DOE/CF-037
Volume 3

U.S. DEPARTMENT OF ENERGY

FY 2010 Congressional Budget Request

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

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

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

(dollars in thousands - OMB Scoring)

	FY 2008 Current Approp.	FY 2009 Current Approp.	FY 2009 Current Recovery	FY 2010 Congressional Request	FY 2010 vs. FY 2009	
					$	%
Discretionary Summary By Appropriation						
Energy And Water Development, And Related Agencies						
Appropriation Summary:						
Energy Programs						
Energy efficiency and renewable energy	1,704,112	2,178,540	16,800,000	2,318,602	+140,062	6.4%
Electricity delivery and energy reliability	136,170	137,000	4,500,000	208,008	+71,008	51.8%
Nuclear energy	960,903	792,000	----	761,274	-30,726	-3.9%
Legacy management	33,872	----	----	----	——	0.0%
Fossil energy programs						
Clean coal technology	-58,000	----	----	----	——	0.0%
Fossil energy research and development	727,181	876,320	3,400,000	617,565	-258,755	-29.5%
Naval petroleum and oil shale reserves	20,272	19,099	----	23,627	+4,528	23.7%
Strategic petroleum reserve	186,757	205,000	----	229,073	+24,073	11.7%
Northeast home heating oil reserve	12,335	9,800	----	11,300	+1,500	15.3%
Total, Fossil energy programs	888,545	1,110,219	3,400,000	881,565	-228,654	-20.6%
Uranium enrichment D&D fund	622,162	535,503	390,000	559,377	+23,874	4.5%
Energy information administration	95,460	110,595	----	133,058	+22,463	20.3%
Non-Defense environmental cleanup	182,263	261,819	483,000	237,517	-24,302	-9.3%
Science	4,082,883	4,772,636	1,600,000	4,941,682	+169,046	3.5%
Energy transformation acceleration fund	----	----	400,000	10,000	+10,000	N/A
Nuclear waste disposal	187,269	145,390	----	98,400	-46,990	-32.3%
Departmental administration	148,415	155,326	----	182,331	+27,005	17.4%
Inspector general	46,057	51,927	15,000	51,445	-482	-0.9%
Advanced technology vehicles manufacturing loan	----	7,510,000	10,000	20,000	-7,490,000	-99.7%
Innovative technology loan guarantee program	4,459	----	----	----	——	0.0%
Section 1705 temporary loan guarantee program	----	----	5,990,000	----	——	0.0%
Total, Energy Programs	9,092,570	17,760,955	33,588,000	10,403,259	-7,357,696	-41.4%
Atomic Energy Defense Activities						
National nuclear security administration:						
Weapons activities	6,302,366	6,380,000	----	6,384,431	+4,431	0.1%
Defense nuclear nonproliferation	1,334,922	1,482,350	----	2,136,709	+654,359	44.1%
Naval reactors	774,686	828,054	----	1,003,133	+175,079	21.1%
Office of the administrator	402,137	439,190	----	420,754	-18,436	-4.2%
Total, National nuclear security administration	8,814,111	9,129,594	----	9,945,027	+815,433	8.9%
Environmental and other defense activities:						
Defense environmental cleanup	5,411,231	5,657,250	5,127,000	5,495,831	-161,419	-2.9%
Other defense activities						
Health, safety and security	425,461	446,471	----	449,882	+3,411	0.8%
Legacy Management	154,961	185,981	----	189,802	+3,821	2.1%
Nuclear energy	75,261	565,819	----	83,358	-482,461	-85.3%
Defense related administrative support	98,104	108,190	----	122,982	+14,792	13.7%
Office of hearings and appeals	4,565	6,603	----	6,444	-159	-2.4%
Congressionally directed projects	----	999	----	----	-999	-100.0%
Subtotal, Other defense activities	758,352	1,314,063	----	852,468	-461,595	-35.1%
Adjustments	-8,893	----	----	----	——	0.0%
Total, Other defense activities	749,459	1,314,063	----	852,468	-461,595	-35.1%
Defense nuclear waste disposal	199,171	143,000	----	98,400	-44,600	-31.2%
Total, Environmental & other defense activities	6,359,861	7,114,313	5,127,000	6,446,699	-667,614	-9.4%
Total, Atomic Energy Defense Activities	15,173,972	16,243,907	5,127,000	16,391,726	+147,819	0.9%
Power marketing administrations:						
Southeastern power administration	6,404	7,420	----	7,638	+218	2.9%
Southwestern power administration	30,165	28,414	----	44,944	+16,530	58.2%
Western area power administration	228,907	218,346	10,000	256,711	+38,365	17.6%
Falcon & Amistad operating & maintenance fund	2,477	2,959	----	2,568	-391	-13.2%
Colorado River Basins	-23,000	-23,000	----	-23,000	——	0.0%
Total, Power marketing administrations	244,953	234,139	10,000	288,861	+54,722	23.4%
Federal energy regulatory commission	----	----	----	----	——	0.0%
Subtotal, Energy And Water Development and Related Agencies	24,511,495	34,239,001	38,725,000	27,083,846	-7,155,155	-20.9%
Uranium enrichment D&D fund discretionary payments	-458,787	-463,000	----	-663,000	-200,000	-43.2%
Excess fees and recoveries, FERC	-20,370	-27,682	----	-26,864	+818	3.0%
Total, Discretionary Funding	**24,032,338**	**33,748,319**	**38,725,000**	**26,393,982**	**-7,354,337**	-21.8%

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, **[**and the purchase of not to exceed two passenger vehicles for replacement, $1,928,540,000**]** *$2,318,602,000*, to remain available until expended **[**: *Provided*, That, of the amount appropriated in this paragraph, $228,803,380 shall be used for projects specified in the table that appears under the heading "Congressionally Directed Energy Efficiency and Renewable Energy Projects" in the text and table under this heading in the explanatory statement described in section 4 (in the matter preceding division A of this consolidated Act)**]**. *(Energy and Water Development and Related Agencies Appropriations Act, 2009.)* **[**In addition to the amounts otherwise provided by section 101 for "Department of Energy—Energy Programs—Energy Efficiency and Renewable Energy" for weatherization assistance under part A of title IV of the Energy Conservation and Production Act (42 U.S.C. 6861 et seq.), there is appropriated $250,000,000 for an additional amount for fiscal year 2009, to remain available until expended.**]** **[**The amount provided by this section is designated as an emergency requirement and necessary to meet emergency needs pursuant to section 204(a) of S. Con. Res. 21 (110th Congress) and section 301(b)(2) of S. Con. Res. 70 (110th Congress), the concurrent resolutions on the budget for fiscal years 2008 and 2009.**]** *(Continuing Appropriations Resolution, 2009.)*

Explanation of Change

The three provisos are deleted because: 1) No funding was needed to replace passenger vehicles under the, Department of Energy Organization Act (42 U.S.C. 7101 et seq.); 2) Funding was received for Congressionally Directed activities within the Energy and Water Development and Related Agencies Appropriations Act, 2009; and 3) Weatherization was appropriated under Energy Efficiency and Renewable Energy for weatherization assistance under part A of title IV of the Energy Conservation and Production Act (42 U.S.C. 6861 et seq.).

Energy Efficiency and Renewable Energy
Office of Energy Efficiency and Renewable Energy

Overview
Appropriation Summary by Program

(dollars in thousands)

	FY 2008 Current Appropriation[a]	FY 2009 Original Appropriation	FY 2009 Additional Appropriation	FY 2010 Request
Energy Efficiency and Renewable Energy				
Fuel Cell Technologies	206,241	168,960	43,400	68,213
Biomass and Biorefinery Systems R&D	195,633	217,000	786,500[b]	235,000
Solar Energy	166,320	175,000	–	320,000
Wind Energy	49,034	55,000	118,000	75,000
Geothermal Technology	19,307	44,000	400,000	50,000
Water Power	9,654	40,000	–	30,000
Vehicle Technologies	208,359	273,238	–	333,302
Building Technologies	107,382	140,000	–	237,698
Industrial Technologies	63,192	90,000	50,000	100,000
Federal Energy Management Program	19,818	22,000	–	32,272
RE-ENERGYSE	–	–	–	115,000
Facilities and Infrastructure	76,176	76,000	100,700[b]	63,000
Weatherization and Intergovernmental Activities	282,217	516,000[c]	11,600,000	301,000
Program Direction	104,057	127,620	50,000	238,117
Program Support	10,801	18,157	–	120,000
Congressionally Directed	186,664	228,803	–	0
Advanced Battery Manufacturing	–	–	2,000,000	–
Transportation Electrification	–	–	400,000	–
Alternative Fueled Vehicles	–	–	300,000	–
EERE RDD&D	–	–	951,400	–
Subtotal, Energy Efficiency and Renewable Energy	1,704,855	2,191,778	16,800,000	2,318,602

[a] SBIR/STTR funding was transferred to the Science Appropriation in FY 2008, which includes a reduction of $16,355,000 that was transferred to the SBIR program, and $1,960,000 that was transferred to the STTR program.
[b] Facilities and Infrastructure includes $13.5 million for the Integrated Biorefinery Research Facility, for a total of $800 million in Biomass related Recovery funded projects.
[c] Includes $250.0 million in emergency funding for the Weatherization Assistance Grants program provided by P.L. 111-6, "The Continuing Appropriations Resolution, 2009."

(dollars in thousands)

	FY 2008 Current Appropriation[a]	FY 2009 Original Appropriation	FY 2009 Additional Appropriation	FY 2010 Request
Use Of Prior Year Balances	-743	-13,238	0	0
Total, Energy Efficiency and Renewable Energy	1,704,112	2,178,540	16,800,000	2,318,602

Preface

The Office of Energy Efficiency and Renewable Energy (EERE) requests $2.319 billion for FY 2010 to help build a new energy economy by changing the national landscape of energy supply and demand and increasing the scale and pace of commercialization for new technologies. Through the research, development, and deployment (RD&D) of EERE's diverse, cutting-edge applied science portfolio, these funds will significantly increase support for critical scientific, policy, and economic advances. DOE's energy efficiency and renewable energy research, effectively partnered with public- and private-sector actions, can help the U.S. meet national and global energy, environmental, and economic challenges concurrently. This RD&D portfolio investment will deliver increased technological advances and accelerate the marketplace changes necessary to meet the needs of the public, stimulate private-sector investment in clean energy, and position the U.S. as a world leader in climate change technology. It will also sustain and build upon the initiatives and economic goals of the American Recovery and Reinvestment Act of 2009 (Recovery Act) and will continue support of the Energy Independence and Security Act of 2007 (EISA) and the Energy Policy Act of 2005 (EPAct).

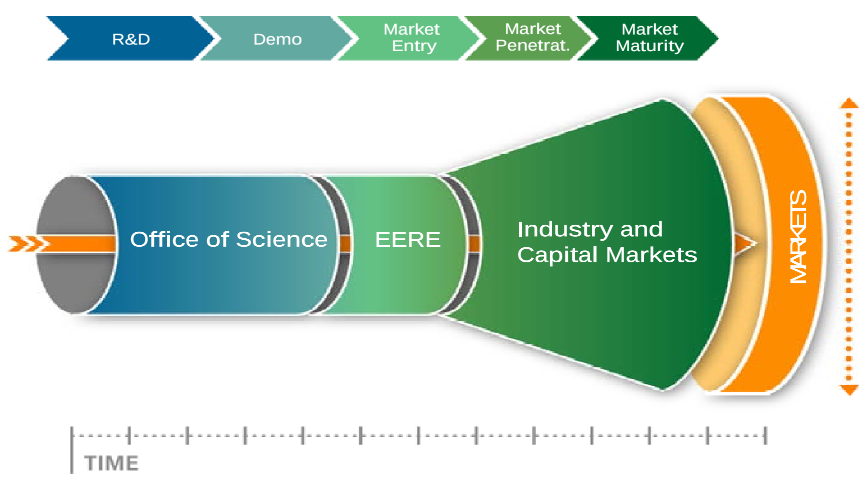
The EERE portfolio leads Administration efforts to invest in clean energy research, reduce dependence on oil and other volatile foreign energy sources, and transform how the U.S. powers the economy by focusing on scientific discovery, job creation, energy transformation, and climate change impacts. EERE's 2010 portfolio investment provides the following benefits:

- Significantly advances the RD&D of technologies and practices in Building Technologies ($237.7 million requested; increase of $97.7 million), Solar Energy ($320.0 million requested; increase of $145.0 million), Vehicle Technologies ($333.3 million requested; increase of $60.1 million) and Wind Energy ($75.0 million requested; increase of $20.0 million);
- Fosters the deployment of clean energy technologies and practices through considerable growth in the Federal Energy Management Program (FEMP; $32.3 million requested; increase of $10.3 million), continuation of the Weatherization and Intergovernmental Program ($301.0 million requested; decrease of $215.0 million) and the start of the REgaining our ENERGY Science and Engineering Edge program (RE-ENERGYSE; $115.0 million requested; increase of $115.0 million);
- Significantly increases program management funds to scale-up staffing and continue the oversight, transparency and reporting activities in Program Direction ($238.1 million requested; increase of $110.5 million); and more effectively informing change in Program Support ($120.0 million requested; increase of $101.8 million) through significant consolidation and growth in corporate technology planning, analysis, commercialization and communication for clean energy technologies, policies, and markets;
- Continues to build upon the recent investments and RD&D advances in Biomass and Biorefinery Systems R&D ($235.0 million requested; increase of $18.0 million), Geothermal Technology ($50.0 million requested; increase of $6.0 million), Fuel Cell Technologies ($68.2 million requested; decrease of $100.7 million), Industrial Technologies ($100.0 million requested; increase of $10.0 million), Water Power ($30.0 million requested; decrease of $10.0 million) and Facilities and Infrastructure ($63.0 million requested; decrease of $13.0 million).

All of these efforts will enhance national energy security, environmental quality and economic productivity. Major reallocations from FY 2009 are discussed in the Significant Changes section of the Overview and in detail in the individual program chapters.

In partnership with organizations that leverage EERE program technologies, the EERE portfolio supports DOE's mission to power and secure America's future by developing cost-effective options for reliable, clean, and affordable energy, by addressing barriers to their adoption, and by enabling a sustainable National energy policy which diversifies energy sources and improves the productivity of energy-intensive sectors of the economy. Figure 1 (below) depicts how EERE is working to accelerate the transition of basic science into applied technologies, advance energy technologies through applied R&D, and deploy technologies in energy markets through collaboration with industry and commercialization mechanisms, including new financing and policy measures.

Figure 1: Enabling Science to Reach Markets



EERE's Technology Development programs work to advance and invest in scientific research through targeted, RD&D programs at National Laboratories, university campuses, and private facilities spanning the country. The programs and National Laboratories participate in a wide variety of public-private partnerships, enabling American firms to partner in planning and conducting R&D with early-stage technological innovations that will provide a stream of market solutions for our Nation's energy needs and economic growth. The combination of EERE resources and expertise with the drive and dynamism of private institutions and individuals can move RD&D activities forward rapidly. These activities also promote job creation and economic revitalization. The rapid growth of renewable energy resources, the installation of energy-efficient technologies, and the development of new electricity and fuel distribution infrastructures will create and preserve thousands of jobs in a variety of industries, which will be a powerful driver of the economy in coming decades. EERE programs work to expand the use of cleaner power sources, and also aim to reduce the energy needed for factories, homes, offices, and cars. The cumulative impact of these efforts will include a rapid and sustainable long-term reduction in greenhouse gas (GHG) emissions, enabling the U.S. to assume an international leadership role in addressing climate change. Furthermore, increasing the market penetration of renewable energy sources and efficiency technologies and measures will help to reduce America's reliance upon petroleum from unstable regions of the world, improving National economic stability and energy security.

This budget also continues to address key legislation and DOE initiatives to create a stronger link among the basic sciences, applied energy programs, policy tools, and enabling market mechanisms. These linkages will more successfully leverage, focus, and accelerate the specific technology advances needed to overcome barriers and expand the value and use of new and emerging technologies.

Within the Energy Efficiency and Renewable Energy Appropriation EERE has 15 programs in FY 2010: Fuel Cell Technologies (2 subprograms), Biomass and Biorefinery Systems R&D (3 subprograms), Solar Energy (5 subprograms), Geothermal Energy (1 subprogram), Wind Energy (2 subprograms), Water Power (1 subprogram), Vehicle Technologies (5 subprograms), Building Technologies (5 subprograms), Industrial Technologies (2 subprograms), Federal Energy Management Program (5 subprograms), Facilities and Infrastructure (1 subprogram), Weatherization and Intergovernmental Activities (3 subprograms), Program Support (5 subprograms), Program Direction (4 subprograms), and the new RE-ENERGYSE program (2 subprograms).

Mission

The mission of EERE is to strengthen America's energy security, environmental quality, and economic vitality through R&D and public-private partnerships that diversify the Nation's sources of energy, increase efficiency and productivity of the existing energy infrastructure, bring clean, reliable, and affordable energy technologies to the marketplace, and make a difference in the everyday lives of Americans by productively enhancing their energy choices and quality of life.

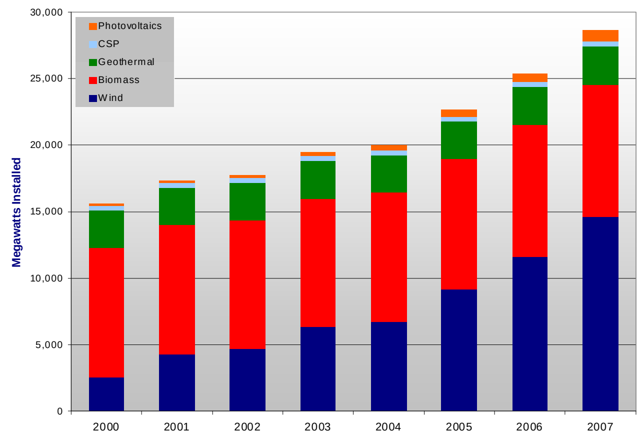
Benefits

Accomplishing the mission will benefit the economy, the environment, and both the supply and demand sides of DOE's energy security equation, enabling more productive use of the energy we have and accelerating the arrival and use of the new fuels and technologies. The expansion and increasing market viability of EERE's RD&D portfolio will create jobs in new industries in the near term and transform America's energy economy for future growth and prosperity in the long term. Three energy paths create those benefits—efficiency, new fuels and power for transportation, and clean domestic renewable energy.

Energy efficiency efforts provide benefits to all sectors of the economy. EERE's efficiency programs focus on initiatives such as more efficient lighting, energy-saving appliance standards, partnerships to improve industrial efficiency, weatherizing homes, and improving the energy efficiency of the Federal Government. These initiatives can employ thousands of Americans in green jobs while slashing energy costs for homes, businesses, industries and taxpayers, while also reducing GHG emissions. Additionally, EERE will continue RD&D to reduce the Nation's dependence upon foreign oil and accelerate the arrival of a low-carbon economy through investment in new vehicle technologies, including high-power lightweight lithium ion batteries, plug-in hybrid vehicles, and next-generation, domestically energy sources such as cellulosic ethanol and fuel cells. EERE's programs will increase usage of renewable energy sources through research in areas such as more durable wind turbine components, next-generation water power systems, more efficient photovoltaic (PV) and concentrating solar power (CSP) systems, and enhanced geothermal power systems (EGS). Through cooperation with the Office of Electricity, EERE will also work to ensure that diverse sources of clean, renewable energy are available to a new national Smart Grid, which will effectively direct electricity from where it is most abundant to where it is most needed.

EERE coordinates and collaborates with DOE's Office of Science to: (1) ensure that the products of applied and basic research and science skill sets utilize resources appropriately; (2) address technology-based barriers and opportunities common to programs of both organizations; and (3) ensure that DOE R&D is strategically and cost-effectively planned for both organizations

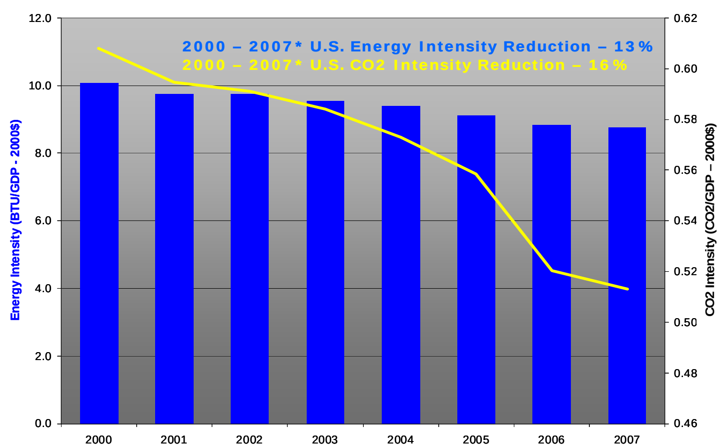
Figure 2: U.S. Renewable Electricity Capacity



EERE's investment in cutting-edge scientific research in renewable energy and efficiency measures will be combined with efforts to address market barriers and work with the public and private sectors to encourage the near-term deployment of innovative energy technologies. EERE's RD&D will enable accelerated and large-scale contributions to meet the growth in demand for energy services, while diversifying energy supply, reducing GHG emissions, creating and preserving jobs, and helping to transform the economy for long-term growth.

The combination and integration of energy technology paths, enabled policy, market partnerships and education directly contribute to the DOE goal by: (1) reducing demand-side pressure on energy markets (mitigates costs); (2) reducing oil imports; (3) diversifying the mix of domestic energy production; (4) providing smaller and decentralized alternative and non-fuel based sources of electricity generation that are inherently less susceptible to interruption or attack; and (5) resolving the technology and market components barriers to widespread use of these solutions. These investments provide the principal energy technologies and pathways that break barriers, accelerate markets and develop durable policies that enable the Nation to achieve its energy and climate change technology leadership goals.

Figure 3: U.S. Energy and CO_2 Intensity



As depicted in Figure 2,[a] there has been unprecedented growth in renewable energy production, enabled by EERE's technology investments and efforts with stakeholders and partners to provide incentives and reduce barriers. The U.S. leads the world in wind energy production, with a 2008 capacity of 25,170 MW, according to the World Wind Energy Association.[b] Domestic biofuels production has also reached record levels, with annual production of over 6.9 billion gallons of ethanol and biodiesel in 2007.[c] In addition to energy supply gains, U.S. deployment of energy efficiency technologies has contributed to a reduction in energy intensity (energy consumption per dollar of gross domestic product) of 13 percent for the U.S. economy since 2000, shown in Figure 3 above.[d]

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[a] Energy Information Administration's (EIA) 2007 Electric Power Annual: http://www.eia.doe.gov/cneaf/electricity/epa/epat1p1a.html.
[b] World Wind Energy Report 2008: http://www.wwindea.org/home/images/stories/worldwindenergyreport2008_s.pdf .
[c] EIA's Annual Energy Review 2007: http://www.eia.doe.gov/emeu/aer/pdf/pages/sec10_11.pdf.
[d] EIA energy intensity data available at: http://www.eia.doe.gov/emeu/international/energyconsumption.html. EIA CO_2 intensity data available at: http://www.eia.doe.gov/oiaf/1605/ggrpt/index.html.

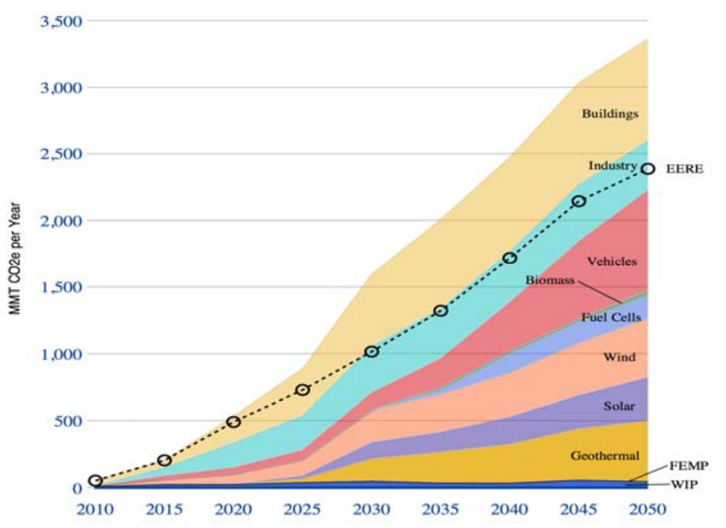
The EERE portfolio will deliver significant energy security, domestic economic, and global environmental benefits. Drawing upon the Energy Information Administration's (EIA) expectations of energy supply, demand, and cost, and EERE scenario modeled estimates of our programs' goals using integrated energy-economy models, it is expected that achievement of EERE program goals would generate significant consumer savings; electric power sector cost savings; job creation; emissions reduction; imported oil offsets; and diversification of the U.S. transportation energy portfolio.

DOE and the Office of Management and Budget (OMB) worked with Congress to create a budget in which results, expected benefits and costs are expressed across DOE in a way that both the informed and casual reader can understand and reasonably compare the benefits of the proposed budget. The FY 2010 portfolio analysis includes EERE program assessment of benefits that are possible to achieve, e.g., if barriers were successfully addressed, technology goals were achieved, and resources were available as necessary. Note that this analysis does not address the question of how the benefits of EERE program goal achievement may be impacted by the achievement of the goals of other DOE energy programs – such interactions may result in higher or lower potential benefits. The achievement of EERE program goals will yield the significant short- and long-term results anticipated by EISA 2007, and enable significant quantitative climate, energy security, and economic impacts from 2010 budget activities, including:

Climate Change

Avoid nearly 10 gigatons of carbon dioxide ($GTCO_2$) emissions by 2030 and more than 45 $GTCO_2$ by 2050 (cumulatively). Relative annual contributions of individual programs to annual avoided CO_2 are shown in Figure 4 below:[a]

Figure 4: EERE Program Contributions to CO_2 Avoidance

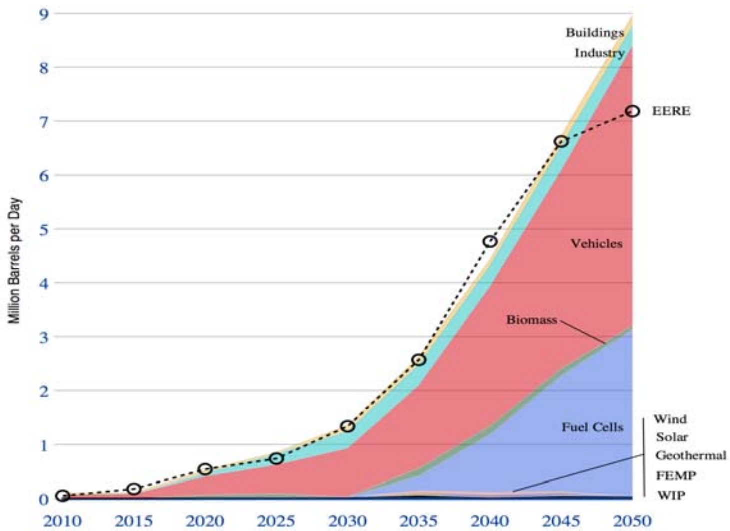


[a] The dotted black line labeled EERE is the integrated sum of EERE program impacts that result from marketplace competition. This sum is lower than the sum of the individual program impacts due to competitive interaction among the technologies. The buildings and solar program received significant additional resources late in the benefits estimation period, their benefits and integrated impacts will be remodeled and the benefits will be updated by July 2009 and made available at: http://www1.eere.energy.gov/ba/pba/program_benefits.html

Energy Security

Offset up to 4 billion barrels of imported oil by 2030 and nearly 40 billion barrels by 2050, considerably diversifying the U.S. energy portfolio with substitutions for oil. Relative annual contributions of individual programs to petroleum import savings are shown in Figure 5, below:[a]

Figure 5: EERE Program Contributions to Petroleum Import Savings



Economic Impact

- Save consumers at least $800 billion by the year 2030 and more than $6 trillion by 2050 (cumulatively).
- Reduce cumulative costs to the electric power sector by $500 billion dollars by 2030 and $1.3 trillion dollars by 2050.
- Relative annual consumer savings contributions by individual programs are shown in Figures 6 and 7 on the following page:[b]

[a] The dotted black line labeled EERE is the integrated sum of EERE program impacts that result from marketplace competition. This sum is lower than the sum of the individual program impacts due to competitive interaction among the technologies. The buildings and solar program received significant additional resources late in the benefits estimation period, their benefits and integrated impacts will be remodeled and the benefits will be updated by July 2009 and made available at: http://www1.eere.energy.gov/ba/pba/program_benefits.html

[b] Ibid.

Figure 6: EERE Program Contributions to Consumer Savings

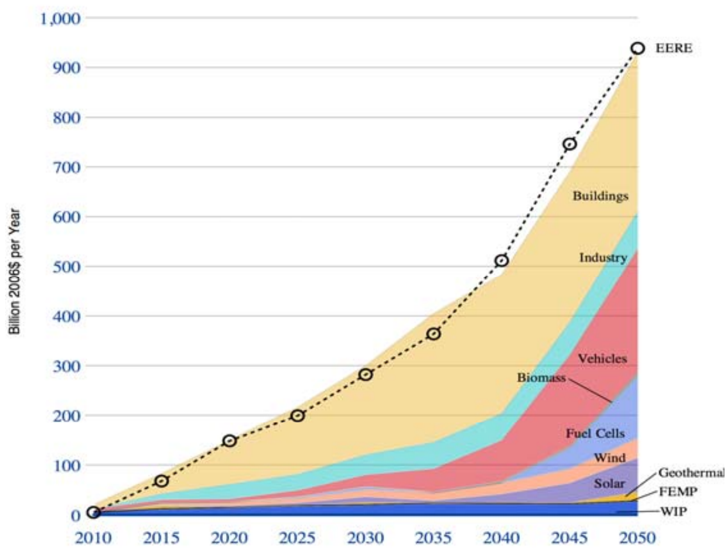
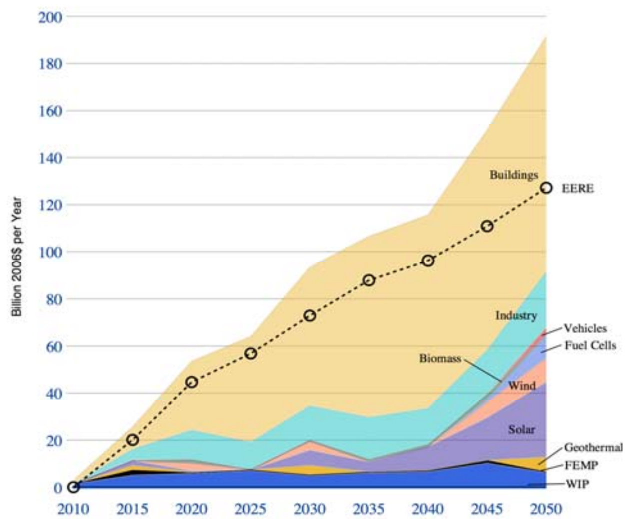


Figure 7: EERE Program Contributions to Electric Power Industry Savings



Performance

EERE pursues its mission through an integrated portfolio of research, development, demonstration, and deployment activities (RDD&D). Tables 2 and 3 provide more detailed expected integrated benefits estimates, which show the effect of combining and competing programs to deliver benefits. Relative expected benefits for individual program contributions, shown in Figures 4-7, are provided in their respective sections. The portfolio focuses on advanced fuels and vehicles, renewable energy, and energy efficiency options that strengthen the national energy security, environmental quality, and economic vitality. These activities directly support DOE's focus on Science, Discovery, and Innovation, and the goals build upon this focus: Clean, Secure Energy; Economic Prosperity; and Lower GHG Emissions.

EERE's portfolio of activities is expected to result in: lower energy bills and reduced susceptibility to energy price fluctuations; reduced cost of controlling regulated pollutants; enhanced energy security as petroleum and natural gas dependence is reduced and domestic fuel supplies increase; greater energy security and reliability from improvements in energy infrastructure; and job growth. These expected benefits are shown in Figures 4-8 and Tables 1, 2, and 3.

EERE uses integrated energy models to analyze the benefits of achieving the programs' technical goals, as well as the portfolio as a whole. The use of integrated models provides a consistent economic framework and incorporates the interactive effects among the various programs. Interactive effects result from: (1) changes in energy prices resulting from lower energy consumption; (2) interaction between supply programs affecting the mix of generation sources and the end-use sector programs affecting the demand for electricity; and (3) additional savings from reduced energy production and delivery.

A modified version of EIA's National Energy Modeling System (NEMS) was one of the models used for this benefits analysis. NEMS is an integrated energy model of the U.S. energy system that was developed by EIA for forecasting and policy analysis purposes. NEMS provides annual projection capability to the year 2030, thus it is used for the midterm benefits analysis. The March 2008 version of the NEMS modeling system, consistent with the basis used for EIA's Annual Energy Outlook (AEO) 2008 revised case was used as the starting point.

For projections to the year 2050, a U.S. MARKAL single-region model was used. The U.S. MARKAL model is a technology-driven linear optimization model of the U.S. energy system that runs in five-year intervals over a 50-year projection period. MARKAL provides a framework to evaluate all resource and technology options within the context of the entire energy/materials system, and captures the market interaction among fuels to meet the system's energy needs. The model explicitly tracks the vintage structure of all capital stock in the economy that produces, transports, transforms, or uses energy. The U.S. MARKAL model was calibrated with the same version of the AEO projection used as the basis for the NEMS modeling in order to maintain consistency between the results from the NEMS and MARKAL models in the mid-term (2010 to 2030).

Future benefits are calculated as the difference between a projection intended to represent the future U.S. energy system with the proposed EERE R&D programs, and as a baseline case intended to represent the future without the effect of EERE programs. A consistent baseline case ensures that all program benefits are estimated based on the same initial forecasts for economic growth, energy prices, and levels of energy demand. The baseline case provides a basis for assessing how EERE's technologies will progress in comparison to conventional energy technologies (e.g., more efficient central power generation). The case also helps ensure that improvements in technologies that would occur in the absence of EERE's programs are not counted as part of the benefits of the EERE programs.

In addition to technology and process advances due to EERE activities, energy market policies, such as state renewable portfolio standards (RPS) and state and federal tax policies, facilitate the development and deployment of clean energy technologies. The expected impact of policies already in place are included in the baseline case, so that the expected benefits calculated reflect as much as possible the effects of activities funded by EERE. Congress passed EISA in 2007, which includes several important mandates for the transportation and buildings sectors: a renewable fuels standard mandating biofuel production levels, revised CAFE standards that require significant increases in light duty vehicle fuel efficiency, and enhanced efficiency standards, including for lighting. These new EISA 2007 mandates are considered current policies in the baseline case.

In contrast to the methodology for factoring in the impacts of EISA 2007, the energy-related policies and investments of the Recovery Act and the Energy Improvement and Extension Act are not considered in the baseline or program cases. While the Recovery Act is expected to impact the deployment of existing renewable energy and energy efficiency technologies in the near term, and the cost and performance of specific existing and emerging technologies in the mid- to long-term, the estimates of the potential impact of these energy-related investments will be under development until final allocations are completed.[a] Recovery Act investments are expected to:

- Increase the market penetration of EERE technologies in the baseline case, which will tend to reduce the prospective benefits associated with specific EERE's deployment-related activities (particularly in the WIP, Industrial, and Buildings programs).
- Increase technology demonstration and R&D activities for some specific technologies, including biofuels and enhanced geothermal systems (EGS), which will likely result in improved cost and/or

[a] Recovery Act allocations and decisions such as which potential competitive bidder and the specific purpose or individual activity to which Recovery Act funding is disbursed have not been completed as of this writing. Current information and progress reporting on Recovery Act projects will updated and current on the Recovery Act Website: http://www.energy.gov/recovery/.

performance for these technologies in the baseline, and in turn, reduce the prospective benefits associated with FY 2011 funding for these activities.

Key assumptions about macroeconomic activity, energy demand, and technology results in the baseline case include:

- Average economic growth of 2.3 percent annually between 2009 and 2030;
- Price per barrel of oil of about $77 (2006 dollars) in 2009, dropping to $57 in 2016, before rising to $70 in 2030. In nominal dollars, the price of oil in 2030 would be about $113; and
- Price per thousand cubic feet of natural gas is $6.75 (2006 dollars) in 2009, dropping to $5.27 by 2016, and then rising slowly to $6.50 by 2030. In nominal dollars, the price of natural gas in 2030 would be about $10.44.

Benefits of EERE's portfolio are represented in three categories that align with DOE's strategic goals:

- Energy security benefits;
- Environmental benefits; and
- Economic benefits.

A summary of the modeled benefits for EERE's portfolio is shown in Tables 1 and 2. As these tables indicate, if program goals are met and the above assumptions prove to be accurate, EERE's programs could provide:

- Annual savings to American consumers of over $135 billion per year by 2030 and over $900 billion per year by 2050.
- Cumulative reductions of carbon dioxide emissions of nearly 10,000 gigatons of CO_2 from 2010 through 2030, and 45,000 gigatons from 2010 through 2050, representing reductions from the business as usual baseline of 7 percent and 15 percent respectively.
- Reductions in annual oil imports of at least 600,000 barrels per day in 2030 and more than 7 million barrels per day (mbpd) in 2050.

In addition, R&D activities being funded by EERE's Solar Energy Program will help stimulate the installation of an additional 34,085 MW of PV electricity generating capacity by 2030, compared to the business-as-usual case.

Figure 8 provides context on the impact of the EERE portfolio on mitigating U.S. carbon dioxide emissions. The long-term annual savings of 2,400 MMTCe in 2050 would return U.S. emissions to 1996 levels, absent any additional climate change policy.

Figure 8. Effect of EERE's Portfolio on Carbon Dioxide Emissions

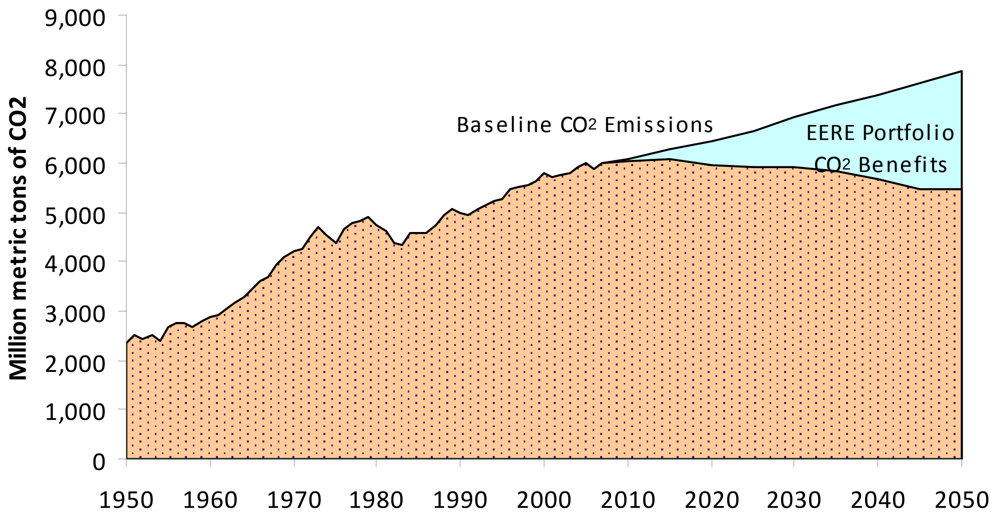


Table 1. Projected Benefits of EERE Portfolio of Programs – Primary Metrics

	Metric[1]	Model	Year 2015	Year 2020	Year 2030	Year 2050
Energy Security	Oil Imports Reduction, cumulative[2] (Bil bbl)	NEMS	0.1	0.3	1.7	N/A
		MARKAL	0.2	1.0	4.2	38.5
	Natural Gas Imports Reduction, cumulative (Tcf)	NEMS	1.8	6.1	19.8	N/A
		MARKAL	3.3	9.3	28.5	118.0
	Reduction in Share of Highway Fuel Demand Derived from Crude Oil[3] (%)	NEMS	0%	1%	1%	N/A
		MARKAL	ns	ns	1%	19%
Environmental Impacts	CO_2 Emissions Reduction, cumulative (Mil mtCO_2)	NEMS	638	2500	9988	N/A
		MARKAL	780	2657	10318	45416
	SO_2 Allowance Price Reduction[4] ($/ton)	NEMS	ns	ns	ns	N/A
		MARKAL	N/A	N/A	N/A	N/A
	NO_x Allowance Price Reduction ($/ton)	NEMS	1013	2805	4133	N/A
		MARKAL	N/A	N/A	N/A	N/A
	Hg Allowance Price Reduction (thousand $/lb)	NEMS	ns	ns	ns	N/A
		MARKAL	N/A	N/A	N/A	N/A
Economic Impacts	Consumer Savings, cumulative[5] (Bil $)	NEMS	97	243	860	N/A
		MARKAL	195	636	1932	6249
	Electric Power Industry Savings, cumulative (Bil $)	NEMS	65	176	494	N/A
		MARKAL	48	181	541	1322
	Household Energy Expenditures Reduction ($/household/yr)	NEMS	100	160	370	N/A
		MARKAL	176	332	588	2305

1. "Reductions" and "savings" are calculated as the difference between results from the baseline case (i.e. no DOE technology) and the technology case (i.e. all DOE technology R&D programs are successful).
2. All cumulative metrics are based on results beginning in 2010.
3. Metric includes oil-derived fuel use by light-duty vehicles, commercial light trucks and freight trucks; the metric excludes buses. Reported oil use is adjusted to exclude ethanol, biodiesel and CTL.
4. All monetary metrics are in 2006$.
5. Cumulative monetary metrics are in 2006$ that are discounted to 2010 using a 3% discount rate.
ns - Not significant
NA - Not yet available
N/A - Not applicable

Table 2. Projected Benefits of EERE Portfolio of Programs – Secondary Metrics

	Metric[1]	Model	Year 2015	2020	2030	2050
Energy Security	Oil Imports Reduction, annual (Mbpd)	NEMS	ns	0.2	0.7	N/A
		MARKAL	0.2	0.5	1.3	7.2
	Natural Gas Imports Reduction, annual (Tcf)	NEMS	0.5	1.0	1.5	N/A
		MARKAL	0.9	1.4	2.4	5.3
	MPG Improvement[2] (%)	NEMS	1%	2%	5%	N/A
		MARKAL	1%	1%	7%	229%
Environmental Impacts	CO_2 Intensity Reduction of US Economy (Kg CO2/$GDP)	NEMS	0.01	0.03	0.05	N/A
		MARKAL	0.01	0.03	0.05	0.08
	CO_2 Intensity Reduction of US Power Sector[3] (Kg CO2/kWh)	NEMS	ns	0.01	0.04	N/A
		MARKAL	ns	0.01	0.03	0.09
	CO_2 Intensity Reduction of US Transportation Sector[4] (Kg CO2/mile)	NEMS	ns	0.01	0.02	N/A
		MARKAL	0.01	0.01	0.04	0.22
Economic Impacts	Consumer Savings, annual[5] (Bil $)	NEMS	30	53	137	N/A
		MARKAL	68	148	282	939
	Electric Power Industry Savings, annual (Bil $)	NEMS	21	37	66	N/A
		MARKAL	20	45	73	127
	Energy Intensity of US Economy (energy/$GDP)	NEMS	0.21	0.39	0.62	N/A
		MARKAL	0.23	0.43	0.66	1.06
	Net Energy System Cost Reduction, cumulative (Bil $)	NEMS	N/A	N/A	N/A	N/A
		MARKAL	687	1702	4143	9666

1. "Reductions" and "savings" are calculated as the difference between results from the baseline case (i.e. no DOE technology) and the technology case (i.e. all DOE technology R&D programs are successful).
2. Change in light duty vehicles miles traveled per gallon of oil, where oil is only that derived from petroleum.
3. Emissions include all power sector emissions. Generation calculated as total net generation adjusted for estimated T&D losses.
4. Emissions calculated using highway fuel use and related carbon emission factor. Miles calculated as highway miles traveled, excluding buses.
5. All monetary metrics are in 2006$.
ns - Not significant
NA - Not yet available
N/A - Not applicable

The expected impact of the EERE portfolio on oil import reductions is less than in prior budget years, primarily due to the inclusion of the EISA 2007 transportation sector-related mandates (RFS and CAFE) in the baseline. Much of the increased production of cellulosic ethanol conversion technology and increased light duty vehicle fuel efficiency that in prior years was attributed to EERE program activities is now assumed to occur as a result of these policies, as opposed to RDD&D activities. While this methodological choice has been made to preserve the philosophical integrity of the model, achieving the aggressive mandated targets with minimum adverse impacts on the U.S. economy will depend on successful current and future EERE RDD&D activities in these programs.

While point estimates are presented, both mid-term and long-term modeling are dependent upon the methodology and assumptions used, and could vary substantially around those points. Many key external factors can affect the benefits estimates, including market and policy interactions, and the future prices of oil, natural gas and electricity generation. Some of the uncertainties in the interaction effects are reflected in the range of projected benefits from the two models used for this analysis.

These benefits result from the mix of interrelated investments supported by EERE's budget request. More efficient buildings and factories, for instance, provide the basis for distributed energy resources, such as building integrated solar photovoltaic systems and combined heat and power cogeneration. In addition to these "business-as-usual" benefits, EERE's portfolio would provide the technical potential to reduce conventional energy use even further if warranted by future energy needs. The development of wide-spread sources of wind, solar, and biomass energy sources; new ways of using energy through hydrogen and distributed power; and technologies that would fundamentally improve the basic efficiency of homes, businesses, factories, and vehicles could facilitate substantial reductions in oil use and convert a larger portion of the electricity system to decentralized capacity and renewable energy sources to improve security and reliability. Further methodology, details and updates will be provided by July 2009 at http://www1.eere.energy.gov/ba/pba/program_benefits.html.

Table 3 highlights some of the benefits associated with each of EERE's programs. The estimates are not directly comparable due to some differences in methodology and assumptions. The table provides relative "order-of-magnitude" estimates while DOE continues to refine and standardize its methodology.

Table 3: Selected Projected Benefits by Program[a]

	Consumer Savings, cum (Bil 2006$)		CO2 Emissions Reduction, cum (Mil mtCO2)		Oil Imports Reduction, cum (Bil bbl)		Natural Gas Imports Reduction, cum (Tcf)	
	2030 NEMS/MARKAL	*2050 MARKAL*	*2030 NEMS/MARKAL*	*2050 MARKAL*	*2030 NEMS/MARKAL*	*2050 MARKAL*	*2030 NEMS/MARKAL*	*2050 MARKAL*
Hydrogen Technology	6/-67	56	166/ns	ns	0.3/ns	9.3	0.8/ns	-1.0
Biomass and Biorefinery Systems R&D	39/11	34	255/49	523	0.4/0.2	1.1	0.6/ns	ns
Solar Energy	15/46	235	426/523	4795	ns/ns	ns	ns/ns	13.1
Wind Energy	113/97	279	1705/1760	8489	ns/ns	ns	4.9/3.6	13.6
Geothermal Technology	22/ns	20	556/638	6817	ns/ns	ns	1.5/0.2	9.3
Vehicle Technologies	40/150	998	277/1185	9558	0.7/2.8	23.4	0.1/ns	8.4
Building Technologies	439/1250	3417	5193/4787	18919	0.4/0.4	1.5	7.3/22.5	65.6
Industrial Technologies	293/333	792	3760/3579	11286	0.4/0.8	3.7	9.5/12.7	34.9
Federal Energy Management Program	6/23	37	50/48	107	ns/ns	ns	N/A /0.2	0.2
Weatherization and Intergovernmental Activities	60/193	365	593/552	1339	0.2/ns	0.3	1.2/2.2	3.9

[a] Table 3 metrics represent cumulative impacts for the periods 2010-2030, and 2010-2050. Prospective benefits do not include any potential policy changes that might enhance technology deployment. In addition, some technologies show diminishing annual benefits by 2050 due to the assumption built into the analysis that industry progress, as reflected in the baseline, will eventually catch up with the more accelerated progress associated with EERE program success. EERE's portfolio approach to RD&D affects benefits and the way they are calculated. Total benefits reported for EERE's entire portfolio are usually less than the sum of the individual programs due to competition between the technologies and resulting tradeoffs. For example, efficiency improvements reduce the future need for new electricity generating capacity, including the potential size of the renewable electric market. In addition, a research failure in one area will not necessarily reduce the technology's overall benefits, as the lack of market penetration by the failed technology may create a market opportunity elsewhere in the EERE portfolio. An integrated benefit total may be higher than the individual sums because of the added impact of multiple EERE programs. Estimates reflect the benefits that may be possible, if all program technical targets are met and are funded at levels consistent with assumptions in the FY 2010 Budget through the program completion year, which varies by program. ns - Not significant and N/A - Not applicable

The American Recovery and Reinvestment Act (Recovery Act)

The Recovery Act of 2009 provided substantial new resources for EERE, which will expand the impact of base activities, as well as initiate new programs to advance energy efficiency and renewable energy RDD&D. Funds provided will allow EERE to advance geothermal technology development and deployment, improve manufacturing processes for advanced car batteries, and weatherize hundreds of thousands of homes. Energy Assistance programs such as the Weatherization Assistance Grants ($5.0 billion), State Energy Program ($3.1 billion), and Energy Efficiency and Conservation Block Grants ($3.2 billion) will help states and local communities advance energy efficiency efforts, help implement the use of renewable energy and reduce energy costs. The Advanced Batteries Manufacturing Grants ($2.0 billion) and Transportation Electrification ($400.0 million) will advance the development and deployment of vehicle technologies that support a transformation of advanced transportation means and work toward meeting the President's goal of deploying 1 million plug-in hybrid electric vehicles by 2015.

Strategic Themes, Goals and the Secretary's Initiatives

A new strategic plan has not yet been established and approved by the Secretary of Energy. The Secretary has established major priorities and initiatives. EERE programs have twelve GPRA Unit Program Goals that contribute to seven of the Secretary's top ten initiatives.

The Secretary's top ten initiatives are:

- Energy Efficient Homes and Businesses: Funding provided through the states for homeowners and businesses to take immediate steps toward energy efficiency – reducing heating and air conditioning bills and creating jobs.

- Greening Federal Buildings: Provide funding for the federal government to improve the efficiency of offices and buildings, reducing energy bills and creating jobs.

- Renewable Energy Projects: Accelerate the construction of solar, wind, geothermal and other renewable energy generation facilities through a combination of loans and grants, creating jobs immediately and provide the United States with clean energy supply for the long term.

- SmartGrid Technology and Transmission Infrastructure: Build the wires and infrastructure needed to transport electricity across the country – from renewable energy plants to population centers, reducing congestion and allowing for more clean energy – and improve the efficiency and reliability of the existing grid.

- Clean Coal Technology: Develop and pilot innovative technologies for the emission-free coal plants of the future, allowing our nation to safely utilize our abundant coal resources.

- Next Generation Biofuels: Provide loans and grants to accelerate the research and deployment of cellulosic biofuels technologies to provide a clean alternative to imported fossil fuel sources.

- Science and Basic Research in the Energy Technologies of the Future: Investments in building and renovating laboratories and scientific research facilities that will create jobs immediately and enable the research on for technologies and innovations that will sustain American industry and provide new energy and climate solutions over the longer term.

- Battery Research and Advanced Vehicle Technologies: Loans and grants to support the development of advanced vehicle batteries and battery systems to reinvigorate the U.S. auto industry, reduce the U.S. dependence on foreign oil and transforming the way automobiles are powered.

- Advanced Research Project Agency-Energy (ARPA-E): Jump start advanced energy technologies by funding high-risk, high-payoff research in collaboration with industry.

- Cleanup of Nuclear Legacy: Redouble the ongoing projects to clean up the radioactive waste from cold war nuclear project sites, creating jobs and reclaiming lands for communities across the country.

Figure 9 aligns the current Strategic Plan with the Secretary's priorities:

Figure 9: Program Contributions to Strategic Themes, Strategic Goals, and Secretarial Priorities

	Strategic Theme	1. Energy Security				
	Strategic Goal	1. Energy Diversity			3. Energy Infrastructure	4. Energy Productivity
	Secretary's Priorities	Economic Prosperity	Clean, Secure Energy	Lower GHG Emissions	Economic Prosperity	Clean, Secure Energy
GPRA Unit Program Number	**GPRA Unit Program Title**					
01	Fuel Cell Tech.	□	□	■	□	
02	Vehicle Tech.	□		■	□	□
03	Solar Energy	□	□	■	□	
04	Wind Energy	□	□	■	□	
05	Geothermal Energy	□	□	■	□	
06	Biomass and Biorefinery R&D	□	□	■	□	
07	FEMP			□		■
08	Water Power	□	■	□		
19	Industrial Tech.			□	□	■
20	Building Tech.			□	□	■
21	Weatherization			□		■
22	State Energy Prog.			□		■
■ = primary focus		□ = concurrent contribution				

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 in headquarters to enable effective basic-applied R&D integration by the science and technology communities (e.g., National Laboratories, universities, and private companies) that support the DOE mission. EERE efforts focus on the following categories:

Energy Efficient Homes and Businesses

Building Technologies

- Connects basic and applied sciences by developing the next generation of highly efficient technologies and practices for both residential and commercial buildings through Emerging Technologies R&D activities.

- Re-energizes the national labs to develop the next generation of advanced building technologies and systems integration through continued investment in national laboratory building technology R&D and demonstration site activities.
- Integrates national laboratory, university, and industry activities through public/private alliances, cost share, and technical advisory efforts in building technology R&D activities.

Industrial Technologies

- Connects basic and applied sciences and re-energizes the national labs by bringing together industry, national laboratories, and academia to spur innovations that work in real industrial environments to save energy and reduce emissions.
- Integrates national laboratory, university, and industry activities by competitively awarding cost-shared funding to collaborative research teams that rely on industry's active participation to ensure that the technologies meet real-world criteria, thus accelerating technology commercialization.

Renewable Energy Projects

Solar Energy

- Re-energizes the national labs through lab facility improvements and increased hiring of post-doctoral students.
- Integrates national laboratory, university, and industry activities through joint solicitations on topics such as thermal storage.
- Connects basic and applied sciences through collaborations with DOE's Office of Science, the National Institute of Standards and Technology (NIST) and the National Science Foundation (NSF).

Wind Energy

- Supports basic and applied research for advanced wind turbine components, materials and analytical modeling.

Geothermal Technology

- Coordinates and shares research globally and supports developing world clean energy through the International Partnership on Geothermal Technology.

Biomass and Biorefinery Systems R&D (as below)

- Coordinates with Doe's Office of Science in key technology areas, such as developing transformational technologies to overcome biomass recalcitrance.

Water Power

- Partners with national labs, universities, and industry to develop, demonstrate and deploy new and innovative water power conversion technologies and assess the resource potential from untapped wave, current and ocean thermal technologies.
- Supports the development of expertise and capabilities between Congressionally-mandated National Marine Renewable Energy Centers.
- Engages in international collaboration for research and development of marine and hydrokinetic technologies and provides US input to the global community on developing international standards for marine and hydrokinetic energy technologies.

SmartGrid Technology and Transmission Infrastructure

The Solar Energy, Wind Energy, Geothermal Technology, Biomass and Biorefinery Systems R&D, and Water Power programs contribute to Smart Grid technology and infrastructure coordination as described within this section.

Next Generation Biofuels

Biomass and Biorefinery Systems R&D

- Coordinates with DOE's Office of Science, National Science Foundation, and academic institutions to ensure that the program's R&D work being conducted by national laboratories, universities, and industry partners remains at the cutting edge of scientific innovation.

The Vehicle Technologies Program also contributes to coordination on Next Generation Biofuels.

Science and Basic Research in the Energy Technologies of the Future

The Fuel Cell Technology, Vehicle Technologies, Solar Energy, Wind Energy, Geothermal Technology, Biomass and Biorefinery Systems R&D and Water Power programs contribute to science and basic research coordination as described within this section.

Battery Research and Advanced Vehicle Technologies

Vehicle Technologies

- Connects basic and applied sciences through computational science, nanoscience, and national laboratory coordination.

Fuel Cell Technologies

- Connects basic and applied science including nanoscience, biological hydrogen production, and hydrogen interactions with material surfaces.
- Re-energizes the national labs and integrates national laboratory, university, and industry activities through Hydrogen Centers of Excellence and encouraging teaming for competitive funding awards.
- Coordinates plans with other DOE offices involved in related research.
- Partners with the International Partnership for a Hydrogen Economy (IPHE), International Energy Agency (IEA) and other international organizations.

REgaining ENERGY Science and Engineering Edge (RE-ENERGYSE)

The Department is undertaking a broad educational effort that cuts across program offices to inspire students and workers to pursue careers in science, engineering, and entrepreneurship related to clean energy. The Regaining ENERGY Science and Engineering Edge (RE-ENERGYSE) is a new initiative to focus on a number of critical areas that will build the foundation of a vibrant American workforce to participate in the green economy. The Office of Energy Efficiency and Renewable Energy will participate in RE-ENERGYSE, which involves a number of important efforts:

- An education and outreach campaign that uses a variety of media technologies to teach students about the role that science and technology can play in addressing our energy challenges
- Energy research opportunities for undergraduates
- Educational opportunities for women and underrepresented minorities who seek careers in the clean energy sector
- Partnerships between industry and two-year and four-year colleges to strengthen education for technicians in the clean energy sector, focusing on curriculum development, teacher training, and career pathways from high schools to community colleges

- Interdisciplinary energy graduate programs at the master's and Ph.D. level that integrate science, engineering, entrepreneurship, and public policy
- Individual fellowships to graduate students and postdoctoral researchers involved in the frontiers of clean energy research

Energy Innovation Hubs (Hubs)

The Office of Energy Efficiency and Renewable Energy takes part in the Department's multi-disciplinary Energy Innovation Hubs (Hubs), which focus on critical science and technology for high-risk, high-reward research to revolutionize how the U.S. produces, distributes, and uses energy. Hubs will promote energy security and reduce greenhouse gas emissions. They will also strengthen the Nation's economy by coordinating teams of experts from multiple fields to blend technology development, engineering design, and energy policy. Finally, they will develop the critical areas of expertise needed for the green economy. The Office of Energy Efficiency and Renewable Energy will support 2 hubs that specifically focus on Solar Electricity and Energy Efficient Building Systems Design.

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 2008	FY 2009	FY 2010
National Renewable Energy Laboratory	2,512	2,043	2,166
Total, Indirect-Funded Maintenance and Repair	2,512	2,043	2,166

Direct-Funded Maintenance and Repair

(dollars in thousands)

	FY 2008	FY 2009	FY 2010
National Renewable Energy Laboratory	1,415	2,200	4,000
Total, Direct-Funded Maintenance and Repair	1,415	2,200	4,000

Significant Changes

Fuel Cell Technologies

The Fuel Cell Systems sub-program consolidates and refocuses efforts in three previously funded sub-programs, Fuel Cell Components R&D, Distributed Energy Fuel Cell Systems and Fuel Processor R&D. By focusing Fuel Cell Systems R&D on materials, stack components, balance-of-plant and integrated fuel cell systems, and by reducing system demonstrations, the resultant budget is more streamlined than the sum of the activities that were funded in the previous sub-programs.

The elimination of hydrogen production, delivery, and storage activities, along with Transportation Fuel Cell Systems, Manufacturing R&D, Education, Safety and Codes & Standards, and Technology Validation reflects a rebalancing of R&D priorities and acceptable technical risk among all EERE programs and within the Fuel Cell Technologies Program.

The resulting funding request is decreased by $100.8 million (-59.6%) from FY 2009.

Biomass and Biorefinery Systems R&D

The Biomass and Refinery Systems R&D program is requesting an $18 million (8.3%) increase in funds. In Feedstock Infrastructure, a $12.0 million (77%) funding increase will support the expansion of projects needed to address potential environmental sustainability barriers. Dedicated energy cropping trials will allow for the measurement of the effects on key environmental criteria including carbon, water, and nutrient fluxes to establish best practices for future feedstock development efforts.

In Thermochemical Platform R&D, an increase of $7.4 million (37%) is due to the final phase of funding for projects initiated in FY 2008 and FY 2009. In addition, a competitive solicitation is planned to develop technology for integrated syngas to infrastructure-ready fuels. The solicitation will target established industrial partners, include fuel synthesis, and total $40 million between FY2010 and FY2014 in support of the EISA 2007 RFS targets for advanced biofuels.

Solar Energy

The Solar Energy program requests an increase in funding of $145.0 million (83%).

The $4.5 million (3%) increase in funding for the Photovoltaic (PV) Energy Systems subprogram is a result of combining projects formerly funded under Applied Research, Systems Development, Technology Evaluation, and Technology Acceptance activities that focused solely on PV into a single key activity.

The $48.4 million (161%) increase in funding for the Concentrating Solar Power (CSP) subprogram reflects the additional Federal funding commitments. The trough and advanced components solicitation moves into Phase III ($14M), the thermal storage solicitation moves into Phase II ($9M), the baseload CSP solicitation is fully funded in Phase I ($15M), and a pilot solar zone will be established ($20M) as a new activity in FY 2010.

The Systems Integration and Market Transformation efforts related to CSP have been moved to new subprograms to be combined with similar efforts in PV. This allows these activities to be managed more effectively and reflects their crosscutting nature. Funding of $29.7 million for Systems Integration includes an increased effort in addressing grid integration issues specific to the high penetration of solar technologies. Funding of $27.5 million for Market Transformation reflects increased efforts in workforce development and technical outreach.

In addition, the increase in funding request is related to expanding PV Manufacturing initiatives and the new Solar Electricity Energy Innovation Hub ($35.0 million) which will incorporate cutting edge research in both PV and CSP technology areas.

Wind Energy

Wind Energy is requesting a $20.0 million (36.4%) increase. An increase of $13.4 million (42%) is requested for the Technology Viability subprogram, which includes a $10.7 million (240%) increase for Low Wind Speed Technology. An increase of $6.56 million (29%) is requested for the Technology Application subprogram, to further prepare and accelerate the adoption of wind technologies.

Geothermal Technology

The Geothermal Technology program is requesting a $6.0 million (13.6%) increase for Enhanced Geothermal System (EGS) funds to expand R&D scope in the areas of reservoir stimulation, fracture mapping and fluid circulation. EGS demonstration site analysis will also be enhanced.

Water Power

Water Power projects initially funded in FY 2008 are expected to be completed in FY 2010, requiring $10 million less (-25%) in funds.

Vehicle Technologies

The Vehicle Technologies program is requesting an overall increase of $60.1 million (22%) in funding across five of its subprograms.

An increase of $32.2 million (153%) is requested for Vehicle and Systems Simulation and Testing to increase the number of PHEVs built by vehicle manufacturers and evaluated in the PHEV Technology Acceleration & Demonstration Activity. Energy Storage R&D funding is increased by 8.0 million (11%). A $12.7 million (73%) increase is requested for Advanced Power Electronics and Electric Motors R&D to initiate a new solicitation for industry contracts to develop power electronics and electric machines to meet the challenges associated with increased vehicle electrification.

Increases in funding are requested for the Advanced Combustion Engine R&D subprogram. The Solid State Energy Conversion activity is requesting an increase of $4.2 million (91%) and the Combustion and Emission Control activity is requesting an increase of $12.1 million (34%) for the development of advanced combustion engines that can achieve FreedomCAR and 21st Century Truck efficiency goals while maintaining cost and durability levels and achieving near-zero regulated emissions.

An increase of $11.7 million (52%) is requested for the Lightweight Materials Technology activity to develop materials processing technology and engineering solutions that can contribute to meeting aggressive weight reduction goals for vehicles.

Technology Validation, Education, and Safety and Codes and Standards activities are transferred from the Vehicles Technologies Program to the Fuel Cell Technologies Program as part of a reprioritization of fuel cell and hydrogen-related work.

Building Technologies

The Buildings Technology (BT) program requests an increase of $97.7 million (70%) across five of its subprograms. An $18.1 million (83%) increase is requested for the Residential Buildings Integration subprogram, which will allow BT to continue research at the 40 percent efficiency level for the hot-humid climate, begin testing strategies to reduce energy use in multifamily buildings, and begin testing strategies to achieve a 50 percent reduction in energy use in single family homes.

An increase of $7.0 million (21%) is requested to accelerate the RD&D of 50 to 70 percent reduced energy consumption through Commercial Building National Accounts and Energy Alliances in three commercial building segments: Retail, Commercial Real Estate, and Hospitals. Two additional Energy Alliances will be launched in FY 2010: Colleges and Universities, and State and local Government.

Lighting R&D requests $5.3 million (-22%) less due to a focus on the most promising topic areas in progress and a down-selected portfolio of R&D projects. Space Conditioning and Refrigeration R&D requests an increase of $5.7 million (173%) to focus on affordable advanced materials, components, refrigeration cycles and systems that improve system energy consumption.

