-shared partnerships (consortium) are: ultra-deepwater architecture and technology, unconventional natural gas and other petroleum resource E&P, and technology challenges of small producers. The fourth program element is complementary research, which will be conducted by the National Energy Technology Laboratory. *Participants included: RPSEA, NETL.*

Receipts Ultra-Deepwater and Unconventional Natural Gas and Other Petroleum Research Fund	**-50,000**	**0**
Total, Ultra-Deepwater and Unconventional Natural Gas and Other Petroleum Research Fund	**0**	**0**

GENERAL PROVISIONS

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. None of the funds in this or any other Act for the Administrator of the Bonneville Power Administration may be used to enter into any agreement to perform energy efficiency services outside the legally defined Bonneville service territory, with the exception of services provided internationally, including services provided on a reimbursable basis, unless the Administrator certifies in advance that such services are not available from private sector businesses.

SEC. 303. When the Department of Energy makes a user facility available to universities or other potential users, or seeks input from universities or other potential users regarding significant characteristics or equipment in a user facility or a proposed user facility, the Department shall ensure broad public notice of such availability or such need for input to universities and other potential users. When the Department of Energy considers the participation of a university or other potential user as a formal partner in the establishment or operation of a user facility, the Department shall employ full and open competition in selecting such a partner. For purposes of this section, the term "user facility" includes, but is not limited to: (1) a user facility as described in section 2203(a)(2) of the Energy Policy Act of 1992 (42 U.S.C. 13503(a)(2)); (2) a National Nuclear Security Administration Defense Programs Technology Deployment Center/User Facility; and (3) any other Departmental facility designated by the Department as a user facility.

SEC. 304. 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 2012 until the enactment of the Intelligence Authorization Act for fiscal year 2012.

SEC. 305. Not to exceed 5 per centum, 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 Appropriation Acts may hereafter be transferred between such appropriations, but no appropriation, except as otherwise provided, shall be increased or decreased by more that 5 per centum by any such transfers, and any such proposed transfers shall be submitted to the Committee on Appropriations of the House and Senate.

SEC. 501. None of the funds appropriated by this Act may be used in any way, directly or indirectly, to influence congressional action on any legislation or appropriation matters pending before Congress, other than to communicate to Members of Congress as described in 18 U.S.C. 1913.

SEC. 502. To the extent practicable funds made available in this Act should be used to purchase light bulbs that are "Energy Star" qualified or have the "Federal Energy Management Program" designation.

Note.—A full-year 2011 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. 111–242, as amended). The amounts included for 2011 reflect the annualized level provided by the continuing resolution.