An increase of $7.3 million (84%) is requested for the Building Envelope R&D subprogram, allowing for Thermal Insulation and Building Materials demonstrations and evaluations and helping the Windows Technologies activity to achieve cost effective R10 windows.

The Energy Innovation Hub will be established with $35.0 million in new funding, and will serve as an R&D institute that focuses on integrating smart materials, designs, and systems to tune buildings to conserve energy and control the allocation of lighting, heating, air conditioning, and electricity.

An increase of $8.7 million (41%) is requested for the Technology Validation and Market Introduction subprogram, which includes an increase of $7.5M (100%) for the ENERGY STAR program.

Industrial Technologies

Requested funding for the Industrial Technologies program is increased by $10.0 million (11.1%). The Specific Industries of the Future subprogram requests a $3.0 million (-19%) reduction. In contrast, the funding requested for the Crosscutting Industries of the Future subprogram is increased by $13.0 million (17%), reflecting increased funding for a strategic expansion of Save Energy Now (SEN) activities through new targeted corporate outreach efforts with the most energy intensive industries in order to achieve improved results.

Federal Energy Management Program

The Federal Energy Management Program requests a $10.3 million (46.7%) increase in funds. The requested increase in funding for the Project Financing subprogram of $4.1 million (51%) will help meet the more aggressive goals of the National Energy Conservation Policy Act (NECPA) and support a greater use of Energy Savings Performance Contracts (ESPCs) by Federal agencies with a larger, more coordinated team of project facilitators, Federal financial specialists, and other technical expertise.

A requested increase in funding of $4 million (100%) for the Technical Guidance and Assistance subprogram will support expanded assistance to Federal agencies in the procurement of energy efficient products by updating the product specifications annually and providing dedicated training and outreach to Federal procurement officials.

Facilities and Infrastructure

Facilities and Infrastructure is requesting a $13.0 million (-17.1%) decrease in Operations and Maintenance and Construction costs. Of the funds requested, an increase of $7 million is allocated to General Plant Projects and $44 million to STM Ingress/Egress and Traffic Capacity Upgrades.

Funding requests are reduced in three other areas. General Capital Equipment is reduced by $10 million, the South Table Mountain Infrastructure, Zone II, is reduced by $13 million as this project was fully funded in FY 2009, and a request for a final funding installment of $41 million for the Energy Systems Integration Facility is deferred.

Weatherization and Intergovernmental Activities

Requested funding for the Weatherization Assistance Grants and Technical and Training Assistance subprogram is decreased by $215.0 million (41.7%) due to availability of funding from the Recovery Act.

State Energy Program (SEP) Formula Grants and Special Projects are requesting an increase of $12.5 million each (50% each). The increase in SEP Formula Grants will support the expansion of state capabilities to deploy energy efficiency and renewable energy technology to local government, businesses, and consumer. The increase in SEP Special Projects will support enhanced technical assistance to states, continued development of web-based reporting and monitoring systems, and additional competitive grants for high impact and crosscutting state energy projects.

EERE proposes to transfer the International Renewable Energy Program from Weatherization and Intergovernmental Activities to the Program Support line item.

RE-ENERGYSE (REgaining our ENERGY Science and Engineering Edge)

EERE requests new funding of $115.0 million to initiate a program to develop the next generation of highly skilled U.S. workers. Through new scholarships and job training programs, RE-ENERGYSE will help to provide a workforce which will accelerate the research, development, and deployment of technologies providing affordable, abundant, and clean energy.

Program Direction

An increase of $110.5 million (86.6%) is requested for Program Direction at Headquarters, a $35.4 million (133%) increase is requested for the Golden Field Office, and a $26.3 million (184%) increase is requested for the National Energy Technology Laboratory.

An increase of $52.4 million (67%) is requested for Salaries and Benefits to hire the 253 additional Federal employees required to advance priorities for RD&D of EERE programs, business administration, and increased project management and oversight. Support Services requests an increase of $38.3 million (138%) due to the requirement to hire additional supporting contractor staff, services, and substantial expansions of IT, communications, and network systems. Other Related Expenses requests a $17.0 million increase (104%) to contract additional workspace and the corresponding support systems required for new Federal and contractor staff, both at Headquarters and at the Project Management Centers.

Program Support

Previously, funding for the Strategic Priorities and Impact Analysis and Commercialization activities were implemented via support from across the EERE portfolio. To improve transparency, these activities are being described and funded under a separate line-item. Program Support requests that Strategic Priorities and Impact Analysis receive $43.0 million and that Commercialization receive $45.0 million to meet evolving challenges and opportunities, as well as the needs of the public and the Administration.

EERE proposes to move the International subprogram from the Weatherization and Intergovernmental program to Program Support for FY 2010, with a request of $10 million. Implementation of these efforts from the corporate level will better serve, coordinate, and integrate international activities across the EERE portfolio.

Key Accomplishments

In pursuit of the scheduled individual targets completed by the programs in FY 2008 and FY 2009, several noteworthy related system delivery accomplishments and intermediate steps took place in FY 2009. Some noteworthy examples include:

Fuel Cell Technologies made significant progress with its partners in several critical areas: The Fuel Cell Technologies program and 3M extended the durability of a membrane electrode assembly to over 7,300 hours in the lab. The lower platinum content of alloy catalysts contributed to a reduction in the modeled cost for large-scale production of 80kW fuel cell systems from $94/kW in 2007 to $73/kW. The program, HRL Laboratories LLC and the Lawrence Livermore National Laboratory have achieved a 60 fold increase in hydrogen desorption rates by incorporating hydrogen storage materials such as $LiBH_4$ (lithium borohydride) into a carbon aerogel scaffold. To accelerate early market acceptance, the program and the Defense Logistics Agency (DLA) Defense Distribution Center Susquehanna in New

Cumberland, PA commissioned 20 fuel cell-powered fork lifts, which have lower life cycle costs than the battery-electric fork lifts that they replace.

Biomass and Biorefinery Systems R&D established 36 cellulosic herbaceous energy crop and corn stover removal trials under the Regional Biomass Energy Feedstock Partnership. The program has also achieved a modeled cost of a mixed, dilute sugar stream suitable for fermentation to ethanol of $0.13/lb sugars (equivalent to $2.39 per gallon of cellulosic ethanol, in $2007) through the formulation of improved enzyme mixtures and pretreatments. Additionally, a modeled ethanol selling price (MESP) of $1.92 per gallon (in $2007) has been achieved for thermochemical gasification followed by mixed alcohol synthesis and ethanol separation. Four commercial scale cellulosic ethanol biorefinery projects have been issued awards, the first currently under construction. Of eight selected smaller scale biorefinery partners, seven have been issued awards while negotiations are underway for the eighth award. The program continues to advance biofuels R&D work at the cutting edge by awarding $12 million in thermochemical and $19 million in biochemical conversion R&D projects in 2008 to competitively selected private sector companies and universities.

Solar Energy worked with Sandia National Laboratory and Stirling Energy Systems (SES) to set a new solar-to-grid system conversion efficiency record of 31.2 percent, which surpassed the prior world record of 29.4 percent set in 1984. The latest dish system incorporates key performance improvements over previous versions: low-iron glass to improve mirror reflectivity, highly-accurate mirror facets, a high efficiency generator, and an upgraded radiator system. The dish was also redesigned to eliminate nearly 6,000 pounds from the structure while making it more resistant to wind loads. SES will deploy this technology through power purchase agreements for two plants in California totaling 800 MW to 1,750 MW.

Wind Energy completed negotiations with GE and Siemens to install two utility scale turbines at the National Wind Technology Center for performance and reliability R&D. A small wind independent testing program was launched to improve turbine safety and consumer confidence. Interconnection studies for key regions of the U.S. were completed in support of efforts on increasing wind penetration on the electric grid.

Geothermal Technology competitively selected four field sites (in California, Nevada, and Idaho) to demonstrate EGS technology and selected 17 research projects designed to advance component EGS technology. If successful, the demonstration sites could result in over 400 MW in new grid capacity. The Program also signed an International Partnership on Geothermal Technology that will address 16 research topics essential for EGS, and partnered with the U.S. Geological Survey for an assessment of electric power generation potential for identified conventional resources (9,000 MW), undiscovered conventional resources (30,000 MW), and EGS resources (500,000 MW) in the western U.S.

Water Power, established in FY 2008, has completed the initial phase of developing a global database of marine and hydrokinetic technology projects and technologies, which aids in technology characterization, assessment and identification of water resources. The program successfully completed its first phase of funding of marine and hydrokinetic R&D projects in the areas of technology development and deployment, resource and cost assessments, and environmental impact studies. The program began a nation-wide assessment of the existing domestic hydropower fleet to build an integrated, higher-resolution database from available Federal and non-Federal sources to describe the current state of the hydropower infrastructure in the U.S. (age, type, ownership, etc.), generation patterns from these assets, and associated water availability and use.

Vehicle Technologies accelerated activities focused on developing and demonstrating plug-in hybrid components (electric motors, batteries, and power electronics) and vehicles. PHEV demonstrations inform the research program and evaluate technology readiness. The program verified progress toward its combustion efficiency goal by demonstrating a 43 percent peak brake efficiency on a GM 1.9 liter passenger car diesel engine, a 43 percent improvement over an equivalent conventional gasoline engine. For hybrid electric vehicles (HEV), the program's research and modeling demonstrated that in high volume production HEV battery cost has been reduced to about $25/kW, approaching the 2010 goal of $20/kW. Battery research success led one partner to begin commercial production of its advanced Li-ion HEV battery.

Building Technologies addressed prior year constraints and returned to its schedule for addressing efficiency standards and test procedures for existing covered products, as well as new EPAct 2005 and EISA 2007 inclusions. In the past three years, final rules were issued addressing the energy conservation standards for nine products: Package Terminal Air Conditioners and Heat Pumps, Distribution Transformers, Residential Furnaces, Small Furnaces, Mobile Home Furnaces, Residential Boilers, Small Electric Motors (Determination), Ceiling Light Fan Kits, and Commercial Refrigeration Equipment. The program established ENERGY STAR criteria for solid state lighting (SSL) products (effective in September 2008) and for advanced water heater products, clothes washers, dishwashers and CFL (effective January 2009). The SSL R&D activities demonstrated new LED and OLED luminaires that rival traditional lighting options.

Industrial Technologies (ITP) developed advanced technologies collaboratively with industry, ranging from new membrane-based technologies for low-energy chemicals production to wireless sensor systems for equipment monitoring, and major commercial sales activities. The new technologies are expected to produce energy savings of 487 trillion Btus in 2020, with carbon emissions reductions of 4.7 MMTCe. R&D activities supported by ITP won three *R&D 100* awards in 2008. ITP is recognized for its highly successful deployment effort. ITP has completed 2,053 Save Energy Now assessments, resulting in over $190 million per year in energy cost savings activities implemented in those plants, with plans for additional activities valued at more than $372 million in annual savings.

The Federal Energy Management Program helped Federal agencies save 49 trillion Btu as a result of FEMP facilitation activities in FY 2008, more than doubling its annual target. Accomplishments in FY 2008 include 14 new Super ESPC contracts awards government wide, with a project investment of $244 million and a corresponding guaranteed cost savings of nearly $608 million; Utility Energy Service Contract project investment of over $120 million, more than 40 percent over 2007 levels; and assistance to agencies in the purchase of 159 GW of wind power and 135 GW of Renewable energy Certificates, equivalent to the annual electricity use of approximately 27,000 American households.

Weatherization and Intergovernmental Activities continued to provide substantial climate change benefits through accelerating the deployment of clean energy technologies and sustainable energy policies. Significant accomplishments related to climate change include: facilitating the standardization of renewable energy certificate trading programs; managing a comprehensive partnership with the Nation's utilities to put energy efficiency on an even footing with energy generation to meet the Nation's energy needs; and initiating a national effort with States and the energy services industry to accelerate the use of ESPCs in state and local government buildings, schools, universities and hospitals.

The Office of Technology Advancement and Outreach (a subprogram of Program Support) successfully launched a national energy efficiency public information campaign in FY 2008. The campaign includes public service announcements on television, radio, and online. The announcements are focused on raising consumer awareness and providing simple suggestions for consumers to save energy.

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

	(dollars in thousands)		
	FY 2008	FY 2009	FY 2010
Ames Laboratory			
Vehicle Technologies	0	340	1,849
Industrial Technologies	540	1,985	604
Total, Ames Laboratory	540	2,325	2,453
Argonne National Laboratory (East)			
Fuel Cell Technologies	15,082	9,890	5,600
Biomass and Biorefinery Systems R&D	2,265	2,650	2,920
Solar Energy	1,400	2,080	2,000
Wind Energy	275	554	756
Geothermal Technology	45	500	500
Water Power	0	15	0
Vehicle Technologies	24,992	18,216	29,274
Industrial Technologies	1,740	73	1,780
Program Support	251	255	6,255
Total, Argonne National Laboratory	46,050	34,233	49,085
Brookhaven National Laboratory			
Fuel Cell Technologies	2,250	3,000	1,200
Solar Energy	470	470	470
Wind Energy	0	18	25
Vehicle Technologies	600	980	980
Industrial Technologies	60	60	0
Program Support	400	672	672
Total, Brookhaven National Laboratory	3,780	5,200	3,347
Golden Field Office/Project Management Center			
Biomass and Biorefinery Systems R&D	1,300	2,665	2,700
Solar Energy	71,231	77,063	189,761
Wind Energy	1,478	4,173	12,691

	(dollars in thousands)		
	FY 2008	FY 2009	FY 2010
Geothermal Technology	13,848	30,000	30,000
Water Power	7,566	37,742	28,915
Weatherization and Intergovernmental Activities	8,900	9,000	4,500
Congressionally Directed Projects	186,664	228,803	0
Program Direction	24,308	26,544	61,910
Program Support	900	1,243	2,486
Total, Golden Field Office	316,195	417,233	332,963
Idaho National Laboratory			
Fuel Cell Technologies	200	0	0
Biomass and Biorefinery Systems R&D	10,045	8,266	10,651
Wind Energy	1,000	906	1,235
Geothermal Technology	0	350	250
Water Power	50	50	50
Vehicle Technologies	3,935	4,324	14,374
Industrial Technologies	400	203	1,320
Federal Energy Management Program	201	0	0
Total, Idaho National Laboratory	15,831	14,099	27,880
Lawrence Berkeley National Laboratory			
Fuel Cell Technologies	2,960	2,500	2,000
Wind Energy	945	468	638
Geothermal Technology	1,342	2,000	1,000
Vehicle Technologies	9,500	9,229	9,729
Building Technologies	9,162	11,945	19,980
Industrial Technologies	1,250	1,500	1,315
Federal Energy Management Program	2,200	2,200	3,227
Program Support	90	151	6,151
Total, Lawrence Berkeley National Laboratory	27,449	29,993	44,040
Lawrence Livermore National Laboratory			
Fuel Cell Technologies	4,313	1,500	300
Solar Energy	0	0	150

	FY 2008	FY 2009	FY 2010
	(dollars in thousands)		
Wind Energy	490	999	1,362
Vehicle Technologies	3,275	5,054	4,354
Industrial Technologies	0	75	0
Total, Lawrence Livermore National Laboratory	8,078	7,628	6,166
Los Alamos National Laboratory			
Fuel Cell Technologies	14,401	13,000	6,000
Biomass and Biorefinery Systems R&D	200	248	0
Wind Energy	125	111	151
Vehicle Technologies	367	3,876	1,866
Industrial Technologies	60	60	750
Total, Los Alamos National Laboratory	15,153	17,295	8,767
National Energy Technology Laboratory			
Fuel Cell Technologies	972	70	0
Biomass and Biorefinery Systems R&D	200	350	0
Wind Energy	168	65	89
Geothermal Technology	19	0	0
Water Power	14	0	0
Industrial Technologies	645	650	675
Federal Energy Management Program	2,787	3,740	5,486
Program Direction	12,933	14,231	40,480
Total, National Energy Technology Laboratory	17,738	19,106	46,730
National Renewable Energy Laboratory			
Fuel Cell Technologies	28,717	8,773	1,500
Biomass and Biorefinery Systems R&D	32,898	38,827	32,250
Solar Energy	69,754	65,351	71,157
Wind Energy	33,217	34,607	38,190
Geothermal Technology	1,630	2,000	1,000
Water Power	904	383	300
Vehicle Technologies	17,634	21,939	19,931
Building Technologies	8,328	10,858	18,161

	(dollars in thousands)		
	FY 2008	FY 2009	FY 2010
Industrial Technologies	1,295	795	790
Federal Energy Management Program	3,762	3,300	4,842
Facilities and Infrastructure	76,176	76,000	63,000
Weatherization and Intergovernmental Activities	800	4,150	4,080
Program Support	6,066	10,167	45,167
Total, National Renewable Energy Laboratory	281,181	277,150	300,368
Oak Ridge National Laboratory			
Fuel Cell Technologies	10,097	6,665	2,300
Biomass and Biorefinery Systems R&D	10,531	9,277	7,205
Solar Energy	390	276	250
Wind Energy	644	1,082	1,476
Geothermal Technology	309	300	0
Water Power	518	550	50
Vehicle Technologies	42,653	45,195	53,734
Building Technologies	7,672	10,002	16,731
Industrial Technologies	7,221	7,510	8,920
Federal Energy Management Program	2,708	2,860	4,195
Weatherization and Intergovernmental Activities	0	5,500	3,500
Program Support	315	529	6,529
Total, Oak Ridge National Laboratory	83,058	89,746	104,890

	(dollars in thousands)		
	FY 2008	FY 2009	FY 2010
Pacific Northwest National Laboratory			
Fuel Cell Technologies	9,447	6,490	2,300
Biomass and Biorefinery Systems R&D	10,377	11,105	9,080
Solar Energy	0	0	300
Wind Energy	832	989	1,349
Water Power	50	150	50
Vehicle Technologies	6,835	13,575	14,675
Building Technologies	12,916	16,839	28,166
Industrial Technologies	1,600	1,870	1,475
Federal Energy Management Program	1,572	1,980	2,904
Program Support	446	859	6,859
Total, Pacific Northwest National Laboratory	44,075	53,857	67,158
Sandia National Laboratories			
Fuel Cell Technologies	11,436	4,800	700
Biomass and Biorefinery Systems R&D	300	450	450
Solar Energy	15,983	17,316	34,313
Wind Energy	7,586	7,475	9,193
Geothermal Technology	1,470	1,700	1,700
Water Power	150	50	50
Vehicle Technologies	8,443	14,152	11,642
Federal Energy Management Program	253	220	323
Weatherization and Intergovernmental Activities	550	500	500
Program Support	350	1,000	1,000
Total, Sandia National Laboratories	46,521	47,663	59,871
Savannah River National Laboratory			
Fuel Cell Technologies	2,100	2,350	200
Total, Savannah River National Laboratories	2,100	2,350	200

	(dollars in thousands)		
	FY 2008	FY 2009	FY 2010
Washington Headquarters			
Fuel Cell Technologies	104,266	109,922	46,113
Biomass and Biorefinery Systems R&D	127,517	143,162	169,744
Solar Energy	7,092	12,444	21,599
Wind Energy	2,274	3,553	7,845
Geothermal Technology	644	7,150	15,550
Water Power	402	1,060	585
Vehicle Technologies	90,125	136,358	170,894
Building Technologies	69,304	90,356	154,660
Industrial Technologies	48,381	75,219	82,371
Federal Energy Management Program	6,335	7,700	11,295
Weatherization and Intergovernmental Activities	271,967	496,850	288,420
Re-ENERGYSE	0	0	115,000
Program Direction	66,816	86,845	135,727
Program Support	1,983	3,281	44,881
Total, Washington Headquarters	797,106	1,173,900	1,264,684
Total, Energy Efficiency and Renewable Energy	1,704,855	2,191,778	2,318,602

Major Changes or Shifts by Site

National Renewable Energy Laboratory

Facilities and Infrastructure

- General Plant Projects increases to complete required maintenance and provide upgrades necessary to maintain the capabilities of EERE’s existing real property and related infrastructure at NREL. Increase in Energy Systems Integration Facility provides the final funding to complete the facility and maintain existing schedule for renewable energy research activities which are scheduled to begin in the 4th quarter of FY 2012. The increase to South Table Mountain will extend the roads and utilities into the southern portions of NREL's primary site, develop storm water management features necessary to meet environmental requirements and build a parking structure necessary to address the increase in research and support staff at the site.

Fuel Cell Technologies

- The significant reduction in funding at NREL from FY 2009 to FY 2010 is reflective of decreases in three subprograms and a refocusing of the overall program. Production and Delivery R&D funding is zero in FY 2010, as is Storage R&D. Systems Analysis funding is significantly reduced.

Washington Headquarters

Fuel Cell Technologies

- The Fuel Cell Technologies budget declines from FY 2009 to FY 2010, reflecting a significant reduction in Systems Analysis, a restructuring of funding for fuel-cell-related R&D, and termination of funding for hydrogen production and delivery and hydrogen storage.

Building Technologies Program

- In FY 2010, there will be a focus on support to Builders Challenge at 30 percent energy savings in thousands of new single family homes and to research strategies to support home performance contracting to achieve 30 percent reductions in energy use in existing homes
- In FY 2010, RD&D of 50 to 70 percent reduced energy consumption will be accelerated through Commercial Building National Accounts and Energy Alliances in three commercial building segments (retail, commercial real estate, and hospitals).
- The total Vehicle Technologies budget increased from FY 2009 to FY 2010. The increase reflects acceleration of development of plug-in hybrid electric vehicles (PHEVs) and a renewed emphasis on commercial vehicle R&D to improve energy efficiency.

Site Description

Ames Laboratory

Introduction

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

Vehicle Technologies

Ames Laboratory is conducting research on new materials with unique properties. It also is working on power electronics to improve magnetic powders for bonded permanent magnets.

Industrial Technologies

Ames Laboratory performs research in Industrial Materials and Nano-Manufacturing activity areas. Research is especially focused on nano-composites that improve degradation resistance and improve mechanical life of industrial tools and mechanical components subject to wear. In Nano-Manufacturing the use of nano-particles for biorefining of non-food feedstocks is also being explored.

Argonne National Laboratory East

Introduction

Argonne National Laboratory (ANL) is located in Argonne, Illinois. It is a multi-discipline laboratory providing support to Fuel Cell Technologies, Biomass and Biorefinery Systems R&D, Vehicle Technologies, Industrial Technologies, Weatherization and Intergovernmental Activities, and Program Support.

Fuel Cell Technologies

ANL is the lead laboratory in fuel cell system analysis as well as fuel cell testing and benchmarking. ANL is developing non-platinum cathode electrocatalysts based on bimetallic particles with a base metal core and a noble metal shell to reduce the cost of fuel cell systems.

Biomass and Biorefinery Systems R&D

ANL conducts research on biomass conversion processes and environmental benefits analysis for several EERE programs, including energy balance and emissions for biofuels in conventional and advanced vehicles with and without fuel cells.

ANL will conduct R&D related to convert biomass to bio-based products with the goal of making the technologies more competitive with petroleum-based alternatives.

Solar

ANL will work on a Programmatic Environmental Impact Statement for CSP technologies.

Wind Energy

ANL will assess and report on the state of the art for wind forecasting, develop advanced wind forecasting techniques, report on operational practices for application of wind forecasting, and develop improved methods for utility control room management.

Geothermal Technology

ANL will conduct strategic planning and analysis in support of enhanced geothermal technologies.

Water Power

ANL provides expertise on analyzing the costs associated with using deep-water OTEC plants to generate ammonia as an energy carrier and transporting it to shore. The study was initiated by the Fuel Cell Technologies Program within EERE.

Vehicle Technologies

ANL provides the Vehicle Technologies (VT) program with expertise in materials, combustion chemistry, electrochemistry, systems simulation, computational fluid dynamics, and techno-economic analysis. In materials ANL performs research on non-destructive testing, advanced capacitors for power electronics, recycling of lightweight materials, 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 CIDI (direct-injection Diesel) 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 VT 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 also 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 also 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 ultracapacitors. The lab uses both its system simulation and techno-economic analysis capabilities to support VT planning and program evaluation with energy, economic, and environmental analyses. ANL also provides general technical and analytical support to VT's battery R&D activity, the Graduate Automotive Technology Education (GATE) activity, and VT's student vehicle competitions.

Industrial Technologies

ANL performs research in the Chemicals, Energy-Intensive Process R&D, and most recently in the Nano-Manufacturing activity areas of ITP. The Chemicals project will be completed in FY 2009, but research projects in Energy-Intensive Process R&D and Nano-Manufacturing will continue into FY 2010. Special techniques for applying nano-particles as coatings, the development of nano-particle catalysts, and the development of special nano-particle containing fluids are particular areas of expertise.

Program Support

Provide analytical support for major crosscutting issues, such as market and benefit analyses.

Brookhaven National Laboratory

Introduction

Brookhaven National Laboratory (BNL) is located in Upton, New York. It is a multi-disciplinary research laboratory dedicated to basic, non-defense scientific research. BNL provides support to Fuel Cell Technologies, Solar Energy, Vehicle Technologies, Industrial Technologies, Weatherization and Intergovernmental Activities, and Program Support.

Fuel Cell Technologies

BNL conducts research and development of electrocatalysts with ultra-low platinum loading, focusing on synthesis and characterization of the materials. Brookhaven also conducts analysis of the CO_2 emissions reductions and petroleum savings benefit for the Program with the MARKAL model.

Solar Energy

BNL performs research and development for the Photovoltaic Energy Systems efforts. BNL has the responsibility for environmental, health, and safety (ES&H) impacts associated with photovoltaic 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 photovoltaic materials, processes, and application options before their large-scale commercialization.

Wind Energy

Collaborate with Policy Office on analytical efforts focused on understanding the impact of DOE Applied Energy R&D and deployment activities on US and global carbon emissions, including improving the characterization of EE and RE technologies in energy-economic and integrated assessment models and cross-model comparison studies that include scenario analyses.

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 (IC) engine emissions for program.

Industrial Technologies

BNL supports the Industrial Technologies R&D activities in the area of hierarchical nanoceramics for industrial process sensors. The project is expected to be completed in FY 2009.

Program Support

Provides analytical support for crosscutting issues such as market and benefit analyses.

Golden Field Office/PMC

Introduction

The Golden Field Office (GO) is located in Golden, Colorado. It provides project management and procurement support for Solar Energy, Wind Energy, Water Power, Program Direction, and Congressionally Directed Activities.

Biomass and Biorefinery Systems R&D

In FY 2009 and FY 2010, there will be a substantial increase in support activities due to reporting, oversight, and risk management requirements for the $800 million in Recovery Act funds for biomass related projects. In addition, GO will continue to conduct a number of Funding Opportunity Announcement's across Program areas and negotiate and manage a large number of biomass-related Congressionally Directed Projects contained in the Omnibus Bill.

Solar Energy

In FY 2009, there will be a substantial increase in support due to increased activities in project management and procurement support for the Solar America Initiative. These activities include Technology Pathyway Partnerships, University Process and Product Development, Future Generation and Grid Integration Inverter solicitations.

Wind Energy

GO administers outreach to the States for Wind Powering America activities, monitors Congressionally-directed projects, and helps to manage solicitations.

Geothermal

In FY 2009, there will be a substantial increase in support due to increased activities in project management and procurement support for geothermal. These activities include Energy Geothermal Systems RD&D, and workforce development solicitations.

Water Power

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

Weatherization and Intergovernmental Activities

GO provides project management and procurement support for Weatherization and Intergovernmental Activities. Specific GO program support includes: 1) Management (in coordination with NETL) of financial assistance awarded to State Energy Program and Weatherization Assistance grantees; and 2) Management of all of the financial assistance and some of the technical assistance for Tribal Energy Activities.

Program Direction

Program Direction funds the salary, benefits, and travel costs for FTE 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 Solar Powering America, Wind Powering America, Clean Cities, Rebuild America, and the Federal Energy Management Program (FEMP).

Program Support

GO administers a number of small contracts on TAO's behalf, including work with the Ad Council on a National Energy Efficiency Public Information Campaign.

Idaho National Laboratory

Introduction

Idaho National Laboratory (INL) is located in Idaho Falls, Idaho. It is a multi-discipline laboratory providing support to Biomass and Biorefinery Systems R&D, Wind Energy, Water Power, Geothermal Technology, Vehicle Technologies, Industrial Technologies, and Federal Energy Management Program.

Biomass and Biorefinery Systems R&D

INL provides support for biomass feedstock infrastructure activities, ranging from core R&D services, to analysis and planning support, to deployment-scale efforts. This work is performed in close collaboration with ORNL and NREL, when appropriate. Specifically in FY 2010, INL will focus on development of the Deployable Process Demonstration Unit, in addition to continuing core feedstock infrastructure R&D efforts. INL also will provide technical support to the Regional Feedstock Partnership effort.

Wind Energy

INL provides technical support to the program to enhance government, military applications and Tribal use of Wind Energy, and to address technical and market barriers to wind.

Geothermal Technology

INL will conduct R&D and analytical support to advance EGS goals including the Geothermal Electric Technologies Evaluation Model (GETEM).

Water Power

INL provides engineering support in the area of hydropower engineering and system assessments.

Vehicle Technologies

INL benchmarks and assesses the performance of new ultracapacitors 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 evaluation and collects performance data from electric, plug-in hybrid and fuel cell light duty vehicles and infrastructure, and supports Federal Fleet acquisition reporting as required.

Industrial Technologies

Ongoing work at INL includes projects in Forest Products, Energy Intensive Processes, and Nano-Manufacturing Technology research areas. An on-going project to develop a process to produce renewable microbial polyesters from waste streams is planned to be completed in FY 2009. Research will continue in FY 2010 in projects in the Energy Intensive Process and Nano-Manufacturing research areas. INL is assisting in the demonstration of a new process that uses steam to help wash black liquor from pulp, and special expertise at the laboratory is being applied to create superhydrophobic surfaces. INL also provides critical support in project management and analysis of ITP program activities.

Federal Energy Management Program

INL will support FEMP with continued enhancement and maintenance of the Federal Automotive Statistical Tool (FAST). In addition, it will provide management and organizational support to the Department of Energy (DOE) sponsored Interagency Committee on Alternative Fuels and Low Emission Vehicles (INTERFUEL).

Lawrence Berkeley National Laboratory

Introduction

Lawrence Berkeley National Laboratory (LBNL) develops membranes for fuel cells that do not require water for proton conduction to reduce water management requirements. LBNL has also supported the development of advanced materials-based hydrogen storage technology.

Fuel Cell Technologies

LBNL develops membranes for fuel cells that do not require water for proton conduction thus easing water and thermal management.

Wind Energy

LBNL performs analyses of opportunities for Wind Energy applications in the electricity market.

Geothermal Technology

LBNL will support R&D on Enhanced Geothermal Systems, including studies of reservoir dynamics and seismic phenomenon.

Vehicle Technologies

LBNL conducts exploratory research in advanced battery technology, including development of new electrode and electrolyte materials and understanding of fundamental electrochemical phenomena. BNL develops devices to measure particulate matter from engines.

Building Technologies

LBNL conducts research and development activities in windows, appliance standards, analysis tools and design strategies and commercial buildings integration.

Industrial Technologies

LBNL supports the Best Practices efforts in the technology delivery activities including assistance in facilitating Allied Partners with supplier industry organizations (e.g., Hydraulic Institute, Compressed Air and Gas Institute). The laboratory supports the tracking of Best Practices implementation results including the impact of training, software tools and other program delivery mechanisms on manufacturing plants.

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.

Program Support

LBNL provides analytical support for major crosscutting issues, such as market and benefit analyses.

Lawrence Livermore National Laboratory

Introduction

Lawrence Livermore National Laboratory (LLNL) is located in Livermore, California. It is a multi-discipline laboratory providing support to Fuel Cell Technologies, Geothermal Technology, Vehicle Technologies and Industrial Technologies. It previously supported the Geothermal Technology Program.

Fuel Cell Technologies

LLNL provides support on an as-needed basis for fuel cell materials and systems analysis..

Solar Energy

System-wide Environmental and Cost Implications of Large-scale PV Penetration. This project will use a power system simulation model for detailed analyses of an integrated PV, thermal, and hydro utility system in the Southwestern United States, focusing on environmental impacts, resource requirements, and economic benefits of PV.

Wind Energy

LLNL will review and evaluate forecasting and prediction techniques for heights relevant to tall turbines, collect industry partner wind farm meteorological and power production data, and develop a wind farm power curve, including ability to account. Develop and validate improved wind forecasting techniques, and improve predictions of wind farm power output through power curve development

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 (ICEs). LLNL develops specialized materials like aerogel-based NO_x catalysts for CIDI engines and high-voltage ultracapacitors 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 NOx sensors for diesel engines.

Industrial Technology

LLNL provides expert resources for the investigation of innovative forming in the aluminum industry.

Los Alamos National Laboratory

Introduction

Los Alamos National Laboratory (LANL) is located in Los Alamos, New Mexico. It is a multi-discipline laboratory providing support to Fuel Cell Technologies, Biomass and Biorefinery Systems R&D, Geothermal Technology, Vehicle Technologies, and Industrial Technologies.

Fuel Cell Technologies

LANL develops lower cost, high performance cathode electrocatalysts by lowering precious metal loading while maintaining performance. It investigates the effects of fuel impurities on fuel cell performance. 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.

Biomass and Biorefinery Systems R&D

LANL collaborates with a private sector CRADA partner in the development of an improved fungal-based enzyme system for biochemical conversion of biomass into biofuels.

Wind

LANL conducts integration and resource planning; resource characterization and performance modeling; communication, policy and education support; wind data analysis.

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 and develops microwave regeneration components and design tools for emission controls. Los Alamos is also performing R&D to discover and develop next-generation emission-control catalysts for lean burn engines and developing technology for onboard generation of chemical reductants from diesel fuel.

Industrial Technologies

LANL supports the Energy-Intensive Process R&D program area of ITP in the development of hollow fiber membrane technologies for separations that normally are accomplished using energy-intensive distillation columns. In the Nano-Manufacturing area, LANL is developing a technique to produce ultra-tough nano-composites for drill bit applications.

National Energy Technology Laboratory

Introduction

The National Energy Technology Laboratory (NETL) is located in Morgantown, West Virginia. It provides project management and procurement support to Fuel Cell Technologies, Biomass and Biorefinery Systems R&D, Industrial Technologies, Federal Energy Management Program, the Weatherization and Intergovernmental Activities, Program Direction and Program Support.

Fuel Cell Technologies

In accordance with a Memorandum of Agreement with the Office of Fossil Energy, NETL co-manages fuel cell research and development efforts to improve the efficiency and lower the cost of fossil-based hydrogen production processes.

Biomass and Biorefinery Systems R&D

NETL coordinates the multi-program Clean Cities Solicitation, which includes a Biomass Program contribution for biofuels related communications, education, and outreach projects.

Geothermal Technology

NETL may conduct R&D in support of EGS advancement. NETL may support R&D in: 1. Characterization and Advanced Study of Drilling Systems via Physical Single-Cutter Drilling Simulator; and 2. Impact of Chemical Reaction on Geothermal Formation Properties in a CO_2 dominated system.

Wind Energy

The goal of the ESIS Initiative is to drive private sector demand for sustainable energy solutions and support the creation of new industries, markets and jobs.

Industrial Technologies

NETL provides support for ITP activities in the areas of Nano-Manufacturing, Fuel and Feedstock Flexibility, and Industrial Distributed Energy activities. In Nano-Manufacturing, research is being conducted to develop erosion-resistant nano-coatings for improved energy efficiency in gas turbines.

Federal Energy Management Program

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

Program Direction

In FY 2009, administrative, management, and oversight functions will be performed from the Washington Headquarters, and the Project Management Centers located at the Golden Field Office, and the National Energy Technology Laboratory. These functions include program and project management, coordination and liaison with other Federal Government organizations, with state and local governments, and with stakeholders.

National Renewable Energy Laboratory

Introduction

The National Renewable Energy Laboratory (NREL) is located in Golden, Colorado. NREL is the principal research laboratory for the DOE Office of Energy Efficiency and Renewable Energy and also provides research expertise for the Office of Science, and the Office of 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 Fuel Cell Technologies, Biomass and Biorefinery Systems R&D, Solar Energy, Wind Energy, Water Power, Geothermal Technology, Vehicle Technologies, Building Technologies, Industrial Technologies, Federal Energy Management Program, Facilities and Infrastructure, Weatherization and Intergovernmental Activities, and Program Support.

Fuel Cell Technologies

NREL leads the Systems Integration and Analysis function for the program. Models of the technical, economic, and integration aspects of the hydrogen infrastructure and fuel cell systems provide guidance for the development of hydrogen fuel cell components and materials.

Biomass and Biorefinery Systems R&D

NREL is the lead R&D laboratory and provides a broad range of analysis support across the program, including: 1) the 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 thermochemical 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 is also actively supporting the initial analysis and assessment activities for conversion of advanced feedstocks such as algae to biofuels. Additionally, NREL will continue to support biofuels infrastructure development through intermediate ethanol blend testing on legacy vehicles, small engines, and materials in coordination with ORNL.

Solar Energy

NREL serves as the lead laboratory for the Solar Energy Program. NREL conducts fundamental and applied materials research on photovoltaic devices, photovoltaic 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 photovoltaic 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 photovoltaic cells, modules, and arrays. The test results are used in developing standards and performance criteria for industry and to improve reliability.

Wind Energy

NREL is the lead laboratory for national wind R&D, performing research in aerodynamics, structural dynamics, and advanced components and control systems related to Wind Energy. The National Wind Technology Center (NWTC), located at NREL, provides research and testing facilities for fatigue testing of turbine blades, dynamometer testing of wind turbine drive trains and generators, atmospheric testing of turbines, and certification testing which are required for sales and operation in many overseas markets. NWTC staff also implement the Department=s Cooperative Research and Development Agreements (CRADAs) and cost-shared R&D industry partnerships for large (> 100kW) wind turbine systems, and provides technical assistance for the Wind Powering America activity.

Geothermal Technology

NREL supports HQ with geothermal technologies risk assessment, multi-year program planning and techno-economic analysis. NREL will also support HQ with system integration

Water Power

NREL is the lead laboratory for ocean energy, participating in water power resource assessments, leading technology characterization activities, and developing CRADAs for technology development and demonstration of 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 CAD/CAE for optimized vehicle system solutions in support of FreedomCAR and Fuels Partnership goals; and general engineering assessments of HEV and AFV 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; and supports the Clean Cities deployment program with technical assistance to regional coalitions and fleet partners, and program analysis and evaluation.

Buildings Technologies

NREL provides technical leadership, conducts research and provides technical management support in a number of Buildings Technologies (BT) activities. The primary one is Building America (Residential Building Integration). They have integrated the BT Stage Gate process into the Building America and Commercial Buildings technical management processes. They also provide technical support to the implementation of Building America by conducting research, providing technical assistance to the teams and coordinating the 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 national accounts 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, and development and implementation of new models and features that expand the capabilities of EnergyPlus

Industrial Technologies

NREL supports technology delivery activities of ITP particularly in the preparation of publications and training materials for industrial best practice.

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 vibrant world-class research and development program at NREL to advance the Administration's energy policy. General Plant Project investments support the safe and efficient operation of NREL and EERE programs and provide for a minimum 2 percent recapitalization of real property assets in support of changing mission needs. General Purpose Equipment 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 the portfolios 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.

Weatherization and Intergovernmental Activities

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

Program Support

NREL provides day to day programming and content support for EERE's corporate web presence. NREL also provides communications support including graphic design, exhibit materials, and publications.

Oak Ridge National Laboratory

Introduction

Oak Ridge National Laboratory (ORNL) is located in Oak Ridge, Tennessee. It is a multi-discipline laboratory providing support to Fuel Cell Technologies, Biomass and Biorefinery Systems R&D, Wind Energy, Water Power, Vehicle Technologies, Building Technologies, Industrial Technologies, Federal Energy Management Program, Weatherization and Intergovernmental Activities, and Program Support.

Fuel Cell Technologies

ORNL carries out R&D on metal bipolar plates with nitride surface to mitigate corrosion. ORNL also characterizes the properties of membrane electrode assemblies to elucidate degradation mechanisms during fuel cell operation.

Biomass and Biorefinery Systems R&D

ORNL is integral to the Feedstock Infrastructure R&D platform resource assessment and resource development efforts. Specifically in FY 2010, ORNL will lead the update to the Billion Ton Vision, a report that explored the feasibility of building a billion tons of feedstocks to convert to biofuels; and, the development of a GIS-based assessment tool; and will continue to support the Regional Feedstock Partnership. These efforts are closely coordinated with INL and NREL, when appropriate. Additionally, ORNL will continue to support biofuels infrastructure development through intermediate ethanol blend testing on legacy vehicles, small engines, and materials in coordination with NREL. ORNL also provided assistance on biomass technology assessment and information transfer for the Integrated Biorefinery Platform.

Solar Energy

ORNL provides support in applied photovoltaic research as well as in technical assistance for the Solar America Cities project.

Wind Energy

ORNL provides analysis and support to wind integration studies and applications.

Geothermal Technology

ORNL may perform R&D in Wear-Resistance NanoComposite Coatings, High Temperature Downhole Tool, and properties of pore-confined CO_2-rich supercritical fluids and their effects on porosity evolution for EGS rocks.

Water Power

ORNL will participate in the resource assessment of ocean energy in the U.S., including current (tidal) resources. ORNL is the lead laboratory for hydropower activities. It will also participate in water power resource assessments, lead technology characterization activities, and develop CRADAs for technology development and demonstration of water power technologies.

Vehicle Technologies

ORNL provides the Vehicle Technologies (VT) program 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 as a user facility for materials characterization, funded by VT. ORNL supports VT's combustion R&D with 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 VT'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 (converters and controllers) 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 maintains the legislatively-mandated automobile *Fuel Economy Guide* and website.

Building Technologies

ORNL is part of a National Laboratory/industry/university consortium conducting research and development for the following activities: Building America; space heating and cooling; envelope and emerging technologies.

Industrial Technologies

ORNL conducts research and provides support in several ITP program areas including: Industrial Materials, Nano-Manufacturing, Industrial Distributed Energy, Technology Delivery (Industrial Assessment Centers and Best Practices), Energy-Intensive Process R&D, and Fuel and Feedstock Flexibility. In support of the Best Practices effort, ORNL provides support to Plant-Wide Assessments and other technical assistance and also assists in the tracking of program impacts. ORNL is the primary laboratory supporting the Industrial Materials of the Future activity. ORNL administers several research projects in the new Nano-Manufacturing, Energy-Intensive Process R&D, and Fuel and Feedstock Flexibility cross-cutting program areas.

Federal Energy Management Program

ORNL facilitates projects, develops guidelines, and provides expert advice on combine heat and power 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 assists in stakeholder outreach for DOE energy efficiency initiatives.

Program Support

ORNL provides analytical support for major crosscutting issues, such as market and benefit analyses.

Pacific Northwest National Laboratory

Introduction

Pacific Northwest National Laboratory (PNNL) is located in Richland, Washington. It is a multi-discipline laboratory providing support to Fuel Cell Technologies, Biomass and Biorefinery Systems R&D, Water Power, Vehicle Technologies, Building Technologies, Industrial Technologies, Federal Energy Management Program, Weatherization and Intergovernmental Activities, and Program Support.

Fuel Cell Technologies

PNNL is the lead laboratory in the development of safety materials and systems for various end use applications. PNNL is developing novel catalyst support to mitigate catalyst support degradation during start/stop cycles in fuel cell operation.

Biomass and Biorefinery Systems R&D

PNNL provides support for the technical and economic assessment of thermochemical research and development on syngas, and bio-oil, and fuels production. Major program components include thermocatalysts for fuels and chemicals. Additionally, PNNL performs research on the use of filamentous fungi in the biorefinery. PNNL is also supporting the initial analysis and assessment activities for conversion of advanced feedstocks such as algae to biofuels and life cycle assessments of alternative fuels.

Solar Energy

Integration of PV Systems into Coordinated Demand and Supply Management Strategies. This project will address operational opportunities for demand responsiveness within an integrated PV system, and will evaluate integrated PV system components in conformance to the developed or developing interoperability framework.

Wind Energy Systems

PNNL provides analysis and support to system integration activities and to addressing market barriers to wind energy deployment.

Water Power

PNNL participates in environmental studies and marine life impacts related to the Water Power Program.

Vehicle Technologies

PNNL supports Vehicle Technologies (VT) primarily through their expertise in a variety of materials technologies. PNNL evaluates advanced energy storage materials for battery R&D. PNNL supports VT materials R&D effort by developing energy-efficient production and processing techniques for magnesium, titanium, polymer, natural fiber 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 develop tools and analytic techniques for developing new catalytic materials for engines using computational methods and materials-by-design approaches, and also develops materials for high-durability lean-burn spark plugs and NO_x sensors. 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 research and development 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 national accounts and energy alliances in three commercial building segments retail, commercial real estate, and hospitals.

Federal Energy Management Program

PNNL developed 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.

Program Support

Provide analytical support for major crosscutting issues, such as market and benefit analyses.

Sandia National Laboratories

Introduction

Sandia National Laboratories (SNL) is located in Albuquerque, New Mexico and in Livermore, California. It is a multi-discipline laboratory providing support to Fuel Cell Technologies, Solar Energy, Wind Energy, Water Power, Geothermal Technology, Vehicle Technologies, Federal Energy Management Program, Weatherization and Intergovernmental Activities, and Program Support.

Fuel Cell Technologies

SNL conducts material property characterization and safety analysis of fuel cells. Sandia also supports the development of the Macro-System with the Systems Integration function to enable the integration of multifunctional models.

Biomass and Biorefinery Systems R&D

SNL is providing support on the initial analysis and assessment activities for conversion of algae to biofuels.

Solar Energy

SNL supports the Photovoltaic 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 Concentrating Solar Power 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 department staff work closely with counterparts at the National Renewable Energy Laboratory to provide the program and the U.S. wind industry with engineering expertise to further the program's knowledge and goals.

Geothermal Technology

SNL will design and fabricate a seismic tool capable of semi-permanent applications such as deployment during temporary field activities and also permanent application as a monitoring tool cemented into the wellbore. Sandia National Laboratory will provide technical and analytic support for use of the high temperature televiewer in the Cooper Basin, Australia, in support of the International Partnership for Geothermal Technology. SNL also will play a role in cooperative bilateral projects with Iceland.

Water Power

SNL provides expertise on technology development and assessment, particularly related to hydrokinetic systems.

Vehicle Technologies

SNL supports the Vehicle Technologies (VT) program 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 VT propulsion and lightweight materials efforts by developing techniques and instrumentation for forging, heat-treatment, coating, welding, and other factory processes.

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.

Program Support

SNL provides analytical support for crosscutting issues such as market and benefit analyses.

Savannah River National Laboratory

Introduction

Savannah River National Laboratory (SRNL) is located in Aiken, South Carolina. It is a multidisciplinary research laboratory that provides support to Fuel Cell Technologies.

Fuel Cell Technologies

SRNL supports fuel cell R&D with its expertise in materials and test protocols.

Washington Headquarters

Introduction

Washington, D.C. is the headquarters for the Office of Energy Efficiency and Renewable Energy operations. The Headquarters operation provides specialized, technical expertise in program planning, formulation, execution, and evaluation, 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 Fuel Cell Technologies, Biomass and Biorefinery Systems R&D, Solar Energy, Wind Energy, Water Power, Geothermal Technology, Vehicle Technologies, Building Technologies, Industrial Technologies, Federal Energy Management Program, Weatherization and Intergovernmental Activities, Re-ENERGYSE, Program Direction, and Program Support.

Fuel Cell Technologies

Funding Profile by Subprogram

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

(dollars in thousands)

	FY 2008 Appropriation[a]	FY 2009 Current Appropriation	FY 2009 Additional Appropriation	FY 2010 Request
Hydrogen Technologies				
Fuel Cell Systems R&D	–	–	–	63,213
Hydrogen Production and Delivery R&D	38,607	10,000	–	0
Hydrogen Storage R&D	42,371	59,200	–	0
Fuel Cell Stack Component R&D	42,344	62,700	–	0
Technology Validation[b]	29,612	–	–	0
Transportation Fuel Cell Systems	7,718	6,600	–	0
Distributed Energy Fuel Cell Systems	7,461	10,000	13,400	0
Fuel Processor R&D	2,896	3,000	–	0
Safety and Codes and Standards[c]	15,442	–	–	0
Education[d]	3,865	–	–	0
Systems Analysis	11,099	7,713	–	5,000
Market Transformation	–	4,747	30,000	0
Manufacturing R&D	4,826	5,000	–	0
Total, Hydrogen Technologies	206,241	168,960	43,400	68,213

[a] SBIR/STTR funding was transferred to the Science Appropriation in FY 2008, which includes a reduction of $4,306,000 that was transferred to the SBIR program, and $515,000 that was transferred to the STTR program.
[b] Funding for this activity appears in the Vehicle Technologies budget in FY 2009, but is included again in Fuel Cell Technologies starting in FY 2010.
[c] Ibid.
[d] Ibid.

Funding Profile by Subprogram
(Comparable Structure to the FY 2010 Request)

(dollars in thousands)

	FY 2008 Appropriation[a]	FY 2009 Current Appropriation	FY 2009 Additional Appropriation	FY 2010 Request
Fuel Cell Technologies				
Fuel Cell Systems R&D	54,201	75,700	—	63,213
Hydrogen Production and Delivery R&D	38,607	10,000	—	0
Hydrogen Storage R&D	42,371	59,200	—	0
Fuel Cell Stack Component R&D	—	—	—	—
Technology Validation[b]	29,612	—	—	0
Transportation Fuel Cell Systems	6,218	6,600	—	0
Distributed Energy Fuel Cell Systems	—	—	13,400	—
Fuel Processor R&D	—	—	—	—
Safety and Codes and Standards[c]	15,442	—	—	0
Education[d]	3,865	—	—	0
Systems Analysis	11,099	7,713	—	5,000
Market Transformation	–	4,747	30,000	0
Manufacturing R&D	4,826	5,000	—	0
Total, Fuel Cell Technologies	206,241	168,960	43,400	68,213

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” (1990)
P.L. 102-486, “Energy Policy Act” (1992)
P.L. 104-271, “Hydrogen Future Act of 1996” (1996)
P.L. 109-58, “Energy Policy Act of 2005” (2005)
P.L. 110-140, “Energy Independence and Security Act of 2007”

[a] SBIR/STTR funding was transferred to the Science Appropriation in FY 2008, which includes a reduction of $4,306,000 that was transferred to the SBIR program, and $515,000 that was transferred to the STTR program.
[b] Funding for Technology Validation appears in the Vehicle Technologies (VT) budget in FY 2009 at $15,000,000; but is included again in Fuel Cell Technologies (FCT) starting in FY 2010.
[c] Funding for Safety and Codes and Standards appears in the VT budget in FY 2009 at $12,500,000; but is included again in FCT starting in FY 2010.
[d] Funding for Education appears in the VT budget in FY 2009 at $4,200,000; but is included again in FCT in FY 2010.

Mission

The mission of the Fuel Cell Technologies (FCT) 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 domestic energy use by enabling the widespread commercialization and application of fuel cell technologies. The program's key mission goals are to advance these technologies, through research, development, demonstration (RD&D), to be competitive with alternate technologies in cost, reliability and performance, and to reduce the institutional and market barriers to their commercialization.

Modifications were made to the budget structure to better reflect the Fuel Cell Technologies Program's activities in FY 2010. The two tables above show a non-comparable and comparable funding profile for the program. The non-comparable table presents the FY 2010 funding in the new budget structure only and FY 2008 and FY 2009 funding is shown as appropriated. The comparable table shows the FY 2008 and FY 2009 funding in the new budget structure to assist in comparing year-to-year funding trends. A cross-walk of the new and old structure is provided that describes in detail the modification to the budget structure.

Benefits

The program pursues its mission through integrated activities designed to improve the efficiency, flexibility, and productivity of the domestic energy economy. These improvements are expected to reduce susceptibility to energy price fluctuations, reduce GHG emissions, reduce EPA criteria and other pollutants, and enhance energy security by increasing the production and diversity of domestic fuel supplies.

In FY 2010, the Fuel Cell Technologies Program proposes to re-focus its efforts on fuel cell systems for stationary, portable, and transportation applications. This revised effort is aligned with DOE's portfolio of technologies for near-term impact, improved energy efficiency using multiple fuels, and job creation, consistent with the Presidential objectives. FCT will develop multiple fuel cell technologies (including solid-oxide, alkaline and polymer electrolyte membrane fuel cells) for multiple fuel sources (including diesel, natural gas, bio-derived renewable fuels such as methanol, and fuels derived from other renewable resources). Applications include distributed generation, backup power, auxiliary power units (APUs), portable power systems, material handling equipment, specialty vehicles, and transportation. Distributed generation and backup power systems supported by this activity may be grid-tied or grid-independent, utilize waste heat, operate directly with hydrogen or natural gas, or use reformers to operate with natural gas, bio-derived fuels or coal-derived fuels.

Fuel cells provide energy that can be cleanly produced from a wide range of abundant domestic energy resources, including natural gas, as well renewable resources such as biofuels and by-products from biomass. Depending on the resource used in the fuel cell, substantial reductions in CO_2 emissions and petroleum use considering the entire energy path could be attained. Since fuel cells are quiet, clean and efficient, they are ideal for generating electricity and heat in commercial, industrial, or residential applications, utilizing up to 80 percent of the energy content of the fuel. These systems have been shown to be economically favorable over conventional technologies for material handling equipment in two to three shift indoor warehouse operations and for combined heat and power supply in data centers. Other early market applications include back up power for critical loads, such as telecommunications. Also, reversible fuel cells can be used for storing energy on the Nation's electric grid for dispatch during peak load or to facilitate the use of intermittent energy sources such as solar or wind. Wastewater treatment gas, by-product gases from industrial processes, and gases created from food processing and agricultural waste can be tapped for on-site electrical generation with fuel cell technology.

The proposed FY 2010 Budget investments complement funds provided by the Recovery Act that accelerate fuel cell market transformation and demonstration activities technology awards. To enable decision makers and the public to follow performance and plans, the program will post its progress in these planned activities at: http://www.energy.gov/recovery/index.htm

Climate Change

Depending on the fuel used, FCT contributes to reducing GHG by providing solutions for many applications. Fuel cells are ideal for using flexible and clean fuels for generating electricity or a combination of electricity and heat for use in commercial, industrial, or residential applications.

Energy Security

FCT aims to help national energy security by reducing reliance on imported oil with widespread commercialization of fuel cells that use domestic and diverse sources of fuel.

Economic Impacts

The program contributes to economic growth in the U.S. by developing fuel cell technologies that lead to new jobs in domestic manufacturing, infrastructure development, and support services. In addition, the reduced dependence on petroleum will improve the Nation's balance of trade and create a more favorable position in the global economy.

Two integrated energy-economy models are used to assess the environmental, energy security and economic benefits from 2010 through 2050 that would result from realization of the program goals: National Energy Modeling System – Government Performance and Results Act 2010 (NEMS-GPRA2010) for benefits through 2030, and Market Allocation Model – Government Performance and Results Act 2010 (MARKAL-GPRA2010) for benefits through 2050.[a] (See table below)

The models do not include any additional policies, incentives or regulatory mechanisms that are expected to support or accelerate the achievement of the program goals. The expected benefits reflect solely the achievement of the program's goals, and do not include any complementary or R&D activities from other Federal agency programs. The vehicle specification used for the basis of the comparison is the same baseline vehicle specification that the EERE Vehicle Technologies Program uses for GPRA 2010 analyses.

[a] Documentation on the analysis and modeling can be found at http://www.eere.energy.gov/ba/pba/program_benefits.html.

Primary Metrics for FY 2010 Budget Request

(Incorporates Approximate Impacts of EISA 2007)

	Metric[1]	Model	Year 2015	2020	2030	2050
Energy Security	Oil Imports Reduction, cumulative[2] (Bil bbl)	NEMS	ns	ns	0.2	N/A
		MARKAL	ns	ns	ns	7.3
	Natural Gas Imports Reduction, cumulative (Tcf)	NEMS	ns	ns	-0.6	N/A
		MARKAL	ns	ns	ns	-2.3
	Reduction in Share of Highway Fuel Demand Derived from Crude Oil[3] (%)	NEMS	ns	ns	1%	N/A
		MARKAL	ns	ns	1%	21%
Environmental Impacts	CO_2 Emissions Reduction, cumulative ($mtCO_2$)	NEMS	ns	ns	95	N/A
		MARKAL	ns	ns	ns	ns
	SO_2 Allowance Price Reduction[4] ($/ton)	NEMS	ns	ns	ns	N/A
		MARKAL	N/A	N/A	N/A	N/A
	NO_x Allowance Price Reduction ($/ton)	NEMS	ns	ns	ns	N/A
		MARKAL	N/A	N/A	N/A	N/A
	Hg Allowance Price Reduction (thousand $/lb)	NEMS	ns	ns	ns	N/A
		MARKAL	N/A	N/A	N/A	N/A
Economic Impacts	Consumer Savings, cumulative[5] (Bil $)	NEMS	ns	ns	ns	N/A
		MARKAL	0	20	62	105
	Electric Power Industry Savings, cumulative (Bil $)	NEMS	ns	ns	ns	N/A
		MARKAL	ns	ns	ns	-60
	Household Energy Expenditures Reduction ($/household/yr)	NEMS	ns	ns	ns	N/A
		MARKAL	0	11	26	88

1. "Reductions" and "savings" are calculated as the difference between results from the baseline case (i.e. no DOE technology) and the technology case (i.e. all DOE technology R&D programs are successful).
2. All cumulative metrics are based on results beginning in 2010.
3. Metric includes oil-derived fuel use by light-duty vehicles, commercial light trucks and freight trucks; the metric excludes buses. Reported oil use is adjusted to exclude ethanol, biodiesel and CTL.
4. All monetary metrics are in 2006$.
5. Cumulative monetary metrics are in 2006$ that are discounted to 2010 using a 3% discount rate.

ns - Not significant
NA - Not yet available
N/A - Not applicable

Secondary Metrics for FY 2010 Budget Request

(Incorporates Approximate Impacts of EISA 2007)

	Metric[1]	Model	Year 2015	2020	2030	2050
Energy Security	Oil Imports Reduction, annual (Mbpd)	NEMS	ns	ns	0.2	N/A
		MARKAL	ns	ns	0.0	2.0
	Natural Gas Imports Reduction, annual (Tcf)	NEMS	ns	ns	-0.3	N/A
		MARKAL	ns	ns	ns	0.0
	MPG Improvement[2] (%)	NEMS	ns	ns	3%	N/A
		MARKAL	ns	ns	ns	101%
Environmental Impacts	CO_2 Intensity Reduction of US Economy (Kg CO2/$GDP)	NEMS	ns	ns	ns	N/A
		MARKAL	ns	ns	ns	ns
	CO_2 Intensity Reduction of US Power Sector[3] (Kg CO2/kWh)	NEMS	ns	ns	ns	N/A
		MARKAL	ns	ns	ns	ns
	CO_2 Intensity Reduction of US Transportation Sector[4] (Kg CO2/mile)	NEMS	ns	ns	ns	N/A
		MARKAL	ns	ns	ns	0.06
Economic Impacts	Consumer Savings, annual[5] (Bil $)	NEMS	ns	ns	ns	N/A
		MARKAL	0	3	11	11
	Electric Power Industry Savings, annual (Bil $)	NEMS	ns	ns	ns	N/A
		MARKAL	ns	ns	ns	-12
	Energy Intensity of US Economy (energy/$GDP)	NEMS	ns	ns	0.03	N/A
		MARKAL	ns	ns	ns	0.02
	Net Energy System Cost, annual (Bil $)	NEMS	N/A	N/A	N/A	N/A
		MARKAL	0	11	40	80

1. "Reductions" and "savings" are calculated as the difference between results from the baseline case (i.e. no DOE technology) and the technology case (i.e. all DOE technology R&D programs are successful).
2. Change in light duty vehicles miles traveled per gallon of oil, where oil is only that derived from petroleum.
3. Emissions include all power sector emissions. Generation calculated as total net generation adjusted for estimated T&D losses.
4. Emissions calculated using highway fuel use and related carbon emission factor. Miles calculated as highway miles traveled, excluding buses.
5. All monetary metrics are in 2006$.

ns - Not significant
NA - Not yet available
N/A - Not applicable

The following external factors could affect the ability of the FCT program to achieve these long-term goals and benefits:

- Fuel availability. Successful deployment of fuel cells will depend on adequate availability of the appropriate fuels for each type of fuel cell.
- Market appeal of fuel-cells. The interest of consumers and businesses in using fuel cells as a substitute for less-efficient power sources will depend in part on the price of conventional sources of energy, such as gasoline and diesel fuel. Historically fluctuating oil prices have not provided a consistent signal to either buyers or manufacturers.

Contribution to the Secretary's Priorities

FCT contributes to several of the Secretary's priorities as enumerated below. The principal focus areas are renewable energy and GHG reduction.

Priority 1: Science and Discovery – Invest in science to achieve transformational discoveries

The program coordinates with the Office of Science in fields such as nanoscience, biological mechanisms of hydrogen production, and understanding hydrogen interactions with material surfaces. The program has reenergized and focused National Laboratory efforts through the creation of multiple Hydrogen Centers of Excellence. The Centers of Excellence serve as "virtual labs" to integrate National Laboratory, university, and industry activities, as does the program's encouragement of teaming for competitive awards.

The program partners globally through the International Partnership for a Hydrogen Economy (IPHE) with 16 countries and the European Commission, International Energy Agency (IEA) with 25 countries, and other international organizations and agreements. The program builds research networks by coordinating plans with other DOE offices involved in hydrogen and fuel cell research, participation in the IEA and IPHE, cooperation with industry associations and the National Hydrogen and Fuel Cells Codes & Standards Coordinating Committee, the Hydrogen and Fuel Cell Technical Advisory Committee, the Inter-agency Task Force, and the Hydrogen and Fuel Cell Interagency Working Group.

Priority 2: Clean Energy – Change the landscape of energy demand and supply

The program encourages technology and business model innovation through competitively-awarded industry partnerships and support for innovative deployment mechanisms. Fuel cell applications open new avenues for fuel diversity and distributed generation.

Contribution to GPRA Unit Program Goal 1.1.01.00 (Fuel Cell Technology)

The key FCT contribution to General Goal 4, Energy Security, is domestic energy supply and energy efficiency through:

- Fuel Cell Component R&D, to improve fuel cell durability and performance while reducing cost. The manufacturing cost of hydrogen-fueled fuel cell power systems will be reduced from $275/kW in 2002 for a 50 kW system to $45/kW in 2010 for an 80 kW system at production levels of 500,000 units per year (projected cost).
- Fuel Cell Component R&D, to increase the electrical efficiency of 5-250 kW stationary fuel cell systems operating on natural gas or propane from 29 percent in 2002 to 40 percent in 2011.

Means and Strategies

The FCT Program will use various means and strategies to achieve its GPRA Unit Program goals as described below. "Means" include operational processes, resources, information, and the development of technologies, and "strategies" include program, policy, management and legislative initiatives and approaches. Various external factors, as listed below, may impact the ability to achieve the program's goals.

FCT employs the following strategies to accomplish its goals:

To organize R&D activities on fuel cell technology, the program established RD&D subprograms. The subprograms have established cost, performance and/or durability goals to enable fuel cell technologies to be competitive with alternate technologies. For example, for transportation fuel cell systems to be competitive, the cost target is $30/kW, the performance target is 50 percent efficiency at rated power and the durability target is 5,000 hours. To meet these goals, the subprograms use a competitive selection process to award projects to National Laboratories, universities and industry, and make use of programmatic, policy and legislative approaches in accordance with EPAct 2005 and EISA 2007 to achieve their GPRA Unit goals.

FCT employs the following means to accomplish its goals:

Collaborations leverage the program's activities within and outside DOE. The program coordinates across five DOE Offices: other technology programs within EERE, and the Offices of Science, Nuclear Energy, Fossil Energy, and Electricity Delivery and Energy Reliability. The EERE FCT program is the DOE fuel cell lead and coordinates RD&D planning, budget formulation and execution, and peer review. Within EERE, the program collaborates with the Vehicle Technologies, Biomass and Biorefinery, Solar Technologies, Wind Energy, and Water Power programs. Coordination with organizations outside of DOE includes:

- Interagency Task Force: The program participates in the Task Force in accordance with EPAct 2005, to leverage and coordinate Federal resources and activities.
- International Partnership for the Hydrogen Economy (IPHE): The program is DOE's primary representative to the IPHE, whose goal is to leverage R&D capabilities globally.
- FreedomCAR and Fuel Partnership: DOE (represented by the Vehicle Technologies and the FCT programs) participates in the FreedomCAR and Fuel Partnership with the U.S. Council for Automotive Research (USCAR), five energy companies, and two utilities. The Partnership focuses on precompetitive high-risk research necessary to provide a full range of affordable energy-efficient cars and passenger trucks, and their fueling infrastructure. Fuel cell vehicles represent the long-term end of the R&D spectrum coordinated through the Partnership.
- Cooperation on research for safety and codes and standards: The program collaborates and coordinates with the Department of Transportation (DOT), EPA and the National Institute of Standards and Technology (NIST) to perform safety research and establish the technical groundwork that will be used by code and standard-setting organizations.

Validation and Verification

To validate and verify program performance, the program conducts internal and external reviews and audits. Programmatic activities are subject to continuing review by, for example, Congress, the Government Accountability Office, the National Academies, DOE's Inspector General, as well as by reviewers from other agencies, such as the EPA and state environmental agencies through FCT’s Annual Merit Review and Peer Evaluation process. Specific milestones, go/no-go decision points, and technical progress are systematically reviewed through the program’s merit review process and independent assessments conducted through the Systems Integration Office. The table below summarizes validation and verification activities.

Data Sources: Merit Review and Peer Evaluation of R&D, Program Peer Reviews, and independent assessments are conducted. Engineering models and experimental results are used to validate technical progress, with documentation provided through quarterly and annual reports. Learning demonstration activities (through FY 2009) also verify and validate technical progress towards meeting targets and help guide R&D. Summary program plans and annual presentations by the program are used to communicate the status of verification/validation activities and to evaluate proposed approaches towards meeting technical targets.

Baselines: The following are the key baselines used in FCT:

- Compressed hydrogen tank-only storage (2003): 1.3 kWh/kg (3.9 percent by weight) and 0.6 kWh/L system capacity
- Solid state materials for storage systems (2003): 1 percent by weight system capacity and 0.5 kWh/L
- Transportation systems/stack component R&D (2002): $275/kW fuel cell cost
- Distributed energy systems/fuel processor R&D (2002): 29 percent electrical efficiency
- Technology validation (2003, laboratory): 1,000 hours durability of fuel cell vehicle systems
- Validated production (delivered) (2004): $3.60/gge (beginning of life testing)

Frequency: Expected results and benefits of the budget are estimated annually in response to GPRA, merit review and peer evaluation of R&D projects and program peer review are conducted biennially. Quarterly reports are submitted to DOE Technology Development Managers. Summary program plans are submitted annually.

Data Storage: EERE Corporate Planning System

Evaluation: The program uses several forms of evaluation to assess progress and to promote program improvement:

- Continue to conduct and build upon the transparent oversight and performance management initiated by Congress and the Administration.
- Technology validation and operational field measurement, as appropriate;
- Peer review by independent outside experts of both the program and sub-program portfolios;
- Annual internal Technical Program Review of the program;
- Specialized program evaluation studies to examine process, impacts, or market baseline and effects, as appropriate;
- Quarterly and annual assessment of program and management results based on Joule (the DOE quarterly performance progress review of budget targets);
- Annual review of methods, and recomputations of potential benefits for GPRA
- The National Academies published a report in 2005 titled: “Review of the

Research Program of the FreedomCAR and Fuel Partnership."[a] The committee's report indicated that DOE's FreedomCAR and Fuel Partnership "has already made an excellent start." The report noted that the partnership faces significant technical challenges, including hydrogen storage in vehicles, commercially viable fuel cells, and the need to build an infrastructure for hydrogen fueling. The report recommended that DOE pay special attention to the challenges of shifting from petroleum to hydrogen as a transportation fuel, including hydrogen safety issues and any environmental impacts of large-scale hydrogen production and use. It also recommended an overall program evaluation to help decide among trade-offs and determine priorities. Finally, the report noted that Congress has appropriated significant portions of the funding for specific projects that are not focused on the partnership's goals, and that the partnership will be unable to meet its milestones if the practice continues;

In 2007, the National Academies conducted a second biennial review of the FreedomCAR and Fuel Partnership and published a report entitled, "Review of the Research Program of the FreedomCAR and Fuel Partnership - Second Report." In this report, the committee noted that, "The FreedomCAR and Fuel Partnership is well planned, organized and managed. It is an excellent example of an effective industry/government cooperative effort." The committee noted that significant progress has been made since the first report but that technological barriers remain to reduce the cost at the vehicle, system and component levels while improving performance in these same areas. In addition to technological barriers, the committee noted that the transition to hydrogen as an energy carrier may be deterred by broad social and economic issues that may arise with the introduction of a new energy carrier. The committee concluded that, "the research efforts of the Partnership are more needed than ever before.";

- Merit reviews and peer evaluations, conducted by energy and fuel cell experts from outside of DOE, are held to evaluate RD&D projects to ensure that priorities and key technology barriers identified in the program's planning documents are addressed;
- In a report released February 11, 2008, the GAO commended DOE for making important R&D progress, for effectively aligning its R&D priorities with industry, and for working with other agencies in coordinating activities and facilitating scientific exchanges. The report stated that DOE and industry officials attribute this progress to DOE's (1) planning process that involved industry and university experts from the earliest stages; (2) use of annual merit reviews, technical teams, centers of excellence, and other coordination mechanisms to continually involve industry and university experts to review the progress and direction of the program; (3) emphasis on both fundamental and applied science, as recommended by independent experts; and (4) continued focus on such high priority areas as hydrogen storage and fuel cell cost and durability. The GAO recognized DOE's increased efforts in stationary and portable fuel cell technologies, as well as the role that these technologies may play in paving the

[a] Report can be found at http://www.nap.edu/catalog.php?record_id=11406.

way for the commercialization of fuel cell vehicles. The report also recognized that difficult technical challenges lie ahead, particularly in hydrogen storage and delivery, fuel cell cost and durability, and hydrogen infrastructure deployment. The GAO recommended that program plans be updated to provide an overall assessment of what DOE reasonably expects to achieve by its technology readiness date. GAO also recommended that the report include a discussion of how these expectations may differ from previous posture plans and project anticipated R&D funding needs.

- The program develops and implements planning documents and supports the development of technology roadmaps with industry.[a] These efforts are used to focus the program's investments on activities that are within the Federal Government's role and that address top priority needs;
- National Laboratories, industry, and universities receive funding through competitive processes. Energy and fuel cell industry experts review each university, laboratory, and industry project at the annual Merit Review and Peer Evaluation. Consistent with the principles of the R&D Investment Criteria, project peer reviews include evaluation of: 1) relevance to overall DOE and FCT objectives; 2) approach to performing the research and development; 3) technical accomplishments and progress toward project and DOE goals; 4) technology transfer/collaborations with industry/universities/laboratories; and, 5) approach and relevance of proposed future research. The panel also evaluates the strengths and weaknesses of each project, and recommends additions to or deletions from the scope of work;
- Most projects are also evaluated by the FreedomCAR joint technical teams each year. The program facilitates supplier-customer relationships to ensure that R&D results from National Laboratories and universities are transferred to industry suppliers and that industry supplier developments are made available to automakers, energy industry and stationary power producers; and
- Reviews are conducted by the Hydrogen Safety Panel to monitor the safety of procedures and facilities throughout the program.

Verification: Quarterly reports from DOE-funded industry, university and National Laboratory partners document the status of quarterly targets and milestones. An Annual Report is used to evaluate progress towards meeting program goals and technical targets. Independent assessments will be conducted by the Systems Integration activity to evaluate research results.

[a] See the following documents: Fuel Cell Report to Congress, Feb. 2003; A National Vision of America's Transition to a Hydrogen Economy, March 2002; National Hydrogen Energy Roadmap, November 2002; FreedomCAR Fuel Cell Technical Roadmap; EERE Hydrogen Program Multi-Year Research, Development and Demonstration Plan; Hydrogen Posture Plan; The 2004 National Academies' Report, The Hydrogen Economy: Opportunities, Costs, Barriers, and R&D Needs; and the National Academies' Report, Review of the Research Program of the FreedomCAR and Fuel Partnership, First Report, August 2005.

Annual Performance Results and Targets

FY 2005 Results	FY 2006 Results	FY 2007 Results	FY 2008 Targets	FY 2009 Targets	FY 2010 Targets
GPRA Unit Program Goal 1.1.01.00 (Fuel Cell Technologies)					
Hydrogen Production and Delivery R&D – Renewable					
Model cost of hydrogen produced from renewable sources and assess versus the 2010 target of $2.85/gge, untaxed at the station at 5,000 psi. [MET]	Due to Congressionally Directed Activities, there will be little activity in FY 2006. Target has been delayed into FY 2007.	Complete lab-scale electrolyzer test to determine whether it achieves 64 percent energy efficiency and evaluate systems capability to meet $5.50/gge hydrogen cost target, untaxed at the station, and with large equipment production volumes [e.g., 500 units/year]. [MET]	Complete benchmark demonstration of reforming technologies and identify development pathways to meet the 2012 target of producing hydrogen from distributed reforming of renewable liquids at 5,000 psi for $<3.80 gge at large equipment production volumes (e.g., 500 units/yr). Reduced costs of hydrogen production will support technology readiness for hydrogen powered vehicles. [MET]		
Hydrogen Production and Delivery R&D-Non Renewable					
Complete the research for a distributed natural gas-to-hydrogen production and dispensing system that can produce 5,000 psi hydrogen for $3.00/gge (untaxed and without co-producing electricity) at the station in 2006. [MET]	Complete the development of a laboratory scale distributed natural gas-to-hydrogen production and dispensing system that can produce 5,000 psi hydrogen for $3.00/gge. [MET]	Complete preliminary lab scale tests to identify technologies that produce 5,000 psi hydrogen from natural gas for $2.50/gge, untaxed at the station and with large equipment production volumes [e.g., 500 units/year]. [MET]			
Hydrogen Storage R&D					
Identify materials with the potential to meet 2010 targets of 2.0 kWh/kg (6 wt percent), 1.5 kWh/L, at $4/kWh. [MET]	Complete fabrication and testing of a sub-scale prototype materials-based storage system to demonstrate projected system capacity of 2.5 wt. percent (0.8 kWh/kg); evaluate progress toward the 2007 target of 4.5 wt. percent (1.5 kWh/kg). [MET]	Complete baseline on-board storage systems analyses, down select materials, and evaluate against 2007 targets of 1.5 kWh/kg (4.5 percent by weight) and 1.2 kWh/L. [MET]	Develop chemical hydrogen storage regeneration methods at laboratory-scale, obtain initial data for efficiency and systems analysis, and demonstrate lab-scale reactions capable of at least 40 percent energy efficiency, leading to greater effective storage density and driving range for fuel cell vehicles. [MET]	Develop solid-state or liquid materials with the potential to meet 2010 targets of 2.0 kWh/kg (6 percent by weight), 1.5 kWh/L, develop system design and evaluate against 2009 interim goal of 5 percent by weight (modeled) or 1.7 kWh/kg.	

FY 2005 Results	FY 2006 Results	FY 2007 Results	FY 2008 Targets	FY 2009 Targets	FY 2010 Targets
Hydrogen Storage R&D: Tanks					
Complete testing of 10,000 psi hydrogen storage tanks; evaluating against the hydrogen storage system target of 1.5 kWh/kg (4.5 percent by weight), and identify approaches to meet the cost target of $6/kWh. [MET]					
Technology Validation					
Complete validation of an energy station that can produce 5,000 psi hydrogen from natural gas for $3.60 per gallon of gasoline equivalent (including co-production of electricity) untaxed at the station with mature equipment production volumes (e.g., 100 units/year). [MET]	Complete installation and 1,000 hours of testing of a refueling station; determine system performance, fuel quality and availability; and demonstrate the ability to produce 5,000 psi hydrogen from natural gas for a projected cost of $3.00 per gallon of gasoline equivalent, untaxed at the station, assuming commercial deployment with large equipment production volumes (e.g., 100 units/year) by 2009. [MET]	Validate achievement of a refueling time of 5 minutes or less for 5 kg of hydrogen at 5,000 psi through the use of advanced sensor, control, and interface technologies. [MET]	Fuel Cell vehicle(s) demonstrate the ability to achieve 250 mile range without impacting cargo or passenger compartments leading to greater adoption of fuel cell vehicles. Technology Validation shows 103-190 mile range under real world operating conditions. [MET]	Verify under real world conditions hydrogen infrastructure technologies with a cost of $3.00 per gge. [a]	
Fuel Cell demonstration vehicles' durability can be projected to 1,000 hours based on voltage measurements. [PARTIALLY MET]	Operate fuel cell vehicle fleets to determine if 1,000 hour vehicle fuel cell durability, using fuel cell degradation data, was achieved by industry. [MET]				
Fuel Cell Systems R&D					
					Improve the catalyst utilization of fuel cell systems to 3.0 kW per gram of platinum group metal at operating pressures less than 2.5 bar.

[a] In FY 2009 this activity was managed by the Vehicle Technologies Program.

FY 2005 Results	FY 2006 Results	FY 2007 Results	FY 2008 Targets	FY 2009 Targets	FY 2010 Target
Fuel Cell Component R&D					
DOE-sponsored research will reduce technology cost to $125/kW for a hydrogen-fueled 50kW fuel cell power system. [MET]	DOE-sponsored laboratory scale research will reduce the modeled technology cost to $110/kW for a hydrogen-fueled 80 kW fuel cell power system. [MET]	DOE-sponsored laboratory scale research will reduce the modeled technology cost of a hydrogen-fueled 80kW fuel cell power system to $90/kW. [MET]	DOE-sponsored research will reduce the modeled technology cost of a hydrogen-fueled 80kW fuel cell power system to $70/kW. Reducing automotive fuel cell costs accelerates the market viability and deployment of fuel cell technologies, which contribute to the Department's goal of increased energy security and reduced greenhouse gas and pollutant emissions. [MET]	DOE-sponsored research will reduce the modeled technology cost of a hydrogen-fueled 80kW fuel cell power system to $60/kW. Reducing automotive fuel cell costs accelerates the market viability and deployment of fuel cell technologies, which contribute to the Department's goal of increased energy security and reduced greenhouse gas and pollutant emissions.	
Distributed Energy Fuel Cell Systems and Fuel Processor R&D					
Achieve 32 percent efficiency at full power for a natural gas or propane fueled 5-250 kW stationary fuel cell system. [MET]	Due to Congressionally Directed Activities, there was no activity in this area in FY 2006.	DOE-sponsored research will improve electrical efficiency to 34 percent at full power for a natural gas or propane fueled 5-250 kW stationary fuel cell power system verified by a prototype (5-50 kW system). [MET]	DOE-sponsored research will improve electrical efficiency to 35 percent at full power for a natural gas or propane fueled 5-250 kW stationary fuel cell power system verified by a 5-250 kW prototype. This will support development of fuel cell power systems as alternative power sources to grid-based electricity for buildings and other stationary applications. [MET]	DOE-sponsored research will improve electrical efficiency to 36 percent at full power for a natural gas or propane fueled stationary fuel cell power system verified by a 5-250 kW prototype. This will support development of fuel cell power systems as alternative power sources to grid-based electricity for buildings and other stationary applications.	
Education					
				[Activity moved to Vehicle Technologies in FY 2009; no target set.]	

Safety and Codes and Standards

FY 2005 Results	FY 2006 Results	FY 2007 Results	FY 2008 Targets	FY 2009 Targets	FY 2010 Targets
			Develop a hydrogen materials technical reference which reports on embrittlement issues for hydrogen usage up to 10,000 psi delivered. Publish a Best Practices Manual describing hydrogen safety guidelines and lessons learned. Wide acceptance of hydrogen technologies depends on developing and meeting safety standards in which the public has confidence. [MET]	[Activity moved to Vehicle Technologies in FY 2009; no target set.]	
Systems Analysis					
			Complete and validate Macro-System Model for complete hydrogen and delivery pathway analysis. This will aid in understanding and assessing technology needs and progress, potential environmental impacts, and the energy-related economic benefits of various hydrogen supply and demand pathways. [MET]	Complete feedstock, capital, capacity and utility sensitivity analyses on the cost of delivered hydrogen for 6 pathways using the Macro-System Model. This will aid in understanding and assessing technology needs and progress, potential environmental impacts, and the energy-related economic benefits of various hydrogen supply and demand pathways.	Identify technology gaps and metrics for 2 different fuel cell systems (solid-oxide and methanol) for at least 2 applications.

Operational Efficiency

Contribute proportionately to EERE's corporate goal of reducing corporate and program adjusted uncosted obligated balances to a range of 20-25 percent by reducing program annual adjusted uncosteds by 10 percent in 2005 relative to the /Fuel Cell Program FY 2004 end of year adjusted uncosted baseline ($29,283K) until the target range is met. [MET]	Maintained total administrative overhead costs (defined as Program Direction and Program Support excluding earmarks) in relation to total program costs of less than 12 percent. [MET]	Maintain total administrative overhead costs (defined as Program Direction and Program Support excluding earmarks) in relation to total program costs of less than 12 percent. [MET]	Maintain administrative costs as a percent of total program costs less than 12 percent. [MET]	Maintain administrative costs as a percent of total program costs less than 12 percent.	Maintain administrative costs as a percent of total program costs less than 12 percent.[a]

[a] Administrative costs are comprised of Program Direction and elements of Program Support (Technology Advancement and Outreach; and Planning, Analysis and Evaluation), baseline and targets under development.

Fuel Cell Systems R&D

Funding Schedule by Activity

	(dollars in thousands)		
	FY 2008	FY 2009	FY 2010
Fuel Cell Systems R&D	–	–	61,443
SBIR/STTR	–[a]	–	1,770
Total, Fuel Cell Systems R&D	–	–	63,213

Description

The Fuel Cell Systems R&D subprogram is a new subprogram proposed for FY 2010. This modification was made to better reflect Fuel Cell Technologies program activities in FY 2010.

In FY 2010, FCT proposes to re-focus its efforts on fuel cell systems for stationary, portable and transportation applications. Fuel Cell Systems R&D will develop multiple fuel cell technologies (including solid-oxide, alkaline and polymer electrolyte membrane fuel cells) for multiple fuel sources (including diesel, natural gas, bio-derived renewable fuels such as methanol, and fuels derived from other renewable resources). Applications include distributed generation, backup power, auxiliary power units (APUs), portable power systems, material handling equipment, specialty vehicles, and transportation. Distributed generation and backup power systems supported by this activity may be grid-tied or grid-independent, utilize waste heat, operate directly with hydrogen or natural gas, or use reformers to operate with natural gas, bio-derived fuels or coal-derived fuels.

The core of Fuel Cell Systems is materials R&D for fuel cell stack components. These efforts will lead to cost reduction and an increase in fuel cell stack durability, enabling fuel cells to transition from a niche market to a robust portfolio of applications, allowing the economic and environmental benefits that are shown in niche applications to expand into larger markets. As recommended in the 2008 National Research Council (NRC) report,[b] FCT reallocated funding to prioritize and emphasize the R&D that addresses the most critical barriers, such as membranes, catalysts, electrodes, and modes of operation. The program is also placing greater emphasis on the science and engineering at the cell level and, from a systems perspective, on integration and subcomponent interactions. In addition, the program is reducing research on carbon-based supported catalysts in favor of developing carbon-free electrocatalysts.

Several years ago, the cost of a fuel cell "stack" (core) was much higher than the cost of the rest of the fuel cell system ("balance of plant"), thus R&D funding focused on reducing the stack cost. Those R&D efforts succeeded in reducing the cost of fuel cell stacks to the point at which their projected high-volume cost is nearly equal to the cost of the rest of the fuel cell system. In FY 2010, the program will therefore increase emphasis on balance-of-plant component R&D (humidification, heat management, and air compression) that can lead to lower cost and lower parasitic loss. Fuel processors will enable

[a] SBIR/STTR funding was transferred to the Science appropriation in FY 2008.
[b] 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; *Review of the Research Program of the FreedomCAR and Fuel Partnership: Second Report,* (Washington, DC: National Academies Press, 2008)

the conversion of fuels such as methanol, ethanol, biomass derived liquids, natural gas, propane or diesel into hydrogen for use in fuel cells, and will result in fuel processors for integrated distributed applications and catalysts suitable for a variety of fuel processing applications.

Integration of components into fuel cell systems ensures the developed components will operate together as they are intended. 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. System control optimizations for efficiency and mitigation of degradation will improve performance and durability, while lowering cost. Analytical tools have been developed and are used to view water transport within bipolar plate channels and gas diffusion media in order to maintain enough humidity in the stack while purging product water and preventing product water from freezing inside the fuel cell stack in sub-freezing environments.

Benefits

Fuel cells offer significant benefits for a wide range of applications. These include direct benefits for the end-user, including improved performance and reliability, and reduced lifecycle costs. Broader benefits for the Nation include reduced petroleum consumption, reduced greenhouse gas emissions, and a more secure, diversified energy infrastructure.

Fuel cells use a highly efficient electrochemical process to produce electricity from a variety of fuels. Fuel cells have gained traction in the marketplace for a few applications that are proven to be economically feasible and beneficial, and can be competitive in other markets. 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. The growth of current markets and expansion into broader markets will allow fuel cell technologies to have significant economic and environmental benefits on a national scale.

Applications for fuel cells that are currently commercially viable or are expected to achieve viability in the near-term include specialty vehicles (including material handling, airport ground support vehicles), backup power, auxiliary power units, primary power systems, combined heat and power systems, and portable power. Although fuel cells used to power light-duty vehicles stand to provide the greatest benefits, they also face some of the steepest challenges including stringent technical requirements for fuel cell cost, durability and operating conditions, significant investment in infrastructure, and the need for large-scale and well-refined manufacturing capability in order to compete with incumbent technologies.

As fuel cells become viable in each new market, the resulting increase in market demand will help reduce costs through economies of scale, promote consumer acceptance, expand the infrastructure, and develop domestic mass manufacturing techniques and capacity, paving the way for future applications. The current FCT focus emphasizes near-term applications that can provide benefits in real-time. As the industry matures through success of near-term applications, transportation applications will become viable.

Fuel cells offer a highly efficient and fuel-flexible technology for distributed power generation and combined heat-and-power (CHP) systems. Key applications include primary power for critical load facilities and remote power applications, power for locations where inexpensive fuel cell-compatible fuels are available (such as wastewater treatment gases and industrial byproducts), and CHP for residential and commercial buildings. While this effort supports small to mid-size fuel cell systems, DOE's Office of Fossil Energy (FE) develops large-scale solid-oxide fuel cell systems for utility-scale distributed generation.

Fuel cells can provide the benefits of distributed generation, such as elimination of electrical transmission and distribution losses, increased reliability, and reduction of peak demand on the electric grid. In addition to these benefits, fuel cells provide higher efficiency, and can make use of waste gases found at municipal landfills, agricultural sites, wastewater treatment, and food and beverage processing plants (methane-based biogas and hydrogen-rich waste streams) as renewable energy resources. Using these resources not only offsets demand of conventional energy sources, but also prevents the release of climate-damaging gases.

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 lead to significant improvement in electrical efficiency of primary power stationary fuel cell systems.

Primary Fuel Cell Power System Performance Metrics: Electrical Efficiency

Year	Target %	Actual %
2002	29	29
2003	30	30
2004	31	31
2005	32	32
2006	32	32
2007	34	34
2008	35	35
2009	36	–
2010	38	–
2011	40	–
2012	40	–
2013	40	–

<u>Distributed Stationary Prime-Power (including combined heat-and-power)</u>

Fuel cells have unique advantages in CHP applications. Currently in the U.S., two thirds (or about 28 quadrillion Btu) of the total energy consumed for power generation is lost in the form of waste heat.[a] The vast majority of this energy loss occurs at centralized power generation facilities. The advantage of CHP systems is that they are able to utilize the heat that would otherwise be lost, and thereby reduce total energy consumption. CHP systems are typically able to use as much as 80 percent of the fuel energy, compared to the roughly 34 percent efficiency of grid-power generation[b]. Fuel cells are uniquely suitable for many commercial and residential applications due to their quiet and vibration-free operation, their ability to use existing natural gas fuel supply, their low operation and maintenance requirements, and their ability to maintain high efficiency over a wide range of loads.

[a] Energy Information Administration Annual Energy Review, 2007

[b] Combined Heat and Power: Effective Energy Solutions for a Sustainable Future, Oak Ridge National Laboratory, 2008.

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 cells offer longer continuous run-time and greater durability in harsh outdoor environments under a wide range of temperature conditions. And compared with generators, fuel cells are quieter and have low to zero emissions (depending on fuel source). In addition, they require less maintenance than both generators and batteries. In a study for DOE, Battelle Memorial Institute found that fuel cells can provide potential savings in the lifecycle cost of backup power for emergency response radio towers, where 2 to 5kW of power are required, with runtimes of eight to 72 hours. The current U.S. market size for emergency backup power for wireless communication is approximately 200,000 sites.[a] Backup power systems need at least eight hours of available power during a grid power failure for each wireless communication tower. The potential U.S. market for emergency back-up fuel cells applied to existing towers is approximately 40,000 units per year and 50,000 units per year of new towers.

Specialty Vehicles

Fuel cells powered by hydrogen have become a cost-competitive option for powering specialty vehicles such as forklifts. Many specialty vehicles require power in the 5 to 20kW range, and often operate in indoor facilities and locations where air quality is important and internal combustion engines cannot be used. Like batteries, fuel cells do not emit criteria pollutants (e.g., NO_x, SO_x, and CO) at the point of use. Fuel cells can increase productivity because they can be rapidly refueled, eliminating the time and labor spent charging and changing batteries. This makes fuel cells a particularly appealing alternative to battery-powered forklifts used continuously in two to three shifts per day. Furthermore, batteries require significant space for charging, storage and change-outs, and the power output of batteries diminishes as they are discharged, while fuel cell power remains constant. Forklifts powered by fuel cells can provide significant potential savings in lifecycle costs over battery-powered forklifts. The electric battery-powered lift truck market is approximately 600,000 units annually worldwide. A 50 percent share of this market by U.S. fuel cell manufacturers would add more than 20,000 U.S. manufacturing jobs.[b]

Auxiliary Power Units (APUs)

Fuel cells can provide auxiliary power for tractor trailers, recreational vehicles, yachts, commercial ships, locomotives, jets and similar applications that frequently use power while stationary, which is very inefficient for the 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 NO_x, and 5,000 tons of particulate matter.[c] For these reasons, idling restrictions have been placed on trucks in some states. In comparison to internal combustion engine (ICE) generators, fuel cells are more efficient and operate much more quietly. Fuel cells produce no NO_x, SO_x, or particulate emissions, and can utilize a number of fuels: hydrogen, propane, diesel, methanol and ethanol. They can be used in EPA designated nonattainment areas, where emissions restrictions prevent other technologies, such as ICE generators, from being used.

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[a] Fuel Cells in Distributed Telecomm Backup, Citigroup Global Markets, August 24, 2005. Identification and Characterization of Near Term Fuel Cell Markets," Battelle Memorial Institute, April, 2007

[b] 8kW per unit X $3,000/kW X 300,000units = $7.2 Billion X 3 Mfg jobs (per $1 million) = 21,600

[c] Blake, Gary D., "Solid Oxide Fuel Cell System Development for Auxiliary Power in Heavy Duty Vehicle Applications", Delphi Corporation.

Portable Power

Fuel cells for portable applications are beginning to enter the consumer marketplace. Portable fuel cells are being developed for a range of applications including use in cell phones, cameras, PDAs, MP3 players, and laptops, as well as portable generators and battery chargers, and can use diverse fuels such as propane, hydrogen, and methanol. Benefits over current technologies include smaller packaging, lower weight, elimination of recharge time, and longer run-time. Some small fuel cells are beginning to become commercially available for some portable consumer electronic devices.

Transportation Applications

In transportation applications, fuel cell systems could substantially reduce the Nation's dependence on imported petroleum and emissions of CO_2 and criteria pollutants. Fuel cell systems produce only water and heat as byproducts, thus there are no direct emissions of CO_2 or criteria pollutants at the point of use. In addition, fuel cells are powered by fuels that can be produced from a diverse and domestic portfolio of energy resources.

Fuel cells have the greatest potential for reducing CO_2 emissions within the transportation sector, particularly in light-duty vehicles. Analysis of well-to-wheels emissions using models developed by Argonne National Laboratory indicate that the use of fuel cell vehicles will produce among the lowest quantities of GHGs per mile of all conventional and alternative vehicle and fuel pathways being developed. Even in the case where hydrogen is produced from natural gas, the resulting emissions per mile traveled in 2020 will be more than 50 percent less than those from advanced gasoline internal combustion engine vehicles, 20 percent less than those from advanced gasoline hybrid vehicles, and more than 15 percent less than those from gasoline powered plug-in hybrid vehicles.[a]

Fuel cell systems must be cost-competitive in the marketplace. The program established cost targets for light-duty transportation fuel cell systems in 2002. Research activities will reduce the cost of the hydrogen-fueled, 80kW fuel cell power systems as indicated below:[b]

[a] DOE Hydrogen Program Record #9002: http://www.hydrogen.energy.gov/program_records.html
[b] Cost of 80 kW fuel cell power systems estimated for production rate of 500,000 units yearly and includes fuel cell stack and balance of plant.

Fuel Cell Power System Performance Metrics

80kW System Cost

Year	Target $/kW	Actual $/kW
2002	–	275
2003	225	225
2004	200	200
2005	125	110
2006	110	107
2007	90	90
2008	70	73
2009	60	–

Detailed Justification

(dollars in thousands)

	FY 2008	FY 2009	FY 2010
Fuel Cell Systems R&D	**–**	**–**	**61,443**

A key to meeting the goals of fuel cell systems will be improving performance and durability, and reducing the cost of stack components in fuel cells. For consumer acceptance, the fuel cell system must be cost-competitive with today’s incumbent technologies and expected advances in technologies.

In FY 2010, Fuel Cell Systems catalyst R&D will include new Platinum Group Metal (PGM) catalyst approaches that increase activity and utilization of current PGM and PGM alloy catalysts. Non-PGM catalyst investigations will provide a better understanding of the active site, including detailed studies of oxygen reduction reaction mechanisms. Tasks will include development of viable supports that allow an increase in loading and thickness for these catalysts. Activities will also include investigation of durable catalysts to enhance stability under 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. Non-carbon support projects will develop materials with superior corrosion resistance and with electrical and structural properties that exceed the properties of carbon.

(dollars in thousands)

FY 2008	FY 2009	FY 2010

Stack Component R&D will be transferred to Fuel Cell Systems R&D subprogram and will develop high temperature membranes that allow better catalyst utilization, reduce the negative effects of impurities and decrease the size of the cooling system, as well as develop bipolar plates and seals that will be inexpensive and corrosion resistant. In addition, R&D will continue to improve the gas diffusion layers between the membrane electrode assemblies (MEAs) and bipolar plates to enhance fuel cell performance. Development of transport models and *in situ* and *ex situ* experiments that provide data for model validation will begin. This effort will include measurement and modeling of mass and electronic/protonic transport in each layer and interface in an MEA.

In FY 2010, 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 2010 targets. Impurities present in both the fuel stream and the air intake have a negative impact on fuel cell performance and durability. In FY 2010, investigation and quantification of the effects of impurities on fuel cell performance will continue, including parametric studies of the effect of poisons on cell 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.

To reduce the amount of time required to evaluate fuel cell components for durability during development, correlations will be determined between fuel cell component degradation in real-world applications to accelerated stress testing conducted in National Laboratories. Projects aimed at evaluating full-scale fuel cell system durability will also begin in FY 2010 because of the inherent lead time required to prove the durability of full-scale systems as they approach their target specifications.

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. In FY 2010, Fuel Cell Systems R&D will focus on the development of low-cost novel and durable humidification materials that perform in all operating environments while meeting size and weight restrictions. 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 2010, portable power R&D will focus on materials such as the anode, cathode, and membrane improvements for fuel cells that convert methanol 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 crossover and increase proton conductivity. Small and durable low power pumps, fans, and power conditioning components for use in portable power systems will be developed for reliability and packaging.

Auxiliary power R&D will focus on developing fuel cell systems for heavy duty trucks as an

	(dollars in thousands)		
	FY 2008	FY 2009	FY 2010

alternative to idling the main diesel engine for providing overnight power to the truck's cab. The fuel cell APUs (auxiliary power units) will supplement the technologies developed in the Vehicle Technologies Program's 21st Century Truck Partnership. Because solid oxide fuel cell (SOFC) technology is more compatible with heavy fuels than polymer electrolyte fuel cells technology, SOFC technology is being developed for these APU applications in coordination with FE's SOFC R&D effort. Cell conductivity, catalyst performance, and chemical degradation issues will also be addressed. In FY 2010, SOFC hardware will be tested for potential application as an APU on heavy duty trucks. Results from these tests will help to assess the impact of the critical issues on SOFC performance and to direct future R&D efforts.

Fuel processors aid the widespread use of fuel cell power technology in distributed applications. Processing conventional fuels (such as natural gas, propane, methanol, ethanol, biomass derived liquids, or diesel) enables environmental and efficiency advantages of fuel cell technologies to be realized in an integrated fuel cell system. The option of using a variety of fuels to power fuel cells contributes to energy independence.

Activities may include promoting early adoption of fuel cell systems to validate performance, durability, and reliability through field testing. The Fuel Cell Systems R&D effort is supported by multiple Research & Development Investment Criteria factors: address market barriers and provide a public benefit; build on existing technology and complement current R&D; incorporate industry involvement in planning, industry cost-sharing, performance indicators, and "off ramps"; and is competitively awarded and peer reviewed.

In addition, these funds may be used to support efforts such as EPAct 2005 and EISA 2007 requirements; peer reviews; data collection and dissemination; and technical, market, economic, and other analyses.

SBIR/STTR	**—**	**—**	**1,770**

In FY 2008, no funds were transferred to the SBIR and STTR programs. The FY 2010 amount shown is the estimated requirement for the continuation of the SBIR and STTR program.

Total, Fuel Cell Systems R&D	**—**	**—**	**63,213**

Explanation of Funding Changes

	FY 2010 vs. FY 2009 ($000)
Fuel Cell Systems R&D	
This activity consolidates and refocuses efforts in the previously funded subprograms of Fuel Cell Components R&D, Distributed Energy Fuel Cell Systems, Transportation Fuel Cell Systems, and Fuel Processor R&D. By focusing Fuel Cell Systems R&D on critical-path issues in materials, stack components, balance-of-plant and integrated fuel cell systems, and by reducing system demonstrations, the proposed budget is more streamlined and will have more near-term impacts than the previous structure.	+61,443
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.	+1,770
Total Funding Change, Fuel Cell Systems R&D	**+63,213**

Hydrogen Production and Delivery R&D

Funding Schedule by Activity

	(dollars in thousands)		
	FY 2008	FY 2009	FY 2010
Hydrogen Production and Delivery R&D	38,607	9,733	0
SBIR/STTR	—[a]	267	0
Total, Hydrogen Production and Delivery R&D	38,607	10,000	0

Description

Hydrogen Production and Delivery R&D encompassed distributed production through renewable liquids reforming and electrolysis, and central production through biomass gasification, wind-powered electrolysis, solar driven high temperature thermochemical cycles, and biological and photoelectrochemical pathways. It also included the technology for hydrogen delivery: transporting and distributing hydrogen both to and at fueling sites. In addition, both production and delivery technologies are applicable for energy storage to enable intermittent, renewable energy resources and combined heat, hydrogen, and power (CHHP) applications. Work involving coal and nuclear-based hydrogen production has been funded by the DOE Fossil Energy and Nuclear Energy offices. The DOE Office of Science conducts basic research to understand the fundamentals of catalysts and of the biological and photoelectrochemical pathways. Areas of collaboration with other offices include production technologies such as gasification, reforming, separations, and purification.

In FY 2010 the program is rebalancing its portfolio to focus on fuel cell systems for stationary, portable, and transportation applications. Due to the long-term nature of Production and Delivery R&D, further funding requests for this subprogram are deferred. This revised effort is aligned with DOE's portfolio of technologies for near-term impact, improved energy efficiency using multiple fuels and job creation, consistent with Presidential objectives.

[a] SBIR/STTR funding was transferred to the Science Appropriation in FY 2008.

Explanation of Funding Changes

	FY 2010 vs. FY 2009 ($000)
Hydrogen Production and Delivery R&D	
In FY 2010 the program is rebalancing its portfolio to focus on fuel cell systems for stationary, portable, and transportation applications. Due to the long-term nature of Production and Delivery R&D, no funding is requested for this subprogram in FY 2010.	-9,733
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.	-267
Total Funding Change, Hydrogen Production and Delivery R&D	**-10,000**

Hydrogen Storage R&D

Funding Schedule by Activity

(dollars in thousands)

	FY 2008	FY 2009	FY 2010
Hydrogen Storage R&D	42,371	57,542	0
SBIR/STTR	—[a]	1,658	0
Total, Hydrogen Storage R&D	42,371	59,200	0

Description

Hydrogen Storage R&D focuses primarily on the R&D of on-board vehicular storage systems that allow for a driving range of more than 300 miles to enable full market penetration across the North American light-duty vehicle market, within the constraints of weight, volume, safety, durability, refueling time, efficiency, and total cost, to meet consumer expectations. The Hydrogen Storage portfolio concentrates on low-pressure, materials-based technologies and will also explore advanced conformable and low cost tank technologies for hydrogen storage systems to meet performance targets. In addition, the portfolio includes activities relevant to non-automotive hydrogen storage such as early-market stationary and materials handling applications, and energy storage to enable renewable energy.

In FY 2010 the program is rebalancing its portfolio to focus on fuel cell systems for stationary, portable, and transportation applications. Due to the long-term nature of Hydrogen Storage R&D (and of the market for such storage), funding for this subprogram is deferred in FY 2010. This revised effort is aligned with DOE's portfolio of technologies for near-term impact, improved energy efficiency using multiple fuels and job creation, consistent with Presidential objectives.

Explanation of Funding Changes

	FY 2010 vs. FY 2009 ($000)
Hydrogen Storage R&D	
In FY 2010 the program is rebalancing its portfolio to focus on fuel cell systems for stationary, portable, and transportation applications. Due to the long-term nature of Hydrogen Storage R&D (and of the market for such storage), no funding is requested for this subprogram in FY 2010.	-57,542

[a] SBIR/STTR funding was transferred to the Science Appropriation in FY 2008.

	FY 2010 vs. FY 2009 ($000)
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.	-1,658
Total Funding Change, Hydrogen Storage R&D	**-59,200**

Fuel Cell Stack Component R&D

Funding Schedule by Activity

(dollars in thousands)

	FY 2008	FY 2009	FY 2010
Fuel Cell Stack Component R&D	42,344	61,034	0
SBIR/STTR	—[a]	1,666	0
Total, Fuel Cell Stack Component R&D	42,344	62,700	0

Description

For fuel cell vehicles to be competitive, fuel cell stacks must become less expensive and more durable. The high cost and insufficient durability of polymer electrolyte membrane (PEM) fuel cell stack components (the membranes, oxygen reduction electrodes, advanced catalysts, bipolar plates, etc.) are currently the most challenging hurdles facing the adoption of fuel cell systems. The program's collaborative R&D efforts with industry, National Laboratories and academia are focused on the critical technical barriers of cost, durability, efficiency, and overall performance of fuel cell stack components for both transportation and stationary applications.

In FY 2010, the program is reprioritizing and restructuring its fuel-cell-related activities, and as a result this subprogram is not funded in FY 2010. Many activities previously funded in this subprogram will continue in the new Fuel Cell Systems R&D subprogram.

Benefits

Fuel cells have the potential to enable the reduction of energy use and dependence on imported petroleum because they are highly efficient and can be powered by fuels that can be produced from a variety of domestic resources. Fuel Cell Stack Component R&D supports the program's mission by focusing on improvement of overall fuel cell performance and durability while lowering cost. These improvements will help make fuel cells competitive with conventional technologies in order to realize benefits in energy security and environmental quality.

Explanation of Funding Changes

	FY 2010 vs. FY 2009 ($000)
Fuel Cell Stack Component R&D	
Fuel-cell-related activities are being consolidated and reprioritized in the new Fuel Cell Systems R&D subprogram.	-61,034
SBIR/STTR	

[a] SBIR/STTR funding was transferred to the Science Appropriation in FY 2008.

	FY 2010 vs. FY 2009 ($000)
Changes in the SBIR/STTR funding are a direct result of changes in the funding of program activities and projected allocation among activities.	-1,666
Total Funding Change, Fuel Cell Component R&D	**-62,700**

Technology Validation
Funding Schedule by Activity

(dollars in thousands)

	FY 2008	FY 2009	FY 2010
Technology Validation[a]	29,612	—	0
SBIR/STTR	—[b]	—	0
Total, Technology Validation	29,612	—	0

Description

Technology Validation includes both Fuel Cell Technology Validation and Hydrogen Infrastructure Validation. Beginning in FY 2009, this activity was funded in the Vehicle Technologies (VT) program, within the Hybrid Electric Systems subprogram and transfers back to the FCT program in FY 2010; however, additional funding requests are deferred.

The Technology Validation activity included validation of both fuel cell vehicle (FCV) technology and hydrogen infrastructure through the Controlled Hydrogen Fleet and Infrastructure Demonstration and Validation Project. The project is both a "Learning Demonstration" to manage the hydrogen and fuel cell component and materials research, and a validation of the technology under real-world operating conditions against time-phased performance-based targets. The project is 50/50 cost-shared between government and industry, including automobile manufacturers, energy companies, suppliers, universities, and state governments. Extensive data have been collected on vehicles operating on-road and during dynamometer testing. Validation of the hydrogen infrastructure included verification of hydrogen production cost and fueling time while gaining experience in the safe operation of stations.

Explanation of Funding Changes

	FY 2010 vs. FY 2009 ($000)
Technology Validation	
Beginning with FY 2009, this subprogram was included in the VT budget. In FY 2010 the Technology Validation activity is transferred back from the VT Program to the FCT as part of a reprioritization of fuel cell and hydrogen-related work. Due to the program's rebalancing of its portfolio to focus on an array of fuel cell technologies, further funding requests for the Technology Validation activity are deferred.	0

[a] Funding for Technology Validation appears in the Vehicle Technologies budget in FY 2009 at $15,000,000, but is included again in Fuel Cell Technologies starting in FY 2010.
[b] SBIR/STTR funding was transferred to the Science Appropriation in FY 2008.

	FY 2010 vs. FY 2009 ($000)
SBIR/STTR	
No change.	0
Total Funding Change, Technology Validation	**0**

Transportation Fuel Cell Systems

Funding Schedule by Activity

(dollars in thousands)

	FY 2008	FY 2009	FY 2010
Transportation Fuel Cell Systems	7,718	6,424	0
SBIR/STTR	—[a]	176	0
Total, Transportation Fuel Cell Systems	7,718	6,600	0

Description

In FY 2010, the program is reprioritizing and restructuring its fuel-cell-related activities to cover a broader array of fuel cell types and applications, and as a result this subprogram is not funded in FY 2010. Some activities previously funded in this subprogram may continue in the new Fuel Cell Systems R&D subprogram.

Transportation Fuel Cell Systems R&D supports the program's mission by developing system balance of plant components and optimizing operating strategies to improve performance and durability, while lowering cost. The improvements help to make energy efficient and zero emissions fuel cells competitive with conventional technologies, contributing to DOE's initiatives for energy security, environmental quality and energy productivity.

The Transportation Fuel Cell Systems activity involves R&D and analyses that address key barriers to developing fuel cell systems for transportation. Key challenges addressed in this subprogram include the cost, durability, performance and size of water, thermal, and air management devices that meet automotive requirements. This activity supports the development of component technologies critical to systems integration, as well as system performance. The activity also supports cost-modeling activities that serve to guide component R&D, benchmarks progress of complete systems and explores alternate system components and configurations. Other activities include modeling of impurity effects and evaluating water and thermal management configurations. In addition to passenger vehicles, other applications supported include material handling equipment and replacing diesel-fueled auxiliary power units for heavy duty trucks. For off-road applications, issues such as vibration, dust, contaminants and harsh duty cycles that could have an adverse effect on stack performance and life are addressed.

Benefits

Research activities for transportation applications (including transportation systems and stack component R&D) have been projected to reduce the cost of the hydrogen-fueled, 80kW vehicle fuel cell power systems through FY 2009 as indicated below:[b]

[a] SBIR/STTR funding was transferred to the Science Appropriation in FY 2008.

[b] Cost of 80 kW vehicle fuel cell power systems estimated for production rate of 500,000 units yearly and includes fuel cell stack and balance of plant.

Fuel Cell Power System Performance Metrics
80 kW System Cost

Year	Target $/kW	Actual $/kW
2002*	–	275
2003*	225	225
2004*	200	200
2005	125	110
2006	110	107
2007	90	90
2008	70	73
2009	60	–

* Costs in years 2002 to 2004 are for a 50 kW System

Detailed Justification

(dollars in thousands)

	FY 2008	FY 2009	FY 2010
Transportation Fuel Cell Systems	**7,718**	**6,424**	**0**

In FY 2010, there will be no work performed in this key activity, any continuing work will be conducted as needed under Fuel Cell Systems R&D.

	FY 2008	FY 2009	FY 2010
SBIR/STTR	–	**176**	**0**

In FY 2009, $176,000 was transferred to the SBIR and STTR programs.

	FY 2008	FY 2009	FY 2010
Total, Transportation Fuel Cell Systems	**7,718**	**6,600**	**0**

Explanation of Funding Changes

	FY 2010 vs. FY 2009 ($000)
Transportation Fuel Cell Systems	
Fuel-cell-related activities are being consolidated and reprioritized in the new Fuel Cell Systems R&D subprogram.	-6,424
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.	-176
Total Funding Change, Transportation Fuel Cell Systems	**-6,600**

Distributed Energy Fuel Cell Systems

Funding Schedule by Activity

(dollars in thousands)

	FY 2008	FY 2009	FY 2010
Distributed Energy Fuel Cell Systems	7,461	9,776	0
SBIR/STTR	—[a]	224	0
Total, Distributed Energy Fuel Cell Systems	7,461	10,000	0

Description

Distributed Energy Systems supports R&D for distributed generation, backup power, auxiliary power units (APUs), portable power systems, and material handling equipment. Distributed generation and backup power systems supported by this activity may be grid-tied or grid-independent, utilize waste heat, operate directly with gaseous fuels, or use reformers to operate with natural gas, bio-derived fuels or coal-derived fuels.

In FY 2010, the program is reprioritizing and restructuring its fuel-cell-related activities to cover a broader array of fuel cell types and applications, and as a result this subprogram is not funded in FY 2010. As this subprogram leverages improved materials developed in Fuel Cell Component R&D, such as high-temperature membranes, catalysts and improved fuel cell stack component durability, any continuing activities will be completed within the new Fuel Cell Systems R&D subprogram.

Benefits

Distributed generation fuel cell systems provide high efficiency and reliability for uninterruptible power sources, remote power and back-up power. Applications include highly efficient fuel cell heating appliances for residential and commercial buildings that cogenerate electricity, highly reliable and cost-effective fuel cell systems which meet the requirements for critical loads and remote power applications, and power for locations where inexpensive fuel cell-compatible fuels are available. Backup power applications include critical loads such as data centers, telecommunication facilities, hospitals, and first-responders. Portable power fuel cell systems are being developed for consumer electronics applications, emphasizing energy density and refueling via fuel cartridge exchange rather than re-charging batteries. While this subprogram supports small to mid-size fuel cell systems, DOE's Office of Fossil Energy develops large-scale solid-oxide fuel cell systems for utility-scale distributed generation.

R&D focuses on overcoming the barriers to stationary fuel cell systems, including cost, durability, heat utilization, start-up time, managing power transients and optimizing control to maximize system efficiency for given power demand. Improvements will help accelerate commercialization of fuel cells by achieving the 2011 stationary system durability target of 40,000 hours and cost of $750 per kW, making fuel cells competitive with conventional technologies.

Distributed Energy Fuel Cell Systems activities include development of fuel cell systems for heavy-duty vehicle applications to reduce fuel consumption and emissions in commercial trucks that idle their

[a] SBIR/STTR funding was transferred to the Science Appropriation in FY 2008.

main engines to supply accessory power when parked for long durations.

Fuel cell systems for portable power can potentially provide much longer run-times than batteries for consumer electronics and are also being developed as an early market application. The size constraints for portable power systems result in packaging challenges and require development of small-scale balance of plant components. Methanol, sodium borohydride and other fuels are used. In some cases, the behavior of liquid reactants or the release of hydrogen from a solid hydrogen carrier must be addressed.

Activities may include promoting early adoption of these systems to validate performance, durability, and reliability and conduct field testing. Commercialization of fuel cells for portable power aid in developing the manufacturing base and will introduce the technology to consumers, thus paving the way for fuel cell systems being used in other applications.

Stationary Fuel Cell Power System Performance Metrics: Electrical Efficiency

Year	Target %	Actual %
2002	29	29
2003	30	30
2004	31	31
2005	32	32
2006*	32	32
2007	34	34
2008	35	35
2009	36	–

* Virtually all work was deferred due to reduced funding. Targets were delayed one year.

Detailed Justification

	(dollars in thousands)		
	FY 2008	FY 2009	FY 2010
Distributed Energy Fuel Cell Systems	**7,461**	**9,776**	**0**

In FY 2010, there will be no work performed in this key activity, any continuing work will be conducted as needed under Fuel Cell Systems R&D.

SBIR/STTR	**–**	**224**	**0**

In FY 2009, $224,000 was transferred to the SBIR and STTR programs.

Total, Distributed Energy Fuel Cell Systems	**7,461**	**10,000**	**0**

Explanation of Funding Changes

	FY 2010 vs. FY 2009 ($000)
Distributed Energy Fuel Cell Systems	
Fuel-cell-related activities are being consolidated and reprioritized in the new Fuel Cell Systems R&D subprogram.	-9,776
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.	-224
Total Funding Change, Distributed Energy Fuel Cell Systems	**-10,000**

Fuel Processor R&D

Funding Schedule by Activity

	(dollars in thousands)		
	FY 2008	FY 2009	FY 2010
Fuel Processor R&D	2,896	2,933	0
SBIR/STTR	—[a]	67	0
Total, Fuel Processor R&D	2,896	3,000	0

Description

Fuel Processor R&D was previously conducted to enable the conversion of fuels such as methanol, ethanol, biomass derived liquids, natural gas, propane or diesel into hydrogen for use in fuel cells. Fuel Processor R&D resulted in fuel processors for integrated distributed applications and catalysts suitable for a variety of fuel processing applications. On-board fuel processing for transportation applications was discontinued as a result of the program's "no go" decision in 2004, and in FY 2009, development of fuel processors for stationary (distributed energy) fuel cell applications concluded. Any future fuel-processing R&D needs can be best addressed within the context of the specific type of fuel cell and application where the processing is needed.

In FY 2010, the program is reprioritizing and restructuring its fuel cell-related activities to cover a broader array of fuel cell types and applications, and as a result this subprogram is not funded in FY 2010. Some activities previously funded in this subprogram may continue in the new Fuel Cell Systems R&D subprogram.

Benefits

Fuel Processor R&D has supported the FCT mission by developing the subsystem that aids the widespread use of fuel cell power technology in distributed applications. Processing conventional fuels (such as natural gas, propane, methanol, ethanol, biomass derived liquids, or diesel) enables environmental and efficiency advantages of fuel cell technologies to be realized in an integrated fuel cell system without needing a hydrogen-delivery infrastructure. The option of using a variety of fuels to power fuel cells contributes to energy independence.

Detailed Justification

	(dollars in thousands)		
	FY 2008	FY 2009	FY 2010
Fuel Processor R&D	**2,896**	**2,933**	**0**

In FY 2010, there will be no work performed in this key activity because stand-alone fuel processing

[a] SBIR/STTR funding was transferred to the Science Appropriation in FY 2008.

(dollars in thousands)

	FY 2008	FY 2009	FY 2010

work has been completed. Further refinements, within the context of a complete system, will be conducted as needed under Fuel Cell Systems R&D.

SBIR/STTR	**–**	**67**	**0**

In FY 2008, $69,000 and $8,000 were transferred to the SBIR and STTR programs respectively. The FY 2009 and 2010 amounts shown are estimated requirements for the continuation of the SBIR and STTR program.

Total, Fuel Processor R&D	**2,896**	**3,000**	**0**

Explanation of Funding Changes

	FY 2010 vs. FY 2009 ($000)
Fuel Processor R&D	
This decrease reflects completion of stand-alone fuel processor work. System-integrated fuel processor development for distributed power systems will be performed as needed within the Fuel Cell Systems R&D subprogram.	-2,933
SBIR/STTR	
Changes in the SBIR/STTR funding are a direct result of changes in the funding of program activities and projected reallocation of continuing work to other areas.	-67
Total Funding Change, Fuel Processor R&D	**-3,000**

Safety and Codes and Standards

Funding Schedule by Activity

	(dollars in thousands)		
	FY 2008	FY 2009	FY 2010
Safety and Codes and Standards[a]	15,442	—	0
SBIR/STTR	—[b]	—	0
Total, Safety and Codes and Standards	15,442	—	0

Description

Beginning in FY 2009, the Safety and Codes and Standards subprogram was funded in the Vehicle Technologies Program and is transferred back to FCT in FY 2010. Due to the program's rebalancing of its portfolio to focus on an array of fuel cell technologies, further funding requests for the Safety and Codes and Standards activity are deferred.

The Safety and Codes and Standards subprogram funded research to provide the technical data on hydrogen technologies (such as fuel cells and hydrogen production, storage, and distribution systems) that are necessary to support and inform the codes and standards development process. Its work included studies to determine the flammability, reactive, and dispersion properties of hydrogen. It also subjected components, subsystems, and systems to environmental conditions that could result in failure to check design practices and failure-mode prediction analysis.

Explanation of Funding Changes

	FY 2010 vs. FY 2009 ($000)
Safety and Codes and Standards	
Beginning with FY 2009, this subprogram was included in the Vehicle Technologies budget. In FY 2010 the Safety and Codes and Standards activity is transferred back from the Vehicle Technologies Program to the FCT as part of a reprioritization of fuel cell and hydrogen-related work. Due to the program's rebalancing of its portfolio to focus on an array of fuel cell technologies, further funding requests for the Safety and Codes and Standards activity are deferred.	0
SBIR/STTR	
No Change.	0
Total Funding Change, Safety and Codes and Standards	**0**

[a] Funding for Safety and Codes and Standards appears in the Vehicle Technologies budget in FY 2009 at $12,500,000, but is included again in Fuel Cell Technologies starting in FY 2010.
[b] SBIR/STTR funding was transferred to the Science Appropriation in FY 2008.

Education

Funding Schedule by Activity

	(dollars in thousands)		
	FY 2008	FY 2009	FY 2010
Education[a]	3,865	–	0
SBIR/STTR	0	–	0
Total, Education	3,865	–	0

Description

Beginning in FY 2009, hydrogen education activities were funded within the Vehicle Technologies budget and in FY 2010 they transfer back to the FCT Program.

In FY 2010 the program is rebalancing its portfolio to focus on fuel cell systems for stationary, portable, and transportation applications, expanding its coverage to include multiple fuels and fuel cell technologies. Because of the focus of the Education subprogram on a single long-term fuel type, further funding requests for this subprogram are deferred.

Education aids in overcoming institutional barriers to widespread use of hydrogen. Education activities have been designed to increase understanding of hydrogen and fuel cell technologies, the facts about hydrogen safety, and the role that certain key target audiences can play in advancing the development and use of hydrogen as an energy carrier. Target audiences, identified by key government and industry stakeholders in the National Hydrogen Energy Roadmap, include state and local government representatives, safety and code officials, potential end-users, and the public. Over the long term, education of teachers and students will also be required.

[a] Funding for Education appears in the Vehicle Technologies budget in FY 2009 at $4,200,000, but is included again in Fuel Cell Technologies starting in FY 2010.

Explanation of Funding Changes

	FY 2010 vs. FY 2009 ($000)
Education	
Beginning with FY 2009, this subprogram was included in the Vehicle Technologies budget. In FY 2010 the Education activity is transferred back from the Vehicle Technologies Program to the FCT as part of a reprioritization of fuel cell and hydrogen-related work Due to the program's rebalancing of its portfolio to focus on an array of fuel cell technologies, further funding requests for the Education activity are deferred.	0
SBIR/STTR	
No change.	0
Total Funding Change, Education	**0**

Systems Analysis

Funding Schedule by Activity

	(dollars in thousands)		
	FY 2008	FY 2009	FY 2010
Systems Analysis	11,099	7,508	4,860
SBIR/STTR	—[a]	205	140
Total, Systems Analysis	11,099	7,713	5,000

Description

The Systems Analysis subprogram supports the development of independent systems analysis and evaluation functions to identify the energy efficiency, economic, and environmental impacts of various fuel cell and fuel technology pathways by assessing associated cost elements and drivers, identifying key costs and technological gaps, evaluating the status and validation of research results, determining the market growth and job creation through application of fuel cell technologies, and assisting in the prioritization of research and development directions.

Benefits

The Systems Analysis subprogram provides the analytical and technical basis for informed decision-making for the Fuel Cell Systems R&D direction and prioritization. Systems Analysis is an essential component of the program in terms of 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 subprogram results provide metrics for multiple components, subsystems and systems that are needed to determine customer requirements and to support annual updates to key program planning documents that provide the current direction and planned milestones for the program.

The subprogram is supported by multiple Research Development Investment Criteria (RDIC) factors: builds on existing technology and complements current R&D; incorporates industry involvement in planning, industry cost-sharing, and performance indicators; and, is competitively awarded and peer reviewed.

[a] SBIR/STTR funding was transferred to the Science Appropriation in FY 2008.

Detailed Justification

	(dollars in thousands)		
	FY 2008	FY 2009	FY 2010
Systems Analysis	**11,099**	**7,508**	**4,860**

Systems Analysis provides the analytical and technical basis for determining technology gaps for R&D prioritization. The subprogram will quantify energy efficiency, economic, and environmental benefits of fuels across applications and for multiple fuel pathways, and optimize cross-cutting synergies with other renewable technologies. In FY 2010, the subprogram will develop the new analytical models and tools to help quantify benefits and identify gaps for various applications, such as materials handling, stationary and portable power, and combined heat and power. The new models, combined with existing systems analysis models, will enable the program to identify resource limitations, options for stationary power production from fuel cells, renewable fuel supply evolution, infrastructure issues, and the potential environmental impacts of wide scale commercialization.

Building on efforts completed in FY 2009 to develop the Macro System Model (MSM), which provides overarching analysis for the program, additional linkages will be developed in FY 2010 to provide analytical capabilities for market and job creation analysis in the near- and mid-term. Additional features will be added to the MSM to enable evaluation of the benefits of integrating stationary power generation with the electrical sector.

In collaboration with the Fuel Cells Systems R&D subprogram, the subprogram will:

- Develop models for program analysis 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 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 combined heat and power (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. The program will also update the Systems Analysis Plan, Technical Requirements Document and the 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 amongst 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 be conducted. The effects of a Federal fuel cell acquisition program on fuel cell cost reduction will be estimated. Program element risk analysis will be conducted with Systems Integration to evaluate progress towards program targets and goals. In addition, these funds will be used to support peer reviews as required.

	(dollars in thousands)		
	FY 2008	FY 2009	FY 2010
SBIR/STTR	**—**	**205**	**140**

In FY 2008, $265,000 and $31,000 were transferred to the SBIR and STTR programs respectively. The FY 2009 and 2010 amounts shown are estimated requirements for the continuation of the SBIR and STTR program.

Total, Systems Analysis	**11,099**	**7,713**	**5,000**

Explanation of Funding Changes

	FY 2010 vs. FY 2009 ($000)
Systems Analysis	
With the reprioritization of the program's fuel cell activities, less vehicle-related systems analysis will be needed, and this activity will focus on identification of technology gaps across a range of fuel cell types and applications.	-2,648
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.	-65
Total Funding Change, Systems Analysis	**-2,713**

Market Transformation

Funding Schedule by Activity

	(dollars in thousands)		
	FY 2008	FY 2009	FY 2010
Market Transformation	—	4,740	0
SBIR/STTR	—[a]	7	0
Total, Market Transformation	—	4,747	0

Description

The Market Transformation subprogram accelerates commercialization of fuel cell power systems. The goal of these activities is to eliminate non-technical barriers and increase opportunities for market expansion. The pathway to expanded use of fuel cells will likely include the introduction of direct hydrogen polymer electrolyte membrane (PEM) fuel cells in near-term markets with fewer technical and cost challenges than later developing markets. By increasing product purchases, these early market applications will accelerate development of manufacturing capability and domestic supplier base, and reduce manufacturing costs. Early markets facilitate the development of codes and standards, raise public acceptance and increase market demand.

The most promising near-term opportunities for PEM fuel cells are in specialty vehicle and backup power applications, as described in an evaluation conducted by Battelle Memorial Institute.[b] Some PEM fuel cell systems are commercially available to support these applications and offer several potential advantages over current technologies, including lower emissions, lower O&M requirements, and longer runtimes. However, the incremental cost as compared with conventional technologies is preventing widespread adoption of hydrogen and fuel cell systems.

PEM fuel cells can provide standby or emergency power to ensure uninterrupted service. These fuel cells can be used to provide electricity that meets standard backup requirements (e.g., in blackout conditions), as well as high quality backup power requirements for industries such as financial services and telecommunications, which are willing to pay more to secure reliable service. In backup applications, efficiency is not as critical as reliability and availability of the system. PEM fuel cells in these applications provide longer runtimes than batteries. They also have low operations and maintenance requirements, and have no emissions as compared to generators. PEM fuel cells can be less expensive, on a life cycle basis, than lead acid batteries because they do not require replacement as often. The FCT program pursues competitively awarded cost shared projects with industry and government that collect valuable data to validate the technology in the field and increase acceptance of fuel cell technologies. These projects increase consumer confidence and promote the adoption of these technologies without government financial assistance. Market Transformation activities are consistent with EPAct 2005 provisions that recognize the need for activities in addition to R&D for disruptive technologies with major societal benefits.

Specialty vehicle users, such as lift truck operators, are looking for alternatives to batteries to increase runtime and productivity, to reduce safety risks, and to reduce O&M costs associated with battery and

[a] SBIR/STTR funding was transferred to the Science appropriation in FY 2008.
[b] http://www1.eere.energy.gov/hydrogenandfuelcells/news_detail.html?news_id=10798

internal combustion engine powered vehicles. PEM fuel cells can provide value over battery-powered forklifts in high productivity environments. When forklifts are operated under conditions of near continuous use, fuel cell vehicles are significantly less expensive than similar battery-powered systems from a life cycle cost perspective. Advantages of PEM fuel cell systems operating under such conditions include rapid refueling, eliminating time and cost of replacing batteries, constant voltage delivery, productivity increases by eliminating battery recharging time, fewer repairs due to fewer moving parts, and elimination of battery storage/changing rooms. Federal agencies can play a critical role in enhancing the market introduction of new technologies by being early adopters to stimulate initial markets. The FCT program collaborates with DOD in deploying fuel cell lift trucks in several locations and supports Federal deployments for backup power applications. In addition, the program considers providing financial assistance to industry in the form of cost-sharing for fuel cell purchases. These purchases generate “market pull” – stimulating market demand – for certain applications.

Benefits

Early market fuel cell deployments stimulate market pull and facilitate the market penetration of hydrogen and fuel cell products through volume purchases of these technologies.

Higher volume purchases of these technologies are expected to lower market barriers by: (a) enabling developers to move down the learning curve, reduce manufacturing costs, and develop manufacturing capability; (b) increasing public awareness of hydrogen and fuel cell technologies; (c) enabling assessments of infrastructure needs (which will help to develop codes and standards and lay the groundwork for financing); (d) creating a demand for technology developers, which will, in turn, encourage expansion of relevant training and education opportunities; and, (e) familiarizing the end-user communities with the technologies.

Detailed Justification

(dollars in thousands)

	FY 2008	FY 2009	FY 2010
Market Transformation	**—**	**4,740**	**0**

To facilitate early adoption of hydrogen and fuel cell technologies, the Market Transformation subprogram uses cost-shared projects with partners from industry and government agencies (Federal, state and local) to deploy fuel cell systems in stationary and transportation applications such as specialty vehicles. Such applications include warehouse lift-trucks currently employing battery or internal combustion systems, and fuel cells for battery recharging.

This effort supports projects enabling Federal, state, and local government leadership in the adoption of fuel cells for critical early markets including emergency back up power, lift trucks, and data center power. Projects at Federal agencies are supported on a cost-shared basis through interagency agreements. State and local governments are supported through competitively–awarded, cost-shared grants that include industry participation. These projects stimulate the development of a domestic supply base. All projects incorporate a data collection element, providing important third-party test data that validate performance characteristics and help to increase consumer acceptance of fuel cell technologies.

	(dollars in thousands)		
	FY 2008	FY 2009	FY 2010
The Market Transformation subprogram builds on existing technology and complements current R&D in support of the program plan.			
SBIR/STTR	**—**	**7**	**0**
In FY 2008, no funds were transferred to the SBIR and STTR programs. The FY 2009 and 2010 amounts shown are estimated requirements for the continuation of the SBIR and STTR program.			
Total, Market Transformation	**—**	**4,747**	**0**

Explanation of Funding Changes

	FY 2010 vs. FY 2009 ($000)
Market Transformation	
Market transformation activities are being accelerated with Recovery Act funding, thus additional funding is not requested in FY 2010.	-4,740
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.	**-7**
Total Funding Change, Market Transformation R&D	**-4,747**

Manufacturing R&D

Funding Schedule by Activity

(dollars in thousands)

	FY 2008	FY 2009	FY 2010
Manufacturing R&D	4,826	4,867	0
SBIR/STTR	—[a]	133	0
Total, Manufacturing R&D	4,826	5,000	0

Description

Manufacturing R&D has supported the FCT technology readiness goal by developing advanced high-volume fabrication and process technologies for hydrogen fuel cells, storage, production and delivery materials, components and systems that meet the cost targets critical for mass penetration in the light-duty vehicle, stationary power, back-up power, and material handling markets. Due to the program's rebalancing of its portfolio to focus on an array of fuel cell technologies, funding for the Manufacturing R&D activity is deferred.

Explanation of Funding Changes

	FY 2010 vs. FY 2009 ($000)
Manufacturing R&D	
Due to the program's rebalancing of its portfolio to focus on an array of fuel cell technologies, funding for the Manufacturing R&D activity is deferred.	-4,867
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.	-133
Total Funding Change, Manufacturing R&D	**-5,000**

[a] SBIR/STTR funding was transferred to the Science Appropriation in FY 2008.

Biomass and Biorefinery Systems R&D

Funding Profile by Subprogram

(dollars in thousands)

	FY 2008 Current Appropriation[a]	FY 2009 Original Appropriation	FY 2009 Additional Appropriation	FY 2010 Request
Biomass and Biorefinery Systems R&D				
Feedstock Infrastructure	12,144	15,500	–	27,500
Platforms Research and Development	65,844	53,400	–	59,700
Utilization of Platform Outputs R&D	112,690	148,100	–	147,800
Cellulosic Ethanol Reverse Auction	4,955	0	–	0
Total, Biomass and Biorefinery Systems R&D	195,633	217,000	786,500[b]	235,000

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” (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” (2005)
P.L. 110-140, “Energy Independence and Security Act of 2007” (2007)
P.L. 110-234, “The Food, Conservation, and Energy Act of 2008” (2008)

Mission

The mission of the Biomass Program is to facilitate the development and transformation of domestic, renewable, and abundant biomass resources into cost-competitive, high performance biofuels,

[a] SBIR/STTR funding was transferred to the Science Appropriation in FY 2008, which includes a reduction of $2,275,000 that was transferred to the SBIR program, and $272,000 that was transferred to the STTR program.
[b] An additional $13.5 million in Biomass related projects is included within EERE Facilities and Infrastructure

bioproducts and biopower through targeted research, development and deployment (RD&D) leveraged by public and private partnerships.

Benefits

The Biomass Program's vision is for a viable, sustainable, domestic biomass industry that produces clean, secure, renewable biofuels, biopower, and bioproducts that can: 1) enhance U.S. energy security by reducing dependence on foreign oil, 2) provide environmental benefits including reduced GHG emissions, and 3) create economic opportunities across the nation.

The Biomass Program's groundbreaking RD&D work and support of private sector investment and innovation is critical to achieving the Energy Independence and Security Act of 2007 (EISA 2007) Renewable Fuel Standard (RFS) targets for advanced and cellulosic biofuels. The RFS requires 36 billion gallons per year of the national fuel supply be comprised of renewable fuels by 2022. Of the 36 billion gallon mandate, 21 billion gallons is to be advanced biofuels. Further, of the 21 billion gallons of advanced biofuels, 16 billion gallons must be cellulosic biofuels.

The Biomass Program has developed an approach centered on the integrated biorefinery concept to support meeting the RFS. A biorefinery is a facility analogous to a petroleum refinery, designed to efficiently produce fuels and a variety of co-products such as power, chemicals, and other materials from biomass. Demonstrating and validating the commercial viability of the integrated biorefinery concept requires: sustainably producing, collecting, and transporting large volumes of biomass feedstocks; advancing biomass conversion technologies; and developing an adequate biofuels distribution and end use infrastructure. The R&D platforms will focus on reducing the costs of feedstock and conversion technology options, while operational data from demonstrating integrated biorefineries at various scales will reduce technology risks. Ultimately, this strategy validates the commercial viability of biorefinery concepts by attracting other sources of capital for larger scale production of biofuels to meet the RFS.

Meeting the RFS targets also requires the concerted efforts of Federal and state policy and decision makers; the industrial, agricultural, and environmental communities; and financial sector and business entrepreneurs. Coordination of multidisciplinary scientific and engineering expertise of academia and National Laboratories will be critical to building a strong technology innovation foundation. The Biomass Program is advancing science in these areas through important collaborations with other programs and agencies such as DOE's Office of Science (Bioenergy Centers) and the United States Department of Agriculture (USDA). The Biomass Program is forging new partnerships and strategic alliances to leverage efforts in meeting the technological and economic challenges of establishing integrated biorefineries such as DOE and USDA's Loan Guarantee Offices.

The FY 2010 Budget investments complement Recovery Act funds that accelerate achievement of program goals. To enable decision makers and the public to follow performance and plans, the program will post its progress in these planned activities at: http://www.energy.gov/recovery/index.htm.

Climate Change

The Biomass Program's research, development, demonstration and deployment activities all support the achievement of a national reduction in GHG emissions. Biofuels have great potential for displacing petroleum-based liquid transportation fuels, lowering the amount of carbon introduced into the Earth's atmosphere. For example, Argonne National Laboratory estimates that biofuels have the potential to reduce GHG emissions by more than 80 percent when compared to gasoline on a life cycle basis, though subsequent studies suggest that emissions reductions may not be as great when the GHG impacts of changes in land-use associated with increased biofuels production are included.[a] The Biomass Program's current activities directly support meeting the goals of EISA 2007. It is estimated that the program's activities will enable the law to reduce total CO_2 emissions by well over 300 million metric tons by 2030. The program's non-EISA 2007 related activities are expected to result in an additional cumulative CO_2 emissions reduction of 49 million metric tons.

Energy Security

The displacement of fossil fuels from foreign sources with sustainably produced advanced domestic biofuels will enhance energy security. At the same time, new markets will be created to produce sustainable feedstocks and biofuels. Production distribution infrastructure and related goods and services throughout the supply chain will create new green jobs. The increased production of biofuels has the potential to help reshape our markets, reinvigorate rural economies, and support a sustainable new generation of transportation technologies critical for reducing our carbon emissions and ensuring America's future prosperity and security in the global community. The Biomass Program's current activities directly support meeting the goals of EISA 2007. It is estimated that the program's activities will enable the law to reduce oil imports by well over 700 million barrels by 2030. The program's non-EISA 2007 related activities are expected to result in a cumulative reduction of 200 million barrels of oil imports.

Economic Impact

The Biomass Program pursues its mission through the set of integrated activities proposed in this budget that are designed to increase the use of domestic renewable resources. Improvements are expected to continue to provide concomitant economic, environmental and security benefits. The most significant benefits are expected to be a reduction of oil imports and in reduction of CO_2 emissions.

The benefits tables following this section show the estimated benefits from 2015 through 2050 that would result from realization of the program's goals. These benefits are achieved by targeted Federal investments in technology research and development through industrial partnerships with auto manufacturers, commercial vehicle manufacturers, equipment suppliers, fuel and energy companies, other Federal agencies, State government agencies, universities, National Laboratories, and other stakeholders. These partnerships facilitate the technical coordination of activities and attract cost sharing to provide leveraged benefits.

The benefits table also reflects the increasing market share of advanced-technology biofuels over time as their projected incremental cost relative to conventional biofuels declines, and as their efficiency relative to conventional biofuels increases. The expected benefits reflect solely the achievement of the program's goals. Not included are any policies, regulatory mechanisms, or other incentives not already in existence that might be expected to support or accelerate the achievement of the program goals. In addition, some technologies show diminishing annual benefits by 2050 due to the assumption built into the analysis that industry progress, as reflected in the baseline, will eventually catch up with the more accelerated progress associated with EERE program success.

The program goal case is modeled along with a "baseline" case in which no DOE R&D exists. The baseline case is intended to represent the future without the effect of the Biomass Program, and is identical for all DOE applied energy R&D programs, thereby ensuring that all program benefits are

[a] Wang et al. "Life-cycle energy and greenhouse gas emission impacts of different corn ethanol plant types." *Environmental Research Letters* 2 (2007) 024001 (13pp)

estimated using the same assumptions for external factors such as economic growth, energy prices, and levels of energy demand. The expected outcome benefits are calculated using the same fundamental methodology across EERE and across all of DOE's applied energy R&D programs, and the metrics by which expected outcome benefits are measured are identical. This standardization of method and metrics has been undertaken as part of DOE's efforts to make all program stated benefits comparable.

Prospective benefits are calculated as the arithmetic difference between the baseline case and the program goal case, and the resulting economic, environmental and security benefits attributed to the program's activities. This approach of calculating the benefits as an incremental improvement to the baseline helps ensure that improvements in biomass technologies that would occur in the absence of the program are not counted as part of the program's benefits. In addition to technology and process advances due to the program's activities, energy market policies, such as state and federal tax policies, facilitate the development and deployment of clean energy technologies. The expected impacts of current legislated policies in the baseline case are included so that the expected benefits calculated reflect as much as possible the effects of activities funded by the program.

The Biomass and Biorefinery Systems R&D Program's expected impact on oil import reductions is less than in prior years, primarily because of the inclusion of the EISA 2007 National Renewable Fuels Standard (RFS) in the baseline. Much of the increased production of cellulosic ethanol conversion technology that in prior years has been attributed to the program's activities is now assumed to occur as a result of the RFS mandate, as opposed to the program's R&D activities. The program's benefits are also impacted by the inclusion of the EISA 2007 Corporate Average Fuel Economy (CAFE) mandate in the baseline, which serves to reduce the demand for oil and biofuels in the light duty vehicle segment of the transportation fuels market. While the program's energy security benefits may be smaller this year due to the inclusion of EISA's RFS mandate in the benefits analysis methodology, achieving the aggressive RFS target with minimum adverse impact to the U.S. economy will depend on successful current and future program R&D activities.

While the EISA 2007 national RFS mandates that 36 billion gallons of cellulosic ethanol production be achieved by 2022, EISA incorporates a waiver process if the target cannot be met. The integrated energy modeling results in achievement of the target in 2030, which impacts the program's oil savings most significantly prior to 2030 in comparison to prior year estimates; during this period, annual savings are very small. The program's contribution to carbon emission reductions and consumer savings are also significantly reduced during this period.[a] The program's impact is also reduced in the long-term and the magnitude of benefits does not return to the level of prior year estimates by 2050.

The benefits are generated by modeling both the program goal and baseline cases within two energy-economy models: NEMS-GPRA10 for benefits through 2030, and MARKAL-GPRA10 for benefits through 2050. The full list of modeled benefits appears below. Some benefits may be shown as lower than projected in previous years' budgets. This is due to the models' inclusion of the effects of legislation such as EISA 2007 in the baseline case, which raises the baseline projected fuel economy and petroleum displacement, and thus reduces the incremental benefit that are attributed to the program's

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[a] The Biomass Program has consistently had smaller savings in prior years because the program's R&D is defined as accelerating the baseline case cost and performance of cellulosic ethanol technology by only a few years. In the NEMS-GPRA10 analysis, the program case results in cellulosic ethanol production beginning sooner than in the baseline, which requires a smaller EISA 2007 RFS waiver and leads to some oil and carbon savings.

R&D efforts. The first table displays the estimated benefits from the applications of the program's technologies, co-developed with industry, that enable EISA 2007. The second table used standard methodology to allocate all benefits from legislation, such as EISA 2007, in the baseline, and displays benefits expected to accrue because of the program's activities in addition to those expected from the legislation.

Estimated Primary Benefits

(Including Program Contribution to EISA 2007)

	Metric[1]	Model	Year 2015	2020	2030	2050
Energy Security	Oil Imports Reduction, cumulative[2] (Bil bbl)	NEMS	ns	ns	0.2	N/A
		MARKAL	ns	ns	0.7	5.7
	Natural Gas Imports Reduction, cumulative (Tcf)	NEMS	ns	ns	0.2	N/A
		MARKAL	ns	ns	ns	0.5
	Reduction in Share of Highway Fuel Demand Derived from Crude Oil[3] (%)	NEMS	ns	ns	1%	N/A
		MARKAL	ns	ns	2%	5%
Environmental Impacts	CO_2 Emissions Reduction, cumulative (Mil mtCO_2)	NEMS	ns	ns	55	N/A
		MARKAL	3	33	327	2295
	SO_2 Allowance Price Reduction[4] ($/ton)	NEMS	ns	ns	268	N/A
		MARKAL	N/A	N/A	N/A	N/A
	NO_x Allowance Price Reduction ($/ton)	NEMS	ns	ns	328	N/A
		MARKAL	N/A	N/A	N/A	N/A
	Hg Allowance Price Reduction (thousand $/lb)	NEMS	ns	ns	ns	N/A
		MARKAL	N/A	N/A	N/A	N/A
Economic Impacts	Consumer Savings, cumulative[5] (Bil $)	NEMS	ns	3	29	N/A
		MARKAL	ns	1	30	49
	Electric Power Industry Savings, cumulative (Bil $)	NEMS	ns	2	4	N/A
		MARKAL	ns	ns	2	-18
	Household Energy Expenditures Reduction ($/household/yr)	NEMS	ns	ns	80	N/A
		MARKAL	ns	ns	11	4

1. "Reductions" and "savings" are calculated as the difference between results from the baseline case (i.e. no DOE technology) and the technology case (i.e. all DOE technology R&D programs are successful).
2. All cumulative metrics are based on results beginning in 2009.
3. Metric includes oil-derived fuel use by light-duty vehicles, commercial light trucks and freight trucks; the metric excludes buses. Reported oil use is adjusted to exclude ethanol, biodiesel and CTL.
4. All monetary metrics are in 2005$.
5. Cumulative monetary metrics are in 2005$ that are discounted to 2009 using a 3% discount rate.
ns - Not significant
NA - Not yet available
N/A - Not applicable

Primary Metrics for FY 2010 Budget Request

(Program Impacts to EISA 2007 are not credited to program)

	Metric[1]	Model	Year 2015	2020	2030	2050
Energy Security	Oil Imports Reduction, cumulative[2] (Bil bbl)	NEMS	ns	0.2	0.4	N/A
		MARKAL	0.0	0.1	0.2	1.1
	Natural Gas Imports Reduction, cumulative (Tcf)	NEMS	ns	0.1	0.6	N/A
		MARKAL	ns	ns	ns	ns
	Reduction in Share of Highway Fuel Demand Derived from Crude Oil[3] (%)	NEMS	ns	ns	ns	N/A
		MARKAL	0%	0%	0%	1%
Environmental Impacts	CO_2 Emissions Reduction, cumulative (Mil mtCO_2)	NEMS	ns	100	255	N/A
		MARKAL	3	11	49	523
	SO_2 Allowance Price Reduction[4] ($/ton)	NEMS	ns	ns	ns	N/A
		MARKAL	N/A	N/A	N/A	N/A
	NO_x Allowance Price Reduction ($/ton)	NEMS	ns	ns	ns	N/A
		MARKAL	N/A	N/A	N/A	N/A
	Hg Allowance Price Reduction (thousand $/lb)	NEMS	ns	ns	ns	N/A
		MARKAL	N/A	N/A	N/A	N/A
Economic Impacts	Consumer Savings, cumulative[5] (Bil $)	NEMS	ns	ns	39	N/A
		MARKAL	2	4	11	34
	Electric Power Industry Savings, cumulative (Bil $)	NEMS	ns	0	6	N/A
		MARKAL	1	4	0	8
	Household Energy Expenditures Reduction ($/household/yr)	NEMS	ns	ns	ns	N/A
		MARKAL	1	3	1	2

1. “Reductions” and “savings” are calculated as the difference between results from the baseline case (i.e. no DOE technology) and the technology case (i.e. all DOE technology R&D programs are successful).
2. All cumulative metrics are based on results beginning in 2010.
3. Metric includes oil-derived fuel use by light-duty vehicles, commercial light trucks and freight trucks; the metric excludes buses. Reported oil use is adjusted to exclude ethanol, biodiesel and CTL.
4. All monetary metrics are in 2006$.
5. Cumulative monetary metrics are in 2006$ that are discounted to 2010 using a 3% discount rate.
ns - Not significant
NA - Not yet available
N/A - Not applicable

The following external factors could affect the program’s ability to achieve its strategic goals:

- Cost and availability of conventional fossil energy sources;
- Federal and state farm policies and grower’s actual adoption rate for new crops;
- Widespread adoption of sustainable crop management practices;
- Consumer acceptance;
- Cost of competing alternative energy technologies;

- Loan guarantee programs as authorized by EPAct 2005, the 2008 Farm Bill, and other future regulations potentially accelerating the adoption and positively impacting the deployment of biorefinery technologies; and
- The market penetration rate of bio-based technologies which is a function of all the external factors listed and technical breakthroughs, incentives; price trends of coal, oil and natural gas; and policy factors.

Contribution to the Secretary's Priorities

The Biomass Program contributes to several of the Secretary's priorities as enumerated below. The principal focus area is Priority 2, Clean Energy.

Priority 1: Science and Discovery – Invest in science to achieve transformational discoveries

The Biomass Program coordinates with the Office of Science, National Science Foundation, and academic institutions to ensure that the program's R&D work being conducted by National Laboratories, universities, and industry partners remains at the cutting edge of scientific innovation. Additionally, much of the program's R&D work already involves direct interaction between these three partner types.

The Biomass Program manages several small scale international projects involving R&D and analysis work, including partnerships with Brazil, China, and India, while also participating in the IPCC, working with Conservation International, and contributing to the IEA (Bioenergy Agreement participation and task sponsorship).

Priority 2: Clean Energy – Change the landscape of energy demand and supply

The Biomass Program demonstrates and deploys integrated biorefinery technologies with commercial partners, while also aggressively advancing feedstock production and biomass conversion R&D at the cutting edge of technology, working with the National Laboratories, universities, private sector partnerships, and other non-profit research organizations (e.g. Gas Technology Institute).

The Biomass Program coordinates its efforts with the DOE Office of Science in key technology areas such as developing transformational technologies to overcome biomass recalcitrance.

Priority 3: Economic Prosperity – Create millions of green jobs and increase competitiveness

The Biomass Program works to develop biofuels for transportation applications, and is involved in the testing of alternative fuel blends. The program also works with the Vehicle Technologies Program and external stakeholders to develop biofuels distribution and end-use infrastructure to create a market for biofuels.

The Biomass Program's commercial, demonstration and pilot scale projects involve private sector employment. The program's R&D work supports the growth of the domestic biofuels industry. It is estimated that each new commercial biorefinery creates 40 to 77 new jobs.[a] Emerging biofuels production, distribution, and end-use technology industries all promise new green employment opportunities.

Priority 5: Lower GHG Emissions – Position U.S. to lead on climate change policy, technology, and science

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[a] Numbers are estimates provided in NREL's 2002 Design Report.

The Biomass Program leverages both domestic and international R&D partnerships to advance biofuels technology development, which is aimed at demonstrating viable biofuel pathways to support private sector deployment of biofuel technologies. Though the program's current focus is on domestic deployment of biofuel technologies, the program's domestic success has clear international implications, as do its partnerships with private and non-profit entities whose influence extends beyond the borders of the U.S.

The Biomass Program participates in the IPCC, and supports the IEA's Bioenergy Agreement, participating regularly in Tasks (such as Task 33, "Thermal Gasification of Biomass," and Task 39, "Commercializing 1st- and 2nd-Generation Liquid Biofuels from Biomass"). The program also participates in collaborative projects with partners in Brazil, China, Conservation International, the EU, India, and Israel.

Contribution to GPRA Unit Program Goal 1.1.06.00 (Biomass and Biorefinery Systems R&D)

The program directly supports the DOE's Energy Security theme by developing our Nation's biomass resource availability and conducting RD&D on technologies that increase the production of biomass-based substitutes for petroleum-derived fuels, chemicals, materials, and/or heat and power, and thereby diversifying and expanding our energy supply. It also addresses the goals and recommendations of the Farm Security and Rural Investment Act of 2002, Energy Policy Act of 2005, Energy Security and Independence Act of 2007, and Food, Conservation, and Energy Act of 2008.

To increase the probability of success, the program funds key technology pathways that contribute to the achievement of this goal. To realize this, intermediate programmatic cost-competitive ethanol target ranges have been established based on EIA oil price projections. Currently these cost range targets are $1.76 to 2.06 per gallon of ethanol by 2012, and $2.01 to 2.87 per gallon of ethanol by 2017 (both ranges in 2007$). The program's technology pathways and their respective contributions are described below.

Feedstock Infrastructure contributions:

- Reduced costs associated with feedstock production, collection, storage and transportation;
- Overcoming major feedstocks-related technical barriers impeding the growth of the biofuels industry; and
- Ensuring sound production strategies, both economically viable and environmentally sustainable, are developed and utilized.

Platforms Research and Development contributions:

- Biochemical Platform R&D will focus on reducing the cost of producing ethanol from biochemical routes. Work to overcome the recalcitrance of biomass, through research institutions and public-private partnerships, will continue to be a priority. The program will continue to make further improvements to feedstock interface, pretreatment and conditioning, enzymes and fermentation processes in addition to process integration in order to reduce intermediate sugar and ethanol production costs as the springboard to launching the next generation of biofuels technology from a wide range of feedstocks; and
- Thermochemical Platform R&D will focus on technologies for converting feedstocks and bioconversion process residues into cost competitive commodity fuels (e.g. ethanol, gasoline, diesel), as well as bioproducts and biopower. The program will continue to make further

improvements to feedstock interface, gasification and bio-oil processes with an emphasis on increased conversion and selectivity. In addition, process integration will continue to be improved in order reduce overall costs of the next generation of biofuels derived from a wide range of feedstocks.

Utilization of Platform Outputs R&D contributions:

- The Integration of Biorefinery Technologies Platform will continue to support companies with the intent of commercializing biorefineries for the production of transportation fuels as the main product, with co-products (such as materials and chemicals, heat and power) as authorized by Section 932 of EPAct 2005, and in support of EISA 2007 RFS. To this end, the program will continue to support commercial, demonstration, and pilot scale biorefinery projects in FY 2010. These projects are critical to validate technical and economic feasibility of their respective integrated biorefineries and will help attract private sector capital leading to their commercialization. Transportation fuels infrastructure activities will continue to include the conducting of testing of ethanol blends; and
- The Products Development Platform will complete funding five industry cost shared partnership projects for developing a commercially viable fermentative micro-organism (aka "ethanologen") at a cost sufficiently low to achieve the 2012 cost range target. These micro-organisms, capable of fermenting major sugars found in cellulosic biomass, will provide necessary technology to support advances in future integrated biorefineries. In addition, the program will continue to evaluate the potential of co-products to stabilize and reduce costs of fuel production within the biorefinery.

Means and Strategies

The Biomass Program will use various means and strategies to achieve its GPRA Unit program goals as described below. "Means" include operational processes, resources, information, and the development of technologies, and "strategies" include program, policy, management and legislative initiatives and approaches. Various external factors, as listed below, may impact the ability to achieve the program's goals.

The Biomass Program will implement the following means to improve the cost-competitiveness of biomass technologies:

- R&D through competitive solicitations for industrial partnerships with appropriate cost sharing to attract innovation and ensure investment value for industry and university contracts;
- Management of R&D by a series of objectives, milestones, and stage gate reviews, which are tracked by the Project Management Center and verified with reviews from industry and university experts;
- Commercial, demonstration, and pilot scale validation of integrated biorefineries through competitive solicitations to validate their economic and technical feasibility in order to facilitate commercialization; and
- Input from peer reviews.[a] Peer reviews of program plans and activities are aimed at obtaining expert, independent opinion on the program's goals and objectives; feasibility of reaching the goals;

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[a] The most recent program peer review was held in November 2007; http://www.obpreview07.govtools.us/. The next program review is scheduled for July 2009; http://www.obpreview2009.govtools.us/.

appropriateness of technical barriers being addressed; appropriateness of the federal role, and, whether the level of Federal funding for projects is commensurate with technical objectives.

The Biomass Program will implement the following strategies:

- For each feedstock targeted, program research will develop handling and conversion technologies specific to feedstock properties and validate the technical performance and projected economics at industrial scale;
- The program will collaborate with the DOE Office of Science to further basic research related to Biochemical Platform R&D, such as overcoming the recalcitrance of certain biomass feedstocks. Additionally, the Biomass Program will collaborate with the DOE Office of Science to target and conduct research on the development of new organisms and techniques for most efficiently processing the variety of sugars found in biomass. This will consolidate several steps in bioprocessing, lead to a significant reduction in tanks and associated equipment currently needed to convert biomass feedstocks into ethanol, and ultimately result in a large reduction in overall biorefinery plant cost;
- The program will continue to support Regional Biomass Feedstock Development Partnerships, thus leveraging local resources through partnerships with agricultural producers, universities, and industry that understand regional opportunities and challenges. These Partnerships will fund research to validate new feedstocks tailored to industrial biorefineries. This will allow the availability of biomass-derived fuels and chemicals to continue to grow beyond the limitations of present commodity crop and forest resources;
- In addition to current collaborations with academia, the program will promote the use of universities' research capabilities in the areas of feedstock interface, biochemical and thermochemical conversion, environmental analysis, and infrastructure development strategies and technologies, while competitively allocating resources;
- The program will support R&D involving high-opportunity, high-impact technologies for converting cellulosic biomass feedstocks to liquid fuels. R&D will include developing process integration methodologies, identifying effective pretreatment catalysts effective on multiple biomass feedstocks, and targeting efficient enzymes. Moreover, as biorefinery plants mature, advanced thermochemical technologies (e.g., catalytic hydroprocessing) will be pursued to increase biofuels production and value; and
- The program will utilize guidance from the Biomass Technical Advisory Committee and the Biomass R&D Board authorized under the Food, Conservation and Energy Act of 2008 to integrate R&D across agencies.

Collaborations are integral to achieving the planned investments, means and strategies, and to addressing external factors. In carrying out its mission, the program performs the following collaborative activities:

- Partnership with DOE's Office of Science on feedstock development and consolidated bioprocessing (technology aimed at reducing the number of unit operations needed in a biorefinery);
- Collaboration on advanced conversion processes and techniques with the DOE Office of Science, which will help define the future of advanced biorefineries;

- Partnership with the DOE Vehicle Technologies and Fuel Cell Technologies Programs, Clean Cities, other Federal agencies, and other key stakeholder organizations to promote the use of biofuels in vehicles, evaluate the viability of ethanol blends, and address biofuels infrastructure barriers;
- Regional Biomass Feedstock Development Partnerships used to enhance the coordination of feedstock R&D efforts with USDA and the Sun Grant Initiative universities; regional information is needed by potential biorefiners in order to assess and improve resource availability and feedstock economics;
- Collaboration with other federal agencies (such as EPA, NSF, and USDA) and non-profit organizations to promote environmentally sustainable biofuel production pathways;
- Interagency Working Groups (IWGs) chartered at the direction of the Biomass R&D Board to improve coordination and technology development within the Biomass Program and Office of Science; and externally with the various agencies of USDA, EPA, DOT, DOI, DOC, Treasury, DOD, NSF, OSTP, and Office of Federal Environmental Executive. These IWGs have been formed for feedstock production, and logistics; sustainability; infrastructure; conversion technologies; and environment, health, and safety;
- An annual USDA-DOE solicitation for biomass technologies R&D and other coordination under the Food, Conservation and Energy Act of 2008; and
- Partnerships with existing biorefineries (e.g., corn-ethanol and pulp and paper mills) to integrate advanced technologies for producing biofuels from lignocellulosic feedstock, for near-term cost effectiveness and environmental sustainability benefits.

Validation and Verification

To validate and verify program performance, the Biomass Program will conduct internal and external reviews and audits. For example, during program peer reviews the programmatic activities are reviewed by experts from universities, state agencies, industry, and the USDA. The sections below summarize validation and verification activities.

Data Sources:	The Renewable Fuels Association's production statistics; the National Renewable Energy Laboratory's Renewable Electric Plant Information System (REPIS); the Energy Information Administration's (EIA) Annual Energy Review, Renewable Energy Annual and Annual Energy Outlook; the Gas Technology Institute Survey of Distributed Resources; EIA Form 860 data analyzed by the Resource Dynamics Corporation. Individual projects develop production cost and quantity estimates for sugar, syngas, ethanol, and other fuels and chemicals (these are reviewed and monitored by managers).
Baselines:	The following are the key baselines used in the Biomass Program:

- In 2007, the total feedstock baseline delivered cost (which includes collection, preprocessing, grower payment, and delivery to a conversion facility inlet, in 2007$) was $69.60 per dry ton for dry herbaceous (equates to approximately $0.97 per gallon of ethanol). A more vigorous analysis is underway for woody feedstocks; however, a 2007 baseline of $67.55 per dry ton for woody feedstocks (equates to approximately $1.58 per gallon of ethanol, in 2007$) is currently being used. In 2012, the Biomass Program currently anticipates a dry herbaceous feedstock cost of $50.90 per dry ton (equates to approximately \$0.57 per gallon of ethanol, in 2007\$) and woody feedstock cost of \$50.70 per dry ton (equates to approximately \$0.71 per gallon of ethanol, in 2007\$), based on the operative 2007 baselines described above.

- In 2005, Thermochemical R&D baseline mature conversion costs for woody feedstocks to ethanol via a gasification route was \$1.89 per gallon (2007\$) based on bench scale data (see figure in the subsequent Platforms R&D "Funding Schedule by Activity" "Benefits" section).
- In 2005, Biochemical R&D baseline mature conversion costs for dry corn stover to ethanol was \$1.79 per gallon (2007\$) based on bench scale data (figure below in the subsequent Platforms R&D "Funding Schedule by Activity" "Benefits" section).

Platform R&D projects utilize an analysis model to generate "nth plant" cost and performance data for an integrated biorefinery based on generic NREL designs. The biorefinery projects funded under Integration of Biorefinery Technologies will be validating each project's specific and proprietary economic and technical performance. As these integrated biorefinery projects are based on different designs (feedstocks, conversion technologies, etc.), they will not likely validate or match up to the "nth plant" modeled cost based on the NREL designs, nor will it be possible to disseminate the specific economic and technical performance data due to proprietary restrictions. Therefore, the program will use an aggregate performance metric for the pilot, demonstration, and commercial scale biorefineries as these facilities become operational in order to protect each project's proprietary data.

Evaluation: In carrying out the program's mission, the Biomass Program uses several forms of evaluation to assess progress and to promote program improvement.

- Stage gate review, technology validation and operational field measurement, as appropriate;
- Peer review by independent outside experts of both the program and subprogram portfolios;
- Specialized program evaluation studies to examine process, impacts, or market baseline and effects, as appropriate;
- Quarterly and annual assessment of program and management results based performance through Joule (the DOE quarterly performance progress review of budget targets);
- Annual review of methods, and updated analysis of potential benefits for the Government Performance and Results Act (GPRA); and
- Technical Advisory Committee feedback.

The National Laboratories receive direct funds for technology R&D, based on their capabilities and performance. Advisory panels consisting of non-Federal and industry experts review each laboratory and industry project at scheduled stage gate reviews and peer evaluation of R&D. Projects are evaluated based on the following criteria: 1) Relevance to overall DOE objectives; 2) Approach to performing the research and development; 3) Technical accomplishments and progress toward project and DOE goals; 4) Technology transfer/collaborations with industry/universities/laboratories; and 5) Approach and relevance of proposed future research. The panels also evaluate the strengths and weaknesses of each project, and recommend additions to or deletions from the scope of work. The program organization facilitates relationships to ensure that Federal R&D results are transferred to industry.

Frequency:	Potential benefits are estimated annually. Independent evaluation of R&D projects are performed according to schedule per the stage gate process for moving each project through an independent review "gate", from a less costly stage (such as preliminary paper studies) to a more costly stage (such as bench-scale experiments). Program peer reviews are conducted biennially.
Data Storage:	EERE Benefits website, the EERE Corporate Planning System, and other computer-based data systems.
Verification:	DOE technology managers verify the achievement of targets through project reviews, including reviews of cost and performance modeling results. Project leaders in the field must provide to the technology managers documentation of experimental and/or analytic results as evidence of success. The evidence is listed in material supporting the DOE Joule performance tracking system. Various trade associations review the data and the modeling processes (e.g., REPIS renewable), and the EIA verifies the REPIS database. Peer reviews are conducted by independent personnel from industry, academia and governmental agencies other than DOE.

Annual Performance Results and Targets

FY 2005 Results	FY 2006 Results	FY 2007 Results	FY 2008 Targets	FY 2009 Targets	FY 2010 Targets
GPRA Unit Program Goal 1.1.06.00 (Biomass and Biorefinery Systems R&D)					
Feedstock Infrastructure					
		Complete a core R&D engineering design and techno-economic assessment of an integrated wet storage - biomass field pre-processing assembly system with a pretreatment process that could potentially be scaled up to produce feedstocks to achieve a reduction to $35 per ton by 2012 from $53 per ton as of 2003. This is based on the original baseline and cost reduction targets specific to corn stover. [MET]	Conduct replicated field trials across regions to determine the impact of residue removal on grain yield (in subsequent years); field trials (including genetic evaluations) to develop energy crops within a geographical region; resource assessments to determine regional feedstock supply curves (variable costs of feedstock across various sites); and economic studies that identify the best site conditions and general locations for biorefineries within a region, all of which can demonstrably contribute to the goal of producing feedstocks at $32 per dry ton by 2012.[a] [MET]	Initiate a GIS-based regional feedstock atlas system incorporating USDA agricultural datasets, energy crop field test results, residue removal trial results, DOE and USDA funded biorefinery project results, and other assessments from public and private sources to provide the best biomass resource database, models, and tools available for a wide variety of users including Federal and State Governments, biorefinery developers, growers, and researchers. These efforts will enable evaluation of potential future feedstock supply in support of the goal of producing feedstocks at $47 per dry ton by 2012.[b]	Achieve a modeled dry herbaceous feedstock logistics cost of $37.80 per dry ton (excluding grower payment, in 2007$). Using Regional Feedstock Partnership trials and analysis efforts, determine feedstock types and regions in which nutrient use efficiency (tons of feedstock per pound of nutrients applied) and soil organic matter can be increased by at least 5%. This data will be input into designing integrated biomass production systems that incorporate positive services to the environment.
Platforms Research and Development					
Completed a technical and economic evaluation of integrated biomass to fuels systems to validate the sugar cost of $0.135 per pound and syngas cost of $6.13 per million Btu. [MET]	Complete laboratory and economic assessment of 2 different feedstocks, identifying operating conditions that link pretreatment with enzymes that could be scaled-up and have the potential of achieving the goal of $0.125 per pound sugar by	Complete integrated tests of pretreatment and enzymatic hydrolysis in conjunction with existing fermentation organisms at bench-scale on com stover that validate $0.125 per pound sugars on the pathway to achieving $0.064 per pound in 2012.	Achieve a modeled cost of a mixed, dilute sugar stream suitable for fermentation to ethanol of $0.13 per pound of sugars (equivalent to $2.39 per gallon of cellulosic ethanol) through the formulation of improved	Demonstrate alternative pretreatment technologies at bench-scale using advanced cellulase enzymes and integrated technologies that have the potential of achieving $0.12 per pound of sugars on the pathway to $0. 073 per	Achieve reduction of the modeled ethanol conversion cost to $1.33/gallon through improvements in pretreatment and hydrolysis; this is in support of achieving the $0.92 conversion cost necessary to achieve the ethanol production cost within the estimated cost

[a] The program has updated all technical targets based on improved data and modeling and updating to 2007 dollars. Previous 2012 feedstock target was stated as $35 per dry ton by 2012.

[b] This Joule was updated to reflect an improved, more inclusive measurement (includes all costs to the “reactor throat”) and based on newer cost information and accounting for market dynamics. Thus, the apparent increase in cost associated with the update is misleading, as the metric is different and cannot be directly compared.

FY 2005 Results	FY 2006 Results	FY 2007 Results	FY 2008 Targets	FY 2009 Targets	FY 2010 Targets
	2007. [MET]	[MET]	enzyme mixtures and pretreatments (in $2007). The cost of the sugar stream ties directly to the price of ethanol, a substitute for gasoline and key output of a biorefinery. Reduction in the cost of sugars can lead to commercialization of biorefineries that produce fuels (such as ethanol), chemicals, heat, and power from biomass. [MET]	pound by 2012 (in $2007). Reduced sugar costs will reduce cellulosic ethanol costs, leading to increased adoption of ethanol and reduced consumption of petroleum.	competitive range of $1.76-2.06/gallon by 2012 (in 2007$).[a]
		Demonstrate conversion of 50 percent of non-methane (C2+ higher) hydrocarbons that result in a syngas cost of $7.15/MBtu in 2007. [MET]	Achieve a modeled cost of a cleaned and reformed biomass-derived synthesis gas or oils of $6.88/MBtu by demonstrating pilot-scale technology capable of economically converting biomass residues, pulping liquors, or waste fats and greases. Reduction in the cost of syngas can lead to commercialization of biorefineries that produce fuels, chemicals, heat, and power from biomass. [MET]	Achieve a modeled ethanol price of $1.97/gal for thermochemical gasification followed by mixed alcohol synthesis and ethanol separation. This will be achieved by demonstrating pilot-scale technology capable of economically converting biomass feedstocks, and will be based on a feedstock cost of $60/dry ton (calculated in 2007 dollars).[b]	Through improved tar reforming catalysts, achieve a modeled ethanol price of $1.90/gal (2007$ feedstock cost $54.20/ton) for thermochemical gasification followed by mixed alcohol synthesis and ethanol separation.

[a] This Joule target has been updated to standardize our conversion R&D Joules, and as the modeled ethanol price has been determined to be a metric more accessible and meaningful to those outside our agency, even though sugar intermediate costs remain a valuable metric still used to internally measure progress.
[b] This Joule target has been updated, as the modeled ethanol price has been determined to be a more useful metric, and newer multiple pass syngas systems make the older measurement less accurate than a modeled price. It is also noted that this modeled price must necessarily be based on a fixed feedstock price for comparison across market periods due to market dynamism.

FY 2005 Results	FY 2006 Results	FY 2007 Results	FY 2008 Targets	FY 2009 Targets	FY 2010 Targets
Utilization of Platform Outputs R&D					
		Complete a preliminary engineering design package, market analysis, and financial projection for at least one industrial-scale project for near term agricultural pathways (corn wet mill, corn dry mill, oilseed) to produce a minimum of 15 million gallons of biofuels per year (as mandated by the Energy Policy Act. [MET]	Approve a final engineering design package of at least one commercial scale biorefinery capable of processing up to 700 metric tones per day of lignocellulosic feedstocks. The approved design package must address any findings from an independent engineering review to validate contractor costs and scheduled timeline. Validation of biorefinery concepts will reduce technological risk and attract additional sources of capital to accelerate deployment and oil displacement. [MET]	Initiate construction of at least one commercial-scale biorefinery project (designed to 700 ton per day feedstock processed) including orders for long lead items, vendor packages, and structural steel. Validation of biorefinery concepts will reduce technological risk and attract additional sources of capital to accelerate deployment and oil displacement.	Initiate construction of two additional commercial-scale biorefinery projects selected in FY 2007 (three in total).
				Approve engineering design of one additional commercial scale biorefineries (two in total) including orders for long lead items, vendor packages, and structural steel. The result of this will ultimately be to complete construction by 2011.	Complete sufficient engineering design to allow initiating construction (after financial and other requirements, i.e. NEPA, are met) for two demonstration projects selected in FY 2008.
				Approve preliminary engineering design package, market analysis and financial projections for at least four demonstration scale biorefineries (designed to 70 ton per day feedstock) selected in FY 2008. These efforts work toward validating the programmatic $2.01-2.87 per gallon estimated cost competitive target range in integrated biorefineries by 2017 (in 2007$).	Complete at least one trial run of an innovative integrated biorefinery process to demonstrate the integrated operation of processing biomass into a biofuel. This will support validating the programmatic $2.01-2.87 per gallon estimated cost competitive target range in integrated biorefineries by 2017 (in 2007$).
Established the technical and market potential of a new bio based product. [MET]	Identify at least one sugar-derived or biomass oil-derived bio-based chemical or material (among those being evaluated) that possesses sufficient				

FY 2005 Results	FY 2006 Results	FY 2007 Results	FY 2008 Targets	FY 2009 Targets	FY 2010 Targets
	potential to enter into the scaled-up developmental phase of R&D from the previous bench-scale phase. [MET]				
Contributed proportionately to EERE's corporate goal of reducing corporate and program adjusted uncosted obligated balances to a range of 20-25 percent by reducing program annual adjusted uncosteds by 10 percent in 2005 relative to the Biomass & Biomass Refinery Systems Program FY 2004 end of year adjusted uncosted baseline ($62,235K) until the target range is met. [MET]	Maintain total administrative overhead costs (defined as program direction and program support excluding earmarks) in relation to total program costs of less than 12 percent. [MET]	Maintain total administrative overhead costs (defined as program direction and program support excluding earmarks) in relation to total program costs of less than 12 percent. [MET]	Maintain administrative costs as a percent of total program costs less than 12 percent [MET]	Maintain administrative costs as a percent of total program costs less than 12 percent. [Baseline and targets under development.]	Maintain total administrative overhead costs in relation to total program costs of less than 12 percent[a].

[a] Administrative costs are comprised of Program Direction and elements of Program Support (Technology Advancement and Outreach; and Planning, Analysis and Evaluation), baseline and targets under development.

Feedstock Infrastructure

Funding Schedule by Activity

	(dollars in thousands)		
	FY 2008	FY 2009	FY 2010
Feedstock Infrastructure	12,144	15,092	26,776
SBIR/STTR	—[a]	408	724
Total, Feedstock Infrastructure	12, 144	15,500	27,500

Description

Feedstock Infrastructure Platform activities are critically important to increasing the availability and accessibility of domestic biomass resources and improving the infrastructure technologies needed to reliably supply lignocellulosic feedstocks to future large-scale biorefineries at reasonable costs. Investments in resource availability and feedstock infrastructure development are needed to ensure a stable feedstock supply critical to the economic viability of a domestic biofuels industry. An increased and reliable domestic supply of environmentally sustainable biomass feedstocks is needed for an expanded bioenergy industry. Considered inseparable from traditional economic cost measures of delivering feedstocks competitively, a greater emphasis is now being placed on the context of sustainability, which encompasses environmental criteria and societal values. The Feedstock Infrastructure Platform's overarching strategic goal is to develop technologies to provide reliable, cost-competitive, and environmentally sustainable biomass feedstock supplies for the U.S. biofuels industry in partnership with USDA and other key stakeholders from all sectors. Three main areas of focus within the platform address this overarching strategic goal: feedstock production, feedstock logistics, and environmental sustainability.

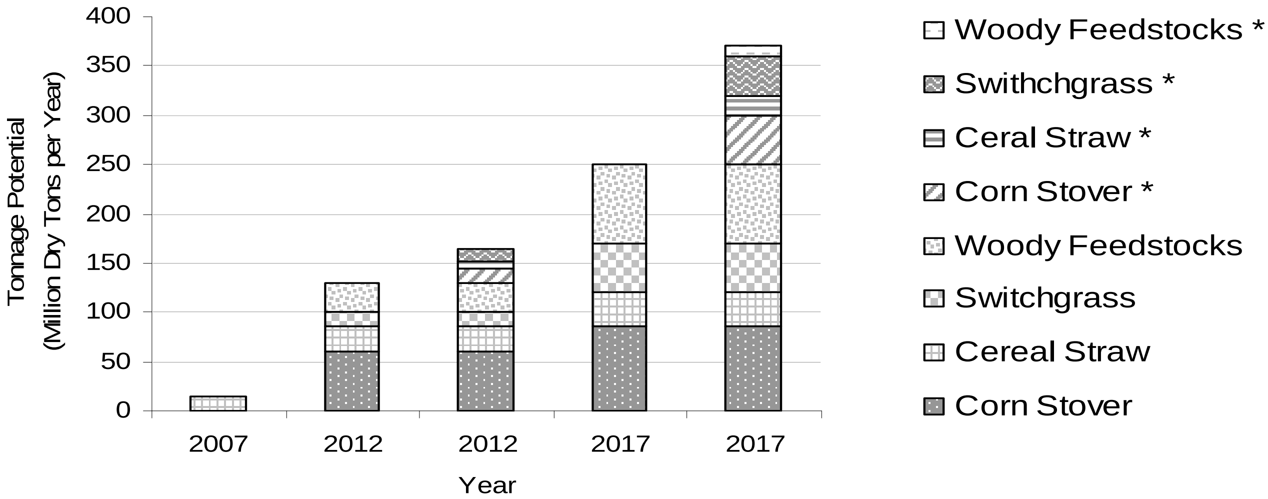
Benefits

To increase feedstock production, the major focus is on support of Regional Feedstock Partnership activities, involving regional stakeholder collaboration and research efforts aimed at collectively achieving an overall volumetric goal of 1.3 billion dry tons of biomass. Additionally, a series of replicated, regionally focused cellulosic feedstock crop trials will be conducted in potential crop growing regions of the U.S. These trials will be monitored for yield, major limiting factors, and carbon management. Results of these Regional Biomass Feedstock Development Partnership trials will be incorporated into a GIS-based regional feedstock 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 government, biorefinery developers, growers, and researchers.

In the near term, the feedstock production goal is to validate that a sufficient, high quality, accessible feedstock supply of 130 million dry tons per year would be available in 2012, growing to 250 million dry tons per year in 2017. This goal is necessary to spatially quantify the accessible resources and

[a] SBIR/STTR funding was transferred to the Science appropriation in FY 2008.

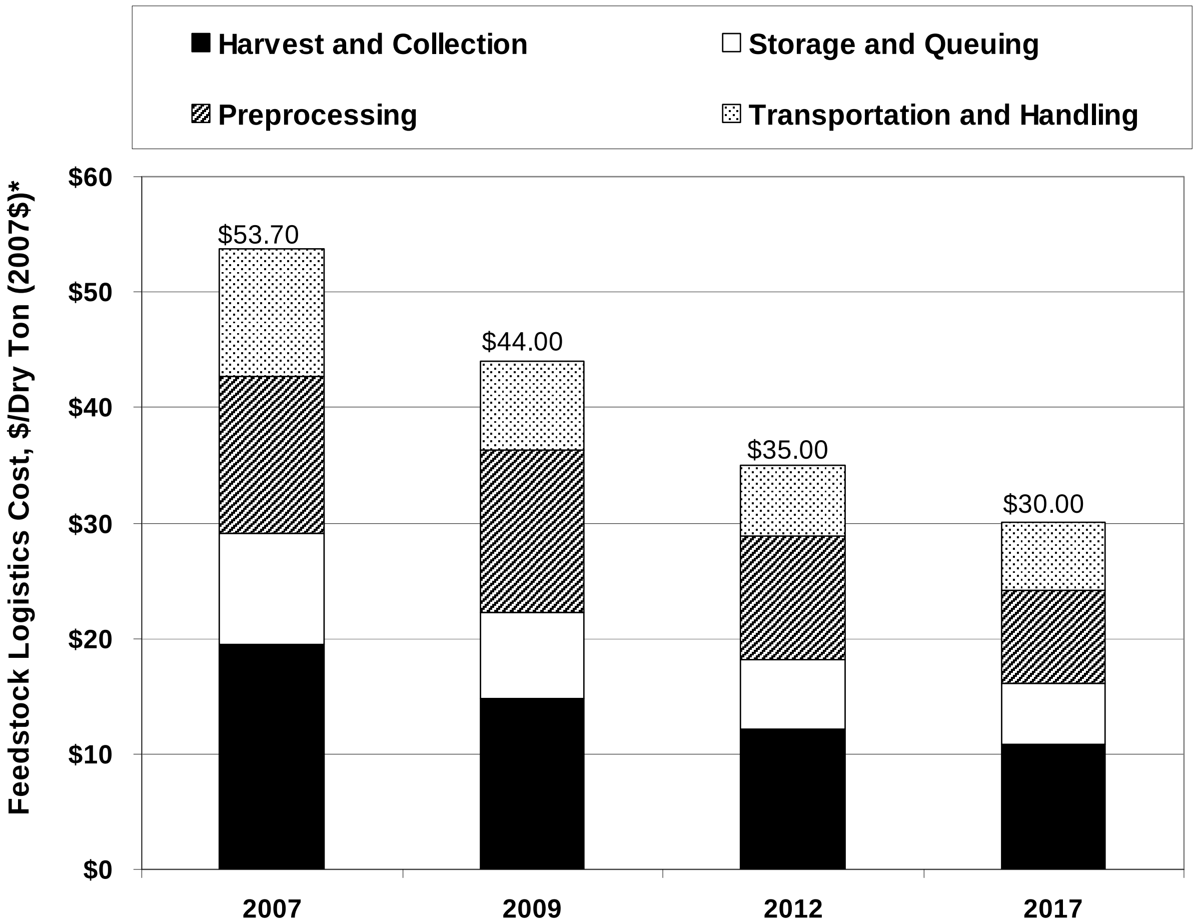
validate the percentage of resources that could be recovered cost effectively. A new effort is also being established to explore the viability of algae as a biofuels feedstock.



Totals assume the following minimum grower payments: for 2007, $15.90/ton; for 2012, $15.90/ton; for 2017, $26.20/ton.
* Shows additional feedstock available through agronomic and environmental improvements or new crop

Industry partnerships are used to improve feedstock logistics to enhance the economic viability of the domestic biofuels. These collaborative efforts involve improvements in existing or the development of new feedstock handling and storage technologies and proving their success through demonstrative trials. The near-term 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, biomass feedstock density needs to be increased to 16 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	2017
Total, Feedstocks Logisitics, $/Dry Ton	**$53.70**	**$44.00**	**$35.00**	**$30.00**
Harvest and Collection	$19.45	$14.81	$12.15	$10.81
Storage and Queuing	$9.64	$7.44	$5.95	$5.29
Preprocessing	$13.54	$14.05	$10.74	$8.03
Transportation and Handling	$11.07	$7.70	$6.16	$5.87

Environmentally-sound designs for integrated dedicated energy cropping systems will also be developed. Currently, there is insufficient information about the potential for well-designed biofuel cropping systems to minimize negative environmental impacts of increased feedstock production while still achieving mandated volumetric targets. This is especially true as it relates to carbon, nutrient, and water fluxes. Dedicated energy cropping systems will measure fluxes of water, nitrogen, phosphorous, and carbon. When coupled with the research-scale energy cropping systems developed through the Regional Biomass Feedstock Development Partnership program, researchers at the National Laboratories can develop new models to predict how agricultural landscapes can deliver optimum environmental benefits. This work will help identify conservation practices that can be widely implemented on biofuel production landscapes and can be easily verified by field experiments from future solicitations. Models will also lead to a complete accounting of various biofuel options that include technology, economics, net energy, and environment.

The Feedstock Infrastructure Platform is an integral part of the Biomass Program's partnered strategic pathway of advancing biomass technologies from basic science to applied research and demonstration, through 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 2008	FY 2009	FY 2010
Feedstock Infrastructure	**12,144**	**15,092**	**26,776**

There are three main areas included in Feedstock Infrastructure:

1) Feedstock Production; 2) Feedstock Logistics; and 3) Sustainability.

Feedstock Production addresses resource assessment, yield improvement, sustainable feedstock systems development, and biomass quality. One major component of this effort is the continuation of existing feedstock production trials with the Regional Biomass Feedstock Development Partnerships (now in the third feedstock growing year of the 6-year study). These replicated field trials are organized by species (energycane, miscanthus, switchgrass, and sorghum) to realize the resource potential of biomass feedstocks for advanced biofuels production on a regional basis. In further efforts, corn stover removal field testing will validate and enhance a tool developed by USDA/Agricultural Research Service and Idaho National Laboratory (INL) to measure the sustainability of corn stover removal from the field. Results of these various trials are one of the inputs into a national GIS assessment tool, which can be used for visualization of scenarios of future biofuels development.

Section 228 of EISA 2007 requires DOE to report the potential of microalgae as a feedstock for biofuels. The 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 sponsored an algal biofuels workshop, in December 2008, which produced a roadmap that included barriers for algae production. The feedstock production component of microalgae development will be incorporated into other algae efforts within the program.

In partnership with industry, Feedstock Logistics R&D addresses barriers associated with accessing and delivering the feedstock supply to an integrated biorefinery. Unit operations for Feedstock Logistics include harvesting, collection, preprocessing, storage, queuing, handling, and transport for all major feedstock categories of cellulosic biomass (e.g., wet, dry and woody). The Feedstock Infrastructure Platform's efforts have expanded from laboratory design work into industrial partnerships. In collaboration with the Integrated Biorefinery Platform, a deployable process demonstration unit housed at INL will develop feedstock logistics systems for different industrial partners on a cost-shared basis.

	(dollars in thousands)		
	FY 2008	FY 2009	FY 2010

The Environmental Sustainability focus area will address potential environmental barriers related to supplying feedstock for the full-scale development of a significant national biofuels industry, as identified by an Interagency Sustainability Task Force. Dedicated energy cropping systems will address a range of criteria necessary to ensure the environmental sustainability of commercial-scale feedstock production and logistics systems (such as fluxes of water, nitrogen, phosphorous, and carbon). When coupled with smaller Regional Biomass Feedstock Development Partnership field research trials, this work will enable the development of decision support tools that, when fully utilized, will advance the adoption of sustainable cropping practices.

SBIR/STTR	**—**	**408**	**724**

In FY 2008, $268,000 and $32,000 were transferred to the SBIR and STTR programs respectively. The FY 2009 and 2010 amounts shown are estimated requirements for the continuation of the SBIR and STTR program.

Total, Feedstock Infrastructure	**12,144**	**15,500**	**27,500**

Explanation of Funding Changes

	FY 2010 vs. FY 2009 ($000)
Feedstock Infrastructure	
Increased funding will support the expansion of projects to address potential environmental sustainability barriers that, if ignored, could constrain the development of a national biofuels industry. Smaller existing field trials will be supplemented by projects encompassing a greater diversity of crops and growing locations than is currently part of the Feedstock Infrastructure program of work. Dedicated energy cropping trials will allow for the measurement of the effects on key environmental criteria including carbon, water, and nutrient fluxes to establish best practices for future feedstock development efforts. In collaboration with the integrated biorefinery platform, a deployable process demonstration unit housed at INL will develop feedstock logistics systems for different industrial partners on a cost-shared basis. A limited new effort will also be initiated for algae feedstock development.	**+11,684**
SBIR/STTR	
Changes in the SBIR/STTR funding are a direct result of changes in the funding of program activities.	**+316**
Total Funding Change, Feedstock Infrastructure	**+12,000**

Platforms Research and Development

Funding Schedule by Activity

(dollars in thousands)

	FY 2008	FY 2009	FY 2010
Platforms Research and Development			
Thermochemical Platform R&D	26,413	19,863	27,263
Biochemical Platform R&D	39,431	32,131	30,866
SBIR/STTR	—[a]	1,406	1,571
Total, Platforms Research and Development	65,844	53,400	59,700

Description

The Platforms Research and Development subprogram supports the advancement of technologies developed within the Thermochemical and Biochemical Platforms for converting feedstocks and intermediates into quality, cost-competitive liquid transportation fuels, materials, and other chemicals. Activities performed in the Products Development interface with Thermochemical and Biochemical Platforms and assist meeting the Platforms' cost competitive conversion goals. The Thermochemical Platform 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 synsthesis. Biochemical Platform R&D will focus on further improvements to feedstock interface (pre-processing), pretreatment, enzymatic and chemical hydrolysis, and process integration. These integrated steps are required to reduce sugar costs and enable economically viable cellulosic ethanol production by biorefineries. This includes awarding payments to projects associated with solicitations initiated in FY 2007 and 2008. For the Thermochemical Platform, this work involves synthesis gas cleanup and subsequent synthesis gas conversion to fuel products, as well as technology development and pyrolysis oil stabilization and upgrading. For the Biochemical Platform, this work involves the development of improved cellulases with increased activities.

Benefits

The R&D work conducted by Platforms Research and Development will result in the development of technologies capable of converting biomass feedstocks into biofuels. The technical projections of the two R&D platforms comprising the Platforms Research and Development subprogram align their progress with the achievement of modeled ethanol costs within the overall Biomass Program target ranges of \$1.76 to \$2.06 per gallon of cellulosic ethanol in 2012, and \$2.01 to \$2.87 per gallon in 2017 (all in \$2007). The two sets of charts and tables below contain the Biomass Program's current conversion cost projections.

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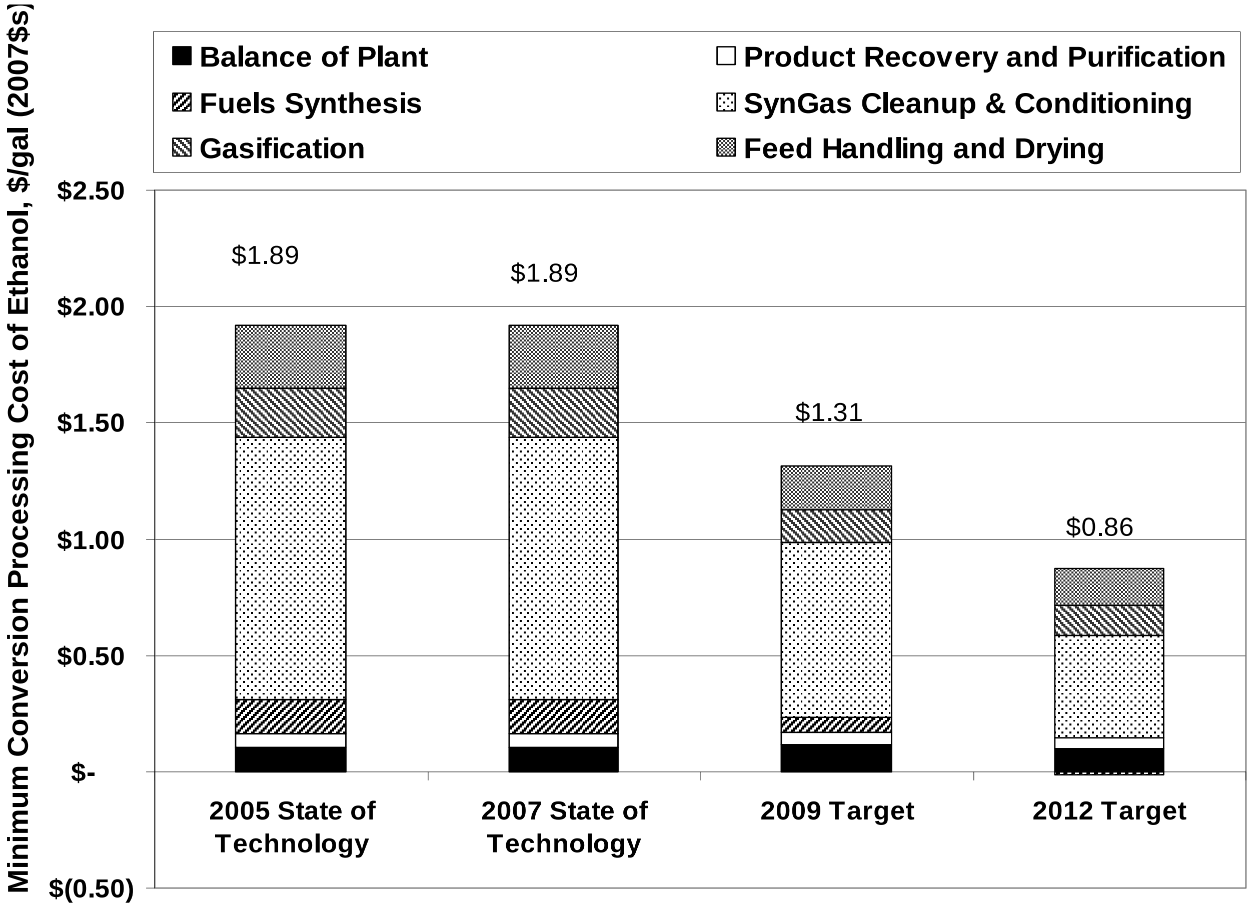
[a] SBIR/STTR funding was transferred to the Science appropriation in FY 2008.

Thermochemical Conversion to Ethanol

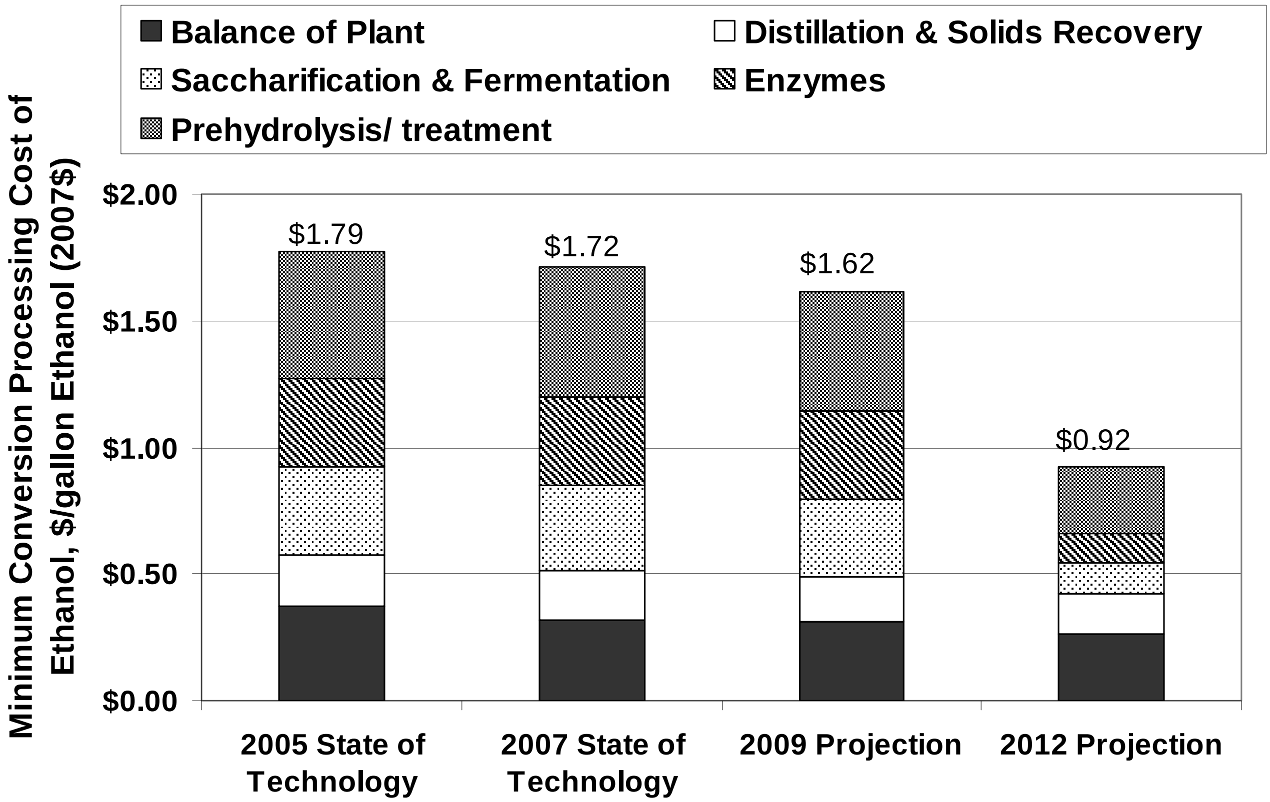


	2005 State of Technology[a]	2007 State of Technology	2009 Projection	2012 Projection
Processing Total	**$ 1.89**	**$ 1.89**	**$ 1.31**	**$ 0.86**
Balance of Plant	$ 0.11	$ 0.11	$ 0.12	$ 0.10
Product Recovery and Purification	$ 0.06	$ 0.06	$ 0.05	$ 0.05
Fuels Synthesis	$ 0.15	$ 0.15	$ 0.07	$ (0.01[b])
SynGas Cleanup & Conditioning	$ 1.13	$ 1.13	$ 0.75	$ 0.44
Gasification	$ 0.21	$ 0.21	$ 0.15	$ 0.13
Feed Handling and Drying	$ 0.27	$ 0.27	$ 0.19	$ 0.16

[a] Note: the numbers in the column below don't exactly add up to this value due to rounding in Microsoft Excel™. 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 coproduct is factored into the calculation, so in this particular instance, costs are reduced enough that the credit for the coproduct is larger than the rest of the costs; a negative cost is shown here to reflect this.

Biochemical Conversion to Ethanol



	2005 State of Technology	2007 State of Technology	2009 Projection	2012 Projection
Processing Total	**$1.79**	**$1.72**[a]	**$1.62**	**$0.92**
Prehydrolysis/ treatment	$0.50	$0.51	$0.47	$0.26
Enzymes	$0.35	$0.35	$0.35	$0.12
Saccharification & Fermentation	$0.35	$0.34	$0.31	$0.12
Distillation & Solids Recovery	$0.21	$0.19	$0.18	$0.16
Balance of Plant	$0.37	$0.32	$0.31	$0.26

The Platforms Research and Development subprogram is an integral part of the Biomass Program's partnered strategic pathway of science to research to technologies to market interdependent approach using linkages and feedback to accelerate the benefits of technology development and adoption.

Detailed Justification

	(dollars in thousands)		
	FY 2008	FY 2009	FY 2010
Thermochemical Platform R&D	**26,413**	**19,863**	**27,263**

Robust and cost-effective biomass thermal/catalytic conversion processes that can convert a variety of biomass materials to suitable clean intermediates (e.g. syngas and bio-oils) for subsequent conversion to fuels are under development. The Thermochemical Platform works to reduce costs of converting biomass and its intermediaries 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 products such as ethanol, other alcohols, gasoline, diesel, jet fuel, ethers, synthetic natural gas, or high-purity hydrogen, or may be used directly for heat and power generation. Core research addresses key technical barriers such as the need for higher yields and selectivity of the intermediates and end products. Due to subsequent catalytic conversion of syngas to ethanol, there is also a need for purification of the syngas and more robust ethanol 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.

FY 2010 activities include the continuation of validation of technology capable of economically converting biomass feedstocks, biomass residues, forest residues and other woody resources to synthesis gas or bio-oils that are suitable for fuels and chemicals production. The target for gasification and subsequent ethanol production is a modeled conversion cost of $1.10/gallon of ethanol ($2007, feedstock cost of $54.20/dry ton). This conversion cost is associated with a modeled ethanol selling price of $1.90/gallon in 2010 ($2007, feedstock cost $54.20/dry ton). The data for completing this modeling target will be produced via both National Laboratory and competitively selected projects. The competitively selected projects will involve developing syngas to liquid fuels technologies (initiated in FY 2007, and slated to be completed in 2010) and pyrolysis oil to liquid fuel conversion technologies (initiated in FY 2008, and planned to be completed in 2011). 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 will 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 fundamental understanding of the factors controlling thermochemical conversion is needed to be able to develop new or improved technologies that increase the efficiency and/or reduce the cost. As feedstock prices increase due to supply and demand, decreased conversion costs will allow the industry to utilize higher priced feedstocks.

(dollars in thousands)

Work will be done in collaboration with competitively selected 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.

	FY 2008	FY 2009	FY 2010
Biochemical Platform R&D	**39,431**	**32,131**	**30,866**

Biochemical Platform R&D focuses on reducing the cost of converting lignocellulosic biomass to mixed, dilute sugars, and further conversion to liquid fuels, like ethanol, to advance technologies needed for successful integrated biorefineries and support the realizing a modeled ethanol cost within the estimated 2012 cost-competitive target range of $1.76 to 2.06 per gallon.

In FY 2010, the Biochemical Platform will continue efforts toward reducing cellulosic biofuel costs by focusing on barriers related to feedstock interface, pretreatment and conditioning, and hydrolysis and fermentation processes (in addition to process integration). The development of these technologies will enable the conversion of a wider range of feedstocks and launch the production of the next generation of cellulosic biofuels. In addition, much of this work will benefit biofuels targeted for development in FY 2010 and beyond, including cellulosic ethanol.

Specific objectives include improved pretreatment, chemical and enzymatic methods to achieve 85 percent of xylan to xylose conversion. Current efforts toward achieving this 2010 target are described below.

Establishing the value of and requirements for feedstock assembly processes to feed bioconversion processes is important in the development of biorefineries. Activities will include developing cost and quality specifications for feedstock assembly technologies that are compatible with biochemical conversion technologies. The key technical objective is improved feedstock yield potential through targeted logistics operations between the field or forest and the biorefinery, in addition to the integration of the feedstock supply with conversion processes. While these activities will focus on the current portfolio of feedstocks, the results will inform future activities as we consider additional feedstocks (e.g. energy crops, other agricultural residues, algal biomass).

Activities will also include continuing support of public-private partnered projects from the 2007 Biochemical solicitation to support the development of commercially-viable enzymes – a key component in the production of biofuels, including cellulosic ethanol. Key objectives for these projects include increasing enzyme productivities and decreasing overall enzyme costs. These efforts will increase sugar yields, which translate into increased yields of fuels. All potential enzymes, such as cellulases and hemicellulases, will be of interest in this effort.

Integration of biomass pretreatment, saccharification and fermentation steps is needed to improve overall efficiency and reduce conversion cost. Thus, initial results from the enzyme development work started in FY 2008 will be combined with the ethanologen development work begun in FY 2007 under the Products Development Platform activity. This integration of technologies will occur at the integrated biorefinery pilot scale facility at NREL and in pilot plant operations conducted with other private sector partners. The aim of this work is to validate the integration of the separate unit operations.

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 to be a priority in FY 2010. Barriers and technical challenges identified in the first of a kind integrated biorefineries under development will determine the necessary fundamental research needs. Work outlined in DOE's EERE and Office of Science joint research agenda "Breaking the Biological Barriers to Cellulosic Ethanol" (June 2006), will also be directly applied to this R&D area. 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.

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.

	FY 2008	FY 2009	FY 2010
SBIR/STTR	**—**	**1,406**	**1,571**

In FY 2008, $1,454,000 and $174,000 were transferred to the SBIR and STTR programs respectively. The FY 2009 and 2010 amounts shown are estimated requirements for the continuation of the SBIR and STTR program.

	FY 2008	FY 2009	FY 2010
Total, Platforms Research and Development	**65,844**	**53,400**	**59,700**

Explanation of Funding Changes

	FY 2010 vs. FY 2009 ($000)
Thermochemical Platform R&D	
The increase is due to the final phase of funding for projects initiated in FY 2008 to FY 2009. In addition, a competitive solicitation is planned to develop technology for integrated syngas to infrastructure ready fuels. The solicitation will target established industrial partners, include fuel synthesis, and total $40 million between FY 2010 to FY 2014 in support of the EISA 2007 RFS targets for advanced biofuels. The solicitation will allow for core technology development, as well as scale-up of near term options in order to accelerate deployment. This funding level will support projects that utilize thermochemical processing pathways as supported by the platform, as well as existing and new project multi-year contractual agreements in the Thermochemical Platform subprogram linked to supporting the EISA 2007 volumetric targets of the RFS. A competitive National Laboratory call for new ideas (biomass-to-fuels synthesis) will also be initiated.	**+7,400**

	FY 2010 vs. FY 2009 ($000)
Biochemical Platform R&D	
This level of funding will support the continuation of multi-year projects initiated in prior fiscal years at the National Laboratories or with other competitively selected R&D partners, but not support the initiation of new projects.	**-1,265**
SBIR/STTR	
Changes in the SBIR/STTR funding are a direct result of changes in the funding of program activities.	**+165**
Total Funding Change, Platforms Research and Development	**+6,300**

Utilization of Platform Outputs R&D

Funding Schedule by Activity

	(dollars in thousands)		
	FY 2008	FY 2009	FY 2010
Utilization of Platform Outputs R&D			
Integration of Biorefinery Technologies	102,769	131,483	132,977
Products Development	9,921	15,677	13,924
SBIR/STTR	—[a]	940	899
Total, Utilization of Platform Outputs R&D	112,690	148,100	147,800

Description

The Utilization of Platform Outputs R&D subprogram consists of two major sub-elements: Integration of Biorefinery Technologies and Products Development. The Integrated Biorefineries Platform's strategic goal is to demonstrate and validate integrated technologies to achieve commercially acceptable performance and cost pro forma targets. This performance and cost data is essential to benchmarking the state of technology and production costs for current and future biorefineries. The Biomass Program is developing a suite of technologies across the biorefinery pathways to enable a broad spectrum of biomass resources to be used in the production of a variety of biofuels. The Integration of Biorefinery Technologies Platform facilitates the integrated demonstration and validation of suites of technologies including those developed under the Feedstock Infrastructure, Platforms R&D, and Products Development Platforms. Currently, the program is focused on implementing public-private cost-shared pilot, demonstration, and commercial-scale biorefinery projects.

These biorefinery projects of various scales are using a diverse spectrum of feedstocks. The projects will demonstrate and validate biorefinery concepts, and reduce technological and financial risks to enable the commercialization of future biorefineries. The program has competitively selected commercial scale (700 dry tonnes per day) and demonstration scale (minimum 70 dry tonnes per day) biorefinery projects, in FY 2007 and 2008, respectively. In FY 2009, the program issued a request for proposals for pilot scale (minimum 1 dry tonne per day) and demonstration scale (minimum 50 dry tonnes per day) projects for a broader range of feedstocks, conversion technologies, and biofuels. The program seeks project partners with credible data to support the next level of technology scale up. These cost-shared partnerships are essential to alleviating the high technical risk which will help encourage capital investment.

The Products Development Platform is currently involved in the conversion of sugars from the Biochemical R&D Platform into biofuels. The present focus on public/private partnerships works to develop a commercially viable fermentation organism which can help reduce the cost of cellulosic biofuel production.

The Integration of Biorefinery Technologies subactivity also includes the transportation fuels infrastructure activities of the Biomass Program. Transportation fuels infrastructure efforts involve collaboration with the DOE Vehicle Technologies Program, other DOE programs, and various external stakeholders to facilitate the development of a viable biofuels transportation infrastructure to support growth in the biofuels industry. To encourage large-scale market adoption of biofuels, these activities address challenges along the supply chain from the point of fuel production at the biorefinery to the point of use at the pump and in the vehicle. Activities include fuel testing on vehicles, specialty engines, and infrastructure components; development of analytical tools and data to optimize infrastructure investments (e.g. the Bioenergy Knowledge Discovery Framework, a GIS-based decision support framework incorporating the best-available feedstock and distribution infrastructure data to facilitate efficient infrastructure development by allowing data, modeling and visualization tools to be accessed and shared by multiple stakeholders, including Federal, state, and local government, researchers, and industry); and, input in the development of relevant biofuels standards.

Benefits

The Utilization of Platform Outputs R&D subprogram is comprised of the Integration of Biorefinery Technologies and Products Development key activities. The Integration of Biorefinery Technologies commercial deployment efforts are central to the Biomass Program's present strategy to support the EISA 2007 RFS by helping the American biofuels industry overcome key technical and economic barriers to rapid growth, which is essential for the meeting of EISA advanced biofuels volumetric targets. Presently, the Biomass Program is working with 4 competitively selected industry partners to establish biorefineries at full commercial scale, and with another 8 for biorefineries at 10 percent of full commercial scale. The continuation of these significant multi-year efforts, and their expansion through solicitations for additional projects, such as that currently underway in FY 2009, will validate technology, fine tune processes and subsequently reduce the risk of the commercialization of novel biorefinery technologies. Following successful Biomass Program demonstrations, the possibility for private sector partner project replication will be enhanced through their leveraging of lessons learned and the ability to garner additional capital for new projects based on proven successes. This will support the achievement of the volumetric objectives of the EISA 2007 RFS. Additionally, the testing of ethanol blends and collaborative work with external stakeholders will help to ensure a market for the transportation fuels produced by these biorefineries exists.

The efforts associated with the Products Development key activity will result in greater overall efficiency of cellulosic ethanol biorefineries, contributing to successful commercial demonstration and deployment. Improvements in all processes, including fermentation, are critical to the viability of these biorefineries, and, thus, meeting the EISA 2007 RFS volumetric goal of 16 billion gallons of cellulosic biofuels by 2022.

Collectively, these activities will promote large-scale market adaptation and private sector acceptance of biofuels as more technologies (for making biofuels, biopower, and bioproducts) involving a diversity of feedstocks are demonstrated, validated, and integrated into scalable commercially viable production systems. This will attract additional sources of financial capital at competitive rates and accelerate biorefinery commercialization and, thus, oil displacement.

Detailed Justification

	(dollars in thousands)		
	FY 2008	FY 2009	FY 2010
Integration of Biorefinery Technologies	**102,769**	**131,483**	**132,977**

In FY 2010, Integration of Biorefinery Technologies will continue cost-shared partnerships from competitive solicitations to demonstrate integrated biorefineries at various scales and across various pathways. Specifically, the program will continue to support multi-year contractual agreements from public-private partnerships initiated in FY 2007, 2008, and 2009 for commercial, demonstration, and pilot scale biorefineries, involving the production of transportation fuels and co-products (such as materials and chemicals, heat and power). Funding levels will increase on a project by project basis, as cost-share partners meet the necessary requirements in the negotiated award to move from Award 1's (pre-construction engineering design, NEPA compliance) to Award 2's (facility construction).

During FY 2010, transportation fuels infrastructure efforts will continue, which involve the testing of intermediate ethanol blends on legacy vehicles, distribution systems, small engines, and materials. In addition, studies and analyses will be conducted on the requirements for an infrastructure system that will deliver biofuels efficiently from production centers to end-users.

Products Development	**9,921**	**15,677**	**13,924**

In FY 2010, the program will continue to support the five cost-share projects selected under the FY 2007 solicitation aimed at developing fermentation organisms that display an increased productivity, stability, and robustness, at a lower cost. The goal of this effort is to accelerate the development of advanced micro-organisms capable of efficiently fermenting mixed sugars from cellulosic residues to increase biofuels production from future biorefineries, ultimately contributing to their commercial viability. This funding will also be used to conduct necessary analysis and assessment activities for conversion of advanced feedstocks such as algae to biofuels. Collectively, this work will contribute to meeting the EISA 2007 RFS targets.

SBIR/STTR	**—**	**940**	**899**

In FY 2008, $553,000 and $66,000 were transferred to the SBIR and STTR programs respectively. The FY 2009 and 2010 amounts shown are estimated requirements for the continuation of the SBIR and STTR program.

Total, Utilization of Platform Outputs R&D	**112,690**	**148,100**	**147,800**

Explanation of Funding Changes

	FY 2010 vs. FY 2009 ($000)
Integration of Biorefinery Technologies	
Funding increases support multi-year contractual agreements for commercial, demonstration, and pilot scale integrated biorefinery projects initiated by prior year solicitations.	**+1,494**
Products Development	
The funding decrease is due to reduced needs associated with the finalization of five public-private partnership projects for fermentation organism (aka ethanologen) development selected for award in FY 2007.	**-1,753**
SBIR/STTR	
Changes in the SBIR/STTR funding are a direct result of changes in the funding of program activities.	**-41**
Total Funding Change, Utilization of Platform Outputs R&D	**-300**

Cellulosic Ethanol Reverse Auction

Funding Schedule by Activity

	(dollars in thousands)		
	FY 2008	FY 2009	FY 2010
Cellulosic Ethanol Reverse Auction	4,955	0	0
Total, Cellulosic Ethanol Reverse Auction	4,955	0	0

Description

The Biomass Program established the framework for implementing a cellulosic ethanol reverse auction in accordance with Section 942 of the EPAct 2005.

The purpose of the Cellulosic Ethanol Reverse Auction was to potentially accelerate rate of introduction of cellulosic ethanol into the market place, in line with production incentives outlined in Section 942 of the EPAct 2005.

Detailed Justification

	(dollars in thousands)		
	FY 2008	FY 2009	FY 2010
Cellulosic Ethanol Reverse Auction	**4,955**	**0**	**0**
The Biomass Program evaluated and developed a framework for an ethanol reverse auction in accordance with Section 942 of EPAct 2005.			
Total, Cellulosic Ethanol Reverse Auction	**4,955**	**0**	**0**

Solar Energy

Funding Profile by Subprogram
(Non-Comparable, or as Appropriated, Structure)

	(dollars in thousands)		
	FY 2008 Current Appropriation[a]	FY 2009 Omnibus Appropriation	FY 2010 Request
Solar Energy			
Photovoltaic Energy Systems	136,744	145,000	149,470
Concentrating Solar Power	27,617	30,000	78,420
Systems Integration	–	–	29,660
Market Transformation	–	–	27,450
Solar Electricity Energy Innovation Hub	–	–	35,000
Solar Heating and Cooling Systems[b]	1,959	–	–
Total, Solar Energy	166,320	175,000	320,000

Funding Profile by Subprogram
(Comparable Structure to the FY 2010 Request)

	(dollars in thousands)		
	FY 2008 Current Appropriation [a]	FY 2009 Omnibus Appropriation	FY 2010 Request
Solar Energy			
Photovoltaic R&D	112,320	124,540	149,470
Concentrating Solar Power	24,420	24,310	78,420
Systems Integration	11,690	12,120	29,660
Market Transformation	15,931	14,030	27,450
Solar Electricity Energy Innovation Hub	–	–	35,000
Solar Heating and Cooling Systems [b]	1,959	–	–
Total, Solar Energy	166,320	175,000	320,000

Public Law Authorizations:

P.L. 93-409, "Solar Heating and Cooling Demonstration Act" (1974)

[a] SBIR/STTR funding was transferred to the Science Appropriation in FY 2008, which includes a reduction of $1,904,000 that was transferred to the SBIR program and $299,000 that was transferred to the STTR program.
[b] Transferred to EERE Buildings Technologies Program in FY 2009.

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" (1989)
P.L. 101-575, "Solar, Wind, Waste, and Geothermal Power Production Incentives Act of 1990" (1990)
P.L. 102-46, "Solar, Wind, Waste, and Geothermal Power Production Incentives Technical Amendments Act" (1991)
P.L. 102-486, "Energy Policy Act (EPAct)" (1992)
P.L. 109-58, "Energy Policy Act of 2005" (2005)
P.L. 110-140, "Energy Independence and Security Act of 2007" (2007)

Mission

The mission of the Solar Energy Program (Solar Program) is to conduct research, development, demonstration and deployment activities to accelerate widespread commercialization of clean solar energy technologies which will lower greenhouse gas emissions, provide a clean and secure domestic source of energy, and create high-paying green jobs.

Modifications were made to the budget structure to better reflect the Solar Energy Program's activities in FY 2010. The two tables above show a non-comparable and comparable funding profile at the subprogram level. The non-comparable table presents the FY 2010 funding in the new budget structure only with the FY 2008 and FY 2009 funding shown as appropriated. The comparable table shows the FY 2008 and FY 2009 funding in the new budget structure to assist in comparing year-to-year funding trends. A cross-walk of the new and old structure is provided in the detail section below that describes the modification to the budget structure and the rationale behind the proposed changes.

Benefits

The United States is the world's largest consumer of electricity, and at the same time has the largest solar resource of any industrialized country.[a] Developing technologies that can reliably and affordably harvest this resource will greatly enhance national energy security while reducing the threat of global warming and create high-paying U.S. jobs. To accomplish this mission, the Solar Program invests in two basic types of solar technologies – photovoltaics (PV) which convert the sun's energy directly into electricity, and concentrating solar power (CSP) technologies which concentrate the sun's rays and produce electricity from the resulting thermal energy.

The R&D effort focuses on technology pathways that have the greatest potential to lower costs and improve performance. Industry-led R&D partnerships, known as "Technology Pathway Partnerships (TPPs)," address the issues of cost, performance and reliability associated with each technology pathway, while other mostly university-led efforts focus on next generation PV devices and processes. Partners include industry, universities, laboratories, and other governmental entities broadening the base and increasing the likelihood of achieving the goals. Our modeling suggests that, in 2015, outcomes and benefits could include 5 to 10GW of cumulative new capacity.

Today, solar energy systems are well established. Demand for these systems is growing in many parts of the world. Possible near-, mid-, and long-term scenarios for solar technologies are:

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[a] Based on radiation data collected by the National Renewable Energy Laboratory.

- Near-term – as system costs continue to decrease, the number of grid-connected solar systems could increase quite rapidly, meeting local energy needs such as decentralized and potentially uninterruptible power, community power, or peak shaving;
- Mid-term – reductions in cost could encourage penetration by solar technologies into large-scale markets, first in distributed markets such as commercial buildings and communities, and later in utility-scale systems; and
- Long-term – provide both distributed and centrally generated electricity and heat throughout the U.S., with an increasing share of residential and commercial buildings generating their own energy on-site with grid-connected systems.

DOE analysis of the potential benefits of its renewable energy programs suggest that by 2030, the Solar Program can directly contribute to private sector development of more than 70GW of electric power to the grid and reduce carbon emissions by roughly 500 million metric tons, and can essentially triple those contributions by mid-century.

The proposed FY 2010 Budget investments complement funds provided by the Recovery Act that accelerated the development of critical path technologies in support of the program's goals of making electricity generated from solar competitive with conventional grid electricity by 2015, and address market barriers and accelerating the development of advanced and next generation PV technology. To enable decision makers and the public to follow performance and plans, the program will post its progress in these planned activities at: http://www.energy.gov/recovery/index.htm.

In addition, the FY 2010 Budget proposes several structural changes within the Solar Energy Program. The PV and CSP Programs were brought together under a single Solar Program in FY 2003. Since that time, Solar has been managed as a single program, with corporate needs for crosscutting areas such as systems analysis, resource assessment, and technical outreach. Accordingly, Solar now consists of four subprograms - two technologies based, PV & CSP, and two crosscutting, Systems Integration and Market Transformation. In this way, the program preserves the technology distinction between two fundamentally different ways of producing solar power, while providing two distinct crosscutting areas that afford better efficiency in addressing needs common to the entire solar technology portfolio. The two technology paths focus on cost reduction, while the two crosscutting paths focus on enabling the high penetration of solar into the market. Together they form an effective strategy for making solar a significant contributor to U.S. alternative energy.

Climate Change

The Solar Program's research, development, demonstration and deployment activities all support the achievement of a national reduction in greenhouse gas (GHG) emissions. Solar technologies have the potential for significantly displacing fossil-based electricity generation, thus reducing the amount of carbon emitted into the atmosphere. For example, DOE analysis suggests that by 2030 the Solar Program's activities could directly contribute to a cumulative reduction of more than 400 million metric tons of CO_2. By mid-century these benefits could increase tenfold.

Energy Security

While solar does not directly displace petroleum imports for transportation, it does displace natural gas used in the electricity sector. Thus, increasing the use of solar for electricity generation will have 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, could also help to displace the demand for petroleum and/or 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.

Economic Impact

Due to continued improvements in the cost and performance of solar technologies the program's activities could result in considerable savings to consumers. For example, by 2030 the program's activities could directly contribute to a cumulative savings to consumers of at least $15 billion (primarily in the form of savings on consumer electricity bills). Consumer savings could grow rapidly to more than $200 billion.

The benefit tables below shows the estimated benefits from 2015 through 2050 that would result from realization of the program's goals. These benefits are achieved by targeted Federal investments in technology research and development in partnership with industry members, universities, National Laboratories, States other governmental and/or other stakeholders. These partnerships facilitate the technical coordination of activities and attract cost sharing to provide leveraged benefits.

The benefits table also reflects the increasing market share of advanced solar technologies over time as projected installed system costs decline and system performance improves. The expected benefits reflect solely the achievement of the program's goals. Not included are any policies, regulatory mechanisms, or other incentives already in existence that might be expected to support or accelerate the achievement of the program goals.

The program goal case is modeled along with a "baseline" case in which no DOE R&D exists. The baseline case is intended to represent the future without the effect of the Solar Energy Program, and is identical for all DOE applied energy R&D programs, thereby ensuring that all program benefits are estimated using the same assumptions for external factors such as economic growth, energy prices, and levels of energy demand. The expected outcome benefits are calculated using the same fundamental methodology across EERE and across all of DOE's applied energy R&D programs, and the metrics by which expected outcome benefits are measured are identical. This standardization of method and metrics has been undertaken as part of DOE's efforts to make all program stated benefits comparable.

Prospective benefits are calculated as the arithmetic difference between the baseline case and the program goal case, and the resulting economic, environmental and security benefits attributed to the program's activities. This approach of calculating the benefits as an incremental improvement to the baseline helps ensure that improvements in solar energy technologies that would occur in the absence of the program are not counted as part of the program's benefits. In addition to technology and process advances due to the program's activities, energy market policies, such as solar tax policy and state and Federal tax policies, facilitate the development and deployment of clean energy technologies. The expected impacts of current legislated policies in the baseline case are included so that the expected benefits calculated reflect as much as possible the effects of activities funded by the program. In 2007, Congress passed the Energy Independence and Security Act (EISA 2007). This act included several important authorizations to advance solar power which included training workforce and research and development to improve solar technologies. These new EISA authorizations are considered current policies in the baseline case.

The benefits are generated by modeling both the program goal and baseline cases within two energy-economy models: NEMS-GPRA10 for benefits through 2030, and MARKAL-GPRA10 for benefits through 2050. The full list of modeled benefits appears below.

Primary Metrics for FY 2010 Budget Request

(Incorporates Approximate Impacts of EISA 2007)

	Metric[1]	Model	Year			
			2015	2020	2030	2050
Energy Security	Oil Imports Reduction, cumulative[2] (Bil bbl)	NEMS	ns	ns	ns	N/A
		MARKAL	ns	ns	ns	ns
	Natural Gas Imports Reduction, cumulative (Tcf)	NEMS	ns	ns	ns	N/A
		MARKAL	ns	ns	ns	13.1
	Reduction in Share of Highway Fuel Demand Derived from Crude Oil[3] (%)	NEMS	ns	ns	ns	N/A
		MARKAL	ns	ns	ns	ns
Environmental Impacts	CO_2 Emissions Reduction, cumulative (Mil mtCO_2)	NEMS	ns	ns	426	N/A
		MARKAL	5	16	523	4795
	SO_2 Allowance Price Reduction[4] ($/ton)	NEMS	ns	ns	ns	N/A
		MARKAL	N/A	N/A	N/A	N/A
	NO_x Allowance Price Reduction ($/ton)	NEMS	ns	ns	626	N/A
		MARKAL	N/A	N/A	N/A	N/A
	Hg Allowance Price Reduction (thousand $/lb)	NEMS	ns	ns	ns	N/A
		MARKAL	N/A	N/A	N/A	N/A
Economic Impacts	Consumer Savings, cumulative[5] (Bil $)	NEMS	ns	ns	15	N/A
		MARKAL	3	10	46	235
	Electric Power Industry Savings, cumulative (Bil $)	NEMS	2	6	34	N/A
		MARKAL	5	10	14	111
	Household Energy Expenditures Reduction ($/household/yr)	NEMS	ns	ns	30	N/A
		MARKAL	8	13	11	61

1. "Reductions" and "savings" are calculated as the difference between results from the baseline case (i.e. no DOE technology) and the technology case (i.e. all DOE technology R&D programs are successful).
2. All cumulative metrics are based on results beginning in 2010.
3. Metric includes oil-derived fuel use by light-duty vehicles, commercial light trucks and freight trucks; the metric excludes buses. Reported oil use is adjusted to exclude ethanol, biodiesel and CTL.
4. All monetary metrics are in 2006$.
5. Cumulative monetary metrics are in 2006$ that are discounted to 2010 using a 3% discount rate.
ns - Not significant
NA - Not yet available
N/A - Not applicable

Secondary Metrics for FY 2010 Budget Request

(Incorporates Approximate Impacts of EISA 2007)

	Metric[1]	Model	Year 2015	2020	2030	2050
Energy Security	Oil Imports Reduction, annual (Mbpd)	NEMS	ns	0.0	0.0	N/A
		MARKAL	0.0	0.0	0.0	ns
	Natural Gas Imports Reduction, annual (Tcf)	NEMS	0.0	0.0	0.1	N/A
		MARKAL	0.0	0.0	0.0	1.1
	MPG Improvement[2] (%)	NEMS	0%	0%	0%	N/A
		MARKAL	ns	0%	0%	ns
Environmental Impacts	CO_2 Intensity Reduction of US Economy (Kg CO2/$GDP)	NEMS	ns	ns	ns	N/A
		MARKAL	ns	0.00	0.01	0.01
	CO_2 Intensity Reduction of US Power Sector[3] (Kg CO2/kWh)	NEMS	ns	ns	ns	N/A
		MARKAL	ns	0.00	0.02	0.06
	CO_2 Intensity Reduction of US Transportation Sector[4] (Kg CO2/mile)	NEMS	ns	ns	ns	N/A
		MARKAL	ns	ns	ns	ns
Economic Impacts	Consumer Savings, annual[5] (Bil $)	NEMS	ns	ns	7	N/A
		MARKAL	1	3	12	69
	Electric Power Industry Savings, annual (Bil $)	NEMS	1	1	8	N/A
		MARKAL	ns	ns	6	32
	Energy Intensity of US Economy (energy/$GDP)	NEMS	ns	ns	0.02	N/A
		MARKAL	ns	ns	0.03	0.07
	Net Energy System Cost Reduction, cumulative (Bil $)	NEMS	N/A	N/A	N/A	N/A
		MARKAL	ns	2	15	80

1. "Reductions" and "savings" are calculated as the difference between results from the baseline case (i.e. no DOE technology) and the technology case (i.e. all DOE technology R&D programs are successful).
2. Change in light duty vehicles miles traveled per gallon of oil, where oil is only that derived from petroleum.
3. Emissions include all power sector emissions. Generation calculated as total net generation adjusted for estimated T&D losses.
4. Emissions calculated using highway fuel use and related carbon emission factor. Miles calculated as highway miles traveled, excluding buses.
5. All monetary metrics are in 2006$.
ns - Not significant
NA - Not yet available
N/A - Not applicable

The following external factors could affect the Solar Program's ability to achieve its strategic goal:

- Material costs and availability (e.g., silicon supply, etc.);
- Labor costs;
- Currency exchange rates;
- The price and availability of alternative technologies and conventional fuels;
- International R&D and deployment efforts;
- Financial incentives and other policies;
- Interest rates and inflation;

- State and local regulation;
- Market participant withdrawal or entry;
- Building community infrastructure; and
- Utility barriers and pricing strategies.

Contribution to the Secretary's Priorities

The Solar Program activities contribute to several of the Secretary's priorities as enumerated below. The principal focus area(s) are Clean Energy and Economic Prosperity.

Priority 1: Science and Discovery – Invest in science to achieve transformational discoveries.

The Solar Energy Program re-energizes the National Laboratories as centers of great science and innovation through lab facility improvements and increased hiring of post-doctoral students. It also creates an effective mechanism to integrate National Laboratory, university, and industry activities through joint solicitations, on topics such as thermal storage that require inputs from all sectors. The Solar Program also participates in the IPCC and contributes to IEA solar related tasks. The Solar Program connects basic and applied sciences through collaborations with DOE's Office of Science, the National Institute of Standards and Technology (NIST), and National Science Foundation (NSF).

Priority 2: Clean Energy – Change the landscape of energy demand and supply.

The Solar Program demonstrates and facilitates the deployment of a range of solar energy technologies with commercial partners, while also aggressively advancing a wide-range of solar energy technologies through cutting edge R&D, working with the National Laboratories, universities, private sector partnerships, and other non-profit research organizations.

Priority 3: Economic Prosperity – Create millions of green jobs and increase competitiveness.

The Solar Program works to develop low-cost solar technologies for residential, commercial and utility-scale applications. These technologies will contribute to fostering economic prosperity through creating green jobs, reducing consumers' energy bills, and improving the reliability of the electricity system.

Priority 5: Lower GHG Emissions – Position U.S. to lead on climate change policy, technology, and science.

The Solar Energy Program works through the International Energy Agency (IEA) in PV and CSP technologies to define joint areas of collaborative research and develop standards that would facilitate the manufacturing scale-up improvements and uniform testing protocols.

Contribution to GPRA Unit Program Goal 1.1.03.00 (Solar Energy)

Solar Energy Program contribute to Strategic Goal 1.1.03.00 by developing next generation technologies with improved performance and by reducing system, manufacturing, and installation costs of solar energy technologies to levels competitive with fossil and nuclear energy sources.

Means and Strategies

The Solar Program will use various means and strategies to achieve its GPRA Unit Program goals as described below. "Means" include operational processes, resources, information, and the development of technologies, and "strategies" include program, policy, management and legislative initiatives and approaches. Various external factors, as listed below, may impact the ability to achieve the program's goals. Collaborations are integral to the planned investments, means and strategies, and to addressing external factors.

The Solar Program will implement the program using the following means:

- Perform research, development, demonstration and deployment activities in partnership with coalitions of industry members, universities, National Laboratories and/or States to reduce costs;
- Increase PV module efficiency, system reliability, and manufacturing capability; develop lower cost production processes for cells and modules;
- Select technology pathways for accelerated development of improved manufacturing methods, materials use, defect control and throughput;
- Increase the efficiency and reliability of CSP systems;
- Develop low-cost thermal storage for CSP systems;
- Conduct systems integration activities such as technology modeling and analysis to help identify research priorities;
- Identify the barriers and benefits of grid integration;
- Work with Solar America Cities to build sustainable solar infrastructures, while assisting a second round of cities in defining and launching their activities;
- Conduct other market transformation activities to identify and address market barriers to solar technology usage, and promote market expansion opportunities; and
- Coordinate with the Buildings Technologies Program through the Solar Buildings Initiative to accelerate deployment of higher-efficiency buildings incorporating PV technologies.

The Solar Program uses the following strategies:

- Work with cost-shared partnerships consisting of industry members, universities, National Laboratories, States and/or other governmental entities to solve scientific and technical barriers necessary to improve performance and reliability, while reducing cost in PV technology pathways;
- Work with States, industry, and other entities to leverage Federal taxpayer resources, communicate technology advances and opportunities effectively, reduce barriers, and accelerate market penetration of technology applications; and
- Work with the Office of Science, the Building Technologies Program and the Federal Energy Management Program on solar R&D and deployment opportunities. This includes work with other agencies such as the Defense Advanced Research Projects Agency (DARPA), the BLM, and others.

These strategies will significantly reduce the cost of solar technologies, which will improve energy security by increasing the amount, availability and diversity of the domestic energy supply.

The Solar Program will work with solar energy and other industry experts outside of DOE to:

- Ensure that the Solar Program's research directions and priorities address the needs of manufacturers, utilities, state agencies, consumers, and other stakeholders;
- Ensure that program activities are within the realm of technical feasibility and properly aligned with market forces;

- Develop technology roadmaps and peer reviews, versions of which have been completed within the last two years for each of the primary solar subprograms;
- Ensure that adequate Federal land is made available for solar power plants; and
- Ensure that adequate transmission is allocated for solar projects.

Validation and Verification

To validate and verify program performance, the Solar Program will conduct internal and external reviews and audits. The table below summarizes validation and verification activities.

Data Sources:	National Solar Technology Roadmaps (2007); Annual Energy Outlook (2007); Solar Program Peer Review (2005); Sargent and Lundy, Assessment of Parabolic Trough and Power Tower Solar Technology Cost and Performance Forecasts (2003); National Research Council, Critique of the Sargent and Lundy Draft Assessment of Cost and Performance Forecasts for Concentrating Solar Power (2002); National Research Council, Renewable Power Pathways: A Review of DOE's Renewable Energy Programs (2000).
Baselines:	The Solar Program's 2003 baselines for system production cost reduction goals are: \$0.19 to \$0.24/kWh for PV electric energy (see the Solar Program Multi-Year Technical Plan) and; \$0.12 to \$0.14/kWh for electricity from CSP technologies (See the CSP Technology Transition Plan 2004). Sargent and Lundy are working on updating the baseline based on 2008 costs.
Frequency:	Annual.
Evaluation:	In carrying out the program's mission, the Solar Program uses several forms of evaluation to assess progress and to promote program improvement: ▪ Technology validation and operational field measurement; ▪ Implementation of a consistent methodology across the program for analyzing levelized cost of energy (LCOE); ▪ Critical peer review of both the program and subprogram portfolios and activities by independent outside experts; ▪ Annual internal Technical Program Review of the Solar Program; ▪ A Technical Review Team specific to the SAI; ▪ Specialized program evaluation studies to examine process, impacts, or market baseline and effects, as appropriate; ▪ Quarterly and annual assessment of program and management results based performance through Joule (the DOE quarterly performance progress review of budget targets); ▪ Annual review of methods, and re-computation of potential benefits for the Government Performance and Results Act (GPRA).

Data Storage:	EIA and other organizations, such as National Laboratories (including the National Renewable Energy Laboratory, Sandia National Laboratories (Sandia), store data on computer servers.
Verification:	Peer reviews; National Laboratory system and component test data; trade association reviews; National Laboratory survey of PV manufacturing cost/capacity data from U.S. industry; EIA survey of solar manufacturers; literature reviews.

Annual Performance Results and Targets

FY 2005 Results	FY 2006 Results	FY 2007 Results	FY 2008 Results	FY 2009 Targets	FY 2010 Targets
GPRA Unit Program Goal 1.1.03.00 (Solar Energy)					
Photovoltaic R&D					
Verify, using standard laboratory measurements, a conversion efficiency of 13.5 percent of U.S.-made, commercial crystalline silicon PV modules. Production cost of such modules is expected to be $1.95 per Watt. [MET]	Verify, using standard laboratory measurements, a conversion efficiency of 13.8 percent of U.S.-made, commercial crystalline silicon PV modules. Production cost of such modules is expected to be $1.90 per Watt. [MET]	Verify, using standard laboratory measurements, a conversion efficiency of 14.5 percent of U.S.-made, commercial crystalline silicon PV modules. Production cost of such modules is expected to be $1.80 per Watt. [MET]	Reduce producer manufacturing cost of silicon PV modules to $1.70 per Watt, roughly equivalent to a modeled levelized cost of energy of $0.14-$0.23/kWh. [MET]	Modeled levelized cost of $0.17-$0.20/kWh for residential PV applications.	Modeled levelized cost of $0.15-$0.18/kWh for residential PV applications.
Develop thin-film PV modules with an 11.0 percent conversion efficiency that are capable of commercial production in the U.S. [MET]	Develop thin-film PV modules with an 11.2 percent conversion efficiency that are capable of commercial production in the U.S. [MET]	Develop thin-film PV modules with an 11.8 percent conversion efficiency that are capable of commercial production in the U.S. [MET]	Complete R&D that will reduce the direct manufacturing cost of thin film PV modules to $1.60 per Watt, roughly equivalent to a modeled levelized cost of energy of $0.14-$0.23/kWh. [MET]	Modeled levelized cost of $0.12-$0.16/kWh for commercial PV applications.	Modeled levelized cost of $0.10-$0.14/kWh for commercial PV applications.
Concentrating Solar Power					
	Conduct advanced research on trough collectors and receivers that will lead to a reduction in the modeled cost of energy from CSP troughs to $0.12-$0.14/kWh. [MET]	Develop CSP trough collector and receiver technologies that enable a system conversion efficiency of 13.1 percent. The levelized cost of energy from such a system is expected to be in the range of $0.11-$0.13/kWh. [MET]	Modeled levelized cost of power from large-scale concentrating solar power (CSP) plants in the range of $0.11-$0.13/kWh from completed R&D. [MET]	Modeled levelized cost of $0.10-$0.12/kWh for utility -scale CSP applications.	Modeled levelized cost of $0.10-$0.12/kWh for utility-scale CSP applications.
Systems Integration					
					Identify at least 5 SEGIS awards to move into prototype development in Phase II.
Market Transformation					
					Complete technical assistance to 20 Solar America Cities to address issues such as financing, permitting, city planning, and outreach.

FY 2005 Results	FY 2006 Results	FY 2007 Results	FY 2008 Results	FY 2009 Targets	FY 2010 Targets
Solar Heating and Cooling Systems					
Achieve 5.0 cents per kilowatt-hour modeled cost of energy from solar water heater capable of operating in non-freezing climates. [MET]					
General Program Goals					
Contributed proportionately to EERE's corporate goal of reducing corporate and program adjusted uncosted obligated balances to a range of 20-25 percent by reducing program annual adjusted uncosteds by 10 percent in 2005 relative to the program FY 2004 end of year adjusted uncosted baseline ($19,342K) until the target range is met. [MET]	Maintain total administrative overhead costs (defined as program direction and program support excluding earmarks) in relation to total program costs of less than 12 percent. [MET]	Maintain total administrative overhead costs (defined as program direction and program support excluding earmarks) in relation to total program costs of less than 12 percent. [MET]	Maintain administrative costs as a percent of total program costs less than 12 percent. [MET]	Maintain administrative costs as a percent of total program costs less than 12 percent.	Maintain administrative costs as a percent of total program costs less than 12 percent[a].

[a] Administrative costs are comprised of Program Direction and elements of Program Support (Technology Advancement and Outreach; and Planning, Analysis and Evaluation), baseline and targets under development.

Photovoltaic R&D

Funding Schedule by Activity
(Comparable, or as Appropriated, Structure)

	(dollars in thousands)		
	FY 2008	FY 2009	FY 2010
Photovoltaic Energy Systems			
Applied Research	36,861	41,439	48,539
Systems Development	64,210	67,725	87,550
Technology Evaluation & Integration	21,503	21,209	10,870[a]
Technology Acceptance	14,170	12,420	0[b]
SBIR/STTR	–[c]	2,207	2,511
Total, Photovoltaic Energy Systems	136,744	145,000	149,470

Photovoltaic R&D

Funding Schedule by Activity
(Non-Comparable Structure to the FY 2010 Request)

	(dollars in thousands)		
	FY 2008	FY 2009	FY 2010
Photovoltaic R&D	0	0	146,959
Applied Research	*36,861*	*41,439*	–
Systems Development	*64,210*	*67,725*	–
Technology Evaluation & Integration	*21,503*	*21,209*	–
Technology Acceptance	*14,170*	*12,420*	–
SBIR/STTR	–[d]	2,207	2,511
Total, Photovoltaic Energy Systems	136,744	145,000	149,470

Description

Modifications were made to the budget structure to better reflect Photovoltaic R&D activities in FY 2010. The two tables above show a non-comparable and comparable funding profile at the subprogram level. The non-comparable table presents the FY 2010 funding in the new budget structure only and FY 2008 and FY 2009 funding is shown as appropriated. The comparable table shows the FY 2008 and FY 2009 funding in the new budget structure to assist in comparing year-to-year funding trends.

[a] This amount represents the tech evaluation funding for PV only. The rest is now included in the new Systems Integration subprogram.
[b] This funding is now covered in the new Market Transformation subprogram.
[c] SBIR/STTR funding was transferred to the Science Appropriation in FY 2008.
[d] SBIR/STTR funding was transferred to the Science Appropriation in FY 2008.

Photovoltaic (PV) technologies utilize semi-conducting materials that directly convert sunlight into electricity. Modular by nature with no moving parts, they can be sized to almost every need and placed almost anywhere sunlight is available. This characteristic differentiates PV from almost all other renewable energy technologies and allows electricity to be created where consumed thereby reducing the need for addition transmission lines.

The basic building block of a PV system is the solar cell that converts sunlight into electricity. Solar cells are connected together to form modules. Modules can be further connected together to form arrays. Modules and/or arrays are primarily used to feed electricity directly into the grid via inverters and can be used to power electrical appliances, such as security lighting or highway signs. R&D efforts focus on improving performance and reliability of systems, and reducing manufacturing and installation costs.

Module size is typically one square meter with a power output ranging from roughly 80 to 200 Watts (W), roughly 2 to 4 times the energy needed for the typical incandescent light bulb (but 8 to 16 times a typical compact fluorescent light bulb). The module comprises 50 to 60 percent of the levelized cost of energy yielded from a PV system and presents a significant opportunity for cost savings. Crystalline silicon is the most mature technology and comprises greater than 85 percent of the market. New technologies with the potential for lower costs include thin films and high performance multi-junction cells for use in concentrating collectors.

To accelerate cost reductions the PV subprogram is accelerating R&D to focus on full system solutions with the highest potential to reach cost competitiveness by 2015. New industry-led partnerships, known as "Technology Pathway Partnerships" (TPPs) are being funded to address the technical issues associated with each pathway. Milestones and metrics are used in a stage-gate process to monitor progress and down select poorly performing projects to ensure that only those technology pathways that have the most potential move forward. This strategy is aimed to maximize public funding benefits while increasing the chance of achieving program goals.

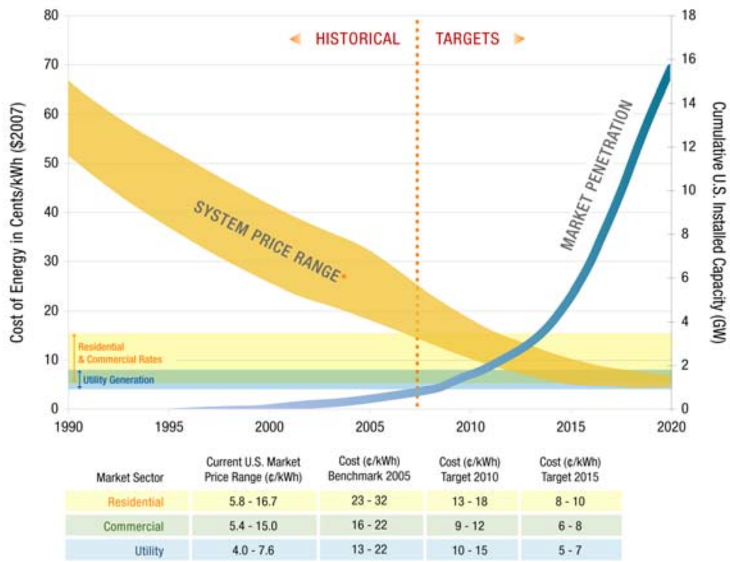
For FY 2010, the PV subprogram's priorities are:

- Align R&D activities to concentrate on the most promising technology pathways and market acceptance activities;
- Produce R&D results and meet all technical milestones commensurate with the second full year of industry-led multi-year 50/50 cost-shared contracts under competitive solicitations to reduce costs. The TPPs and Technology Acceptance activities will include teams with industrial, university, National Laboratory, and/or state agency partners;
- Advance module and system manufacturing technologies to achieve higher performance and lower-cost products with faster throughput; and
- Continue systems reliability research to increase the lifetime of modules and the mean time to failure of DC-to-AC current inverters for low-cost, grid-tied distributed PV systems.

Benefits

The Solar Program goal of achieving cost-competitive solar electricity translates to a range of costs based on specific markets. For PV, the estimated cost ranges for market-specific cost-competitive electricity generation in 2015 are:

- 5-7¢/kWh for centralized power markets;
- 6-8¢/kWh for commercial markets; and
- 8-10¢/kWh for residential markets.
- By 2010, reduce the 30-year user cost for PV electric energy to 10-18¢/kWh from 18-23¢/kWh in 2005.[a,b]



Because the Solar Program is designed to affect the levelized cost of energy, the program changed the primary metrics from $/W to $/kWh. In addition, the metric was split into commercial/utility and residential, which more accurately reflect the divides of the solar market. The cost of power is expressed in ranges due to the diversity of PV module applications. The low-end reflects commercial applications under good conditions, such as advantageous financing terms and sunny locations, while the higher end is more common in residential applications. Costs could be impacted by changing key factors such as: interest rates; labor costs; raw material costs; Federal, state and local incentives; global deployment efforts; and geography of installation. A sample of data across U.S. installations was used to calibrate the cost analysis tool, which resulted in higher cost estimates for residential PV installations.

Projected Solar Energy Costs Targets and Actuals

	Historic					
	2003	2004	2005	2006	2007	2008
Levelized Electricity Cost from PV Modules ($/kWh)[c]						
Target	0.19-0.24	0.18-0.23	0.18-0.23	0.17-0.23	0.16-0.27	0.14-0.23
Actual	0.19-0.24	0.18-0.23	0.18-0.23	0.17-0.23	0.16-0.27	0.14-0.23

[a] Key technology pathways to the goals include detailed annual performance progress indicators are presented in their respective benefits sections.
[b] The additional American Recovery Reinvestment Act funds would increase the probability of achieving the goals.
[c] The Levelized Cost of Electricity (LCOE) is the principle metric by which electricity generation technologies are compared. This established basis for evaluating the cost of a generation method takes into account those aspects of a technologies performance that directly impact power generation efficiency, system cost, and reliability. LCOE is a measure of the total lifecycle costs associated with a PV system divided by the expected lifetime-energy output, while accounting for the appropriate adjustments such as time value of money, etc. The National Renewable Energy Laboratory (NREL) has developed a robust model that considers the climatic variables which impact solar energy generation for hundreds of US locations called: the Solar Advisor Model (SAM). The SAM was used by EERE's Solar Program to calculate the LCOE estimates if its technical goals were met, under a range of assumptions about factors outside the Program's direct control, such as Operations & Maintenance costs.

	Planned			
	2009	2010	2011	2015
Levelized Electricity Cost from Residential PV Modules ($/kWh)				
Target	0.17-0.20	0.15-0.18	0.13-0.16	0.08-0.10
Levelized Electricity Cost from Commercial Utility PV Modules (E/kWh)				
Target	0.12-0.16	0.10-0.14	0.09-0.13	0.05-0.08

Detailed Justification

(dollars in thousands)	FY 2008	FY 2009	FY 2010
Photovoltaic R&D	**0**	**0**	**146,959**

The Photovoltaic R&D subprogram has five components: Exploratory Research, Conversion Devices, Measurements and Characterization, Systems Development, and Technology Evaluation.

Exploratory Research consists of work on cutting-edge next generation R&D, which currently includes technologies such as plasmonics, organic cells, and multiple exciton generation (MEG). The core activity is the Next Generation PV R&D work, begun in FY 2008 through a competitive solicitation that resulted in awards to universities and industry members. These three year projects will reach go/no-go decision points in FY 2010. R&D on non-traditional PV technologies is essential to ensure innovation and support the development and expansion of advanced PV options. Seed funding for refreshing the National Laboratory PV research portfolio with the earliest stage technology is also a focus of Exploratory Research. This work helps bridge the gap between basic science and technology development. (Approximate funding $13,300,000)

Conversion Devices covers research to improve PV cells in all the major currently commercially available technologies: Wafer Silicon, Film Silicon, Copper Indium Gallium Selenide (CIGS), Cadmium Telluride (Cd Te), Concentrating PV, Organic PV, and Sensitized Cells. The focus of this R&D is semiconductor materials, device properties, and fabrication processes to improve the efficiency, stability, and cost of PV solar energy conversion. Researchers work closely with industry to help solve current problems, and conduct further research to prepare improvements that industry can adopt in the future. (Approximate funding $19,100,000)

The Measurement and Characterization activity supports cross-cutting research including the device-level analysis of NREL's Measurements and Characterization (M&C) group and the new manufacturing-development focused Process Development Integration Laboratory (PDIL), housed in the Science and Technology Facility at NREL. M&C provides test, measurement, and analysis support and research for all PV material technologies, and 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 commercial product development. The PDIL 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. With the capability to study their processes in more depth as the cells are made, the improvement in manufacturing will be accelerated. (Approximate funding $13,400,000)

The Systems Development activity works primarily through cost-shared contracts with industry to advance the development of PV systems and components. This activity has three primary projects: the TPPs; the PV Incubator Project; and the University Process and Product Development.

The industry-led TPPs are executing projects segmented into three manageable three-year phases, with new funding opportunities released at the completion of each phase ─ for both continuing industry-led teams and new applicants. These phases will progressively reduce the cost of commercially-available PV systems and components, and will ultimately yield commercial products and production processes that achieve the cost and capacity targets for 2015.

In FY 2010, the third year of the first phase, the partnerships will focus on development, testing, demonstration, validation, and interconnection of new PV components, systems, and manufacturing equipment. Results from these projects will help inform the issuance of a funding opportunity announcement for a second round of projects.

In phase one, TPPs are developing new PV solutions for the residential, commercial, and utility market sectors of grid-tied electric power:

- Residential Rooftop Market ─ Typically mounted on rooftops and range in size from under 1kW to 10kW, most commonly in the 3 to 4 kW range. These systems are connected to the grid on the retail (customer) side of the utility meter. These systems can be retrofitted onto existing homes or integrated into new construction through building-integrated PV (BIPV) designs.
- Commercial Rooftop Market ─ Typically mounted on the large flat roofs of commercial, institutional, and industrial buildings, ranging in size from less than 10kW to 500kW and connected on the retail side of the utility meter. Retrofits and BIPV are also possible applications in this market.
- Utility Market ─ Large-scale (multi-megawatt) systems that displace conventional utility generated intermediate load (e.g. natural gas continuous cooling transformation (CCT) plants) on a wholesale basis. Typical utility PV systems are ground-mounted and range in size from 1MW to10MW, although much larger systems are also possible. Designs include both fixed and tracking configurations.

The TPPs are developing systems which have the greatest potential for cost-competitiveness by 2015. Examples of promising PV technologies include crystalline silicon, thin film, and concentrating PV. The partnerships are also developing and testing balance-of-system component designs that address emerging requirements for modularity, interface standardization, reliability, and decreased installation cost.

(dollars in thousands)

FY 2008	FY 2009	FY 2010

The PV Incubator project, launched in FY 2008, enables start-up PV companies to work with the National Laboratories to scale up laboratory processes into pilot manufacturing processes. Additional awards are issued each year, with the third round planned for FY 2010. All performers will continue to work closely with the laboratories in order to deliver new module prototypes and demonstrate ≥ 3MW of pilot production within 18 months of the start of the projects. This will reduce risk in capital investments for manufacturing capacity expansion, and allow private capital markets to fund the build-out of manufacturing capacity based on these projects.

The University Process and Product Development Project, entering its third year, leverages the essential expertise that universities hold through competitively awarded university-led process and product development projects. Universities possess a fundamental understanding of materials and device physics, as well as experience with laboratory-scale processes and prototype production. This experience uniquely positions universities to leverage their knowledge in assisting the transition of PV technology from laboratory to marketplace, as well as offer guidance to industry on how to move forward efficiently. Additionally, market-oriented research offers students exposure to the growing PV-related commercialization efforts and supplies industry with a stream of qualified scientists

A new effort in FY 2010 is the PV Manufacturing Initiative. This initiative intends to accelerate the commercialization and cost reduction of PV technologies. The initiative would involve individual consortiums of industry and university participants centered around specific processes or device architectures in order to identify and solve critical manufacturing problems. (Approximate funding $90,100,000for Systems Development Activities)

Technology Evaluation activities will focus on the critical need to test and evaluate all deliverables developed under the TPPs. The information will be used to determine if the TPPs are meeting milestones and goals on time. This independent testing activity will provide the data necessary to conduct stage-gate reviews and periodic down selects through its series of competitive phases. The Reliability R&D activity also includes laboratory R&D to help reduce the cost of installed systems and improve their reliability. The laboratory R&D emphasizes four technical objectives: 1) reducing life-cycle costs; 2) improving reliability of systems; 3) increasing and assuring the performance of fielded systems; and 4) removing barriers to the use of the technology.

Performance evaluation of thin-film systems will continue to be conducted in the field by the Regional Experiment Stations (RESs) to compare against benchmark data in both hot, humid climates representative of the Southeastern U.S. and hot, dry climates representative of the Southwestern U.S. Accelerated lifetime testing in the laboratory will be conducted in parallel with the field testing Any failures found in the field or in the laboratory will be analyzed to determine the degradation mechanisms. Work at the RESs will also continue to improve the reliability of distributed grid-tied systems, especially in the buildings sector.

The Community Project solicitation was issued in FY 2009 using industry input from the Accelerated Aging and Reliability Workshop. Awardees will test new PV systems in various climates and configurations, and then correlate test results with failure modes. In FY 2010 accelerated testing will be conducted in the lab to guide the design, material, and process changes for further product improvements in performance and cost reduction.

	(dollars in thousands)		
	FY 2008	FY 2009	FY 2010

In addition, researchers will work in partnership with universities, industry and the National Laboratories to improve the efficiency of cell materials and devices by investigating fundamental properties and operating mechanisms. This team research approach identifies efficiency-limiting defects in cell materials and analyzes their electrical and optical properties. Researchers will also work with the TPPs to improve the understanding of materials, impurities and defects and their impact on device performance and reliability. (Approximate funding $11,000,000 for Technology Evaluation Activities)

	FY 2008	FY 2009	FY 2010
Applied Research	**36,861**	**41,439**	**−**

Applied Research has been a separate key activity under the Photovoltaic subprogram that included next generation concepts and cross-cutting research on semiconductor materials and devices. Beginning in FY 2010, these activities will be consolidated with the former Systems Development key activity and the technology evaluation component of the former Technology Evaluation & Integration key activity into a unified Photovoltaic R&D subprogram which captures only PV-related efforts. The main purpose in this change is to move the Systems Integration and Market Transformation activities that cut across both PV and CSP out from under the PV subprogram into their own crosscutting subprograms. This allows the Solar Program to be managed and operated more efficiently, improving both the speed and effectiveness of program implementation.

	FY 2008	FY 2009	FY 2010
Systems Development	**64,210**	**67,725**	**−**

Systems Development has been a separate key activity under the Photovoltaic subprogram that included cost-shared contracts with industry to advance the development of PV systems and components. Beginning in FY 2010, these activities will be consolidated with the Applied Research and technology evaluation activities specific to PV as noted in the above paragraph.

	FY 2008	FY 2009	FY 2010
Technology Evaluation & Integration (TEI)	**21,503**	**21,209**	**−**

TEI has been a separate key activity under the Photovoltaic subprogram that focused on the evaluation of technical advances throughout the Solar Program using independent testing and analysis. Beginning in FY 2010, all of the non PV-specific elements of testing and evaluation are being combined with similar activities that had been funded under the CSP subprogram and moved to a separate cross-cutting subprogram called Systems Integration. This will allow these activities to be managed much more effectively with a single point of contact.

	FY 2008	FY 2009	FY 2010
Technology Acceptance	**14,170**	**12,420**	**−**

Technology Acceptance has been a separate key activity under the Photovoltaic subprogram that focused on achieving solar energy technology cost competitiveness by minimizing market barriers to solar commercialization and promoting opportunities for solar technology market penetration. Beginning in FY 2010, these activities are being combined with similar activities formerly funded under the CSP subprogram and moved into a separate cross-cutting subprogram called Market Transformation. This will heighten their visibility and improve management as noted above.

	FY 2008	FY 2009	FY 2010
SBIR/STTR	**0**	**2,207**	**2,511**

In FY 2008, no funding was transferred to the SBIR and STTR programs. The FY 2009 and FY 2010

	(dollars in thousands)		
	FY 2008	FY 2009	FY 2010
amounts shown are estimated requirements of the continuation of the SBIR and STTR program.			
Total, Photovoltaic Energy Systems	**136,744**	**145,000**	**149,470**

Explanation of Funding Changes

	FY 2010 vs. FY 2009 ($000)
Photovoltaic R&D	
The increase in the PV subprogram funding is a result of combining projects formerly funded under Applied Research, Systems Development, and the projects formerly under Technology Evaluation that solely focused on PV into a single key activity. The increase is also related to the new Solar Electricity Energy Innovation Hub and PV Manufacturing initiatives.	+ 146,959
Applied Research	
These activities will be consolidated under Photovoltaics R&D.	-41,439
Systems Development	
These activities will be consolidated under Photovoltaics R&D.	- 67,725
Technology Evaluation	
These activities will be consolidated under Systems Integration.	- 21,209
Technology Acceptance	
These activities will be consolidated under Market Transformation.	- 12,420

SBIR/STTR

Changes in the SBIR/STTR funding are a result of shifting the above program activities to new areas with the Solar Program request.	+ 304
Total Funding Change, Photovoltaic R&D	**+ 4,470**

Concentrating Solar Power

Funding Schedule by Activity

	(dollars in thousands)		
	FY 2008	FY 2009	FY 2010
Concentrating Solar Power	27,617	29,621	77,250
SBIR/STTR	0[a]	379	1,170
Total, Concentrating Solar Power	27,617	30,000	78,420

Description

Concentrating solar power (CSP) has over 350 MW operating in the Mojave Desert for the past 20 years. Various factors such as deregulation and the large capital investment for utility-scale plants kept additional plants from coming on line for many years. However, with rising fuel prices, favorable government incentives, and recent R&D advances, CSP is experiencing a rebirth with new plants coming on line both domestically and overseas. With a renewed sense of urgency to commercialize renewable energy sources, and the prospect of developing a prolific domestic source of renewable energy that can provide power on demand, the Solar Program is ramping up its CSP research, development, and deployment efforts. These efforts, which leverage both industry partners and the National Laboratories, are directed toward the development of parabolic trough, dish/engine, and power tower CSP systems.

The Solar Program's goals include increasing the use of CSP in the U.S., making CSP competitive in the intermediate power market by 2015, and developing advanced technologies that will reduce systems and storage costs, enabling CSP to be competitive in the baseload power market by 2020. DOE plans to achieve these goals through cost-shared contracts with industry, advanced research at National Laboratories, and working with other government agencies to remove barriers to the deployment of the technology.

Concentrated sunlight from CSP systems produces thermal energy to run heat engines or steam turbines for generating power. These plants can also store the sun's energy so it can be used when the sun is not shining, enabling it to displace significant quantities of carbon dioxide. Although CSP plants can be configured in all sizes, they are most cost effective when they generate greater than 100MW.[b] Their size and economical energy storage make CSP systems strong candidates for centralized power applications by utilities. The major focus of the CSP subprogram in FY 2010 will be twofold: the development of low cost systems that include thermal storage and establishment of a pilot solar zone that will facilitate the construction of several utility-scale solar projects.

Benefits

Today, in areas with favorable conditions, CSP technology can generate electricity at costs as low as $0.13/kWh. The goal for CSP is being cost-competitive (7-9 ¢/kWh) in the intermediate power market by 2015 with a modest amount of storage. The long-term goal for CSP systems is cost competitive (5-7¢/kWh) baseload power including 12 to 17 hours of thermal storage by 2020. Key technology pathways to the goals include (detailed annual performance progress indicators are presented in their respective benefits sections):

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[a] SBIR/STTR funding was transferred to the Science Appropriation in FY 2008.

[b] Based on reports by Sandia National Laboratory and Sargent and Lundy Draft Assessment Cost and Performance (see Validation and Verification).

By 2010, reduce the cost of large-scale CSP power plants in the Southwest U.S. to 10 to 12¢/kWh from 12 to 14¢/kWh in 2004. The Solar Program uses the following historical cost data and projections as indicators of progress toward achieving program benefits.

U.S.-Produced Parabolic Trough System Efficiency Targets and Actuals

	Historic						Planned			
	2003	2004	2005	2006	2007	2008	2009	2010	2011	2015
Annual Solar-to-Electric Conversion Efficiency (%)										
Target	n/a	n/a	n/a	11.9	13.1	14.0	14.8	15.4	16.0	16.6
Actual	11.1	11.9	11.9	11.9	14.0	14.3	–	–	–	–

CSP Solar Energy Cost Targets and Actuals[a]

	Historic						Planned			
	2003	2004	2005	2006	2007	2008	2009[b]	2010	2011	2015
Levelized Electricity Cost from Utility-scale CSP										
Target	0.12-0.14	0.12-0.14	0.12-0.14	0.12-0.14	0.11-0.13	0.11-0.13	0.10-0.12	0.10-0.12	0.10-0.12	0.07-0.09
Actual	0.12-0.14	0.12-0.14	0.12-0.14	0.12-0.14	0.11-0.13-	0.11-0.13	–	–	–	–

Detailed Justification

(dollars in thousands)

	FY 2008	FY 2009	FY 2010
Concentrating Solar Power (CSP)	**27,617**	**29,621**	**77,250**

The primary focus of the CSP subprogram is to achieve cost competiveness of CSP in the intermediate power market by 2015. A solicitation issued in FY 2007 resulted in 12 industry contract awards focused on establishing a U.S. manufacturing capability of low cost trough components and the technical feasibility of lower cost thermal storage and innovative new concepts such as linear Fresnel. In FY 2008, the Solar Program funded Phase I of these contracts. In FY 2009, the more promising contracts moved into Phase II and will undergo a rigorous evaluation at the end of that Phase (some in FY 2009 and some in FY 2010). Those that continue on will be completed in FY 2010 or FY 2011. (Approximate funding $18,000,000)

[a] In this table, years indicate the years in which field verification of modeled cost occurs.
[b] These cost projections are based on 2004 dollars. The program is currently working on updating the numbers to reflect 2009 dollars as well as the impact of rising commodity costs. The cost of steel, for example, has risen 43 percent in two years. The cost of nitrate salts (the baseline for thermal storage) has risen 69 percent over that time frame.

The development of low cost thermal storage is another major focus of the CSP subprogram. The addition of energy storage helps alleviate the intermittent nature of the solar resource and enables CSP plants to operate whenever homes and businesses require power regardless of weather or time of day. Although the addition of storage increases the cost of building a CSP power plant, it will actually reduce the cost of power generated by the plant. It also has the advantage of increasing the value of the power produced because the power can be put into the grid when it is most needed; for example in the early evening when the weather is still warm. This provides a double benefit to consumers: lower cost and power on demand. Low cost thermal storage systems, however, have to be developed. To this end, a solicitation issued in FY 2008 focused on establishing the technical feasibility of several storage concepts and identifying the potential for near-term thermal storage demonstrations. Phase I of many of these contracts will be completed in FY 2009. Phase II of these contracts, prototype development and evaluation will begin in FY 2010. (Approximate funding $12,000,000)

The additional funds provided in FY 2010 will be used to establish two new activities; both of which are designed to lower the cost of the technology:

- A solicitation will be released challenging industry to develop CSP systems capable of operating competitively in the baseload power market by 2020. This is a stretch goal for CSP because baseload power is fueled primarily by coal, which is the least expensive fossil fuel. In addition, to provide baseload power would require CSP plants to have between 12 and 17 hours of storage, whereas the optimum (lowest cost) amount of storage for CSP is about 6 hours. In order to meet this goal, CSP systems that operate at higher temperatures will be required. Higher temperature operation results in higher system efficiency and enables thermal storage systems to be less costly. (Approximate funding $17,000,000)
- A pilot solar zone will be established whose goal is to develop a piece of land in a manner that facilitates the construction of utility-scale solar projects. It will serve as a model for the western States that are exploring the use of zones as a method of planning for the development of renewable energy. The use of zones will potentially speed the deployment of solar power plants. These plants will lead to cost reduction as a result of industry learning from those plants how to incorporate cost savings into their manufacturing, installation, and operation. DOE has been working with the Bureau of Land Management (BLM) on their current land proposal evaluations with plans to expand this working relationship into addressing infrastructure (e.g. roads, water, transmission tie-in), and conducting environmental studies. DOE will work with BLM to develop a process by which developers of solar projects would gain access to a piece of the zone and with state regulators to get access to transmission. (Approximate funding $22,000,000)

The CSP subprogram will also expand laboratory R&D efforts in the areas of dish/engine and parabolic trough technologies, and new R&D efforts in the areas of linear Fresnel technology and distributed power towers. There will be an increased National Laboratories effort in thermal storage, including R&D by lab staff, as well as new and refurbished facilities. The labs will provide technical assistance to the solar industry with emphasis given to those companies that have won

	(dollars in thousands)		
	FY 2008	FY 2009	FY 2010

competitive CSP awards and those preparing for upcoming projects. Research will also focus on materials research related to reflector coatings (e.g. glass, aluminum, polymers), thermal receivers, and high temperature heat transfer fluids and thermal storage media. It is expected that a good portion of this work will be at universities. (Approximate funding $8,000,000)

SBIR/STTR	**0**	**379**	**1,170**

In FY 2008, $1,883,000 and $227,000 were transferred to the SBIR and STTR programs respectively. The FY 2009 and 2010 amounts shown are estimated requirements of the continuation of the SBIR and STTR program.

Total, Concentrating Solar Power	**27,617**	**30,000**	**78,420**

Explanation of Funding Changes

	FY 2010 vs. FY 2009 ($000)
Concentrating Solar Power	
This increase in funding reflects additional commitments for the trough and advanced components solicitation moves into Phase III ($14M), the thermal storage solicitation moves into Phase II ($9M), and the baseload CSP solicitation is fully funded in Phase I ($15M), and establishment of a pilot solar zone ($20M). In addition, the market transformation and systems integration efforts related to CSP have been moved to those new subprograms to be combined with similar efforts in PV. This allows these activities to be managed more effectively and reflects their crosscutting nature.	+ 47,629
SBIR/STTR	
Changes in the SBIR/STTR funding are a direct result of changes in the funding of program activities.	+ 791
Total Funding Change, Concentrating Solar Power	**+ 48,420**

Systems Integration

Funding Schedule by Activity

(dollars in thousands)

	FY 2008	FY 2009	FY 2010
Systems Integration	–	–	29,270
SBIR/STTR	–	–	390
Total, Systems Integration	–	–	29,660

Description

The Systems Integration subprogram is a new subprogram proposed for FY 2010. This modification was made to better reflect Photovoltaic R&D program activities in FY 2010.

The Systems Integration subprogram focuses on the integration of high-penetration solar energy systems into end-use locations and the electricity grid. This subprogram emphasizes on engineering development and integration of technical advances throughout the Solar Program into end-use applications, including those advances made through ongoing system-level progress of the TPPs. Systems Integration also features development of integration devices, i.e., inverters, controllers, and interfaces to energy management systems, which are required to integrate solar systems into end-use locations and the electricity grid. A key application area is in the residential/commercial/industrial buildings, where Systems Integration activities are coordinating with the Building Technologies Program to provide the thermal energy and electricity, generated from solar energy technology, needed for a zero-energy building (or home). Similar coordination is being carried out with DOE's Office of Electricity Delivery and Energy Reliability (OE) to achieve high-penetration levels of solar energy technologies into both transmission and distribution grid. System Analysis activities will continue enhancing Solar Advisor Model (SAM) development, validating component/system models, and integrating varying modeling platforms for collaborative development and use.

Benefits

Systems Integration activities provide enabling technologies with technology evaluation tools, and methodologies to support meeting the target goals of high-penetration levels of grid-tied solar electric generation. In addition, these activities drive energy independence through a systems engineering approach by incorporating advances in technologies along with innovative policy, regulation, and financing practices.

Detailed Justification

	(dollars in thousands)		
	FY 2008	**FY 2009**	**FY 2010**
Systems Integration	**–**	**–**	**29,270**

Systems Integration contains three primary activities: Systems Modeling & Analysis, Grid Integration, and Resource & Safety R&D.

System Modeling & Analysis activities will continue benchmarking, modeling and analysis for the systems-driven approach. Validation of models for annual energy production using data collected from the four "technology showcase" arrays and one additional system atop the DOE Forrestal building will be completed in FY 2010. The datasets from the Forrestal systems allow validation of models performance of PV systems operating in a diffuse irradiation environment under partly cloudy weather conditions like those in Washington, D.C. In FY 2010, System Modeling & Analysis will also support continuing development and enhancements for Solar Advisory Model (SAM), guided by the needs of the SAM user forum, and continuing market, value, and policy analyses.

Grid Integration activities focus on high-penetration integration of a solar energy systems into end-use locations and the electricity grid. Within Grid Integration, there is critical need to improve the reliability of the inverter and other balance of system (BOS) components. Emphasis is placed on reducing life-cycle costs by increasing mean-time-between-failure (MTBF) of inverters and battery charge controllers, by developing higher performance technologies through advanced solutions to thermal management and surge protection, and by optimizing designs to achieve "plug and play" ability. FY 2010 will be the third and last year of funding for the Solar Energy Grid Integration Systems (SEGIS) contracts with industry to advance into pilot production of advanced inverters and energy management systems with improved reliability, enhanced value and reduced cost. In addition, new awards are planned for FY 2010 to support development of energy storage systems for integration with PV operations through the SEGIS-Energy Storage (ES) FOA. The SEGIS-ES efforts will accomplish the planned SEGIS progression to address integration of PV and storage technologies at distribution levels to meet the challenges of high penetration. Additionally, the program will continue to support projects awarded through the FY 2009 Funding Opportunity Announcement on field demonstration projects to analyze the effects of high penetration of distributed PV systems on electricity grid performance.

The Solar Program will also work with DOE's Office of Electricity to address the lack of access to electrical transmission which will be a major inhibitor to the increased use of CSP. The program will provide resource information and analyses that recommend optimum routes for new transmission lines that will enable CSP to be moved from arid areas of the Southwest U.S. to major population centers throughout the western U.S.

Resource & Safety R&D will look at improving resource maps for both PV and CSP technologies with an emphasis on providing "bankable data" to assist industry in site selection. Main activities will include: development, validation, and dissemination of reliable, accurate solar resource information; continued benchmarking of U.S. data with international data sets; improvements of the quality and completeness of the National Solar Radiation Data Base; 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 staff outreach activities. The program will also develop a better method of accurately predicting 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	**–**	**–**	**390**

In FY 2008, no funding was transferred to the SBIR and STTR programs. The FY 2010 amounts shown are estimated requirements for the continuation of the SBIR and STTR program.

Total, Systems Integration	**–**	**–**	**29,660**

Explanation of Funding Changes

	FY 2010 vs. FY 2009 ($000)
Systems Integration	
The increase in Systems Integration subprogram funding is the result of combining elements formerly included under the Technology Evaluation key activity under the Photovoltaics subprogram and several activities formerly funded under Concentrating Solar Power. Creation of this separate subprogram was done in order to highlight the crosscutting nature of this subprogram across both PV and CSP technologies and to more effectively manage these efforts together rather than as separate projects in different key activities. Funding for FY 2010 includes a significantly increased effort in addressing grid integration issues specific to the high penetration of solar technologies.	+ 29,270
SBIR/STTR	
Changes in the SBIR/STTR funding are a direct result of changes in the funding of program activities.	+ 390
Total Funding Change, Systems Integration	**+29,660**

Market Transformation

Funding Schedule by Activity

	(dollars in thousands)		
	FY 2008	FY 2009	FY 2010
Market Transformation	–	–	27,450
Total, Market Transformation	–	–	27,450

Description

The Market Transformation subprogram is a new subprogram proposed for FY 2010. This modification was made to better reflect Photovoltaic R&D program activities in FY 2010.

The Solar Program recognizes it is of critical importance to engage adopters and decision makers in identifying existing market barriers and ways to address those barriers. Market transformation efforts focus on facilitating the commercialization of solar technologies by identifying and breaking down market barriers and promoting deployment through stakeholder outreach at all levels. Market transformation efforts look to ensure that technologies do not wind up "on the shelf" instead of "on the roof" because of barriers in areas such as interconnection standards, net metering, utility policies, solar access laws, policymaker understanding of solar technologies, and international safety issues. Activities also seek to capture opportunities to promote market-pull through the facilitation of large-scale solar deployment opportunities.

Benefits

Market Transformation creates significant benefits for the Solar Program across a wide variety of technical, financial and policy activities. The 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. Efforts under this subprogram complement the R&D work of the PV and CSP subprograms, as well as the Systems Integration work, by focusing on addressing these critical, post-development obstacles.

Detailed Justification

	(dollars in thousands)		
	FY 2008	FY 2009	FY 2010
Market Transformation	–	–	**27,450**

The Solar America Board of Codes and Standards ("Solar ABCs" formerly called Solar Codes and Standards Working Group) is now in the third year of activity. Areas of work include improving national and international standards coordination, providing inputs into National Electrical Code revisions, maintaining current product safety standards, developing and promoting national module performance rating test procedures, and streamlining interconnection and net metering regulations. DOE will work closely with many stakeholders, including state and local governments, the solar manufacturing community, non-profits, and others.

A professional development program to support the training and certification of solar installers and code officials will continue in order to create a sufficiently large and qualified workforce that can install PV systems in sufficient quantities to meet Solar Program goals. FY 2010 efforts will focus on the second year of a series of multi-year development awards.

With Solar America Cities and Solar America Showcases, the Solar Program is supporting direct technical partnerships that work to overcome key barriers to significant solar penetration. Both activities involve partnerships between DOE and stakeholders to leverage the advanced efforts occurring throughout the U.S. on a local level. The Solar America Cities activity features assistance to 25 U.S. cities that have committed to using solar power, and helps to address implementation issues such as financing, permitting, city planning, stakeholder engagement, and grid integration. The Solar America Showcases activity provides technical assistance (not hardware purchases) to large-scale, high-visibility installations, such as new building communities, big box retailer installations, and utility-scale solar. FY 2010 funds will be used to support previously selected Solar America Cities under multi-year awards some selected during the FY 2007 for whom work commenced in FY 2008, and the others selected during FY 2008 for whom work commenced in FY 2009. Cities will be encouraged to share best practices through the use of interactive tools and discussion opportunities provided by DOE. In addition, in response to EPAct Section 931, funding will support a Government Solar Installation Program that will employ third-party financing to capitalize large installations on Federal sites. Through these funds, the Solar Program will work with Federal Energy Management Program to provide administrative services to Federal agencies that will enter into power purchase agreements with private third-party project developers, facilitating rapid adoption of solar technologies

Market Transformation features technical outreach and communications activities to engage other key decision makers in the wide scale adoption of solar. Target audiences include States, local governments, and utilities. These activities will provide technical information and peer sharing opportunities on solar technologies and related policy topics for the purpose of accelerating innovative approaches to solar implementation. This outreach now includes working with these same entities to help CSP gain market penetration such as: state governments to provide information on the impact of state incentives on+ cost of power, the job impacts of CSP projects, resource assessment; utilities to assist in technical evaluation of proposals; and the Western Governors' Association to assist in their Clean and Diversified Energy Initiative and Renewable Energy Zone project, as well as other regional renewable activities (e.g. transmission, renewable energy credits).

The Solar Policy and Analysis Network (SPAN) is a new market transformation activity being launched in FY 2010. SPAN will help fulfill the continuing critical need for accurate and timely research and analysis on local, state, regional, national, and international policies that promote solar market transformation by tapping into the expertise of the Nation's universities. Competitively-selected institutions of higher education located in geographically diverse areas will conduct analysis on regional policies and markets and provide technical outreach to stakeholders. This regional approach will complement the Solar Program's traditional top-down, Federal approach to advancing the U.S. solar marketplace. SPAN will engage engineering, business, law, policy, urban planning and other related schools within universities that can develop novel solutions to reducing barriers to wide scale solar commercialization. In addition, SPAN will further solar professional development by attracting and educating a new generation of university students who can join the solar industry in various capacities, as well as by expanding the expertise of faculty members across disciplines to include solar energy issues. SPAN universities will also assist in conducting technical assistance for DOE-selected projects in their regions. In FY 2010, DOE anticipates selecting approximately six SPAN universities, with the potential to add more in later fiscal years.

Total, Market Transformation	–	–	**27,450**

Explanation of Funding Changes

	FY 2010 vs. FY 2009 ($000)
Market Transformation	
The increase in Market Transformation subprogram funding is the result of combining elements formerly included under the Technology Evaluation key activity under the PV subprogram and several activities formerly funded under CSP, as well as increased efforts in professional development and technical outreach. Creation of this separate subprogram was done in order to highlight the crosscutting nature of this subprogram across both PV and CSP technologies and to more effectively manage these efforts together rather than as separate projects in different key activities.	+ 27,450
Total Funding Change, Market Transformation	**+ 27,450**

Solar Electricity Energy Innovation Hub

Funding Schedule by Activity

	(dollars in thousands)		
	FY 2008	FY 2009	FY 2010
Solar Electricity Energy Innovation Hub	–	–	34,294
SBIR/STTR	–	–	706
Total, Solar Electricity Energy Innovation Hub	–	–	35,000

Description

DOE proposes to establish multi-disciplinary Energy Innovation Hubs (Hubs) to address the basic science, technology, economic, and policy issues hindering the ability to become energy secure and economically strong while being good stewards of the planet by reducing greenhouse gas (GHG) emissions. The main focus of the hub is to push the current state-of-the-art energy science and technology toward fundamental limits and support high-risk, high-reward research projects that produce revolutionary changes in how the U.S. produces and uses energy.

The hubs are inspired by the Bell Labs research model, which produced the transistor, the building block of modern computers. Their objective is to focus a high-quality team of researchers on a specific question and to encourage 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. The grants will not provide "bricks and mortar," but up to $10 million of the $35 million award may be used for retrofits and capital equipment.

Benefits

The hubs will create significant benefits for the Nation's energy security, growing economy and reducing green house gas emissions. The Solar Electricity Energy Innovation Hub will be devoted to the discovery and design of wholly new concepts and materials needed by solar to electricity conversion.

Detailed Justification

(dollars in thousands)

	FY 2008	FY 2009	FY 2010
Solar Electricity Energy Innovation Hub	–	–	**34,294**

The Solar Electricity Hub will incorporate cutting edge research that may include both PV and CSP technology areas. PV research will be the primary focus of the hub with emphasis on the synthesis and modeling of disruptive PV device structures and processes to enable conceptual and cost breakthroughs. More specifically, projects will incorporate optical, electrical, and thermal phenomena, previously demonstrated only at the material level, into a PV device structure in order to demonstrate the technical viability and economic promise of the approach. Additionally, radical processes which promise disruptive 5 to 10x reductions in feedstock, processing costs or capital expenditure will be explored at the laboratory scale. The CSP portion would likely focus on materials research related to reflector coatings (e.g. glass, aluminum, polymers), thermal receivers, and high temperature heat transfer fluids and thermal storage media. The grants will not provide "bricks and mortar," but up to $10 million of the $35 million award may be used for retrofits and capital equipment.

	FY 2008	FY 2009	FY 2010
SBIR/STTR	–	–	**706**

This is an estimated amount based on the continuation of the SBIR and STTR program.

	FY 2008	FY 2009	FY 2010
Total, Solar Electricity Energy Innovation Hub	–	–	**35,000**

Explanation of Funding Changes

	FY 2010 vs. FY 2009 ($000)
Solar Electricity Energy Innovation Hub	
This is a new activity for FY 2010.	+ 35,000
Total Funding Change, Solar Electricity Energy Innovation Hub	**+ 35,000**

Solar Heating and Cooling Systems

Funding Schedule by Activity

	FY 2008	FY 2009	FY 2010
	(dollars in thousands)		
Solar Heating and Cooling Systems	1,959	–	–
Total, Solar Heating and Cooling Systems	1,959	–	–

Description

Solar hot water and space heating/cooling technologies were previously managed by the Solar Program. Following increased collaboration with the Buildings Technologies Program (BT), the Solar Program transferred the Solar Heating and Cooling Systems activity to BT in FY 2009. BT continues to focus on developing a zero energy home with a cost within the means of most Americans. To accomplish this in the most efficient manner possible, all aspects of a home (e.g. walls, windows, insulation, HVAC, PV, solar water heating, solar space heating/cooling) have to be designed and analyzed as a whole system. The transfer of the Solar Heating and Cooling Systems activity provides a more complete and efficient use of these technologies to help advance zero energy home R&D. The Solar Program continues to promote the Solar Heating and Cooling technologies along with the growing suite of market-ready solar technologies as part of its market transformation efforts. In addition, the Solar Program will continue to provide technical assistance to BT as needed. PV R&D related to buildings remains the responsibility of the Solar Program.

Detailed Justification

	FY 2008	FY 2009	FY 2010
	(dollars in thousands)		
Solar Heating and Cooling Systems	**1,959**	–	–

The Solar Heating and Cooling Systems subprogram completed the development of hybrid solar lighting and solar water heating for nonfreezing locations in FY 2008. These technologies were sufficiently developed to enable their transfer to industry for commercialization. The conclusion of these activities facilitated the transition to the Building Technologies Program in FY 2009.

	FY 2008	FY 2009	FY 2010
Total, Solar Heating and Cooling Systems	**1,959**	–	–

Wind Energy
Funding Profile by Subprogram

(dollars in thousands)

	FY 2008 Current Appropriation[a]	FY 2009 Original Appropriation	FY 2009 Additional Appropriation	FY 2010 Request
Wind Energy				
Technology Viability	26,461	32,000	94,000	45,440
Technology Application	22,573	23,000	24,000	29,560
Total, Wind Energy	49,034	55,000	118,000	75,000

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 (EPACT)" (1992)
P.L. 109-58, "Energy Policy Act of 2005" (2005)
P.L. 110-140, "Energy Independence and Security Act of 2007" (2007)

Mission

The mission of the Wind Energy Program is to increase the development and deployment of reliable, affordable, and environmentally sustainable wind power and realize the benefits of domestic renewable energy production.

Benefits

Wind energy is currently the fastest growing renewable electricity generation technology in the world. Since 2000, wind energy has demonstrated significant expansion and promise as an affordable energy supply, increasing from about 2.5 GW of installed capacity to over 25 GW by the end of 2008.[b] In July of 2008, the Department issued a report describing in detail the implications and challenges of meeting 20 percent of the Nation's electricity needs with wind energy by the year 2030.[c] This report, developed in collaboration with a broad range of wind industry and energy sector experts, identifies priority needs for accelerating wind energy expansion in the U.S., and provides a foundation for coordinated action from the Wind Energy Program, industry, utility, governmental and other stakeholders.

The Wind Energy Program is helping to facilitate wind's rapid growth by addressing key market, institutional, and technology areas of concern. This will increase and diversify the domestic energy supply, offering the U.S. a clean, domestic technology that will help mitigate greenhouse gas (GHG) emissions on a large scale, while strengthening the Nation's infrastructure by reducing the economic effects of fuel price or supply disruptions through increased system reliability. In addition, expanding the affordability and applications for wind offers an increasingly attractive investment for addressing scalable growth in electricity demand and significant economic development potential. To support this expansion of wind energy, the program concentrates on improving: the performance and reliability of

[a] SBIR/STTR funding was transferred to the Science Appropriation in FY 2008, which includes a reduction of $456,000 that was transferred to the SBIR program, and $55,000 that was transferred to the STTR program
[b] American Wind Energy Association Annual Wind Industry Report, Year Ending 2008
[c] "20% Wind Energy by 2030: Increasing Wind Energy's Contribution to U.S. Electricity Supply," May 2008

large scale land-based wind energy technology while reducing costs; facilitating wind energy's rapid market expansion by anticipating and addressing potential barriers to integrating wind into the electric transmission system; streamlining siting, permitting, and related environmental issues; and investigating offshore, distributed, tribal, and community-owned wind technology projects.

The proposed FY 2010 Budget investments complement funds provided by the Recovery Act that expand large turbine reliability R&D efforts through a variety of activities, including expanded wind turbine drivetrain testing. To enable decision makers and the public to follow performance and plans, the program will post its progress in these planned activities at: http://www.energy.gov/recovery/index.htm.

Climate Change

The generation of electricity from wind energy contributes no GHGs directly into the atmosphere. EERE estimates the cumulative reduction in CO_2 emissions from program efforts will be over 1.7 gigatons by 2030.

Energy Security

As a domestic energy source, wind requires no imported fuel, and the wind turbine components can be either produced in the U.S. or imported from friendly Nations with production capabilities. Our estimates show that the program's activities could reduce natural gas imports by a cumulative 3.6 to 4.9 trillion cubic feet by 2030. Diversifying the electrical generation mix with increased domestic renewable energy enhances national energy security by increasing energy diversity and price stability.

Economic Impact

The U.S. is a prime location for developing wind resources, providing local businesses opportunities to meet many of the needs associated with 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., particularly in rural areas. In many areas of the country, wind energy has already boosted the local economy. Wind plants offer seasonal employment during the construction phase and permanent jobs during the operational phase. Tax revenues from wind plants can be a major revenue source for funding local and state government services. EERE estimates of economic impact show cumulative consumer savings in 2030 on the order of $100 billion and additional industry savings approaching one quarter that size.

The benefit tables below show the estimated benefits from 2015 through 2050 that would result from realization of the program's goals. These benefits are achieved by targeted Federal investments in technology research and development in partnership with wind turbine manufacturers, equipment suppliers, fuel and energy companies, other agencies, state government agencies, universities, National Laboratories, and other stakeholders. These partnerships facilitate the technical coordination of activities and attract cost sharing to provide leveraged benefits.

The benefit tables also reflects the increasing market share of advanced-technology wind turbines over time as their projected incremental cost relative to conventional technology declines, and as their efficiency relative to conventional wind turbines increases. The expected benefits reflect solely the achievement of the program's goals. Not included are any policies, regulatory mechanisms, or other incentives not already in existence that might be expected to support or accelerate the achievement of the program goals. In addition, some technologies show diminishing annual benefits by 2050 due to the assumption built into the analysis that industry progress, as reflected in the baseline, will eventually catch up with the more accelerated progress associated with EERE program success.

The program goal case is modeled along with a "baseline" case in which no DOE R&D exists. The baseline case is intended to represent the future without the effect of the Wind Energy Program, and is identical for all DOE applied energy R&D programs, thereby ensuring that all program benefits are estimated using the same assumptions for external factors such as economic growth, energy prices, and levels of energy demand. The expected outcome benefits are calculated using the same fundamental methodology across EERE and across all of DOE's applied energy R&D programs, and the metrics by which expected outcome benefits are measured are identical. This standardization of method and metrics has been undertaken as part of DOE's efforts to make all program stated benefits comparable.

Prospective benefits are calculated as the arithmetic difference between the baseline case and the program goal case, and the resulting economic, environmental and security benefits attributed to the program's activities. This approach of calculating the benefits as an incremental improvement to the baseline helps ensure that improvements in wind energy technologies that would occur in the absence of the program are not counted as part of the program's benefits. In addition to technology and process advances due to the program's activities, energy market policies, such as state and Federal tax policies, facilitate the development and deployment of clean energy technologies. The expected impacts of current legislated policies in the baseline case are included so that the expected benefits calculated reflect as much as possible the effects of activities funded by the program.

The benefits are generated by modeling both the program goal and baseline cases within two energy-economy models: NEMS-GPRA10 for benefits through 2030, and MARKAL-GPRA10 for benefits through 2050. The full list of modeled benefits appears below.

Additionally, the "20% Wind Energy by 2030" Report provided estimates of potential benefits associated with an alternative scenario in which deployment of wind energy is significantly accelerated as compared to EERE modeled estimates of deployment due to the achievement of the wind program's current goals. The report concluded that producing 20 percent of projected U.S. electricity demand by 2030 from wind technology would avoid nearly all of the anticipated increase in electric sector CO_2 emissions (the most prevalent GHG) between now and 2030. Under the 20 percent scenario, wind energy could displace 11 percent of natural gas consumption and reduce the Nation's energy vulnerability to uncertain natural gas supplies and price volatility. The 20 percent study also identified an 8 percent reduction in water consumption by the electricity sector which uses water for cooling natural gas, coal, and nuclear plants. Further, the report estimated that a wind industry of this size (annual installations exceeding 15 GW per year and totaling over 300 GW by 2030) would directly support over 150,000 employees and provide over $20 billion in economic activity annually.

Primary Metrics for FY 2010 Budget Request

(Incorporates Approximate Impacts of EISA 2007)

	Metric[1]	Model	Year 2015	2020	2030	2050
Energy Security	Oil Imports Reduction, cumulative[2] (Bil bbl)	NEMS	ns	ns	ns	N/A
		MARKAL	ns	ns	ns	ns
	Natural Gas Imports Reduction, cumulative (Tcf)	NEMS	ns	1.1	4.9	N/A
		MARKAL	0.5	1.5	3.6	13.6
	Reduction in Share of Highway Fuel Demand Derived from Crude Oil[3] (%)	NEMS	ns	ns	ns	N/A
		MARKAL	ns	ns	ns	ns
Environmental Impacts	CO_2 Emissions Reduction, cumulative (Mil mtCO_2)	NEMS	ns	390	1705	N/A
		MARKAL	96	359	1760	8489
	SO_2 Allowance Price Reduction[4] ($/ton)	NEMS	ns	ns	ns	N/A
		MARKAL	N/A	N/A	N/A	N/A
	NO_x Allowance Price Reduction ($/ton)	NEMS	ns	328	909	N/A
		MARKAL	N/A	N/A	N/A	N/A
	Hg Allowance Price Reduction (thousand $/lb)	NEMS	ns	ns	ns	N/A
		MARKAL	N/A	N/A	N/A	N/A
Economic Impacts	Consumer Savings, cumulative[5] (Bil $)	NEMS	13	44	113	N/A
		MARKAL	11	35	97	279
	Electric Power Industry Savings, cumulative (Bil $)	NEMS	4	11	23	N/A
		MARKAL	ns	6	11	34
	Household Energy Expenditures Reduction ($/household/yr)	NEMS	ns	30	20	N/A
		MARKAL	10	14	5	32

1. "Reductions" and "savings" are calculated as the difference between results from the baseline case (i.e. no DOE technology) and the technology case (i.e. all DOE technology R&D programs are successful).
2. All cumulative metrics are based on results beginning in 2010.
3. Metric includes oil-derived fuel use by light-duty vehicles, commercial light trucks and freight trucks; the metric excludes buses. Reported oil use is adjusted to exclude ethanol, biodiesel and CTL.
4. All monetary metrics are in 2006$.
5. Cumulative monetary metrics are in 2006$ that are discounted to 2010 using a 3% discount rate.
ns - Not significant
NA - Not yet available
N/A - Not applicable

Secondary Metrics for FY 2010 Budget Request

(Incorporates Approximate Impacts of EISA 2007)

	Metric[1]	Model	Year 2015	2020	2030	2050
Energy Security	Oil Imports Reduction, annual (Mbpd)	NEMS	ns	ns	ns	N/A
		MARKAL	ns	ns	ns	ns
	Natural Gas Imports Reduction, annual (Tcf)	NEMS	ns	ns	0.4	N/A
		MARKAL	0.2	0.2	0.2	0.7
	MPG Improvement[2] (%)	NEMS	ns	ns	ns	N/A
		MARKAL	ns	ns	ns	ns
Environmental Impacts	CO_2 Intensity Reduction of US Economy (Kg CO2/$GDP)	NEMS	ns	ns	ns	N/A
		MARKAL	0.00	0.00	0.01	0.01
	CO_2 Intensity Reduction of US Power Sector[3] (Kg CO2/kWh)	NEMS	ns	0.02	0.04	N/A
		MARKAL	0.01	0.02	0.05	0.09
	CO_2 Intensity Reduction of US Transportation Sector[4] (Kg CO2/mile)	NEMS	ns	ns	ns	N/A
		MARKAL	ns	ns	ns	ns
Economic Impacts	Consumer Savings, annual[5] (Bil $)	NEMS	ns	ns	ns	N/A
		MARKAL	4	8	15	39
	Electric Power Industry Savings, annual (Bil $)	NEMS	2	2	2	N/A
		MARKAL	ns	3	4	10
	Energy Intensity of US Economy (energy/$GDP)	NEMS	ns	0.05	0.06	N/A
		MARKAL	0.02	0.02	0.06	0.07
	Net Energy System Cost Reduction, cumulative (Bil $)	NEMS	N/A	N/A	N/A	N/A
		MARKAL	ns	9	31	119

1. "Reductions" and "savings" are calculated as the difference between results from the baseline case (i.e. no DOE technology) and the technology case (i.e. all DOE technology R&D programs are successful).

2. Change in light duty vehicles miles traveled per gallon of oil, where oil is only that derived from petroleum.

3. Emissions include all power sector emissions. Generation calculated as total net generation adjusted for estimated T&D losses.

4. Emissions calculated using highway fuel use and related carbon emission factor. Miles calculated as highway miles traveled, excluding buses.

5. All monetary metrics are in 2006$.

ns - Not significant

NA - Not yet available

N/A - Not applicable

The following external factors could affect the Wind Energy Program's ability to achieve its strategic goal:

- Delays in development of national transmission infrastructure;
- The availability of conventional energy supplies;
- The cost of competing technologies;
- The ability of the industry to respond quickly as wind installation demand increases;
- Fluctuating material costs (i.e., steel, copper, fiberglass, and concrete) and currency exchange rates;
- State and international efforts to support wind energy;
- Federal, state and regional regulatory actions affecting land-based and offshore wind installations;
- Continuation of Federal tax incentives;
- Implementation of other policies at the national level, including Federal efforts to reduce carbon and criteria pollutant emissions; and
- Availability of wind and power data from wind energy installations.

Contribution to the Secretary's Priorities

The Wind Energy Program contributes to four of the Secretaries priorities as shown below. The principal areas of focus are clean energy and lowering GHG emissions.

Priority 1: Science and Discovery — Invest in science to achieve transformational discoveries

The Wind Energy Program addresses basic and applied science through partnerships between National Laboratories, universities, and industry. These partnerships allow specialized technical expertise, comprehensive design and analysis tools, and unique testing capabilities to be brought to bear on problems that industry is or will encounter in bringing new turbine technology to the marketplace.

The Wind Energy Program supports active collaboration across government, industry, and international organizations. The Wind Powering America program works with states and other domestic stakeholders to address barriers to domestic wind energy development. Industry collaborative address important industry needs such as reliability and wind turbine gearbox failure analysis. Environmental and transmission cooperation is supported through the National Wind Coordinating Committee. Wind energy expertise is provided to regulatory agencies such as the Department of the Interior, Federal Aviation Administration, and Federal Energy Regulatory Commission. The Wind Energy Program is highly engaged in international technical and policy collaboration through the International Energy Agency (IEA).

Priority 2: Clean Energy — Change the landscape of energy demand and supply

The Wind Energy Program funds R&D activities to improve the reliability and performance of wind turbine systems through competitively selected industry and university partnerships, targeted research activities by the National Laboratories, and wind turbine component testing and analysis.

Priority 3: Economic Prosperity — Create millions of green jobs and increase competitiveness.

Wind is a domestic renewable resource, which the program strategically uses to encourage U.S. domestic employment, supply chain development, and related economic growth. The program funds activities in resource planning and manufacturing improvement. The program is also active in workforce development initiatives, to ensure an adequately trained and available workforce to support the large-scale deployment of wind energy in the U.S.

Priority 5: Lower GHG Emissions — Position U.S. to lead on climate change policy, technology, and science

The Wind Energy Program collaborates with National Laboratories, universities, industry, and government to ensure timely sharing of technical and environmental information. International collaboration is through the IEA wind energy implementing agreement, which cooperates on matters related to R&D, deployment, and policy.

Contribution to GPRA Unit Program Goal 1.1.04.00 (Wind Energy)

The Wind Energy Program's key contribution to GPRA Strategic Theme 1, Energy Security, is through supply growth and diversification of energy resources. Key technology pathways that contribute to achievement of these benefits include (annual performance indicators are provided in the individual technology benefits narrative):

- Low Wind Speed Technology[a]
  - By 2012, complete research that will achieve modeled cost of energy from large wind systems in Class 4 winds to $0.036/kWh for land-based systems (from a baseline of $0.055/kWh in 2002); and
  - By 2014, complete research that will achieve modeled cost of energy from large wind systems in Class 6 winds to $0.070/kWh for shallow water (depths up to 30 meters) offshore systems (from a baseline of $0.095 in FY 2005).
- Distributed Wind Technology (DWT): By 2015, facilitate a five-fold expansion of the number of distributed wind turbines deployed in the U.S. market from a 2007 baseline (2,400 units); and
- Technology Application:
  - By 2010, facilitate the installation of at least 100 MW in at least 30 States, from a baseline of 8 States in 2002; and
  - By 2018, facilitate the installation of at least 1,000 MW in at least 15 States, from an estimated baseline of 3 States in 2008.

Means and Strategies

The Wind Energy Program will use various means and strategies to achieve its GPRA Unit Program goals as described below. "Means" include operational processes, resources, information, and the development of technologies, and "strategies" include program, policy, management and legislative initiatives and approaches. Various external factors, as listed below, may impact the ability to achieve the program's goals. Collaborations are integral to the planned investments, means and strategies, and to addressing external factors. Beginning in FY 2009, the Wind Energy Program substantially increased the portion of its activities accomplished via competitive funding opportunities for industry and National Laboratories.

The Wind Energy Program will be implemented through the following means:

- In Low Wind Speed Technology (LWST), the program increasingly uses Cooperative Research and Development Agreements (CRADAs) for large wind system technology. CRADAs allow collaborative development activities, closely supported by laboratory-based research and testing, to assist private organizations in expanding the applicability of wind technology into new, more

[a] Annual targets using Cost of Energy are tracked to a fixed technology baseline that reflects a set of standard financial and technology assumptions for each technology (Land-based and Offshore wind technologies). Cost of energy targets differ from actual market conditions, as baseline technology assumptions do not include such factors as the impact of the on and off nature of the Production Tax Credit that leads to turbine demand spikes; changing financial variables; fluctuating commodity prices and currency exchange rates; and changes in expected equipment life.

effective and efficient generators. Laboratory-based Supporting Research and Testing (SR&T) works to advance technologies that have shown potential to reduce the cost or improve the performance and reliability of large utility-scale and distributed wind systems. Activities under this area also address more basic technology assessments by identifying the underpinnings of new applications for wind technology, such as offshore applications and wind/fuel-cell technology development. These efforts also improve the basic understanding of wind phenomena such as advanced blade aerodynamics and upper air resource assessment and modeling. Due to the different financial and technical strengths of wind industry companies, the use of collaborative partnerships will vary depending on specific needs and desired results. Some projects whose results will be made public may require higher Federal cost-share while other technology development will rely on strong industry support. Through the collaboration with governmental and industry partners, combined with laboratory-based research, the program will assess the market for a U.S. based offshore wind industry during a program review in FY 2009.

- Distributed Wind Technology (DWT) has been conducting an independent testing and certification effort since FY 2008. This activity will help the small wind industry build credibility, increase consumer confidence in small wind turbines, and stabilize the market. For more than a decade, DWT focused on projects in partnership with industry to develop innovative concepts, components, and prototypes primarily for residential, farm, and industrial applications. The targeted turbine size is 100kW or less. In order to fully explore the potential of distributed wind, there is a need to consider the market and technology for applications that require larger turbines. Market assessments in recent years suggest that there is a significant market for mid-size turbines in the range of 200kW to 500kW for industrial operations, farms, and public facilities. However, the lack of economically viable products for this segment has not been addressed by the current market, which is dominated by utility-scale turbines. In addition to supporting technology development and market adoption for small turbines, the program will continue to explore the potential of larger turbines for distributed applications and will structure its activities accordingly in FY 2010 and beyond.
- The Systems Integration key activity will expand on all areas to address the technical barriers to integrating increasing amounts of wind energy into our Nation's generation mix. The subprogram will expand and refine data sets of wind resource potential throughout the country, as well as at resolutions needed for utility planning and operations. To aid the electricity planning community, the program will provide the capability for state-of-the-art representations of renewable energy development potential in support of the evolution of the Nation's electric system. In support of power system operations, this activity will acquire information on actual system performance characteristics, develop system models for integrated resource planning activities, develop advanced wind forecasting models and promote their use in utility control rooms. Support will be provided for key regional planning efforts, such as Western Renewable Energy Zones, and for promoting expansion of wind energy power systems capabilities via university programs.
- Dedicated outreach efforts will be funded through the Technology Acceptance key activity. The Wind Energy Program supplies information on a range of wind energy technologies and related issues to national, state, and local stakeholders, decision makers, and potential customers and investors to ensure a transparent exchange of credible information. Started in FY 2007, this effort will continue to expand regional relationships in FY 2010, as decision makers are increasingly looking to regional approaches to energy resource and planning. This is especially true in the electricity market where national policy has multi-state Regional Transmission Organizations. Electricity generators no longer serve loads in a single State, but rather serve interconnected markets that cross multiple political boundaries. Open and clear dialogue is necessary for making informed and long-lasting energy and environmental decisions.

The Wind Energy Program will implement the following strategies:

- The Wind Energy Program will provide leadership to the wind industry and focus priorities on removing the barriers to the use of wind energy technology. Additionally, the state of progress in advanced wind energy technology R&D projects and the financial strength of an emerging utility market for wind turbine systems are decreasing the level of government support needed for technology development in large scale, land-based wind turbine systems in favor of targeted research on components and others issues affecting technology reliability.

The program works with a number of other entities to accomplish its mission. For transmission, the program works with the Office of Electricity Delivery and Energy Reliability (OE) and transmission/distribution industry groups. To reduce barriers to wind energy deployment the program works with the Federal Aviation Administration (FAA) and the Department of Defense on radar and other military issues affected by wind turbines. Environmental siting issues are worked with wind energy stakeholder groups and industry representatives. For offshore wind rules and regulations, the program works with the Department of the Interior's Minerals Management Service (DOI MMS). Cooperative R&D is performed with the IEA, academia, and the National Laboratories. In carrying out the program's mission, the Wind Energy Program collaborates in several important activities, including:

- Program activities dependent upon outputs from academia, manufacturers, developers, and National Laboratories (e.g., the Offshore Wind Collaborative, a joint Federal/State/industry/academia collaboration to address barriers to U.S. offshore wind development);
- Research plans and priorities, as set forth in the "20% Wind Energy by 2030" report cooperatively prepared by DOE, NREL, and the American Wind Energy Association (AWEA);
- Interconnection policy and R&D issues on electricity transmission and distribution with Federal, state, and regional oversight bodies and the utility industry;
- Coordination with the DOE's OE on transmission-related issues;
- Research and coordination with the FAA and other defense and civilian agencies on radar and other military issues affected by wind turbines;
- Regulation of offshore wind energy with the DOI MMS;
- Industry and R&D directions for the production of hydrogen for energy use, and for other non-energy uses;
- Cooperative research and development with the IEA; and
- Peer review of the Wind Energy Program's overall strategies and its activities by academia, industry representatives, National Laboratories, and independent experts.

Validation and Verification

To validate and verify program performance, the Wind Energy Program will conduct internal and external reviews and audits, as well as continue to conduct and build upon the transparent oversight and performance management initiated by Congress and Administration. The table below summarizes validation and verification activities.

Data Sources:	DOE Report "20% Wind Energy by 2030," May 2008. "Musial, W.D.; Butterfield, S.; Laxson, A.; Heimiller, D.; Ram, B – "*Large-Scale Offshore Wind Power in the United States: Assessment of Opportunities and Barriers,*" NREL Report #TP-50040745, November 2007. "*Distributed Wind Market Applications,*" Trudy Forsyth and Ian Baring-Gould, NREL Technical Report TP-500-39851, November 2007. "Low Wind Speed Technologies Annual Turbine Technology Update

(ATTU): Process for Land-Based Utility-based Technology," NREL Report #TP-50037505, June 2005. "Assessment of Potential Improvements in Large-Scale Low Wind Speed Technology," J. Cohen, Proceedings of Global Wind Power 2004, Chicago, Illinois, March 28-31, 2004, published by American Wind Energy Association. "Low Wind Speed Turbine Technology Characterization," Migliore and Cohen, presented at Wind Power 2003; "Wind Energy Technology Characterization, 1997," published by EPRI. "Low Wind Speed Turbine Technology Benefits," internal analysis for the FY 2002 request, peer reviewed by A.D. Little. FY 2001, FY 2002, FY 2003, FY 2004, FY 2005 and FY 2006 Wind Energy Program Peer Reviews. American Wind Energy Association (AWEA)/Global Energy Concepts Wind Plant Database, reviewed by EIA, contain proprietary data. Various published and unpublished data on wind projects economics. AWEA Small Wind Turbine Industry Roadmap.

Baselines: Low Wind Speed Technology: $0.055/kWh in FY 2002 for land-based applications in Class 4 winds; $0.095/kWh in FY 2005 for shallow water offshore applications in Class 6 winds. Distributed Wind Technology: 2400 turbines deployed in distributed wind applications in 2007**.** Technology Application: Eight States in 2002 with at least 100 MW wind installed, and 6 States in FY 2008 with at least 1000 MW installed.

Frequency: Annual.

Data Storage: Web, paper publications and on-line storage.

Annual Performance Results and Targets

FY 2005 Results	FY 2006 Results	FY 2007 Results	FY 2008 Targets	FY 2009 Targets	FY 2010 Targets
GPRA Unit Program Goal 1.1.04.00 (Wind Energy)					
Technology Viability/Low Wind Speed Technology					
Complete fabrication and begin testing advanced variable speed power converter. Test first advanced blade, incorporating improved materials and manufacturing techniques. Field test the first full-scale Low Wind Speed Technology prototype turbine. This contributes to the Annual LWST COE Target: 4.3 cents per kWh in Class 4 winds. [MET]	Annual COE Target: 4.2 cents per kWh in onshore Class 4 winds; 9.3 cents per kWh for offshore systems in Class 6 winds. [MET]	Annual COE target: 4.1 cents per kWh in onshore Class 4 winds; 9.25 cents per kWh for shallow water offshore systems in Class 6 winds. [MET]	4.0 cents per kWh modeled cost of wind power in land-based Class 4 wind speed areas (i.e., 13 mph annual average wind speed at 33 feet above ground). [NOT MET 4.05 cents per kWh] 9.2 cents per kWh modeled cost of wind power in Class 6 wind speed areas (i.e., 15 mph annual average wind speed at 33 feet above ground) for shallow offshore systems. [MET]	3.9 cents per kWh modeled cost of wind power in land-based Class 4 wind speed areas (i.e., 13 mph annual average wind speed at 33 feet above ground). 9.15 cents per kWh modeled cost of wind power in Class 6 wind speed areas (i.e., 15 mph annual average wind speed at 33 feet above ground) for shallow offshore systems.	3.8 cents per kWh modeled cost of wind power in land-based Class 4 wind speed areas (i.e., 13 mph annual average wind speed at 33 feet above ground). 9.10 cents per kWh modeled cost of wind power in Class 6 wind speed areas (i.e., 15 mph annual average wind speed at 33 feet above ground) for shallow offshore systems.
Technology Viability/Distributed Wind Technology (DWT)					
Complete prototype testing of 1.8 kW Small Wind Turbine, finishing the International Electrotechnical Commission suite of tests for acoustics, power, durability, and safety. This contributes to the Annual DWT COE Target: 12-18 cents per kWh in Class 3 winds. [MET]	COE Target: 11-16 cents per kWh in Class 3 winds. [MET]	COE Target: 10-15 cents per kWh in Class 3 winds. [Met] New effort: Distributed Wind (DW): 2400 units of distributed wind turbines in market. [baseline] [MET]	500 new units of distributed wind turbines deployed in market). [MET]	600 new units of distributed wind turbines deployed in market.	800 new units of distributed wind turbines deployed in market.
Technology Application					
32 States with over 20 MW installed; 15 States with over 100 MW installed. [PARTIALLY MET]	19 States with over 100 MW wind installed. [PARTIALLY MET]	20 States with over 100 MW wind installed. [PARTIALLY MET]	22 States with at least 100 megawatts (MW) of wind power capacity installed). [MET]	27 States with at least 100 megawatts (MW) of wind power capacity installed, and 4 States with over 1,000 MW wind power capacity installed.	30 States with at least 100 megawatts (MW) of wind power capacity installed, and 7 States with over 1,000 MW wind power capacity installed.

FY 2005 Results	FY 2006 Results	FY 2007 Results	FY 2008 Targets	FY 2009 Targets	FY 2010 Targets
Contribute proportionately to EERE's corporate goal of reducing corporate and program adjusted uncosted obligated balances to a range of 20-25 percent by reducing program annual adjusted uncosteds by 10 percent in 2005 relative to the program FY 2004 end of year adjusted uncosted baseline ($18,371K) until the target range is met. [MET]	Maintain total administrative overhead costs (defined as Program Direction and Program Support excluding earmarks) in relation to total program costs of less than 12 percent. [MET]	Maintain total administrative overhead costs (defined as Program Direction and Program Support excluding earmarks) in relation to total program costs of less than 12 percent. [MET]	Maintain administrative costs as a percent of total program costs less than 12 percent. [MET]	Maintain administrative costs as a percent of total program costs less than 12 percent.	Maintain administrative costs as a percent of total program costs less than 12 percent.[a]

[a] Administrative costs are comprised of Program Direction and elements of Program Support (Technology Advancement and Outreach; and Planning, Analysis and Evaluation), baseline and targets under development.

Technology Viability
Funding Schedule by Activity

(dollars in thousands)

	FY 2008	FY 2009	FY 2010
Technology Viability			
Low Wind Speed Technology (LWST - Large Systems)	5,812	4,522	15,257
Distributed Wind Technology (DWT - Small Systems)	3,818	3,495	5,907
Supporting Research and Testing (SR&T)	16,831	23,353	23,353
SBIR/STTR	–[a]	630	923
Total, Technology Viability	26,461	32,000	45,440

Description

Technology Viability activities advance wind turbine components and systems through targeted public/private collaborative R&D and Cooperative Research and Development Agreements (CRADAs), and by research and testing that bring specialized technical expertise, comprehensive design and analysis tools, and unique testing facilities to address market barriers to wind technology.

Technology Viability key activities focus on research, development and testing for improving performance, cost effectiveness and reliability of large and distributed wind energy systems, which are primary barriers to wind energy's viability. Achieving these goals will help wind energy expand more widely and rapidly in energy markets. The focus of the Low Wind Speed Technology (LWST) activity is to improve the cost and performance of land-based and offshore wind turbines. Developing U.S. coastal waters show promise for longer-term growth, and as a hedge against transmission bottlenecks that may limit land-based wind development in eastern regions. The focus of Distributed Wind Technology (DWT) is to expand the market for distributed wind technologies five-fold from 2007, the baseline year.

The following table provides expected annual indicators of progress for the LWST and DWT:

(fiscal year)

	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16
Low Wind Speed Technology – Land-based (Modeled cost of energy in Class 4 in cents/kWh)															
Target	5.5	5	4.6	4.3	4.2	4.1	4	3.9	3.8	3.7	3.6	–	–	–	–
Actual	5.5	5	4.4	4.3	3.9	3.8	4.05	–	–	–	–	–	–	–	–
Low Wind Speed Technology –Shallow Offshore Wind Systems (Modeled cost of energy in Class 6 in cents/kWh)															
Target	–	–	–	9.5	9.3	9.25	9.2	9.15	9.1	8.9	8.3	7.6	7.0	–	–
Actual	–	–	–	9.5	9.3	9.25	9.2	–	–	–	–	–	–	–	–

[a] SBIR/STTR funding was transferred to the Science Appropriation in FY 2008.

(fiscal year)

	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16
Distributed Wind Technology – (Class 3 in cents/kWh for historical program activity)															
Target	17-22	14-20	13-19	12-18	11-16	10-15	–	–	–	–	–	–	–	–	–
Actual	17-22	14-20	13-19	12-18	11-11.5	9.9-10.7	–	–	–	–	–	–	–	–	–
Distributed Wind Technology: new distributed wind turbines deployed in market (new effort since FY 2008)															
Target	–	–	–	–	–	–	500	600	800	1,000	1,200	1,400	1,700	2,200	–
Actual	–	–	–	–	–	–	763	–	–	–	–	–	–	–	–

The Wind Energy Program developed a methodology for measuring and tracking program performance. Levelized cost of energy (LCOE), in constant dollars, is the primary performance indicator for the LWST effort for land-based and offshore wind technology. Achieving the planned LCOE target will be possible through the technology improvement opportunities being addressed by the large turbine R&D portfolio. Cost of energy estimates for full-scale prototypes are based on industry experience in maturation of technologies and manufacturing processes. Determining the LCOE impact of improvements in individual components and subsystems are based on comparisons against a baseline turbine composite with a well-understood cost of energy. Using a peer-reviewed process, the impact of technology improvements is assessed each year. Forecasts of LCOE impact are based on progress of existing subcontracts and the results of research efforts at the time of the assessment, thereby allowing a clear picture of the impact of improvements against the overall goals and objectives.

The program will also assess the number of distributed wind turbines deployed each year. While deployment levels are impacted by many outside factors (Federal tax incentives, state renewable portfolio standards, and other factors listed under “Means and Strategies” above), this metric may be used to quantify the program’s success in the removal of technology, market, and implementation barriers for distributed wind technologies.

The Wind Energy Program 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.

Benefits

The Wind Energy Program accomplishes its activities through partnerships using competitive funding opportunities or CRADAs. The LWST activity is aimed at improving the reliability and affordability of utility scale wind turbine systems. Laboratory-based Supporting Research and Testing (SR&T) works to advance technologies that have shown potential to reduce the cost or improve the performance, reliability, and manufacturability of large utility-scale and distributed wind systems.

Through independent testing and certification, the DWT activity helps the small wind industry build credibility, increase consumer confidence in small wind turbines, and stabilize the market. Although the program has focused mainly on turbines up to 100kW in size, research suggests that there is a significant market for mid-size turbines in the range of 200kW to 500kW for industrial operations, farms, and public facilities[a]. In addition to supporting technology development and market adoption for small turbines, the program will continue to explore the potential of larger turbines for distributed applications and will structure its activities accordingly.

Detailed Justification

(dollars in thousands)

	FY 2008	FY 2009	FY 2010
Low Wind Speed Technology (LWST - Large Systems)	**5,812**	**4,522**	**15,257**

The LWST activity supports public/private partnerships, CRADAs, and specific National Laboratory research, analysis, and testing for large wind system technology pathways (turbines over 100kW) to achieve the following goals:

- $0.036/kWh for land-based systems in Class 4 winds by 2012; and
- $0.07/kWh for shallow water offshore systems in Class 6 winds by 2014.

For land-based systems, public/private partnerships and CRADAs catalyze industry adoption of technology developments and emerging innovation, in collaboration with National Laboratory expertise. A series of two LWST competitive solicitations were conducted to promote land-based wind technology development. Phase I (FY 2002) and Phase II (FY 2004) were cost-shared industry partnerships and concentrated on three technical areas: 1) conceptual design studies; 2) component development and testing; and 3) full turbine prototype development and testing. CRADAs continue to be used to forge industry partnerships aimed at component improvements to existing large wind turbine designs.

Through FY 2009, the program applied limited resources to offshore wind technology research to analyze the potential of offshore wind energy development. Activities, including technology assessment, deployment and outreach, and international collaboration and standards, will obtain and evaluate the information needed to allow the development of a programmatic strategy for future offshore wind technology development. In addition, the Wind Energy Program will participate in a limited manner to explore initial deployment issues for offshore wind turbines in the U.S., including assessing environmental conditions and working with the DOI's MMS to develop offshore regulatory policy in accordance with Section 321 of EPAct 2005, *Alternate Energy-Related Uses on the Outer Continental Shelf*. These activities will allow the program to determine whether there are any significant market and governmental constraints to offshore wind technologies.

If expanded, initial DOE investments in offshore wind are likely to consist of phased solicitations to facilitate development of offshore technology and build on the success of the program's partnering strategy.

FY 2010 activities will focus on: 1) conducting initial investments in offshore wind technology development; and 2) supporting development of turbine technology aimed at reducing Operations and Maintenance costs and expanding reliability of existing systems.

[a] "An Analysis of the Technical and Economic Potential for Mid-Scale Distributed Wind," Subcontract Report NREL/SR-500-44280, December 2008, http://www.nrel.gov/docs/fy09osti/44280.pdf

	(dollars in thousands)		
	FY 2008	FY 2009	FY 2010
Distributed Wind Technology	**3,818**	**3,495**	**5,907**

DWT will support independent testing and certification efforts for small wind turbines. A concerted effort will be made to transfer technical expertise from NREL and assist state energy offices and other interested parties to develop regional testing capabilities across the U.S. In FY 2010, the program will begin an activity to support technology development for mid-size turbines. Manufacturers that have potential to succeed in this market segment tend to be small and undercapitalized companies that do not have the means to invest in high risk R&D.

Supporting research and testing is an integral part of the DWT effort. It includes a variety of supporting activities. Design review and analysis activities assist project partners on technical, market and cost challenges. Basic research activities are conducted to evaluate turbine aero acoustics, new materials for blades, and innovative power electronics components such as inverters and controllers. Some distributed wind turbine systems or components will be field or laboratory tested at the National Wind Technology Center (NWTC), to assess loads, power, acoustic emission, power quality, and other performance parameters.

FY 2010 activities will include: 1) continued independent, laboratory field testing of distributed turbines; 2) technical assistance for small wind certification and creation of regional testing capabilities; 3) collaboration with turbine manufacturers to develop a mid-size turbine prototype or value engineered unit; and 4) continuation of efforts to evaluate technologies for small-scale turbines.

Supporting Research and Testing (SR&T)	**16,831**	**23,353**	**23,353**

In support of achieving cost of energy goals, NREL and Sandia National Laboratory (SNL) provide 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 transition of designs and component improvements into full systems. Large turbine projects are periodically reviewed against analytically established performance measures to provide the basis for funding and planning adjustments needed to optimize the portfolio for success.

Through the National Laboratories, specialized technical expertise, comprehensive design and analysis tools, and the unique testing facilities are brought to bear on problems that industry is or will encounter in bringing new turbine technology to the marketplace. This technical support is essential to the public/private partnerships and collaboratives, and engages the capabilities of the National Laboratories, universities and other technical support available in private industry.

- Advanced Rotor Development – The blades of a wind turbine control the energy capture and almost all the loads, and are therefore a primary target of research efforts. The challenge is to create the scientific knowledge base and engineering tools to enable designers to achieve optimum performance at the lowest possible cost by using new materials, advanced control techniques, improved manufacturing processes, and enhanced design tools. Rotor development work will assist the industry in meeting its cost goals by increasing rotors' swept areas to enable use in previously uneconomic wind regimes. Advanced rotor development will be done in blade development, aerodynamic code development and validation, aeroacoustics research and testing, and systems and controls.
- Site Specific Design - Future wind energy installations will be in areas of significantly different

wind resource potential and terrain roughness. The benefits of designing large installations (100 MW or more) for specific site conditions are substantial. The nature of atmospheric loading at increasing heights will be assessed and documented. Blade designs, including aerodynamic geometry, controls, and structural details, consider energy capture requirements and durability suitable for low-energy lightly-loaded sites, i.e., sites without gusty and strong winds. Site specific design covers the development of systematic methods for specifying site energy, load conditions, and turbine inflow characterization.

- Generator, Drivetrain, and Power Electronics - The generator, gearbox, and power converter represent roughly 25 percent of the installed capital cost of a modern wind turbine. The drivetrain is becoming a primary factor in machine design because its weight and size affect other wind turbine configuration and erection factors, such as tower size and crane rating. Variable-speed wind turbine designs are dependent on the efficiency and mode of operation of the power converter that changes variable-frequency AC from the generator to fixed-frequency AC conditioned for injection into the electrical grid. Conversion efficiency is a critical factor. Future designs of generators and power converters must be specialized and tailored for wind turbines as wind turbines operate at less than rated power. Permanent magnet generators that allow lighter generator rotor designs and have lower losses will play a role, as will power converters and generators that allow variable-speed operation and have higher efficiencies below rated power. Reliability will be an issue because the generator and power converter are key points of system failure. Public/private partnerships to explore areas that will contribute to improvements in converter and generator designs, focusing on generator and converter architecture, controls, and reliability will be examined. As the Wind Energy Program develops new technology through industry collaboration, it will also provide oversight and technical support. Design review and analysis provides a means by which NREL and SNL can provide specialized expertise for industry-led activities. It also supports the proposal or CRADA evaluation process. This support and oversight will assist industry, protect the taxpayer’s investment in these partnerships, and enhance their chance of success.

The NWTC has unique facilities developed to provide the testing capabilities needed to achieve large turbine cost goals. Testing is conducted on full-scale turbine systems installed in the field and on turbine components and subsystems. Component testing utilizes the NWTC’s specialized blade and dynamometer test facilities. These tests support certification and technology characterization. Field testing of turbine loads, power performance, power quality, and acoustic emissions are conducted in accordance with standards developed under the International Electrotechnical Commission (IEC) and the American Association of Laboratory Accreditation.

As described above, computer modeling and dynamic simulations are important elements of DOE’s support of industry turbine development. Validating and improving these models is difficult because the models cannot always simulate true inflow, turbine response, or control performance. To fill this gap, extensive and detailed field and laboratory testing is necessary. The data are used to optimize turbine configurations and LCOE, e.g. by improving control algorithms and simulation codes from which the turbines were designed. Three primary types of testing are conducted through the DOE program, structural testing, dynamometer testing, and field testing.

Performance for R&D activities is measured using analytically-established targets linking contributions from each activity to meeting program goals. Outputs of this activity include periodic design reviews

	(dollars in thousands)		
	FY 2008	FY 2009	FY 2010

and results of tests at industry and laboratory locations.

In FY 2010, the program expects to achieve the following milestones for this key activity: 1) startup of utility scale turbine at the NWTC for field testing of control logic enhancements; and 2) perform detailed testing and analysis of drive train and blade performance and reliability using NWTC testing facilities.

SBIR/STTR	**0**	**630**	**923**

In FY 2008, $456,000 and $55,000 were transferred to the SBIR and STTR programs respectively. The FY 2009 and 2010 amounts shown are estimated requirements of the continuation of the SBIR and STTR program.

Total, Technology Viability	**26,461**	**32,000**	**45,440**

Explanation of Funding Changes

	FY 2010 vs. FY 2009 ($000)
Low Wind Speed Technology (LWST - Large Systems)	
This increase is for new investments in offshore wind activities following a program strategy to be developed in FY 2009. Efforts will be aimed at characterizing the offshore wind resource and identifying offshore wind turbine design requirements, which may be vastly different than the design requirements for land-based wind turbines. Partnerships and solicitations will be used to accelerate the development of offshore wind technology in the U.S. Funds will also be used to support competitively selected technology development projects from a FY 2009 funding opportunity announcement (FOA). These projects are aimed at improving the reliability and cost effectiveness of land-based wind turbine systems.	+10,735
Distributed Wind Technology	
The increase is for a new collaborative effort to support American manufacturers to develop capabilities to produce a mid-size turbine prototype or value engineered unit; based on a market assessment to be completed by the program in FY 2009.	+2,412
Supporting Research and Testing (SR&T)	
No change	+0
SBIR/STTR	
Changes in the SBIR/STTR funding are a direct result of changes in the funding of program activities.	+293
Total Funding Change, Technology Viability	**+13,440**

Technology Application
Funding Schedule by Activity

	(dollars in thousands) FY 2008	FY 2009	FY 2010
Technology Application			
Systems Integration	15,709	16,000	18,430
Technology Acceptance	6,864	7,000	11,130
Total, Technology Application	22,573	23,000	29,560

Description

The Technology Application subprogram addresses opportunities and barriers, other than the turbine cost of energy, concerning use of wind energy systems. Efforts managed in this area of the program help to prepare and accelerate the market adoption of wind technologies.

Through one of its key activities, Technology Acceptance, Technology Application focuses on resolving institutional issues, providing State and regional energy sector outreach, and investigating and mitigating social, environmental and wildlife issues associated with wind energy development. The second key activity, Systems Integration, focuses on anticipating and overcoming operational issues associated with interconnecting greater amounts of wind energy and other renewables on the electricity system.

Technology Application helps the program achieve its mission by focusing on the cost barriers other than generator technology that enhance or impede wind energy use in the U.S. Helping stakeholders and officials understand wind energy technologies and how wind can be integrated into their State energy systems will reduce institutional and regulatory barriers, helping wind contribute energy in a competitive wholesale electric market.

The following table provides expected annual indicators of progress for Technology Application:

(fiscal year)	08	09	10	11	12	13	14	15	16	17	18
Technology Application - # of States with over 100 MW installed											
Target	22	27	30	–	–	–	–	–	–	–	–
Actual	19	–	–	–	–	–	–	–	–	–	–
Technology Application - # of States with over 1000 MW wind installed											
Target		4	6	6	7	8	9	10	12	13	15
Actual		–	–	–	–	–	–	–	–	–	–

Technology Acceptance is used as a way to measure the success of the Wind Energy Program’s outreach activities. Reaching 100 MW installed capacity threshold has been used an important indicator that wind is being accepted as a large-scale generating option by the State’s utilities, regulators and investors. As the scale of penetration increases, a 1,000 MW state goal has been added. Activities conducted under the Technology Application subprogram will contribute to this new goal, as large scale integration studies are necessary and complementary to outreach activities in order to enable such large penetration of wind energy in States and regions.

The Wind Energy Program 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.

Benefits

The Systems Integration activity will address the technical barriers of integrating increasing amounts of wind energy in the Nation's energy generation mix. In support of utility power system operations and planning needs, this activity will expand and refine datasets of wind resource potential, acquire information on actual system performance characteristics, develop system models for integrated resource planning activities, develop advanced wind forecasting models, and promote their use in utility control rooms.

Dedicated outreach efforts will be completed by the Technology Acceptance key activity. Laboratory and contract staff supply information on a range of wind energy technologies and related issues to national, state, and local stakeholders, decision makers, and potential customers and investors for a transparent exchange of credible information.

Detailed Justification

	(dollars in thousands)		
	FY 2008	FY 2009	FY 2010
Systems Integration	**15,709**	**16,000**	**18,430**

Systems Integration addresses technical barriers to interconnecting large amounts of wind energy into the Nation's electric grid and supporting operational evaluations. In FY 2010 the activity will continue to provide more detailed technical information requested by the electric power industry to make informed decisions about wind energy. Coordination with DOE's Office of Electricity Delivery and Energy Reliability (OE) will continue on grid interconnection related to wind energy.

Meso-scale modeling of the wind resource in areas around the country with high levels of potential will continue, and will improve understanding and analysis of the wind characteristics in areas where wind energy projects are established or are being planned. The data collected through this activity will be compiled in a comprehensive national database of wind energy siting and development information, and will be used to support utility analysis of wind energy integration and regional wind penetration scenarios. Advanced wind energy forecasting models and applications will be validated in utility control room operation for effectiveness in mitigating wind energy ancillary service costs.

Development and validation of wind energy system models for incorporation into utility operations and planning tools will continue, along with broad based technical outreach activities to promote understanding and adoption by utilities, regional transmission authorities, system operators, and system reliability organizations.

Wind energy technical interconnection support will be provided to assist implementation of results from three regional high renewable penetration operational and transmission studies, to allow utility planning efforts to proceed for commercially viable large-scale wind energy development identified through the collaborative studies. Implementation action will also be coordinated with key electric power market development activities, including designation of regional renewable energy development zones.

Technology Acceptance	**6,864**	**7,000**	**11,130**

Technology Acceptance focuses on outreach activities to overcome market and regulatory barriers at the national, state, and local levels that are essential to making progress towards significant increases in wind energy use. Within Technology Acceptance, Wind Powering America is aimed at facilitating the deployment of wind technology to increase the use of wind energy in the U.S.; bringing economic and environmental benefits to the country; and stimulating sustainable tribal and rural-based energy sectors. Activities are conducted in partnership with utility generators, equipment manufacturers, project financiers and developers, public and private officials, regulators, industrial and public sector consumers, other Federal and state agencies, and public stakeholder groups to provide technical support, guidance, and information on national, regional, state, and local efforts to explore and develop wind energy resources, both on land and offshore. Technology Acceptance also supports cooperative activities with utility-based and other key stakeholder organizations to expand access to wind resource data and to provide information on technical and institutional barriers to development.

FY 2010 activities will continue to emphasize efforts to assess and mitigate effects of wind turbines on

	(dollars in thousands)		
	FY 2008	FY 2009	FY 2010

Federal mission areas and the environment. These efforts include working with all stakeholders to address the following specific barriers: direct and indirect Federal mission area, wildlife, and other environmental risks associated with wind technology and projects; lack of government consensus on regulatory or process requirements necessary to protect Federal mission areas and reduce these risks; lack of tools for industry to assess and mitigate Federal mission area, wildlife, and other environmental risks from wind; and public perception that the environmental risks associated with wind power outweigh its benefits. Many of these efforts will be applicable to local and regional siting and permitting proceedings.

FY 2010 activities will also continue to focus on enhancing the program's regional wind support effort. Since many benefits and challenges associated with wind energy are not limited by state borders, developing regional collaborations allows many organizations to more effectively address common issues. Support will continue to be provided for development of regional wind institutes; existing and emerging state wind working groups; Tribal wind technical assistance on wind resources and project planning, in coordination with financial assistance provided through the EERE's Tribal Energy program activity; partnership activities with national agriculture-sector organizations; collaboration with public power organizations; and community and rural schools projects by expanding activity over regions of the country with similar issues. Distributed wind system support activities, such as working with state regulators, small wind stakeholders, and the agricultural sector on market acceptance issues specific to distributed wind technologies will also continue. In addition, 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 the DOI to revise siting guidelines; supporting mitigation research; and producing technical and outreach materials on ways to develop wind in an environmentally sensitive manner. The FY 2010 performance target for this activity is 30 States with over 100 MW, and 6 States with over 1,000 MW wind installed.

Total, Technology Application	**22,573**	**23,000**	**29,560**

Explanation of Funding Changes

	FY 2010 vs. FY 2009 ($000)
Systems Integration	
Increase expands support to electric utility sector organizations for study, application, and coordination actions needed for increased wind energy penetration, as well as support to six National Laboratories contributing to wind energy integration methods development and application assistance.	+2,430
Technology Acceptance	
Increased funding will be used to address barriers to wind energy deployment. A mitigation toolbox will be further developed to allow industry to address the impact of wind turbines on radar. Support to state wind working groups will be expanded, especially in areas of education and workforce development. Funds will also be used to support competitively selected technology acceptance projects from a FY 2009 competitive FOA.	+4,130
Total Funding Change, Technology Application	**+6,560**

Geothermal Technology

Funding Profile by Subprogram

	(dollars in thousands)			
	FY 2008 Current Appropriation[a]	FY 2009 Original Appropriation	FY 2009 Additional Appropriation	FY 2010 Request
Geothermal Technology				
Enhanced Geothermal Systems	19,307	44,000	−	50,000
Non-EGS	0	0	−	0
Oil and Gas Well Co-Production and Resource Assessment	0	0	−	0
Total, Geothermal Technology	19,307	44,000	400,000	50,000

Public Law Authorizations:
P.L. 93-410, "Geothermal Energy Research, Development, and Demonstration Act of 1976" (1976)
P.L. 95-91, "Department of Energy Organization Act" (1977)
P.L. 95-618, "Energy Tax Act of 1978" (1978)
P.L. 96-294, "Energy Security Act" (1980)
P.L. 101-218, "Renewable Energy and Energy Efficiency Technology Competitiveness Act of 1989" (1989)
P.L. 101-575, "Solar, Wind, Waste, and Geothermal Power Production Incentives Act of 1990" (1990)
P.L. 102-486, "Energy Policy Act of 1992" (1992)
P.L. 109-58, "Energy Policy Act of 2005" (2005)
P.L. 110-140, "Energy Independence and Security Act of 2007" (2007)

Mission

The mission of the Geothermal Technology Program (GTP) is to conduct research, development, and demonstration to establish Enhanced Geothermal Systems (EGS) as a major contributor for baseload electricity generation.

Benefits

Accomplishing the mission will benefit the supply side of DOE's energy security equation by accelerating the arrival and use of new fuels and technologies. GTP's mission and activities directly support DOE's mission to promote scientific and technological innovation in support of advancing the national, economic and energy security of the U.S. A DOE-sponsored analysis[b] published in January 2007 by an MIT-led panel shows the potential for Enhanced (or engineered) Geothermal Systems to contribute 100,000 MW to the U.S. energy supply by 2050. Ultimately, commercial EGS could provide significant amounts of clean baseload domestic power and contribute to the security and diversity of U.S. energy supplies. A core of research projects will be performed through cost-shared awards to private companies and academic institutions via competitive solicitations. National Laboratories with unique expertise in the subject areas will conduct the balance of the competitively-selected research

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[a] SBIR/STTR funding was transferred to the Science Appropriation in FY 2008, which includes a reduction of $456,000 that was transferred to the SBIR program and $55,000 that was transferred to the STTR program.

[b] The Future of Geothermal Energy: Impact of Enhanced Geothermal Systems (EGS) on the United States in the 21st Century, Massachusetts Institute of Technology, 2006. http://geothermal.inel.gov

projects. Field demonstrations with private companies and academic institutions via competitive solicitations will validate the commercialization potential of EGS.

When implemented, EGS will avoid greenhouse gas (GHG) emissions. Typical EGS power plants will use more advanced closed loop conversion systems that will not add CO_2, NO_x, or other greenhouse gases to the atmosphere. Expected program outcomes include demonstrating the ability to create an EGS reservoir capable of producing 5MW by 2015. This system demonstration should foster rapid growth in the use of geothermal energy in the outyears as predicted by the MIT study. Today, grid-connected high temperature hydrothermal systems are well established. In the midterm, next generation geothermal plants using engineered geothermal systems technology could come online, greatly expanding the utilization of the U.S.' geothermal resources. In the long term, EGS could be a major source of baseload electricity for large regions.

Under Strategic Theme 1 (Energy Security), Strategic Goal 1.1. (Energy Diversity), geothermal technology increases energy options and reduces dependence on oil, thereby reducing vulnerability to disruptions and increasing the flexibility of the market to meet U.S. needs. Geothermal technology also supports the reduction of GHG emissions.

The Geothermal Program pursues its mission primarily through the set of integrated activities proposed in this budget that are designed to increase the use of domestic renewable electricity technologies. These improvements will continue to provide concomitant economic, environmental and security benefits. It is expected that the most significant benefit will be a reduction of CO_2 emissions and a reduction in natural gas imports.

Climate Change

A geothermal power plant emits 35 times less carbon dioxide than the average U.S. coal power plant per kilowatt of electricity produced resulting in significantly reduced GHG emissions. CO_2 emissions reductions are estimated to increase from 2 million mt CO_2 in 2015 to more than 6 gigatons of CO_2 in 2050.

Economic Impact

- Cumulative consumer savings are estimated to reach $20 billion by 2030.
- Electric power industry savings are expected to be an additional $4 billion over the same period.

The proposed FY 2010 budget investments complement funds provided by the Recovery Act that support the acceleration of cost-shared EGS field demonstrations and the development of advanced technology to address key aspects of engineered reservoir creation, management, and utilization. Investments on advanced EGS technology and industry coupled drilling will also continue. To enable decision makers and the public to follow performance and plans, the program will post its progress in these planned activities at: http://www.energy.gov/recovery/index.htm.

The benefits tables below shows the estimated benefits from 2015 through 2050 that would result from realization of the program's goals. These benefits are achieved by targeted Federal investments in technology research and development in partnership with the drilling and service industry, geothermal energy developers, equipment suppliers, oil and gas production companies, other Federal agencies, State government agencies, universities, National Laboratories, and other stakeholders. These partnerships facilitate the technical coordination of activities and attract cost sharing to provide leveraged benefits.

The benefits estimates also reflect the increasing market share of advanced-technology Engineered Geothermal Systems (EGS) and low-temperature power plants over time as their projected incremental cost relative to conventional base-load power plants declines. The expected benefits reflect solely the achievement of the program's goals. Not included are any policies, regulatory mechanisms, or other incentives not already in existence that might be expected to support or accelerate the achievement of the program goals. In addition, some technologies show diminishing annual benefits by 2050 due to the assumption built into the analysis that industry progress, as reflected in the baseline, would eventually catch up with the more accelerated progress associated with EERE program success.

The program goal case is modeled along with a "baseline" case in which no DOE R&D exists. The baseline case is intended to represent the future without the effect of the Geothermal Program, and is identical for all DOE applied energy R&D programs, thereby ensuring that all program benefits are estimated using the same assumptions for external factors such as economic growth, energy prices, and levels of energy demand. The expected outcome benefits are calculated using the same fundamental methodology across EERE and across all of DOE's applied energy R&D programs, and the metrics by which expected outcome benefits are measured are identical. This standardization of method and metrics has been undertaken as part of DOE's efforts to make all program stated benefits comparable.

Prospective benefits are calculated as the arithmetic difference between the baseline case and the program goal case, and the resulting economic, environmental and security benefits attributed to the program's activities. This approach of calculating the benefits as an incremental improvement to the baseline helps ensure that improvements in geothermal technologies that would occur in the absence of the program are not counted as part of the program's benefits. In addition to technology and process advances due to the program's activities, energy market policies, such as state and Federal tax policies, facilitate the development and deployment of clean energy technologies. The expected impacts of current legislated policies in the baseline case are included so that the expected benefits calculated reflect as much as possible the effects of activities funded by the program.

The benefits are generated by modeling both the program goal and baseline cases within two energy-economy models: NEMS-GPRA10 for benefits through 2030, and MARKAL-GPRA10 for benefits through 2050. The full list of modeled benefits appears below.

Primary Metrics for FY 2010 Budget Request

(Incorporates Approximate Impacts of EISA 2007)

	Metric[1]	Model	Year 2015	Year 2020	Year 2030	Year 2050
Energy Security	Oil Imports Reduction, cumulative[2] (Bil bbl)	NEMS	ns	ns	ns	N/A
		MARKAL	ns	ns	ns	ns
	Natural Gas Imports Reduction, cumulative (Tcf)	NEMS	ns	ns	1.5	N/A
		MARKAL	0.0	0.1	0.2	9.3
	Reduction in Share of Highway Fuel Demand Derived from Crude Oil[3] (%)	NEMS	ns	ns	ns	N/A
		MARKAL	ns	ns	ns	ns
Environmental Impacts	CO_2 Emissions Reduction, cumulative (Mil mtCO_2)	NEMS	ns	60	556	N/A
		MARKAL	2	10	638	6817
	SO_2 Allowance Price Reduction[4] ($/ton)	NEMS	ns	ns	ns	N/A
		MARKAL	N/A	N/A	N/A	N/A
	NO_x Allowance Price Reduction ($/ton)	NEMS	ns	ns	ns	N/A
		MARKAL	N/A	N/A	N/A	N/A
	Hg Allowance Price Reduction (thousand $/lb)	NEMS	ns	ns	ns	N/A
		MARKAL	N/A	N/A	N/A	N/A
Economic Impacts	Consumer Savings, cumulative[5] (Bil $)	NEMS	ns	5	22	N/A
		MARKAL	ns	ns	ns	20
	Electric Power Industry Savings, cumulative (Bil $)	NEMS	ns	1	4	N/A
		MARKAL	ns	ns	ns	ns
	Household Energy Expenditures Reduction ($/household/yr)	NEMS	ns	ns	ns	N/A
		MARKAL	ns	ns	ns	ns

1. “Reductions” and “savings” are calculated as the difference between results from the baseline case (i.e. no DOE technology) and the technology case (i.e. all DOE technology R&D programs are successful).
2. All cumulative metrics are based on results beginning in 2010.
3. Metric includes oil-derived fuel use by light-duty vehicles, commercial light trucks and freight trucks; the metric excludes buses. Reported oil use is adjusted to exclude ethanol, biodiesel and CTL.
4. All monetary metrics are in 2006$.
5. Cumulative monetary metrics are in 2006$ that are discounted to 2010 using a 3% discount rate.

ns - Not significant
NA - Not yet available
N/A - Not applicable

Secondary Metrics for FY 2010 Budget Request

(Incorporates Approximate Impacts of EISA 2007)

	Metric[1]	Model	Year			
			2015	2020	2030	2050
Energy Security	Oil Imports Reduction, annual (Mbpd)	NEMS	ns	ns	ns	N/A
		MARKAL	ns	ns	ns	ns
	Natural Gas Imports Reduction, annual (Tcf)	NEMS	ns	ns	0.1	N/A
		MARKAL	0.0	0.0	0.0	0.9
	MPG Improvement[2] (%)	NEMS	ns	ns	ns	N/A
		MARKAL	ns	ns	ns	0%
Environmental Impacts	CO_2 Intensity Reduction of US Economy (Kg CO2/$GDP)	NEMS	ns	ns	ns	N/A
		MARKAL	ns	ns	ns	0.01
	CO_2 Intensity Reduction of US Power Sector[3] (Kg CO2/kWh)	NEMS	ns	ns	ns	N/A
		MARKAL	ns	ns	0.03	0.10
	CO_2 Intensity Reduction of US Transportation Sector[4] (Kg CO2/mile)	NEMS	ns	ns	ns	N/A
		MARKAL	ns	ns	ns	ns
Economic Impacts	Consumer Savings, annual[5] (Bil $)	NEMS	ns	2	4	N/A
		MARKAL	ns	ns	ns	17
	Electric Power Industry Savings, annual (Bil $)	NEMS	ns	0	1	N/A
		MARKAL	ns	ns	ns	ns
	Energy Intensity of US Economy (energy/$GDP)	NEMS	ns	ns	ns	N/A
		MARKAL	ns	ns	0.05	0.08
	Net Energy System Cost Reduction, cumulative (Bil $)	NEMS	N/A	N/A	N/A	N/A
		MARKAL	0	3	16	67

1. "Reductions" and "savings" are calculated as the difference between results from the baseline case (i.e. no DOE technology) and the technology case (i.e. all DOE technology R&D programs are successful).
2. Change in light duty vehicles miles traveled per gallon of oil, where oil is only that derived from petroleum.
3. Emissions include all power sector emissions. Generation calculated as total net generation adjusted for estimated T&D losses.
4. Emissions calculated using highway fuel use and related carbon emission factor. Miles calculated as highway miles traveled, excluding buses.
5. All monetary metrics are in 2006$.

ns - Not significant
NA - Not yet available
N/A - Not applicable

External factors impacting geothermal development include a precipitous decline in the equity market that makes debt financing very difficult, loss of key investment banks, and fluctuations in the price of basic materials for constructing wells and power plants. Reduced demand for drill rigs has resulted in less wait time for rigs to drill geothermal wells. In addition, the following external factors could affect the GTP's ability to achieve its mission:

- Demand for electricity
- Availability of conventional energy supplies
- Regulatory requirements
- State Renewable Portfolio Standards (RPS)
- Availability of prospective land for geothermal leasing
- Market incentives
- Cost of competing technologies
- Federal tax incentives and implementation of other policies at the national level; and
- Proximity of transmission grid and resolution of grid choke points.

Contribution to the Secretary's Priorities

GTP contributes to several of the Secretary's priorities as enumerated below. The principal focus areas are:

Priority 2: Clean Energy – Change the landscape of energy demand and supply.

GTP coordinates with DOE's Offices of Science and Fossil Energy, the Department of Interior, and academic institutions to ensure that the program's R&D work being conducted by National Laboratories, universities, and industry partners remains at the cutting edge of scientific innovation. Additionally, some of the program's R&D work already involves direct interaction between these partners.

Priority 3: Economic Prosperity – Create millions of green jobs and increase competitiveness

GTP coordinates with the U.S. Department of Education, DOE's Office of Science, the U.S. geothermal industry, and academic institutions on the development of curriculum and methods for the training and long-term retention of the geothermal workforce

Priority 5: Lower GHG Emissions – Position U.S. to lead on climate change policy, technology, and science

GTP coordinates with Iceland and Australia under the International Partnership on Geothermal Technology and also coordinates with the U.S. State Department and Canadian and Mexican geothermal organizations to establish research areas of mutual interest.

Contribution to GPRA Unit Program Goal 1.1.05.00 (Geothermal Technology)

GTP's key contribution to the GPRA Unit Program Goal is through diversification of the energy portfolio and lowering of GHG emissions. GTP will provide the technology needed to create and manage EGS that mine heat from rock and transport the heat to the surface for electricity generation. EGS will create little to no GHG emissions, and ultimately, commercial EGS could provide significant amounts of clean baseload domestic power and contribute to the security and diversity of U.S. energy supplies.

Means and Strategies

GTP will use various means and strategies to achieve its GPRA unit program goals as described below. "Means" include operational processes, resources, information, and the development of technologies, and "strategies" include program, policy, management and legislative initiatives. However, various external factors may impact the ability to achieve these goals. The program also performs collaborative activities with industry and government agencies to help meet its goals.
GTP will implement the following means:

- To ensure the best value for the taxpayer dollar, a coherent core of research projects will be performed through cost-shared awards to private companies and academic institutions selected via competitive solicitations. National Laboratories having unique expertise in the subject areas will conduct the balance of the research projects through competitive "lab calls".
- To reduce or eliminate institutional, regulatory, and other non-technical barriers that hamper the expanded use of geothermal energy in the U.S., the program will provide comprehensive and timely information about geothermal resources and technology to interested stakeholders from the public and private sector.

GTP will implement the following strategies:

- Conduct research on EGS-related technologies that have the greatest impacts on EGS reservoir creation, operation, and management using laboratory facilities and field sites;
- Improve efficiency of exploration tools, energy conversion, and drilling systems;
- Demonstrate and validate EGS-related tools and technologies at competitively-selected field sites;
- To reduce exploration risk, establish a National Geothermal Database to store critical geothermal site attribute information; and
- Expand geothermal power production into geologically and geographically diverse areas of the U.S.

A detailed program plan entitled "Geothermal Technologies Program Multi-Year Research, Development and Demonstration Plan, 2009-2015 with program activities to 2025" (http://www1.eere.energy.gov/geothermal/plans.html) was developed for the GTP during Fiscal Year 2008.

Validation and Verification

To validate and verify program performance, the GTP will conduct internal and external reviews and audits with the assistance of experts from a variety of stakeholder organizations. The table below summarizes validation and verification activities.

Data Sources:	“The Future of Geothermal Energy”, Massachusetts Institute of Technology; 2006; EGS Technology Evaluation Workshops (June- October, 2007). “An Evaluation of Enhanced Geothermal Systems Technology,” Geothermal Technologies Program, 2008. (http://www1.eere.energy.gov/geothermal/publications.html) “Assessment of Moderate- and High-Temperature Geothermal Resources of the United States,” 2008 (http://pubs.usgs.gov/fs/2008/3082/)
Baselines:	GTP is in the process of developing a baseline of technology performance for EGS.
Evaluation:	GTP will continue to conduct and build upon the transparent oversight and performance management initiated for the Recovery Act. GTP will establish a process for conducting external reviews of program performance. Quarterly and annual assessment of program and management results based performance through Joule (the DOE quarterly performance progress review of budget targets); PMA (the President’s Management Agenda -- annual Departmental and Program Secretarial Officer (PSO) based goals whose milestones are planned, reported and reviewed quarterly); and PART (common government wide program/OMB reviews of management and results).
Frequency:	Annual
Data Storage:	A web-based public data center.
Verification:	EGS long-term flow test at The Geysers, CA; EGS reservoir creation at three additional field sites: Brady Hot Springs, NV, Raft River, ID, The Geysers, CA; R&D component technologies and field sites reviews.

Annual Performance Results and Targets

FY 2005 Results	FY 2006 Results	FY 2007 Results	FY 2008 Targets	FY 2009 Targets	FY 2010 Targets
GPRA Unit Program Goal 1.1.05.00 (Geothermal Technology)					
Enhanced Geothermal Systems					
Field test a fully integrated Diagnostics-While-Drilling (DWD) advanced drilling system in a high-temperature geothermal well, verifying control of drilling operations in real time, thereby reducing costs. If successful, DWD will reduce drilling costs by one half of the total cost reduction target for drilling. [MET]	Develop an Electronic Repository which makes digitized copies of all Geothermal Technology Program Research Development and Deployment Technical Reports available via the internet, while demonstrating reduction in cost of power for flash systems to 4.9 cents/kWh from 5.3 cents/kWh in 2005 and reducing cost of binary to 8.2 cents/kWh from 8.5 in 2005 based on modeled analysis. [MET]	Complete an interim report on EGS technology evaluation, and report on completion of program activities and projects funded in FY 2006. [MET]	Conclude EGS technology evaluation and publish a new Geothermal Program Plan. [MET]	Determine actual (baseline) pre-stimulation reservoir flow rate for at least one EGS field site.	Modeled 10% increase in flow rate for EGS field site demo.
Contribute proportionately to EERE's corporate goal of reducing corporate and program adjusted uncosted obligated balances to a range of 20-25 percent by reducing program annual adjusted uncosteds by 10 percent in 2005 relative to the program FY 2004 end of year adjusted uncosted baseline ($21,644K) until the target is met. [MET]	Maintain total administrative overhead costs (defined as Program Direction and Program Support excluding earmarks) in relation to total program costs of less than 12 percent. [MET]	Maintain total administrative overhead costs (defined as Program Direction and Program Support excluding earmarks) in relation to total program costs of less than 12 percent. [MET]	Maintain administrative cost at less than 12% of total program cost. [MET]	Maintain administrative cost at less than 12% of total program cost.	Maintain administrative cost at less than 12% of total program cost.[a]

[a]Administrative costs are comprised of Program Direction and elements of Program Support (Technology Advancement and Outreach; and Planning, Analysis and Evaluation), baseline and targets under development.

Enhanced Geothermal Systems

Funding Schedule by Activity

	(dollars in thousands)		
	FY 2008	FY 2009	FY 2010
Enhanced Geothermal Systems			
Enhanced Geothermal Systems	19,307	43,322	49,229
SBIR/STTR	—[a]	678	771
Total, Enhanced Geothermal Systems	19,307	44,000	50,000

Description

Natural geothermal systems depend on three factors to produce energy: heat, water, and permeability. Heat is present virtually everywhere at depth; water and permeability are less abundant. Enhanced Geothermal Systems (EGS) are engineered reservoirs created to produce energy from geothermal resources deficient in economical amounts of water and/or permeability. By 2015 the program seeks to demonstrate the ability to create an EGS reservoir capable of producing 5MW.

EGS generally involves drilling wells into hot rock, fracturing the rock between the wells, and circulating a fluid through the fractured rock to extract the in situ heat. This "heat mining" mimics naturally-occurring, conventional hydrothermal reservoirs but includes several advantages not common to conventional reservoirs:

- Siting flexibility - hot rock is omnipresent in the earth, and EGS can be located close to load centers or distant from environmentally sensitive areas;
- Sizing flexibility - EGS can be created in distinct units and sized to fit the need or expanded to meet increased needs; and
- Controlled operation - as engineered reservoirs, EGS can be managed with regard to heat extraction rates and production of dissolved minerals over time.

While pilot EGS reservoirs of limited size have been designed, built and tested for a short period in various countries, many technical hurdles remain in reservoir creation, operation, and management. Program activities will focus on the R&D needed to reduce barriers and address these hurdles.

The program will promote the advancement of EGS through an integrated portfolio of cost-shared research. One approach to overcoming the hurdles is to focus initially on controlling the amount and period over which geothermal heat can be extracted. The strategy involves working with cost-sharing partners at existing geothermal fields to develop, test, and perfect the tools needed to fracture hot, impermeable rock. Some novel or cutting-edge technologies may be too risky for tests in commercial wells. Consequently, suitable test sites may be employed for verification of innovative EGS technology. These sites would allow DOE to control site operations and scheduling, an ability not available at commercial fields.

Initially, priority will be given to reservoir technology R&D, including the development of modeling tools necessary for simulating long term circulation tests. The program will conduct continuous systems

[a] SBIR/STTR funding was transferred to the Science Appropriation in FY 2008

analysis to determine technical, environmental, and economic effectiveness. Based on the results, GTP will update the R&D portfolio. Periodic technology evaluations will be performed by calling on experts from geothermal and allied industries such as the petroleum service sectors.

GTP will continue to work with the Bureau of Land Management (BLM) and the U.S. Geological Survey (USGS), and seek to expand interactions with other Federal agencies as necessary.

EGS R&D is expected to provide technological tools and information that will enable business decisions by the private sector to create commercial-scale EGS reservoirs. Carbon avoidance analysis performed by NREL shows EGS has the potential to substantially reduce GHG emissions[a].

Benefits

This subprogram will provide the technology needed to create and manage EGS systems that mine heat from rock and transport the heat to the surface for electricity generation. Commercial EGS could provide baseload, indigenous power and contribute to the security and diversity of U. S. energy supplies. When implemented, EGS will avoid GHG emissions and be a source of clean, secure energy. Expected program outcomes include demonstrating the ability to create an EGS reservoir capable of producing 5 MWe by 2015. This system demonstration should foster rapid growth in the use of geothermal energy in the outyears. A DOE-sponsored analysis published in January 2007 by an MIT-led panel shows the potential for EGS to contribute 100,000 MW to the U.S. energy supply by 2050.

Detailed Justification

	(dollars in thousands)		
	FY 2008	FY 2009	FY 2010
Enhanced Geothermal Systems	**19,307**	**43,322**	**49,229**

In FY 2008, a draft detailed program plan entitled “Geothermal Technologies Program Multi-Year Research, Development and Demonstration Plan, 2009-2015 with program activities to 2025” (http://www1.eere.energy.gov/geothermal/plans.html) was developed that outlines the goals and specific activities of the EGS effort. During FY 2010, GTP plans to conduct six EGS demonstrations at field sites selected in previous years and conduct the second year of R&D that addresses key aspects of engineered reservoir creation, management, and utilization. The program will continue implementation of solicitations issued in FY 2008 and FY 2009 that support R&D in the areas of reservoir stimulation, fracture mapping, and fluid circulation, and additional R&D for EGS-related drilling and energy conversion. Priority EGS research and technology development will continue at various research institutions, selected through a competitive process. Complementary activities will include a web-based, public geothermal database for resource, power plant, and institutional data; international collaborative activities; investigation of low temperature geothermal opportunities; and support for geothermal workforce development to meet the needs of a rapidly growing energy sector.

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[a] Carbon avoidance calculated by National Renewable Energy Laboratory using Markal model displayed in the program benefits table on page 4.

	(dollars in thousands)		
	FY 2008	FY 2009	FY 2010
SBIR/STTR	**–**	**678**	**771**

In FY 2008, $456,000 and $55,000 were transferred to the SBIR and STTR programs respectively. The FY 2009 and 2010 amounts shown are estimated requirements for the continuation of the SBIR and STTR program.

Total, Enhanced Geothermal Systems	**19,307**	**44,000**	**50,000**

Explanation of Funding Changes

	FY 2010 vs. FY 2009 ($000)
Enhanced Geothermal Systems	
This increase funds an expanded R&D scope in the areas of reservoir stimulation, fracture mapping, fluid circulation, and EGS-related drilling and energy conversion. EGS demonstration site analysis will also be enhanced.	+5,907
SBIR/STTR	
Changes in the SBIR/STTR funding are a direct result of changes in the funding of program activities.	+93
Total Funding Change, Enhanced Geothermal Systems	**+6,000**

Water Power

Funding Profile by Subprogram

	(dollars in thousands)		
	FY 2008 Current Appropriation[a]	FY 2009 Original Appropriation	FY 2010 Request
Water Power	9,654	40,000	30,000
Total, Water Power	9,654	40,000	30,000

Public Law Authorizations:

P.L. 109-58, "Energy Policy Act of 2005" (2005) Title IX, Sec. 931
P.L. 110-140, "Energy Independence and Security Act of 2007" (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 marine and hydrokinetic technologies, a new suite of renewable technologies that harness the energy from untapped wave, tidal, current and ocean thermal resources. In addition, the Water Power Program works to develop technologies and processes to improve the efficiency, flexibility, and environmental performance of hydroelectric generation, which represent one of the fastest and most cost-effective options for increasing clean and renewable energy generation in the U.S.

Benefits

Research and development of innovative water power technologies and growth of a viable water power industry directly contribute to the Presidential and Secretarial objectives of strengthening U.S. scientific discovery promoting clean and secure energy, increasing economic prosperity, and demonstrating U.S. leadership in addressing climate change. Marine and hydrokinetic technologies represent a substantial opportunity for the U.S. to engage directly in an emerging area of energy science and discovery while developing an entirely new suite of renewable technologies available to reduce emissions, revitalize stagnant sectors of the economy, and help states meet Renewable Portfolio Standard (RPS) targets.

The development of incremental hydropower and pumped storage will allow for quick and cost-effective increases in stable, emissions-free generation and further the ability of the U.S. electricity network to integrate variable resources. The re-establishment of Federal R&D for conventional hydropower demonstrates a commitment to quickly expand carbon-free generation and to ensure the world's largest renewable energy resource is an effective and environmentally responsible instrument for reducing GHG emissions.

The proposed FY 2010 Budget investments complement funds provided by the Recovery Act. To enable decision makers and the public to follow performance and plans, the program will post its progress in these planned activities at: http://www.energy.gov/recovery/index.htm.

[a] SBIR/STTR funding was transferred to the Science Appropriation in FY 2008, which includes a reduction of $228,000 that was transferred to the SBIR program and $27,000 that was transferred to the STTR program.

Climate Change

The program's priorities and activities are aligned to reduce greenhouse gas emissions by developing emission-free marine and hydrokinetic technologies. Additionally, the program's hydropower activities are aligned to increase the efficiency and generation of the U.S.'s largest renewable energy resource by supporting increased incremental generation and ancillary benefits to support grid stability and integration of other variable generation sources.

Energy Security

The program's investment in the assessment and development of water power resources provide a significant opportunity to increase clean and secure domestic energy generation, as they reduce foreign fuel dependency, have no carbon or other air pollution emissions, and provide a reliable energy source 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.

Economic Impact

The program's priorities are aligned with the development of a viable and competitive water power industry. The program is investing heavily in partnerships with wave, tidal, and ocean thermal technology developers that will drive job creation in the green technology sector, manufacturing sector and maritime and coastal communities. DOE-sponsored hydropower projects also increase demand for highly skilled technical workers with specific capabilities in hydropower technology design, manufacture and operations.

The following external factors could affect the Water Power Program's ability to achieve its benefits:

- The availability of conventional energy supplies;
- The cost of competing technologies;
- The ability of the domestic industry to quickly adapt to marketplace and technology changes;
- State and international efforts to support water power technologies;
- The state of internationally recognized standards and certification;
- Federal, state and regional regulatory actions affecting water power technologies;
- Application of State or Federal tax or other incentives; and
- Implementation of other policies at the national level, including Federal efforts to reduce carbon and criteria pollutants.

Contribution to the Secretary's Priorities and GPRA Unit Program Goals

The Water Power Program contributes to four of the Secretaries priorities as shown below. The principal foci are science and discovery and clean energy.

Priority 1: Science and Discovery — Invest in science to achieve transformational discoveries.

The Water Power Program works in partnership with National Laboratories to help develop new and innovative water power conversion technologies, and assess the resource potential from untapped wave, current and ocean thermal technologies. The program supports the development of expertise and capabilities between National Marine Renewable Energy Centers and universities, which provide value to industry and National Laboratories through the creation of integrated, standardized test centers. The Water Power Program also engages in international collaboration for R&D and provides U.S. input to the global community on developing international standards for marine and hydrokinetic technologies.

Priority 2: Clean Energy — Change the landscape of energy demand and supply

The Water Power Program provides one of the only U.S. public funding sources for ocean energy technologies, which represent an entirely new suite of renewable energy technologies available to reduce emissions and meet Renewable Portfolio Standards targets.

Priority 3: Economic Prosperity — Create millions of green jobs and increase competitiveness

The Water Power Program supports industry development of technologies to increase hydroelectric generation at existing facilities and impoundments. Efficiency and capacity gains at existing facilities represent one of the fastest and most-cost effective options for increasing clean, renewable energy generation. In addition, the program supports a Nation-wide assessment of existing and potential hydropower assets and resources to identify current generation profiles and cost-effective opportunities to increase domestic hydropower generation.

The Water Power Program also supports the development of advanced water power technologies, including advanced hydropower technologies, pumped storage, and installation of power stations at non-powered dams, which have the potential to increase grid flexibility and allow for higher penetration of other clean, renewable energy technologies.

The Water Power Program engages in strategic partnerships with wave, tidal, and ocean thermal technology developers and with industry to develop a roadmap for technology development and deployment to accelerate water power industry growth and the creation of workforce needs in shipyards, port facilities, and related maritime industries.

Priority 5: Lower GHG Emissions — Position U.S. to lead on climate change policy, technology, and science

The Water Power Program partners with National Laboratories, universities, and industry to develop, demonstrate, and deploy water power conversion technologies. The program also supports the development of guidelines to assist project developers through the existing regulatory process and a framework for siting marine and hydrokinetic energy for developers and policymakers to identify critical project siting information.

The Water Power Program supports device and component testing, development and deployment for industry and universities to reduce capital costs and improve quality, quantity and reliability of marine and hydrokinetic technologies. The program provides U.S. input into the development of international standards for marine and hydrokinetic technologies and partners with the global community and Federal regulatory agencies. The program coordinates in international partnership, and facilitates DOE's leadership role in investigating the potential environmental impacts of ocean energy systems.

Contribution to GPRA Unit Program Goal 1.1.08.00 (Water Power)

The Water Power Program's key contribution to Strategic Theme 1, Energy Security, is through R&D of innovative technologies capable of generating renewable, environmentally responsible, and cost-effective electricity from water to reduce oil consumption and improve energy independence. In support of this, the program's activities include:

Marine and hydrokinetic technology testing, development and deployment: By 2010, the program will help industry conduct in-water energy conversion testing for at least two new water power technologies.

Marine and hydrokinetic technology characterization and resource assessments: By 2010, the program will complete an assessment of wave and tidal resources in the U.S. and complete a new, web-based database designed and maintained to provide up-to-date information on marine and hydrokinetic renewable energy technologies and projects, both in the U.S. and around the world. By 2010, the program will complete the creation of guidelines for developers and a framework for siting marine and hydrokinetic energy projects.

Marine and hydrokinetic environmental impact analysis: By 2010, the program will complete a report describing the potential environmental effects of marine and hydrokinetic energy development.

Conventional hydropower national asset assessment study: By 2010, the program will construct a new database from available Federal and non-Federal sources to describe the current state of the hydropower infrastructure in the U.S. (age, type, ownership, etc.), generation patterns from these assets, and associated water availability and use. The database will be designed to integrate monthly hydrology and generation and civil works information by river basin, for a period of at least the last 10 years. Once assembled, the database will be used to study regional patterns in generation variability, their causes, and opportunities for upgrading hydropower facilities to stabilize and increase generation.

Means and Strategies

The Water Power Program will use various means and strategies to achieve its strategic objectives and programmatic targets. "Means" include operational processes, resources, information, and activities, and "strategies" include general program, policy, and management approaches. Collaborations are integral to the planned investments, means and strategies.

The Water Power Program will implement the following means:

- Competitive solicitations for partnerships with industry and academia to: develop, deploy and test existing water power systems, both marine and hydrokinetic and incremental hydropower; help develop new and innovative water power conversion technologies; fully characterize water power resources; and address non-technical barriers to the development and deployment of water power devices.
    - For marine and hydrokinetic technologies, means include prototype or demonstration project deployment and testing, scale and tank testing, sub-scale system or component development, and device/array design and modeling. The program will also implement basic and materials research, pre- or post-deployment environmental studies or monitoring, resource assessments, cost and economic stimulus analyses and grid integration studies.
    - For conventional hydropower technologies, means include advanced turbine development and deployment, basic and materials research, sensors and controls to improve power system performance and reliability, collection and dissemination of data on the environmental, competing use and navigational impacts of water power technologies, resource/asset assessments, and economic analyses.
- Program Announcements to identify and leverage areas of existing expertise resident within the National Laboratory network to accelerate the technical development and commercial deployment of water power systems.
    - For marine and hydrokinetic technologies, means include basic science and materials research, device testing and monitoring methodologies, hydrodynamic and systems modeling, device interconnection and systems integration R&D, technologies and methodologies to monitor, assess, minimize or mitigate environmental impacts.
    - For conventional hydropower technologies, means include water use optimization, asset management and improvement, sensors and controls to improve power system performance and reliability and in-stream flow studies.
- Characterizations of the various marine and hydrokinetic conversion technologies, with the goal of determining cost, performance and reliability characteristics.

- Regular communication with stakeholders to understand R&D needs and concerns and to provide useful and timely information on the development of technologies and projects and the availability of valuable development and testing resources.
- Active collaboration with international industry and agencies to leverage international experience and expertise, and to provide U.S. input into the development of international technology standards.
- Support for one or more National Marine Renewable Energy Centers, to serve as integrated RD&D and testing facilities for marine and hydrokinetic technologies, as well as clearinghouses for information on the technologies.

The Program will implement the following strategies:

- Directly engage industry and academia, and leverage outside sources of funding where possible and appropriate. Encourage broad collaboration among all industry members, National Laboratories, and research organizations engaged in program-funded projects.
- Collaborate actively with other Federal and state agencies funding water power research, including the Department of Defense and military organizations.
- Address both technical and non-technical barriers to the development and deployment of water power technologies.
- Actively support industry efforts to determine water power RDD&D priorities.
- Work collaboratively with developers, regulators, state and Federal resource agencies, tribal governments, environmental stakeholders and local communities to understand both positive and negative impacts of technology deployment, and to minimize the cost, time, and negative impacts associated with siting water power projects.
- Conduct strategic planning process to engage industry and public stakeholders' input in formulating program direction and initiate a roadmapping process to identify needs and barriers critical to the development of a viable U.S. water power industry.
- Conduct annual program reviews of all program-funded projects, with continued funding dependent upon successful project performance.
- Hold annual meetings to allow industry and other stakeholders to assess the program's overall performance and offer suggestions for improved direction.

These strategies will serve to consolidate the needs of the emerging water power industry, and enable prioritization of RDD&D requirements and quantification of the potential barriers of this emerging industry. Ultimately, this could result in significant cost savings and reductions in greenhouse gas emissions and fuel imports.

The program collaborates and seeks feedback from industry partners, including technology developers and utilities, to determine and prioritize RDD&D efforts and engages public stakeholders in formulating the direction of the program. The program leverages its relationships with universities, particularly the National Marine Renewable Energy Centers, as well as its relationships with other agencies, including the Department of the Interior, the National Oceanic and Atmospheric Administration and the Department of Defense. On issues concerning water power licensing and interconnection, the program is actively collaborating with Federal and state regulators, and engages Federal and state resource agencies, local stakeholders, and the environmental community regarding environmental and navigational impacts and competing resource use. The program works closely with international researchers and technology developers to cooperate on research efforts and to develop international standards for the marine industry worldwide. In addition, the program benefits from the strong capabilities extant within the DOE National Laboratories, from both the former Hydropower Program and technology programs that share overlapping elements.

Validation and Verification

To validate and verify program performance, Water Power will conduct various internal and external reviews and audits. These programmatic activities are subject to continuing review by Congress, the General Accountability Office, the Department's Inspector General, the U.S. EPA, and State environmental agencies. The table below summarizes validation and verification activities.

Evaluation:	In carrying out the program's mission, the program will use several forms of evaluation to assess progress and promote program improvement. Conduct internal and external independent peer reviews and audits, program reviews and review of baseline data; Marine and hydrokinetic resource assessments, cost analyses, environmental impact studies and testing and development of these technologies to set the baseline for quantifying the benefits of these technologies, identifying technology improvement opportunities and for furthering the development of technology goals and annual targets; For conventional hydropower, the program's assessment of the existing domestic hydropower fleet to provide the baseline data necessary to identify and quantify the potential for incremental hydropower, including: advanced hydropower systems and modernization technologies to increase efficiency and capacities at existing power stations; the development of power stations at existing non-powered dams and in constructed waterways; and small hydropower (<5 MW); Conduct annual program reviews of all program-funded projects, with continued funding dependent upon successful project performance; Hold annual meetings to allow industry and other stakeholders to assess the program's overall performance and offer suggestions for improved direction; Work collaboratively with developers, regulators, state and Federal resource agencies, tribal governments, environmental stakeholders and local communities to understand both positive and negative impacts of technology deployment, and to minimize the cost, time, and negative impacts associated with siting water power projects; Conduct strategic planning process to engage industry and public stakeholders' input in formulating program direction and initiate a roadmapping process to identify needs and barriers critical to the development of a viable U.S. water power industry; and Continue to conduct the transparent oversight and performance management initiated by Congress and Administration.
Frequency:	Potential benefits will be estimated annually and program peer reviews will be conducted annually.
Verification:	DOE technology managers verify the achievement of targets through project reviews, including reviews of cost and performance modeling results. Project leaders in the field must provide to the technology managers documentation of experimental and/or analytic results as evidence of success. The evidence is listed in material supporting the DOE Joule performance tracking system. Various trade associations review the data and the modeling processes (e.g., REPIS), and the EIA verifies the REPIS database. Peer reviews are conducted by independent personnel from industry, academia and governmental agencies other than DOE.

Annual Performance Results and Targets

FY 2005 Results	FY 2006 Results	FY 2007 Results	FY 2008 Targets	FY 2009 Targets	FY 2010 Targets
GPRA Unit Program Goal 1.1.08.00 (Water Power)					
n/a					
n/a	n/a	n/a	n/a	Complete draft Multi Year Program Plan.	
					Identify priority research areas to reduce project development costs by completing environmental impact assessment of marine and hydrokinetic energy development.
					Complete analysis of generation and water flow data at 20 percent of the hydropower projects in the U.S to establish baseline data.
				Maintain administrative costs as a percent of total program costs less than 12 percent.	Maintain administrative costs as a percent of total program costs less than 12 percent.[a]

[a] Administrative costs are comprised of Program Direction and elements of Program Support (Technology Advancement and Outreach; and Planning, Analysis and Evaluation), baseline and targets under development.

Water Power
Funding Schedule by Activity

	FY 2008	FY 2009	FY 2010
	(dollars in thousands)		
Water Power			
Water Power	9,654	39,082	29,353
SBIR/STTR	—[a]	918	647
Total, Water Power	9,654	40,000	30,000

Description

In FY 2009, the program established broad-based collaboration with the water power industry to develop, test, and evaluate technologies, conduct resource assessments, understand environmental impacts, and address barriers to project and technology development in marine and hydrokinetics and hydropower.

Specifically marine and hydrokinetic energy program activities are focused on development and deployment of in-water prototypes and projects, testing and modeling of deployed technologies, the development of new and innovative technologies, resource assessments, environmental impact studies, and cost analyses. The program is also helping industry develop a roadmap to guide investment and address technical and non-technical industry barriers.

For hydropower, the program is supporting a full assessment of domestic existing hydropower assets and developing more efficient and environmentally friendly hydropower turbines for the commercial market. The program's National Hydropower Asset Assessment Project describes the current state of U.S. hydropower infrastructure, generation patterns, associated water availability and use, and will identify opportunities to upgrade these facilities to stabilize and increase generation.

Benefits

The program is investing in marine and hydrokinetic technology development and demonstration projects that will reduce technology costs, assess performance and reliability, develop more robust devices and components, and identify and evaluate potential environmental impacts.

Program investment in resource assessments and cost analyses will help to determine the available, extractable and cost-effective marine and hydrokinetic resources in the U.S. In addition, the program's development of the Marine & Hydrokinetic Technology and Project Database will identify cost and performance data and help technology developers match their technologies with prime resource areas. This facilitates the fact-finding and assessment process for technology developers and industry as a whole, contributing to lowering technology development costs and expediting project development time. Development of an industry roadmap is necessary to identify technology improvement opportunities and will drive down technology and project development costs.

Environmental studies supported by the program will identify strategies to minimize time, costs and potential environmental effects associated with siting and deploying marine and hydrokinetic systems. These studies will lower project development costs and reduce overall environmental impacts.

[a] SBIR/STTR funding was transferred to the Science Appropriation in FY 2008.

Advanced hydropower systems, such as scalable and variable-speed pumped storage, could allow for dramatically higher levels of renewable energy to be integrated into the U.S. electric grid, and provide significant benefits in stabilizing and adding resilience to regional transmission systems.

Assessments of existing and potential hydropower assets and resources will identify current generation profiles and cost-effective opportunities to increase domestic hydropower generation. These assessments also allow the program to quantify the current and potential value of hydropower, including pumped storage, in integrating variable renewable resources and identify areas for improvement.

Investment in improving environmental performance at hydropower facilities has two benefits: increased power generation and quality by mitigating existing environmental impacts associated with flexible scheduling; and reduced cumulative impacts and stresses on wildlife and the environment.

Detailed Justification

	(dollars in thousands)		
	FY 2008	FY 2009	FY 2010
Water Power	**9,654**	**39,082**	**29,353**

For marine and hydrokinetic technologies, the program is concentrating on: (1) understanding the full-range of marine and hydrokinetic technologies and their performance characteristics; (2) industry partnerships to reduce technology cost, improve performance and reliability, and assess the performance and cost of water power projects; (3) resource assessments to determine the available, extractable, and cost-effective marine and hydrokinetic resources in the U.S. and identify prime domestic resource areas; (4) investigating potential environmental impacts of marine and hydrokinetic technologies and how projects can be sited to mitigate or minimize these impacts; and (5) the development of international marine and hydrokinetic energy standards.

For conventional hydropower, the program is focusing on (1) increases in incremental hydropower, including: advanced hydropower systems and modernization technologies to increase efficiency and capacities at existing power stations; the development of power stations at existing non-powered dams and in constructed waterways; and small hydropower (<5 MW); (2) understanding and minimizing the environmental impacts of hydropower facilities and generation, including GHG reservoir emissions; (3) understanding existing and potential hydropower resources, assets, and cost of development; and (4) quantifying and maximizing the current and potential value of hydropower, including pumped storage, in providing flexibility and stability to electricity grids and integrating variable renewable resources.

SBIR/STTR	**—**	**918**	**647**

In FY 2008, $228,000 and $27,000 was transferred to the SBIR and STTR programs respectively. The FY 2009 and 2010 amounts shown are estimated requirements for the continuation of the SBIR and STTR program.

Total, Water Power	**9,654**	**40,000**	**30,000**

Explanation of Funding Changes

	FY 2010 vs. FY 2009 ($000)
Water Power	
Projects initially funded in FY 2008 are expected to be completed in FY 2010. The FY 2010 funding request represents a continuation of activities begun in FY 2009 and includes technology testing, development, and deployment, resource assessments and cost analyses, and environmental impact studies.	**-9,729**
SBIR/STTR	
Changes in the SBIR/STTR funding are a direct result of changes in the funding of program activities.	**-271**
Total Funding Change, Water Power	**-10,000**

Vehicle Technologies
Funding Profile by Subprogram

(dollars in thousands)

	FY 2008 Current Appropriation[a]	FY 2009 Original Appropriation	FY 2009 Additional Appropriation	FY 2010 Request
Vehicle Technologies				
Hybrid Electric Systems	92,079	125,709	–	164,661
Advanced Combustion Engine R&D	43,443	40,800	–	57,600
Materials Technology	38,616	39,903	–	54,905
Fuels Technology	17,376	20,122	–	25,122
Technology Integration	16,845	46,704	–	31,014
Advanced Battery Manufacturing	–	–	2,000,000	–
Transportation Electrification	–	–	400,000	–
Alternative Fueled Vehicles	–	–	300,000	–
Total, Vehicle Technologies	208,359	273,238[b]	2,700,000	333,302[c]

Public Law Authorizations:

P.L. 95-91, "U.S. Department of Energy Organization Act" (1977)
P.L. 102-486, "Energy Policy Act" (1992)
P.L. 109-58, "Energy Policy Act of 2005" (2005)
P.L. 110-140, "Energy Independence and Security Act of 2007" (2007)

Mission

The mission of the Vehicle Technologies (VT) program is to develop more energy-efficient and environmentally friendly highway transportation technologies (for both cars and trucks) that will meet or exceed drivers' performance expectations and environmental requirements and that will enable America to use significantly less petroleum and reduce greenhouse gas (GHG) emissions.

Modifications were made to the budget structure of two subprograms to better reflect the Vehicle Technology program's activities in FY 2010.

Benefits

The VT program mission and activities contribute directly to the DOE and Secretarial goals of improving national energy and economic security by addressing the President's call for reducing dependence on oil imports by about 3.5 million barrels per day within 10 years and modernizing conservation technologies and practices.

[a] SBIR/STTR funding was transferred to the Science Appropriation in FY 2008, which includes a reduction of $4,183,000 that was transferred to the SBIR program, and $501,000 that was transferred to the STTR program.
[b] Includes activities previously funded in the Hydrogen Program in years prior to FY 2009 (now the Fuel Cell Technologies Program): Technology Validation, Safety and Codes and Standards, and Education.
[c] Technology Validation, Safety and Codes and Standards, and Education have been transferred to the Fuel Cell Technologies Program from the Vehicle Technologies Program.

Vehicle Technologies focuses on highway vehicles (passenger and commercial vehicles), which account for 55 percent of total U.S. oil use ─ more than all U.S. domestic oil production. Cost-competitive, more energy-efficient and fuel diverse vehicles will enable individuals and businesses to accomplish their daily tasks while reducing consumption of gasoline and diesel fuels. This will reduce U.S. demand for petroleum, lower carbon emissions, and decrease energy expenditures. 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]

To achieve higher fuel efficiency and to lower GHG emissions, DOE strives to meet the following Presidential goals:

- Within 10 years save more oil than currently imported from the Middle East and Venezuela combined;
- Invest in developing advanced vehicles and put 1 million plug-in hybrid electric vehicles (PHEVs) on the road by 2015;
- Deploy the cheapest, cleanest, fastest energy source – energy efficiency; and
- Establish a National Low Carbon Fuel Standard.[b]

The VT Program funds and performs the advanced technology R&D needed to achieve these goals.

In the near to mid-term, transportation energy use can be reduced through improved vehicle energy efficiency from more efficient advanced combustion engines, hybrid-electric (HEV) and PHEV vehicle powertrains, and reducing vehicle weight. Other fuels, such as ethanol, natural gas, electricity with storage, and biodiesel, can also provide attractive means for reducing oil use through fuel displacement. These efficiency gains and fuel alternatives also provide other benefits, such as improving air quality, reducing CO_2 emissions, and enhancing energy security.

By 2030, the program's results could directly contribute a cumulative reduction of at least 0.7 billion bbls of oil, 0.3 gigatons of carbon, and consumer savings of nearly $40 billion. By mid-century the benefits could increase tenfold.

Climate Change:

The VT program contributes to reducing greenhouse gases (GHG, i.e., CO_2) by providing technology which, when commercialized, will make the Nation's highway vehicles more energy efficient and make it possible for those vehicles to be powered by renewable energy. Lightweight materials, advanced combustion, and hybrid drive-trains all improve vehicle efficiency. The use of alternative fuels with advanced combustion and advanced batteries to store electricity, which could come from renewable sources, could increase the displacement of fossil fuels.

As one simple example, a hybrid vehicle that combines advanced, more efficient combustion with lightweight materials and a hybrid drive-train could easily double the fuel efficiency – meaning half the GHG emissions – of a conventional vehicle. If all of these technologies were utilized, the car could achieve triple the fuel efficiency, and one-third the GHG emissions, of a conventional vehicle.

[a] Remarks on Jobs, Energy Independence, and Climate Change, President Barack Obama, Jan. 26, 2009 (http://www.whitehouse.gov/blog_post/Fromperiltoprogress/)
[b] Energy and the Environment Agenda, www.whitehouse.gov/agenda/energy and environment/ (as of April 13, 2009).

Energy Security:

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. Flexible-fuel vehicles (FFVs) allow the consumer to choose what type of fuel to use based on price and availability. Plug-in hybrid vehicles (PHEVs) will allow consumers to displace fuel use with electricity, based on price and convenience (and how "green" their electricity supply is). PHEVs with flex-fuel engines will provide "all of the above" flexibility in choosing energy sources.

Achievement of VT's goals is expected to displace 0.4 million barrels per day (mbpd) of imported oil in 2030 and 5.2 mbpd in 2050, based on energy-economy models. This displacement will yield energy security benefits by diversifying our energy base and increasing energy productivity which, in turn, lower GHG, provide clean, secure energy, and stimulate economic prosperity.

In the nearer term, program R&D is expected to contribute about half of the oil savings needed from highway transportation to achieve the President's 10 year oil reduction goal. This savings, about 1.8 million barrels per day, will be comprised of contributions from PHEVs, HEVs, other vehicle efficiency gains, and substitution of other energy sources for oil, e.g. ethanol, biodiesel, and electricity. The remaining portion of the savings will need to be met from oil reductions by other transportation methods and from other sectors such as industry, utilities and home heating.

Economic Impact:

Reduced petroleum use can be expected to lead to reduced oil imports, improving the Nation's balance of trade and position in the global economy. New technologies developed and manufactured within the U.S., and fuels produced domestically, will create jobs and economic growth. Finally, achieving the VT goals for reducing the cost of advanced vehicle technologies will save the consumer money that can stimulate other areas of the national economy.

The benefits tables below show the estimated security, economic and environmental benefits from 2015 through 2050 that would result from realization of the program's goals. These benefits are achieved by targeted Federal investments in technology research and development in partnership with auto manufacturers, commercial vehicle manufacturers, equipment suppliers, fuel and energy companies, other Federal agencies, State government agencies, universities, National Laboratories, and other stakeholders. These partnerships facilitate the technical coordination of activities and attract cost sharing to provide leveraged benefits for the American taxpayer.

The benefits table also reflects the increasing penetration of the program's technologies over time as performance and cost goals are met. Not included are any policies, regulatory mechanisms, or other incentives not already in existence that might be expected to support or accelerate the achievement of the program goals. The expected benefits reflect solely the achievement of the program's goals.

The goals are modeled in contrast to the "baseline" case, in which no DOE R&D exists. The baseline case is identical to those used for all DOE applied energy R&D programs.[a] Across all of DOE's applied energy R&D programs, the expected outcome benefits are being calculated using the same fundamental methodology. The metrics by which expected outcome benefits are measured are identical for all of

[a] The starting point for the baseline case is the Energy Information Administration's "reference case," as published in the AEO 2007. Program analysts across DOE examined the AEO to determine the extent to which their program goals are modeled (explicitly or implicitly). If program goals are modeled in the AEO, they are removed in the GPRA baseline. Further, some programs believe that the AEO's technology representation is too conservative, even in the absence of program goals, and thus in certain cases a modification is made to make the technology representation in the baseline case more optimistic than the AEO.

DOE's applied energy R&D programs.[a] This standardization of methodology and metrics has been undertaken as part of the DOE's efforts to respond to OMB's request to make all programs' outcomes comparable.

The difference between the baseline case and the program goal case results in economic, environmental, and security benefits. For example, achievement of program goals results in a reduction in cumulative net consumer expenditures of almost $40 billion dollars by 2030 and $1 trillion by 2050. The achievement the programs goals would also result in carbon emissions reductions of 0.3 gigatons by 2030 and 9.6 gigatons by 2050. The results are generated by modeling the program goals within two energy-economy models: NEMS-GPRA10 for benefits through 2030, and MARKAL-GPRA10 for benefits through 2050.[b] The full list of modeled benefits appears below.

The notion of a baseline has become more complicated this year as a result of the inclusion of EISA 2007 provisions into the baseline model. EISA 2007 was not included in the modeling for the FY 2009 budget request. EISA requires increased use of alternative fuels and sets higher fuel economy standards relative to current law. The technologies that VT is developing will help meet those requirements more economically. Therefore, in effect, both EISA and the baseline now incorporate many of the benefits expected to arise from the achievement of VT's R&D program targets. This causes the models to show a much smaller incremental "gain" from VT's R&D than in previous years. The estimated benefits in this request reflect gains expected from VT's R&D goals in addition to EISA requirements. For example, the NEMS estimated 2030 benefits are only about 16 to 17 percent of what they were when EISA, with its assumption of benefits from VT technologies, was not included: the consumer savings of $40 billion by 2030 attributable to the achievement of the goals of the VT program would be more than $240 billion if the benefits from VT assumed by EISA were included. However, the model does not estimate the extent to which VT's R&D program contributes towards cost-effectively implementing EISA – and hence does not provide a full accounting of the benefits of the program.

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[a] The set of expected outcome metrics used this year differs in substantial ways to that of most years. In addition to the standardization across DOE's applied energy R&D programs, the list is expanded and more comprehensive. The list also maps to DOE strategic goals. The expected outcome metrics represent inherent societal benefits that stem from achievement of program goals.

[b] Documentation on the analysis and modeling can be found at http://www.eere.energy.gov/ba/pba/program_benefits.html.

Primary Metrics for FY 2010 Budget Request

(Incorporates Approximate Impacts of EISA 2007)

	Metric[1]	Model	Year 2015	2020	2030	2050
Energy Security	Oil Imports Reduction, cumulative[2] (Bil bbl)	NEMS	ns	ns	0.7	N/A
		MARKAL	0.2	0.6	2.8	23.4
	Natural Gas Imports Reduction, cumulative (Tcf)	NEMS	ns	ns	ns	N/A
		MARKAL	ns	ns	ns	8.4
	Reduction in Share of Highway Fuel Demand Derived from Crude Oil[3] (%)	NEMS	ns	ns	ns	N/A
		MARKAL	ns	ns	1%	5%
Environmental Impacts	CO_2 Emissions Reduction, cumulative (Mil mtCO_2)	NEMS	ns	ns	277	N/A
		MARKAL	99	317	1185	9558
	SO_2 Allowance Price Reduction[4] ($/ton)	NEMS	ns	ns	ns	N/A
		MARKAL	N/A	N/A	N/A	N/A
	NO_x Allowance Price Reduction ($/ton)	NEMS	ns	ns	ns	N/A
		MARKAL	N/A	N/A	N/A	N/A
	Hg Allowance Price Reduction (thousand $/lb)	NEMS	ns	ns	ns	N/A
		MARKAL	N/A	N/A	N/A	N/A
Economic Impacts	Consumer Savings, cumulative[5] (Bil $)	NEMS	ns	ns	40	N/A
		MARKAL	41	62	150	998
	Electric Power Industry Savings, cumulative (Bil $)	NEMS	ns	ns	ns	N/A
		MARKAL	ns	ns	ns	ns
	Household Energy Expenditures Reduction ($/household/yr)	NEMS	ns	ns	10	N/A
		MARKAL	ns	ns	26	1117

1. "Reductions" and "savings" are calculated as the difference between results from the baseline case (i.e. no DOE technology) and the technology case (i.e. all DOE technology R&D programs are successful).
2. All cumulative metrics are based on results beginning in 2010.
3. Metric includes oil-derived fuel use by light-duty vehicles, commercial light trucks and freight trucks; the metric excludes buses. Reported oil use is adjusted to exclude ethanol, biodiesel and CTL.
4. All monetary metrics are in 2006$.
5. Cumulative monetary metrics are in 2006$ that are discounted to 2010 using a 3% discount rate.

ns - Not significant
NA - Not yet available
N/A - Not applicable

Secondary Metrics for FY 2010 Budget Request

(Incorporates Approximate Impacts of EISA 2007)

	Metric[1]	Model	Year 2015	2020	2030	2050
Energy Security	Oil Imports Reduction, annual (Mbpd)	NEMS	ns	ns	0.4	N/A
		MARKAL	0.1	0.3	0.9	5.2
	Natural Gas Imports Reduction, annual (Tcf)	NEMS	ns	ns	ns	N/A
		MARKAL	ns	ns	ns	0.8
	MPG Improvement[2] (%)	NEMS	ns	ns	3%	N/A
		MARKAL	1%	1%	7%	95%
Environmental Impacts	CO_2 Intensity Reduction of US Economy (Kg CO2/$GDP)	NEMS	ns	ns	ns	N/A
		MARKAL	ns	ns	0.01	0.02
	CO_2 Intensity Reduction of US Power Sector[3] (Kg CO2/kWh)	NEMS	ns	ns	ns	N/A
		MARKAL	ns	ns	ns	ns
	CO_2 Intensity Reduction of US Transportation Sector[4] (Kg CO2/mile)	NEMS	0.00	0.00	0.02	N/A
		MARKAL	0.01	0.01	0.03	0.16
Economic Impacts	Consumer Savings, annual[5] (Bil $)	NEMS	ns	ns	15	N/A
		MARKAL	6	5	24	250
	Electric Power Industry Savings, annual (Bil $)	NEMS	ns	ns	ns	N/A
		MARKAL	ns	ns	ns	ns
	Energy Intensity of US Economy (energy/$GDP)	NEMS	ns	ns	0.05	N/A
		MARKAL	0.02	0.04	0.10	0.38
	Net Energy System Cost Reduction, cumulative (Bil $)	NEMS	N/A	N/A	N/A	N/A
		MARKAL	ns	ns	ns	712

1. "Reductions" and "savings" are calculated as the difference between results from the baseline case (i.e. no DOE technology) and the technology case (i.e. all DOE technology R&D programs are successful).
2. Change in light duty vehicles miles traveled per gallon of oil, where oil is only that derived from petroleum.
3. Emissions include all power sector emissions. Generation calculated as total net generation adjusted for estimated T&D losses.
4. Emissions calculated using highway fuel use and related carbon emission factor. Miles calculated as highway miles traveled, excluding buses.
5. All monetary metrics are in 2006$.
ns - Not significant
NA - Not yet available
N/A - Not applicable

The model used to estimate these benefits increases the market share of advanced-technology vehicles over time as their projected incremental cost relative to conventional vehicles declines, and as their efficiency relative to conventional vehicles increases. The energy savings (in the long-term benefits) are the net savings to the vehicle users, including both the value of fuel saved and the incremental expenditures made to purchase their advanced vehicles. Carbon emission reductions are based on the amount of carbon that the petroleum products saved which would have been released if used.

The following external factors could affect the ability of the VT program to achieve these long-term goals and benefits:

- Ethanol distribution infrastructure. Successful deployment of alternative fuel vehicles (AFV's) depends on development of adequate infrastructure for large-scale distribution of ethanol and ethanol blends.
- Electricity grid capacity. Successful deployment of PHEVs depends on adequate grid capacity during peak charging hours.
- Market Appeal. The interest of consumers in new vehicle fuel economy can be very dependent on the price of gasoline. Because gasoline prices have historically gone up and down, they have not provided a consistent signal to either buyers or manufacturers. Within the typical development period for a new car model (3 to 5 years), recent oil prices have risen from the $40s per barrel to over $140, then crash down into the $30s per barrel, and back into the $50s again. Consumer interest in alternative fuels and HEVs generally follows those roller-coaster price fluctuations.

Contribution to the Secretary's Priorities

The VT program contributes to several of the Secretary's priorities as enumerated below. The principal focus area is to create economic prosperity through the formation of green jobs and increased competitiveness by means of reduced energy demand from highway transportation and through the deployment of cost-effective low-carbon clean energy technologies by establishing low carbon fuel standards in transport.

Priority 1: Science and Discovery — Invest in science to achieve transformational discoveries.
VT works with the Office of Science and its National Laboratories for better scientific understanding and improved computational tools, for instance to develop and improve materials models using advanced computational resources. VT has also worked with the Office of Science to define basic research needs to improve fundamental electrochemistry understanding and to identify opportunities for improving battery energy storage using nanotechnology. Additionally, VT collaborates with industry and universities to improve the fundamental understanding of materials.

Priority 2: Clean Energy — Change the landscape of energy demand and supply

VT's mission directly advances this priority by providing technologies to decrease energy use in highway transportation. VT performs R&D to make PHEV technology both practical and cost effective, and validates the performance of state-of-the-art PHEV technology through vehicle testing. VT works with industry, universities, and the national labs to understand and improve the opportunities for PHEV vehicles including limitations and opportunities for vehicle-to-grid connectivity, electric range optimization, and recharging options. VT is also characterizing intermediate-blend alternative fuels for broader and faster petroleum displacement. VT also develops and demonstrates improved combustion efficiency for more effective utilization of alternative fuels.

Priority 3: Economic Prosperity — Create millions of green jobs and increase competitiveness.
VT is working to transform highway transportation efficiency through development of new combustion, battery, lightweight material, and energy-management technologies for both passenger vehicles and heavy commercial vehicles. Every area of activity includes industrial participation with the aim of translating R&D into products and jobs as quickly as possible. VT also supports universities in training the future engineering workforce that will continue to develop and utilize advanced highway transportation technologies.

Contribution to GPRA Unit Program Goal 1.1.02.00 (Vehicle Technologies)

The key program contribution to Strategic Theme 1, Energy Security, is the direct reduction of petroleum use. The VT Program supports an R&D portfolio focused on developing technologies that can enable dramatic improvements in the energy efficiency of passenger vehicles (e.g., cars, light trucks, and SUVs/crossovers) and commercial vehicles (heavy trucks, buses, etc.). In addition, R&D will focus on reducing the cost and overcoming technical barriers to volume manufacturing of advanced vehicle technologies.

The program's goals presented below demonstrate key technology pathways that contribute to achievement of reduced oil use.

- Hybrid Electric Systems subprogram (Power Electronics and Electric Motor R&D):
  - As an intermediate goal, by the end of 2010, develop an integrated electric propulsion system that costs no more than \$19/kW peak and can deliver at least 55kW of power for 18 seconds and 30kW of continuous power with an inlet coolant temperature of 90°C (\$1,045 per system compared to the cost of \$1,925 in 2004 with an inlet coolant temperature of 70°C). Additionally, the propulsion system will have an operational lifetime of 15 years.
  - By 2015, meet the same life and performance requirements at a cost of \$12/kW with an inlet coolant temperature of 105°C.
- Hybrid Electric Systems subprogram (Energy Storage):
  - Reduce the production cost of a high power 25kW battery for use in passenger vehicles from \$3,000 in 1998 to \$500 by the end of 2010, enabling cost competitive market entry of hybrid vehicles; and
  - Reduce the production cost of a high energy and high power battery from \$1,000/kWh in 2006 to \$300/kWh by 2014, enabling cost competitive market entry of PHEVs.
- Hybrid Electric Systems subprogram (Vehicle and Systems Simulation and Testing): Demonstrate market readiness of PHEV technologies by 2015.
- Advanced Combustion R&D subprogram and Fuels Technology subprogram: Improve the efficiency of internal combustion engines from 30 percent (2002 baseline) to 45 percent by the end of 2010 for passenger vehicles, and from 40 percent (2002 baseline) to 50 percent validated in vehicle tests by 2014 for commercial vehicle applications, while utilizing an advanced fuel formulation that incorporates a non-petroleum based blending agent to reduce petroleum dependence and enhance combustion efficiency.
- By the end of 2010, develop material and manufacturing technologies which, if implemented in high volume, could cost-effectively reduce the weight of passenger vehicle body and chassis systems by 50 percent with safety, performance, and recyclability comparable to 2002 vehicles.

The proposed FY 2010 Budget investments complement funds provided by the Recovery Act that support ongoing vehicles R&D and will speed the transition of the highway vehicles market from current technology to one dominated by advanced technology high efficiency vehicles. To enable decision makers and the public to follow performance and plans, the program will post its progress in these planned activities at: http://www.energy.gov/recovery/index.htm.

Means and Strategies

"Means" include operational processes, resources, information, and the development of technologies, and "strategies" include program, policy, management and legislative initiatives and approaches. Various external factors, as listed below, may impact the ability to achieve the program's goals.

VT employs the following strategies to accomplish its goals:

The program supports a portfolio of activities that include both near-term and long-term R&D, early deployment and field validation of advanced technologies, and support for higher-education programs that "fill the pipeline" with young engineers motivated to improve America's energy efficiency.

The primary barriers and opportunities for improved vehicle efficiency are technological. Therefore, the principal strategy of the program is to support R&D of technologies that have the potential to achieve significant improvements in vehicle fuel efficiency or significant displacement of petroleum-based fuels with clean, cost-competitive alternative fuels that can be produced domestically.

The R&D strategy is subdivided into the pursuit of four technology pathways, each of which can improve vehicle efficiency relative to conventional technology, thus lowering vehicle oil use and GHG emissions:

- Improve hybrid electric vehicle component efficiency (up to 50 percent improvement in fuel economy);
- Improve PHEV components (up to 300 percent improvement in fuel economy);
- Improve combustion engines and fuel characteristics (up to 40 percent improvement in fuel economy and displacement of oil by non-petroleum fuels); and
- Reduce the weight of vehicles (up to 30 percent improvement in fuel economy).

These improvements can be combined to create integrated advanced technology vehicles capable of between 200 and 400 percent increased fuel economy per vehicle for passenger vehicles and 40 to 50 percent for commercial vehicles.

In addition to the main R&D pathways, the program strategy includes support of other activities to facilitate market adoption of new technologies, to train new engineers in advanced technologies, and to inform the program's own strategic planning.

VT employs the following means to achieve its goals:

The most important means is to engage in partnerships – with industry, with other Federal agencies, with State and local governments, and as opportunities arise, with foreign governments and international organizations.

The VT program has a long and successful history of working in partnership with industry to develop technology roadmaps, coordinate pre-competitive R&D, and determine which activities are the sole responsibility of industry and which may be appropriate for DOE support. The principal current collaborations are:

- **FreedomCAR and Fuel Partnership.** DOE (represented by the Vehicle Technologies and the Fuel Cell Technologies programs) participates in the FreedomCAR and Fuel Partnership with the U.S. Council for Automotive Research (USCAR), five energy companies, and two utilities. The Partnership is focused on precompetitive high-risk research necessary to provide a full range of affordable energy-efficient cars and passenger trucks, and their fueling infrastructure. The primary focus is supporting R&D of HEV and PHEV technologies, and combustion engines for the nearer term and fuel-cell hybrids for the long term.
- **21st Century Truck Partnership.** The 21st Century Truck Partnership (21CTP) is a cooperative effort between the commercial vehicle (truck and bus) industry and major Federal agencies to develop technologies that will make the Nation's commercial vehicles more efficient, clean, and safe. The 21CTP focus is on R&D to increase engine efficiency, improve performance of hybrid power-trains, reduce parasitic and idling losses, and validate and demonstrate efficient, clean, and safe technologies.

VT also participates in an effort to integrate and harmonize R&D pathways across DOE's energy research programs. VT's principal counterparts are the Biomass and Biorefinery Systems R&D, Building Technologies, and Fuel Cell Technologies programs within EERE, the Office of Electricity Delivery and Energy Reliability, and the Basic Energy Sciences Program within the Office of Science. Examples of collaborative activities with the Office of Science include development of nano-scale materials and structures that have potential for improving battery performance and exploring opportunities to study fundamental combustion processes.

The program also collaborates with the Environmental Protection Agency (EPA) to promote deployment of two specific technologies: (1) DOE's Technology Integration activity will leverage its Clean Cities partnerships to work with EPA's SmartWay Transport Partnership to promote the installation of more biodiesel and E85 ethanol refueling stations around the country; and (2) cooperate with EPA to promote the adoption of idling-reduction technologies and practices for trucks and buses.

The program also uses a variety of other means to achieve its goals, including the following:

- The program funds and facilitates demonstration and deployment of prototype/pre-prototype vehicles to identify and eliminate technology flaws prior to technology introduction and technology development opportunities that lead to further cost reductions and/or performance improvements.
- University-oriented activities create graduate education opportunities for working with new automotive technologies and encourage undergraduate engineering students to gain experience with hybrid and plug-in hybrid systems technology and advanced combustion engines.
- R&D and deployment activities fund market and economic analyses needed to properly inform the program's technology strategies and multi-year plans.
- The program's goals, activities, and progress are reviewed by industry partners in the FreedomCAR and Fuel Partnership, and the 21st Century Truck Partnership, by industry and academic experts, through technical and programmatic reviews, and by the National Academies of Science (NAS) through a formal biennial peer review process.

The following chart shows how broad, long-term Administration and Departmental goals cascade down to specific activities and measures of program performance.

Cascade from Goals to Performance Measures

Goals:	Energy Security and Greenhouse-Gas Reductions				
Strategies:	More efficient use of petroleum fuels			Displacement by non-petroleum fuels	
Technical Strategies:	More efficient engines	Lighter vehicles	Cost-competitive hybrid vehicles	Optimize combustion of alternative fuels / blends	Enable cost-competitive plug-in hybrid vehicles
Program Performance Measures:	Improve engine efficiency for gasoline, diesel, and advanced combustion regimes. Capture and use waste heat.	Reduce cost of advanced materials like carbon fiber.	Reduce cost of high-power batteries. Reduce cost of power electronics & motors.	Improve gasoline and diesel engine efficiency when using alt-fuel blends.	Reduce high-power/high-energy battery cost. Field demonstrations of PHEVs.

Validation and Verification

To validate and verify program performance, the VT Program will conduct internal and external reviews and audits. These programmatic activities are subject to continuing review by, for example, Congress, the Department's Inspector General, and the NAS. The VT Program also uses several program performance management methods to validate and verify its performance during the course of the program on an annual and ongoing basis, including: management standards; incorporation of goals; measurement and reporting from program contracts; peer reviewed roadmaps and activities; performance modeling and estimation; prototype testing; site visits; and annual program reviews.

Data Sources:	Program Reviews, Peer Reviews, Laboratory Tests, On-Road Tests, and Peer-Reviewed Model Baselines.
Baseline:	Cost of hybrid batteries in 1998 ($3,000 projected for volume production of a high power 25 kW battery), combustion efficiency in 2002 (30 percent for passenger vehicles and 40 percent for commercial vehicles), 2002 passenger vehicle weight (3450 pounds as the nominal weight for a mid-sized car), cost of plug-in hybrid high energy battery in 2006 ($1,000/kWh), and integrated electric propulsion system cost in 1998 ($1,900). (Note: cost values are not adjusted for inflation.)
Frequency:	Biennial Peer reviews will be conducted in alternate years for the FreedomCAR and Fuel Partnership and for the 21st Century Truck Partnership.
Data Storage:	EE Corporate Planning System
Evaluation:	In carrying out the program's mission, the VT Program uses several forms of evaluation to assess progress and to promote program improvement. These are conducted at both the program and the activity levels. The types of evaluations are:

- Continue to conduct and build upon the transparent oversight and performance management initiated by Congress and the Administration.
- Technology validation and operational field measurement, as appropriate;
- Peer review by independent outside experts of both the program and subprogram portfolios;
- Annual internal Technical Program Review of the VT Program;
- Specialized program evaluation studies to examine process, impacts, or market baseline and effects, as appropriate;
- Quarterly and annual assessment of program and management results based on Joule (the DOE quarterly performance progress review of budget targets), and PART (common government wide program/OMB reviews of management and results);
- Annual review of methods, and computation of the potential benefits for the Government Performance and Results Act (GPRA); and
- Biennial reviews of both the FreedomCAR and Fuel Partnership and the 21st Century Truck Partnership by an independent third party, such as the NAS/National Academy of Engineering, to evaluate progress and program direction. The reviews include evaluation of progress toward achieving the Partnership's technical goals and direction. Based on this evaluation, resource availability, and other factors, the FreedomCAR and Fuel partners and the 21CT partners will consider new opportunities, make adjustments to technology specific targets, and set goals as appropriate.

Verification: Run and document vehicle simulation tests, conduct bench tests, run laboratory tests on the engine and vehicle dynamometers, run wind tunnel tests, and conduct on-road and track tests to evaluate the technology. Conduct fleet tests and undertake target performance review.

Annual Performance Results and Targets[a]

FY 2005 Results	FY 2006 Results	FY 2007 Results	FY 2008 Targets	FY 2009 Targets	FY 2010 Targets
GPRA Unit Program Goal 1.1.02.00 (Vehicle Technologies)					
Hybrid Electric Systems/Advanced Power Electronics and Electric Motors R&D					
		Demonstrate in the laboratory a motor with a specific power of 1.0 kW/kg, power density of 3.0 kW/liter, projected cost of $9/kW peak, and efficiency of 90 percent. [MET]	Reduce the projected cost (modeled) of a combined inverter/motor to $22/kW peak for a specific power of 1.0 kW/kg, a power density of 2.0 kW/liter, and an inlet coolant temperature of 90^{o} C. [MET]	Reduce the projected cost (modeled) of a combined inverter/motor to $19/kW peak for a specific power of 1.0 kW/kg, a power density of 2.2 kW/liter~~,~~ and an inlet coolant temperature of 90^{o} C.	Demonstrate a combined inverter/motor with a specific power of 1.1 kW/kg, a power density of 2.6 kW/liter, and a cost of $19/kW peak at an inlet coolant temperature of 90^{o} C.
Hybrid Electric Systems /Energy Storage R&D					
Reduce high-power, 25 kW, light vehicle, lithium ion battery cost to $900 per battery system. [MET]	Reduce the projected cost at high volume of a high power, 25 kW, light vehicle, lithium ion battery to $750 per battery system. [MET]	Reduce high power, 25 kW, passenger vehicle, lithium ion battery cost to $700 per battery system for conventional hybrid vehicles. [MET]	Reduce modeled production cost of high-power, 25 kW passenger vehicle lithium-ion battery to $625. (Storage batteries are a key cost and performance component for hybrid vehicles, which offer improved fuel economy.) [MET]	Reduce modeled production cost of high-power, 25 kW passenger vehicle lithium-ion battery to $550. (Storage batteries are a key cost and performance component for hybrid vehicles, which offer improved fuel economy.)	Reduce modeled production cost of high-power, 25 kW passenger vehicle lithium-ion battery to $500. (Storage batteries are a key cost and performance component for hybrid vehicles, which offer improved fuel economy.)
Advanced Combustion Engine R&D; Fuels Technology					
Light vehicle combustion engines will reach 39 percent brake thermal efficiency and commercial heavy-duty vehicle combustion engines will be greater than 45 percent efficient while meeting EPA 2007 emission standards (1.2 g/hp-hr NO_x). [MET]	Achieve 41 percent brake thermal efficiency for light vehicle combustion engines and 50 percent brake thermal efficiency, while meeting EPA 2010 emission standards (0.2 g/hp-hr NOx), for heavy vehicle combustion engines. [MET]	In the laboratory, demonstrate passenger vehicle combustion engines with a 42 percent brake thermal efficiency. [MET]	Internal combustion laboratory demonstrated engine efficiency for light-duty vehicles of 43 percent. (Engine efficiency improvements can improve vehicle fuel economy.) [MET]	Internal combustion laboratory demonstrated engine efficiency for light-duty vehicles of 44 percent. (Engine efficiency improvements can improve vehicle fuel economy.)	Internal combustion laboratory demonstrated engine efficiency for light-duty vehicles of 45 percent. (Engine efficiency improvements can improve vehicle fuel economy.)
			Complete progress review of heavy-duty engine research and down-select from 4 to 2 the number of cooperative agreements for continued R&D, based on the best prospects of achieving the 2013 goal of 55 percent engine efficiency. [MET]		

[a] The performance target for Technology Validation is shown in the Fuel Cell Technology budget as a result of the transfer of that activity in FY 2010.

FY 2005 Results	FY 2006 Results	FY 2007 Results	FY 2008 Targets	FY 2009 Targets	FY 2010 Targets
Materials Technology/Lightweight Materials Technology					
Complete R&D on technologies, which, if implemented in high volume, could reduce the price of automotive-grade carbon fiber to less than $4.50/pound. [MET]	Complete R&D on technologies, which, if implemented in high volume, could reduce the projected (i.e., modeled) bulk cost of automotive-grade carbon fiber to less than $3.00/pound. [NOT MET]	Reduce the modeled weight of a mid-sized passenger vehicle body and chassis components by 10 percent relative to baseline. [MET]	Reduce the modeled weight of a passenger vehicle body and chassis system by 25 percent relative to the 2002 baseline. [MET]	Reduce the modeled weight of a passenger vehicle body and chassis system by 40 percent relative to 2002 baseline.	Reduce the modeled weight of a passenger vehicle body and chassis system by 50 percent relative to 2002 baseline.
Contribute proportionately to EERE's corporate goal of reducing corporate and program adjusted uncosteds to a range of 20-25 percent by reducing program annual uncosteds by 10 percent in 2005 relative to the program uncosted baseline (2006) until the target range is met. [PARTIALLY MET]	Maintain total administrative overhead costs (defined as Program Direction and Program Support excluding earmarks) in relation to total program costs of less than 12 percent. [a] [MET]	Maintain total administrative overhead costs (defined as Program Direction and Program Support excluding earmarks) in relation to total program costs of less than 12 percent. [a] [MET]	Maintain administrative costs at less than 12 percent of total program costs. [a] [MET]	Maintain administrative costs at less than 12 percent of total program costs. [a]	Maintain administrative costs at less than 12 percent of total program costs. [a]

[a] Administrative costs are comprised of Program Direction and elements of Program Support (Technology Advancement and Outreach; and Planning, Analysis and Evaluation); baseline and targets under development.

Hybrid Electric Systems
Funding Schedule by Activity

	(dollars in thousands)		
	FY 2008	FY 2009	FY 2010 Request
Hybrid Electric Systems			
Vehicle and Systems Simulation and Testing	28,234	21,126	53,353
Technology Validation	—[a]	*14,789*	—[b]
Energy Storage R&D	48,348	69,425	77,437
Advanced Power Electronics and Electric Motors R&D	15,497	17,358	30,041
SBIR/STTR	—[c]	3,011	3,830
Total, Hybrid Electric Systems	92,079	125,709	164,661

Description

Modifications were made to the Hybrid Electric Systems subprogram budget structure to better reflect activities planned in FY 2010. The Technology Validation key activity is proposed to be moved back to the Fuel Cell Technologies Program as part of a reprioritization of fuel cell and hydrogen-related work.

This subprogram includes all of the VT efforts directly relating to the planning and modeling, development, and evaluation of advanced hybrid, electric, and plug-in hybrid drive systems. The Hybrid Electric Systems subprogram funds R&D on advanced vehicle technologies for both passenger and commercial vehicles that could achieve significant improvements in fuel economy without sacrificing safety, the environment, performance, or affordability. Primary emphasis is given to R&D on those technologies that support development of advanced HEVs and PHEVs. The subprogram also conducts simulation studies, component evaluations, and testing to establish needs, goals, and component/vehicle performance validation. This subprogram's funding contributes to the 21st Century Truck Partnership and the FreedomCAR and Fuel Partnership.

The subprogram focuses on the two basic building blocks of hybrid vehicles, and activities that tie the R&D efforts together and evaluate their progress.

- Energy Storage R&D addresses the first building block of a hybrid-electric vehicle: electricity storage. The needs of "regular" HEVs 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.
- Advanced Power Electronics and Electric Motors R&D addresses the second building block, which includes the electric and electronic devices that deliver the power stored in the battery to the vehicle's drive-train: power control circuits, charging circuits, electric motors, logic to synchronize

[a] Prior to FY 2009, Technology Validation was funded in the Hydrogen Technology (now Fuel Cell Technologies) Program.
[b] Technology Validation is transferred to the Fuel Cell Technologies Program from the Vehicle Technologies Program in FY 2010.
[c] SBIR/STTR funding was transferred to the Science Appropriation in FY 2008.

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 control strategies.

- Vehicle and Systems Simulation and Testing ties all of the hardware R&D together. System-level simulations help specify the necessary performance characteristics of the hardware and predict the overall vehicle efficiency and performance for a given configuration. Both simulation and testing activities can be used to evaluate the development and progress of individual components, and predict how well they will integrate with other components being developed. Tests and simulations also evaluate how well the program is approaching its whole-vehicle goals and provides technical inputs to mathematical models of projected oil reduction and economic benefits. Closed-track and on-road evaluations of advanced technology vehicles are utilized to identify potential limits to market penetration and petroleum reduction to inform R&D activities.

The Technology Validation activity has included validation of both fuel cell vehicle (FCV) technology and hydrogen infrastructure through the Controlled Hydrogen Fleet and Infrastructure Demonstration and Validation Project. The project is both a "Learning Demonstration" to manage the hydrogen and fuel cell component and materials research, and a validation of the technology under real-world operating conditions against time-phased performance-based targets. The project is 50/50 cost-shared between government and industry, including automobile manufacturers, energy companies, suppliers, universities, and state governments. Extensive data have been collected on vehicles operating on-road and during dynamometer testing. Validation of the hydrogen infrastructure included verification of hydrogen production cost and fueling time while gaining experience in the safe operation of stations. In FY 2010 the Technology Validation activity is transferred from the VT Program to the Fuel Cell Technologies Program as part of a reprioritization of fuel cell and hydrogen-related work.

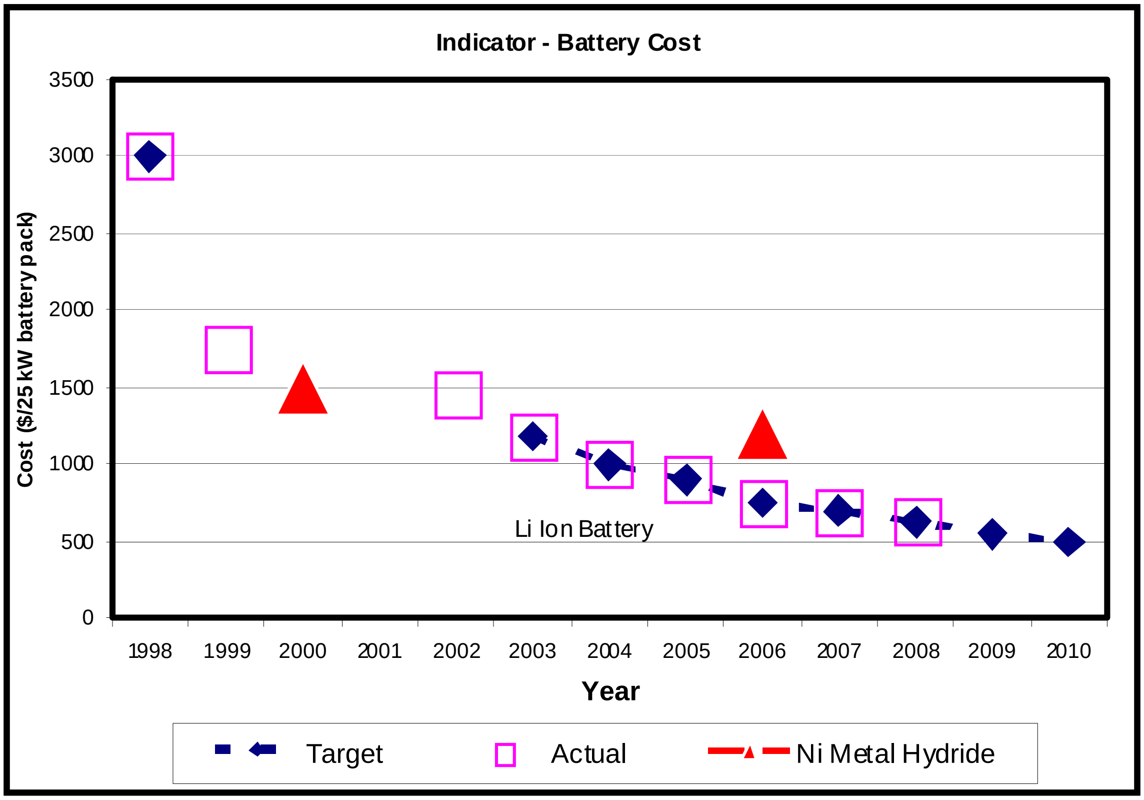
Benefits

The Hybrid Electric Systems subprogram supports VT Program goals by addressing the utilization of electric energy storage, electric drives, and energy recovery in new, more efficient vehicle designs.

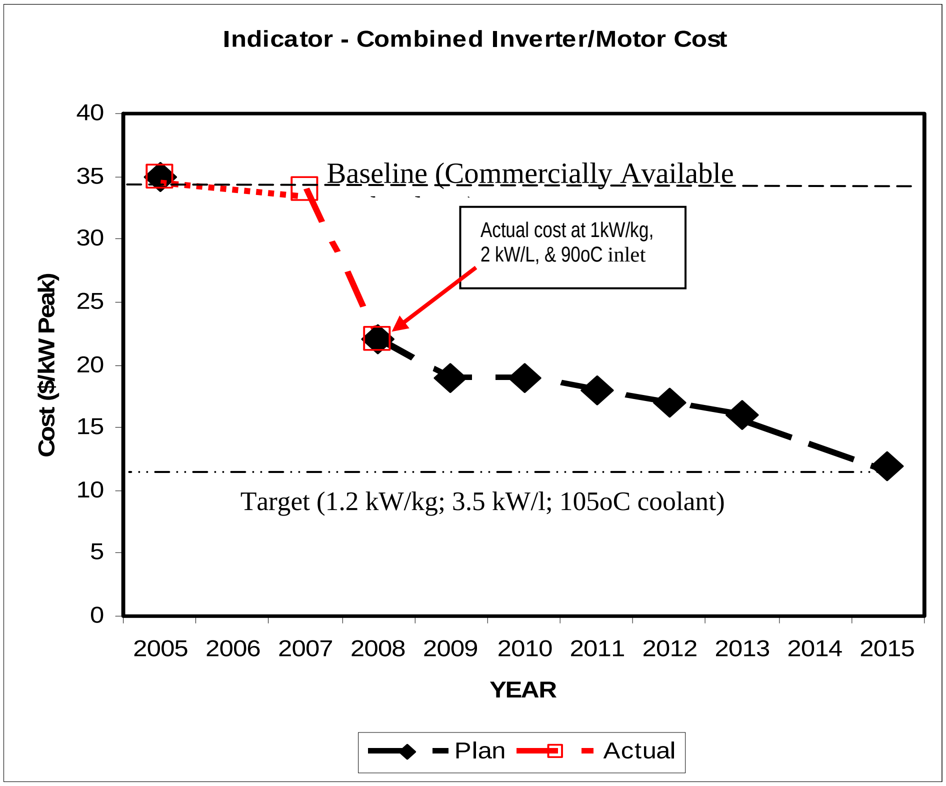
The following are representative goals of the Hybrid Electric Systems subprogram that can contribute to meeting national energy security, environmental, and economic objectives:

- Power Electronics and Electric Motor R&D:
  - As an intermediate goal, by the end of 2010, develop an integrated electric propulsion system that costs no more than $19/kW peak and can deliver at least 55kW of power for 18 seconds and 30kW of continuous power with an inlet coolant temperature of 90^{o}C ($1,045 per system compared to the cost of $1,925 in 2004 with an inlet coolant temperature of 70^{o}C). Additionally, the propulsion system will have an operational lifetime of 15 years.
  - By 2015, meet the same life and performance requirements at a cost of $12/kW with an inlet coolant temperature of 105^{o}C.
- Energy Storage:
  - Reduce the production cost of a high power 25kW battery for use in passenger vehicles from $3,000 in 1998 to $500 by the end of 2010, enabling cost competitive market entry of hybrid vehicles; and
  - Reduce the production cost of a high energy and high power battery from $1,000/kWh in 2006 to $300/kWh by 2014, enabling cost competitive market entry of PHEVs.
- Vehicle and Systems Simulation and Testing: Demonstrate market readiness of PHEV technologies by 2015.

Progress for energy storage and electric propulsion system is indicated by cost per 25kW battery system and combined inverter/motor cost estimated for a production level of 100,000 systems per year. Actual and projected progress for the battery cost and integrated inverter/ motor cost indicators are shown graphically below:



Note: 1998 value is baseline.



Note: 2005 and 2007 Actual data are cost for commercially available systems.

Additionally, in FY 2010 the subprogram will continue to accelerate the development of low-cost, high-energy batteries and corresponding improvements to electric drive systems (motors, power electronics, and electric controls) needed for cost-effective PHEVs. PHEVs (i.e., those that can be plugged into and recharged from an electric outlet) offer the potential for significant additional fuel savings benefits, particularly for commuter and local driving, for either combustion or fuel cell powered hybrid passenger vehicles.

Detailed Justification

(dollars in thousands)

	FY 2008	FY 2009	FY 2010
Vehicle and Systems Simulation and Testing	**28,234**	**21,126**	**53,353**

The Vehicle and Systems Simulation and Testing (VSST) activity integrates the modeling, systems analysis, and testing efforts that support the VT Program. The significant increase in funding for FY 2010 will support expanded heavy vehicle systems modeling and development of technologies to reduce commercial vehicles' "parasitic" losses such as aerodynamics and friction. It will also support significantly increased testing of both commercial vehicles and passenger vehicles. The additional funds will increase the number of PHEVs evaluated in the PHEV Technology Acceleration & Demonstration Activity. Additional advanced electric-drive vehicles, including hybrid electric vehicles and battery electric vehicles, will also be baseline tested and evaluated in cooperation with manufacturers, utilities and other industry partners. A portion of the increase will also be used to expand the laboratory and field evaluation 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. VSST will also expand the evaluation of advanced HEVs and PHEVs in medium and heavy duty uses such as school buses, urban delivery vehicles, and transit buses.

The VSST activity uses a systems approach to define technical targets and requirements, guide technology development, and validate performance of VT Program-sponsored technologies for passenger and commercial vehicles. The activity 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, and fuel cell vehicles; and
- Develop advanced vehicle performance and characteristics data that is then used to predict market potential and petroleum displacement, which can help guide office-wide research.

The modeling and validation effort is supported by laboratory and field testing to benchmark and validate the performance of passenger and commercial vehicles that feature one or more advanced technologies. Benchmarking performance and capabilities of advanced technologies supports development of industry and DOE technology targets. Testing results also are used in component, system, and vehicle models, as well as in hardware-in-the-loop testing that operates selected pieces of hardware linked to a real-time simulation of the rest of the vehicle.

This activity will also research heavy vehicle systems to develop advanced heavy vehicle systems models, as well as R&D on technologies that will reduce non-engine parasitic energy losses from aerodynamic drag, friction and wear, under-hood thermal conditions, and accessory loads.

In FY 2010, the subprogram will continue simulation studies of advanced control strategies and components for PHEVs, as well as the validation of advanced PHEV 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. The program also will complete a series of detailed component models linked to the overall vehicle systems integration model ensuring the use of the most accurate component data. This effort, which builds upon an existing cooperative research and development agreement (CRADA) with industry, is developing a centralized vehicle modeling tool that will standardize vehicle modeling across manufacturers and component suppliers, thus reducing component and vehicle developments costs and bringing technologies to market faster. This model also increases accuracy of results and allows simulations that support R&D in all other VT subprograms.

	(dollars in thousands)	
FY 2008	FY 2009	FY 2010

The VSST activity will utilize the PHEV Mobile Automotive Technology Testbed (MATT) and hardware-in-the-loop techniques 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 2010 VSST will incorporate more advanced energy storage systems and dual battery systems, and continue evaluations of advanced combustion technologies developed by other VT 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 the power electronics and energy storage technology R&D activities, and examine overall vehicle impacts associated with integration of other advanced vehicle technologies.

The activity also will conduct laboratory and closed track baseline testing and real-world monitored fleet evaluations of advanced original equipment manufacturer (OEM) PHEVs and complete tests of vehicles retrofitted with components developed through VT R&D activities. 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 PHEV knowledge base and help accelerate market introduction of these fuel saving vehicles. Efforts focus on infrastructure/vehicle interface evaluations and potential impacts on the electricity grid.

VSST will 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 the completed integration of turbulence and other computational fluid dynamics (CFD) models. In FY 2010, additional vehicle testing data from VSST activities, as well as other independent testing sources, will be utilized to validate medium duty vocations in the heavy vehicle model. In FY 2010, VSST will complete the second year of a three year effort focused on on-road and wind tunnel evaluation of the most promising tractor/trailer aerodynamic drag reduction devices being developed through a competitively awarded contract with industry partners. The funds will support CRADAs and National Laboratory projects to reduce drive-train friction and wear, and to develop and evaluate under-hood thermal management approaches that will improve vehicle efficiencies while increasing component reliability and life. The VSST will also work directly with industry partners to accelerate the development and validation of advanced medium and heavy hybrid 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.

	FY 2008	FY 2009	FY 2010
Technology Validation	**–**	**14,789**	**–**

In FY 2010 the Technology Validation activity is transferred from the VT Program to the Fuel Cell Technologies Program as part of a reprioritization of fuel cell and hydrogen-related work.

In past budgets, this funding was requested as two budget items: validation of fuel cell vehicles and validation of hydrogen infrastructure, although the work was performed as an integrated project. In FY 2007 the split is $25.0 million for fuel cell vehicles and $14.566 million for infrastructure. In FY 2008 funding was requested as a single budget item, and the comparable split is $18.65 million for fuel cell vehicles and $11.224 million for infrastructure. In FY 2009 the anticipated split is $11.0 million for fuel cell vehicles and $4.0 million for infrastructure.

	(dollars in thousands)		
	FY 2008	FY 2009	FY 2010
Energy Storage R&D	**48,348**	**69,425**	**77,437**

The Energy Storage activity supports long-term research, applied research, and technology development of advanced batteries. Low-cost, abuse-tolerant batteries with higher energy, higher power, excellent low-temperature operation, and longer lifetimes are needed for the development of the next-generation of HEVs, PHEVs, and pure electric vehicles (EVs). Lithium-based batteries offer the potential to meet all three applications.

The program's long-term research is focused on developing advanced materials for the next generation of energy storage technologies. This research effort is being conducted at universities and National Laboratories. Applied research conducted at seven National Laboratories (ANL, BNL, INL, LBNL, NREL, ORNL, and SNL) is focused on the development and validation of low-cost, abuse-tolerant, and long-life lithium-ion (Li-ion) batteries for vehicle applications. Nearer-term technology development is conducted in cooperation with industry through the United States Advanced Battery Consortium (USABC). All USABC subcontracts to develop advanced batteries are awarded under a competitive process and are at least 50 percent cost-shared by developers.

The Energy Storage activity coordinates with other DOE programs working in advanced battery technologies to maximize returns on DOE's technology investments in this area. Close cooperation with the Office of Basic Energy Sciences (BES) provides valuable technical and programmatic support. The activity also coordinates with the Energy Storage Program in the Office of Electricity Delivery and Energy Reliability (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.

In FY 2010, the Energy Storage long-term activity will continue to examine innovative materials and electrochemical couples with the potential for significant improvements over existing technologies for use in both hybrid and plug-in hybrid electric vehicles. These efforts are being coordinated with the Office of Science.

This supports the R&D aimed at reducing the detrimental effects of the volume change during cycling of metallic and intermetallic alloys (1,000 to 4,000 mAh/g) as a replacement for carbon/graphite materials (372 mAh/g) used in present-day lithium batteries. Efforts are underway to accelerate the development of solid polymer electrolytes with significantly higher stiffness and improved ionic conductivity at room temperature that show promise in retarding dendrite formation in cells with lithium metal anodes (3,800 mAh/g). Dendrites are metallic particles that form on the surface of an electrode during cycling and eventually cause an internal short circuit resulting in battery failure. Emphasis will be placed on block copolymers, with one block providing conduction and other block offering stiffness, and protective single-ion conducting ceramic glasses to isolate the lithium metal from the electrolyte.

In addition to new high-voltage electrolytes, research efforts will also be devoted to the development of redox shuttle 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.

The activity will continue to develop advanced diagnostic techniques to investigate and better understand life- and performance-limiting processes in lithium-based batteries in transportation applications. The program will develop and apply electrochemical models to understand failure mechanisms, thermal runaway mechanisms in lithium batteries, and to design new functional materials.

In coordination with BES and OE, the VT 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 could be required to investigate these materials.

In FY 2010, Energy Storage applied research will focus on the investigation of cell behavior of higher energy Li-ion cells. Historically, this activity focused on the development and enhancement of high power Li-ion chemistries. Since high-power Li-ion ion batteries are poised to enter the hybrid vehicle market, the emphasis in FY 2010 will focus on the development of electrochemistries that are required to achieve the higher energy density for the 40-mile all electric range (AER) PHEV application. Li-ion cell chemistries based on existing materials do not provide a sufficiently high energy density to meet the weight and volume constraints when providing sufficient energy for the 40-mile AER application. The primary goal of this activity is to develop and engineer higher-energy electrodes utilizing high capacity cathode and anode materials. Optimal cell chemistries will be developed around the most promising higher energy density materials and evaluated.

The applied research activity also supports the development of other energy storage devices, such as ultra-capacitors, that might be used for micro hybrids (start/stop power only) and fuel cell HEVs. Ultra-capacitors still have relatively low specific energy (less than 3 Wh/kg), which limits their capacity to serve as the main energy-storage devices in hybrid vehicles, but they offer the possibility of improved vehicle performance in a battery-plus-ultra-capacitor hybrid configuration. This configuration will be evaluated and optimized for lower cost and durability in a PHEV platform when the ultra-capacitor is sized for power assist and the battery is sized for energy. Ultra-capacitor development 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 their specific energy.

In FY 2010, the Energy Storage technology development will continue to support cost-shared subcontracts through the USABC with multiple battery suppliers to drive down the cost of Li-ion batteries. The program will continue to develop full-sized Li-ion modules using low-cost, thermally stable, high-performance anode and cathode materials. The emphasis is on driving down the cost and extending the life of higher energy Li-ion batteries for PHEVs.

The FY 2010 request reflects a new emphasis on accelerating the development of batteries for PHEVs. The dual use of batteries in PHEV applications for electric drive range during charge-depleting mode and for engine power assist during charge-sustaining mode challenges the design of the battery and the methodology to evaluate its performance and life. As a result, materials with higher energy capacity than currently being used are preferred. Also, as the battery becomes larger, abuse-tolerance (susceptibility to damage or failure from vibration or impact, over-charging, fire, etc.)

(dollars in thousands)

becomes a primary concern requiring higher stability between the electrodes and the electrolyte, and adequate/active thermal management at the module and system level. This activity will continue to validate requirements and refine standardized testing procedures to evaluate performance and life of PHEV batteries, as well as continue to identify areas for additional R&D and address the specific needs of PHEVs. VT will continue to solicit proposals and award additional subcontracts to battery suppliers for development of batteries for plug-in hybrid application. The goal is to reduce the cost of the PHEV battery to $300/kWh by 2014. In FY 2010, VT 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. The additional funding will support new contracts with industry to: (1) develop high energy batteries for PHEVs with a 20 to 40 mile all-electric range; (2) develop more cost-effective manufacturing processes for high-volume production of Li-ion batteries; or, (3) improve the quality of the materials and cell components from domestic suppliers, and enhance manufacturing efficiencies to reduce the component's or material's cost. Detailed studies of recycling and reuse of lithium batteries continue. In addition, these funds may be used to support peer reviews; data collection and dissemination; and technical, market, economic, and other analyses.

	FY 2008	FY 2009	FY 2010
Advanced Power Electronics and Electric Motors R&D	**15,497**	**17,358**	**30,041**

The Advanced Power Electronics and Electric Motors activity supports long-term R&D on power electronics, electric motors and other electric propulsion components, as well as the thermal control subsystems necessary for the development and ultimate adoption of fuel cell, electric and PHEVs. Supporting R&D on capacitors, magnets and wide band-gap materials (such as silicon carbide [SiC]) for advanced power electronics technologies also is included to enable the higher operating temperatures that are necessary to reduce systems cost and to meet PHEV and fuel cell HEV performance and reliability requirements.

The power electronics module conditions the flow of electrical power from the energy-storage device (battery, fuel cell, and ultra-capacitor) 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 to reduce the overall size of the battery. The objective of the R&D efforts is to develop advanced, low cost technologies compatible with the high-volume manufacturing of motors, inverters, and DC/DC converters for advanced vehicle applications.

In FY 2010, a new solicitation will be issued to fund industry R&D efforts 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 imports, and advance power electronics and electric motors are critical components for the successful deployment of advanced vehicles. These awards 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. Awards will also accelerate the 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 components, low-cost permanent magnet materials, high temperature capacitors, advanced thermal systems, and motor control systems to meet future passenger vehicle hybrid systems

	FY 2008	FY 2009	FY 2010

(dollars in thousands)

requirements. Existing work in these areas will be expanded to address the more stringent performance requirements for PHEVs, including utilizing the power electronics to provide plug-in capability by integrating the battery charging function into the traction drive, thereby reducing electric propulsion system cost. Activities focusing on advanced materials will be enhanced to 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 bandgap materials will be emphasized and enhanced to enable earlier use of advanced devices and components.

The power electronics and electric motors activity coordinates with other DOE programs doing relevant work in advanced technologies in order to maximize the return on DOE's technology investments in this area. Interagency coordination on advanced power electronics and motors development is conducted through the government-sponsored 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 tested at National Laboratories for validation of performance and conformance to specifications. Crosscutting technologies also will be evaluated for potential application for advanced vehicle applications. 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**	**3,011**	**3,830**

In FY 2008, $1,836,000 and $220,000 were transferred to the SBIR and STTR programs respectively. The FY 2009 and 2010 amounts shown are estimated requirements for the continuation of the SBIR and STTR program.

Total, Hybrid Electric Systems	**92,079**	**125,709**	**164,661**

Explanation of Funding Changes

	FY 2010 vs. FY 2009 ($000)
Vehicle and Systems Simulation and Testing The additional funds will be used to increase the number of PHEVs built by vehicle manufacturers and evaluated in the PHEV Technology Acceleration & Demonstration Activity. Additional advanced electric-drive vehicles, including hybrid electric vehicles and battery electric vehicles, will also be baseline tested and evaluated in cooperation with manufacturers, utilities and other industry partners. A portion of these funds will also be used to expand the laboratory and field evaluation 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. Funds will be utilized to expand the evaluation of advanced HEVs and PHEVs in medium and heavy duty uses such as school buses, urban delivery vehicles, transit buses, and other applications.	+32,227
Technology Validation Funding for this activity is transferred from the VT Program to the Fuel Cell Technologies Program as part of a reprioritization of fuel cell and hydrogen-related work.	-14,789
Energy Storage R&D Near and mid-term activities continue to focus on the development and validation of low-cost, abuse-tolerant, and long-life Li-ion batteries for vehicle applications. The activity also expands the work on high-energy/high-power batteries for PHEVs, while the long-term activities will continue to examine innovative materials and electrochemical couples that offer the potential for significant improvements over existing technologies for use in both HEVs and PHEVs. These efforts are being coordinated with the Office of Science to assure best utilization of the research efforts. Additional activities will include R&D focused on reducing the cost to domestically synthesize and produce advanced materials in support of battery manufacturers.	+ 8,012
Advanced Power Electronics and Electric Motors R&D The additional funds will be used to expand the laboratory R&D in the areas of reliability packaging, and materials. Efforts to improve understanding of reliability issues will be accelerated with increased coordination with component manufacturers and OEMs. Emphasis on advanced packaging materials and techniques will be accelerated as part of R&D of advanced power electronics technologies. New projects to transition and scale-up prototype advanced DC bus capacitors will begin. These new efforts will speed the transition of these new technologies to industry, which will allow for smaller and lower cost power electronics. Also, research to replace expensive rare earth magnetic materials used in electric motors will be expanded. Joint focus and efforts with other programs and agencies in wide bandgap materials, capacitors and	

	FY 2010 vs. FY 2009 ($000)
magnets will be emphasized and enhanced to enable earlier use of advanced devices and components. These funds will also be used to initiate a new solicitation for industry contracts to develop advanced power electronics and electric machines to meet the challenges associated with increased vehicle electrification. The new awards will enable substantial reductions in cost, weight, and volume, while ensuring a domestic supply chain. Emphasis will be placed on R&D projects to develop advanced packaging, improve reliability, and manufacturability. Awards will also accelerate the technology transfer from research organizations to domestic manufacturers.	+12,683
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.	+819
Total Funding Change, Hybrid Electric Systems	**+38,952**

Advanced Combustion Engine R&D
Funding Schedule by Activity

	(dollars in thousands)		
	FY 2008	FY 2009	FY 2010
Advanced Combustion Engine R&D			
Combustion and Emission Control	38,906	35,089	47,239
Solid State Energy Conversion	4,537	4,568	8,748
SBIR/STTR	— [a]	1,143	1,613
Total, Advanced Combustion Engine R&D	43,443	40,800	57,600

Description

The Advanced Combustion Engine R&D subprogram focuses on removing critical technical barriers to commercialization of higher efficiency, advanced internal combustion engines for passenger and commercial vehicles. The goals are to improve the fuel efficiency of internal combustion engines for passenger vehicle applications from 30 percent in 2002 to 45 percent by 2010, and for commercial vehicles from 40 percent in 2002 to 55 percent by 2017, while meeting cost, durability, and emissions constraints. Research will be conducted in collaboration with industry and industry partnerships, National Laboratories, and universities followed by demonstrations on vehicle platforms. The Advanced Combustion Engine R&D subprogram includes Combustion and Emission Control R&D and Solid State Energy Conversion activities.

The most promising method to reduce petroleum consumption in the mid-term (10 to 20 years) – or until fuel-cell HEVs dominate the market – is to develop high-efficiency internal combustion engines and enable their introduction in conventional vehicles, HEVs and PHEVs. Improvements in engine efficiency alone have the potential of increasing fuel economy by 40 to 50 percent. Accelerated research on advanced combustion regimes, including homogeneous charge compression ignition (HCCI) and other modes of low-temperature combustion and lean-burn gasoline operation, is aimed at realizing this potential.

Benefits

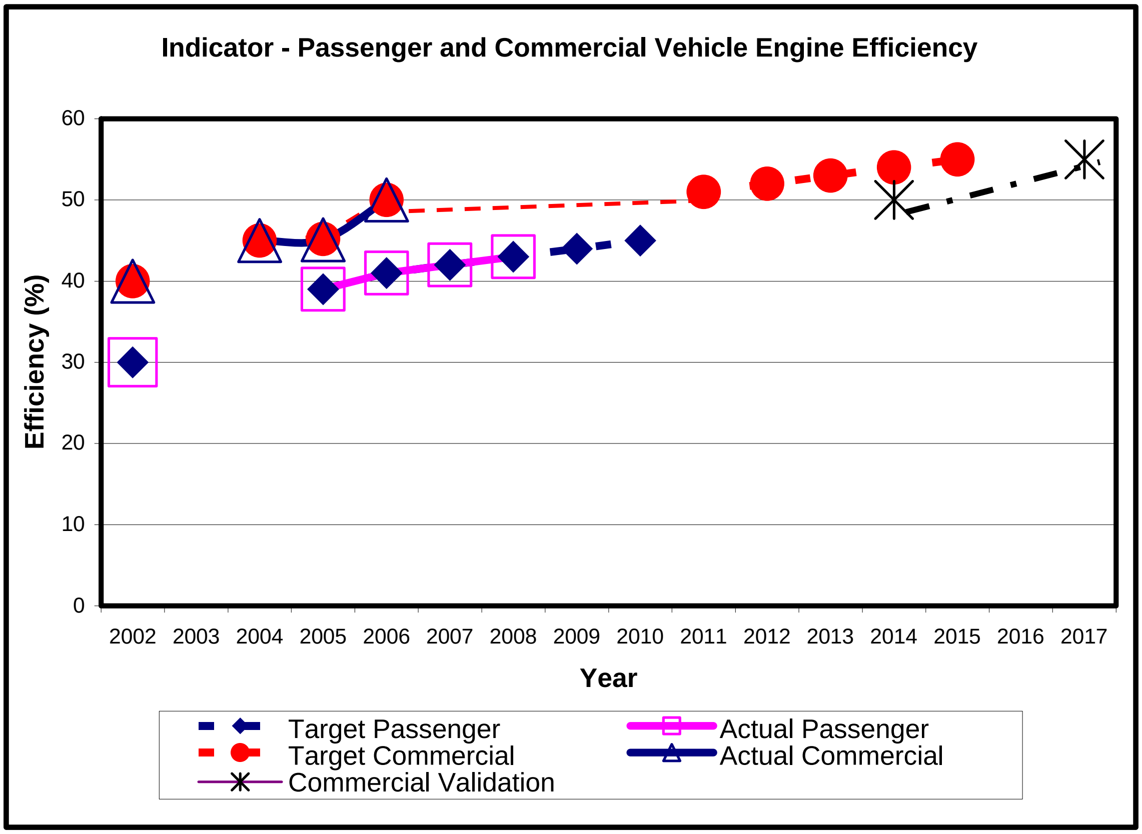
The Advanced Combustion Engine R&D subprogram and Fuel Technology subprogram contribute to the VT Program goals by dramatically improving the efficiency of internal combustion engines and will identify fuel properties that improve the system efficiency or can displace petroleum based fuels. Improved efficiency and petroleum displacement can directly reduce petroleum consumption.

The following are representative goals of the Advanced Combustion R&D subprogram that can contribute to meeting national energy security, environmental, and economic objectives:

- Passenger vehicles: Improve the efficiency of internal combustion engines from 30 percent (2002 baseline) to 45 percent by 2010; and
- Commercial vehicles: Improve the efficiency of internal combustion engines from 40 percent (2002 baseline) to 50 percent (20 percent improvement in fuel economy) by 2014 and further improve engine efficiency to 55 percent by 2017 with demonstrations on commercial vehicle platforms utilizing advanced fuel formulations that incorporate a non-petroleum based blending agent to reduce petroleum dependence and enhance combustion efficiency.

[a] SBIR/STTR funding was transferred to the Science Appropriation in FY 2008.

Progress is indicated by efficiency of passenger and commercial vehicle internal combustion engines and is shown graphically below.



Note: 2002 value is baseline.

Detailed Justification

	(dollars in thousands)		
	FY 2008	FY 2009	FY 2010
Combustion and Emission Control	**38,906**	**35,089**	**47,239**

Combustion and Emission Control research supports the VT Program 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 VT'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.

Although advanced diesel engine technology has demonstrated Tier 2 emissions performance, the current energy consumption, cost, and durability of the emission control system will limit the rate of market penetration. To address this issue, in parallel with advanced combustion regime development, innovative emission control strategies will be pursued through National Laboratory and university projects designed to reduce cost and 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 further improve the efficiency and reduce the cost of engines used in commercial vehicles.

In FY 2010, the Combustion and Emission Control activity will continue emphasis on R&D of advanced combustion engines that can achieve the program's efficiency goals for passenger and commercial vehicles, while maintaining cost and durability levels and achieving near-zero regulated emissions. This activity will continue to fund cooperative agreements awarded in FY 2007 and FY 2009 for passenger vehicle low temperature combustion technologies and advanced power-train systems targeting a 25 to 40 percent improvement in vehicle fuel economy. FY 2010 funding will complete previous competitively-awarded cooperative agreements for improving heavy-duty engine efficiency through the utilization of advanced combustion regimes (HCCI, LTC and mixed-mode and utilization of waste heat recovery). The activity will continue to fund awards from the FY 2009 solicitation to work in partnership with the commercial vehicle industry on incorporating advanced engine technologies capable of demonstrating 50 percent thermal efficiency and a 20 percent fuel economy improvement in a Class 8 truck by 2014. A parallel path will be followed to demonstrate the feasibility of achieving 55 percent engine efficiency in a laboratory while meeting prevailing emissions standards. The selected participants will 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 losses, friction and pumping losses, to meet these engine system goals.

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 will include 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 also 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 both 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.

(dollars in thousands)

The activity will conduct optical laser diagnostics of in-cylinder combustion processes for advanced combustion regimes such as HCCI, other modes of LTC, and mixed-mode regimes. Through simulation and experimentation, it will also conduct R&D on advanced thermodynamic strategies that will enable engines to approach 60 percent thermal efficiency. The activity also will utilize laser-based, optical diagnostics to conduct in-cylinder engine research focused on overcoming barriers to the development of high-efficiency, hydrogen-fueled IC engine technology in coordination with the Fuel Cell Technologies Program. 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.

Cost-shared cooperative agreements awarded in FY 2009 to automotive suppliers and universities will continue to develop innovative component technologies such as variable valve timing, variable compression ratio, and NO_x and PM sensors that enable cost-effective implementation of advanced combustion engines with high efficiency and near-zero emissions of NO_x and PM.

Also in FY 2010, the fifth full year of the Advanced Collaborative Emissions Study (ACES) will continue to generate and characterize emissions from 2010 emissions compliant commercial vehicle diesel engines and from Selective Catalytic Reduction (SCR) Urea after-treatment devices. DOE is responsible for the generation, characterization and collection of samples for ACES. These characterized engine emissions have been routed to expose animals (rats and mice) beginning last year and will continue through FY 2011 for chronic bioassays of tissue samples from these animal exposures supported by the other ACES sponsors.

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	**4,537**	**4,568**	**8,748**

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.

In FY 2010, the activity will continue to fund cost-shared cooperative agreements awarded in FY 2009 to develop and fabricate high efficiency thermoelectric generators and thermoelectric air conditioning for passenger vehicles. Thermoelectric generators could directly convert a nominal 1kW of electric power from engine waste heat for passenger vehicle and up to 5kW for commercial vehicles. These improvements could increase vehicle fuel economy by up to 10 percent. These agreement(s) will develop thermoelectric devices that can operate as coolers/heaters to replace current R134-a gas air conditioners in passenger and commercial vehicles.

The program will release a completive solicitation in FY 2010 for research in advanced thermoelectric materials and scale-up for demonstration in vehicle applications. This activity will also continue

	(dollars in thousands)		
	FY 2008	FY 2009	FY 2010

investigating the use of segmented or nano-modified bulk materials and high-efficiency materials that have shown potential for greater than 30 percent efficiency in laboratory evaluations. 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**	**1,143**	**1,613**

In FY 2008, $1,025,000 and $123,000 were transferred to the SBIR and STTR programs respectively. The FY 2009 and 2010 amounts shown are estimated requirements for the continuation of the SBIR and STTR program.

Total, Advanced Combustion Engine R&D	**43,443**	**40,800**	**57,600**

Explanation of Funding Changes

	FY 2010 vs. FY 2009 ($000)
Combustion and Emission Control	
The Combustion and Emission Control activity will continue emphasis on the RD&D of advanced combustion engines that can achieve the program's efficiency goals for passenger and commercial vehicles while maintaining cost and durability levels, and achieving near-zero regulated emissions. The most promising method to reduce petroleum consumption in the mid-term (10 to 20 years) is to improve the efficiency of advanced internal combustion engines and enable their rapid introduction in conventional vehicles, HEVs and PHEVs. The health impacts research will continue to evaluate the relative toxicity and consequent human health implications of emissions from new combustion technologies, new fuels derived from unconventional feedstocks, and new blending agents.	
FY 2010 funding for combustion engine R&D is increased to place greater emphasis on engine systems R&D. This will allow several awards that will be selected from the competitive solicitation issued in 2009 to develop a complete engine system capable of demonstrating 50 percent engine efficiency and a 20 percent improvement in fuel economy by 2014 for commercial vehicles, and a 25 to 40 percent improvement in fuel economy for passenger vehicles. This selection will be focused on the highest risk technologies with industry absorbing more of the moderate risk R&D activities.	+12,150

	FY 2010 vs. FY 2009 ($000)
Solid-State Energy Conversion (formerly Waste Heat Recovery)	
The Solid State Energy Conversion activity develops thermoelectrics and other solid state systems that recover energy from waste heat and also can operate as coolers/heaters. The increase in funding will allow continuation of cooperative agreements awarded in FY 2009 to develop first-generation thermoelectric devices that can operate as coolers/heaters to replace current R134-a gas air conditioners. The increase will also fund competitively selected awards on an FY 2010 solicitation focused on demonstrating thermoelectric devices in vehicle applications and on research of the next generation of advanced thermoelectric materials.	+4,180
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.	+470
Total Funding Change, Advanced Combustion Engine R&D	**+16,800**

Materials Technology
Funding Schedule by Activity

	(dollars in thousands)		
	FY 2008	FY 2009	FY 2010
Materials Technology			
Propulsion Materials Technology	9,654	10,742	13,666
Lightweight Materials Technology	22,383	22,374	34,039
High Temperature Materials Laboratory	6,579	5,670	5,662
SBIR/STTR	— [a]	1,117	1,538
Total, Materials Technology	38,616	39,903	54,905

Description

The Materials Technologies subprogram supports the development of cost-effective materials and materials manufacturing processes that can contribute to fuel-efficient passenger and commercial vehicles. This subprogram contributes to concepts developed throughout the VT Program. The subprogram consists of three activities: Propulsion Materials Technology, Lightweight Materials Technology, and the High Temperature Materials Laboratory (HTML).

Benefits

The Materials Technology subprogram contributes to the VT Program goal by developing 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.

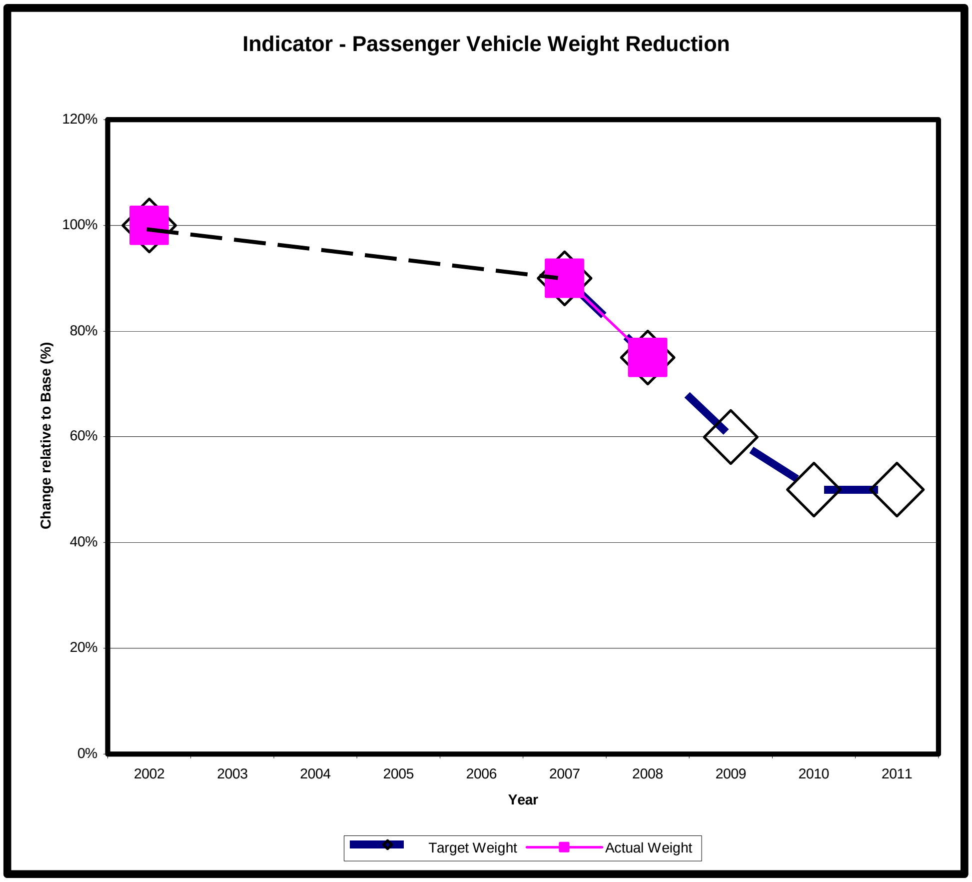
The following representative goal of the Materials Technology subprogram can contribute to meeting national energy security, environmental, and economic objectives:

- By 2010, develop material and manufacturing technologies which, if implemented in high volume, could cost-effectively reduce the weight of passenger vehicle body and chassis systems by 50 percent with safety, performance, and recyclability comparable to model-year 2002 vehicles.

This is a broader goal than the previous subprogram goal of reducing the projected mass-production price of carbon-fiber materials to $3 per pound. The broader goal encompasses both further progress in carbon-fiber composites and advances in a variety of other lightweight automotive materials.

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 was transferred to the Science Appropriation in FY 2008.



Note: 2002 value is baseline

Detailed Justification

	(dollars in thousands)		
	FY 2008	FY 2009	FY 2010
Propulsion Materials Technology	**9,654**	**10,742**	**13,666**

The Propulsion Materials Technology key activity will conduct R&D on improved materials that will enable development of highly efficient propulsion systems for advanced passenger cars and commercial vehicles operating on a combination of conventional and non-petroleum fuels. Improved propulsion materials are critical for the performance and cost targets of advanced technologies being developed by the VT Program.

In FY 2010, Propulsion Materials will conduct targeted materials research that complements the efforts of three VT teams: 1) Advanced Combustion Engines; 2) Fuels; and 3) Hybrid Electric Systems supporting the efficiency and petroleum displacement goals. In support of the Advanced Combustion Engines team, Propulsion Materials will use specialized characterization and processing techniques to develop materials for in-cylinder thermal management, friction reduction, improved dynamic response, increased power to weight ratios, and robust catalysts for emissions control.

(dollars in thousands)

Propulsion materials will quantify potential efficiency improvements by evaluating prototype components in research engines. Technology transfer tasks will communicate these results to industry to accelerate deployment of beneficial technologies.

Implications of utilizing new fuel formulations in internal combustion engines on the durability of fuel systems and engine components will be evaluated in concert with Fuels Technology research. Propulsion materials will develop new materials and processing techniques that mitigate fuel-materials interaction issues. The program will also develop improved thermoelectric materials that are durable, efficient, and operate in temperature ranges of interest for various applications.

Support for hybrid- and electric-drive systems will be expanded by addressing materials requirements for high efficiency components including improved materials for high efficiency electric motors, high-temperature power electronics, high performance electrical connections, and characterization and evaluation of battery component materials. Additional efforts will support the long-term sustainability of advanced batteries through the development of materials recycling and recovery techniques.

Activities will include collaborative, pre-competitive R&D with support to automotive suppliers. States and other automotive manufacturing organizations to develop promising new technologies for energy efficient, performance-specific, factory-ready materials, processes, and designs. In addition, these funds may support efforts such as peer reviews; data collection and dissemination; and technical, market, economic, and other analyses.

Lightweight Materials Technology	**22,383**	**22,374**	**34,039**

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- and metal-matrix composites reinforced with fibers and particulates including *in-situ*-grown. Since cost-effectiveness is the major materials challenge, this element supports research, development and validation of materials needed to meet the FreedomCAR 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 approach the FY 2010 goal of cost neutrality.

In FY 2010 increased funding will focus on new development and demonstrations at pilot-scale of technologies for reducing the effective costs of automotive aluminum, magnesium, carbon-fiber and carbon-fiber composites and components and structures made from these materials.

High Temperature Materials Laboratory (HTML)	**6,579**	**5,670**	**5,662**

FY 2010 funding will provide continued support of the HTML and the HTML user program, with increased emphasis on industrial user needs. The HTML facility is an advanced materials characterization R&D industrial user center located at the Oak Ridge National Laboratory. The HTML strives to maintain world-class, state-of-the-art advanced materials characterization (i.e., the determination of the composition and structure of materials which determine their properties and functionality) capabilities not available elsewhere and makes them available to U.S. industries (at

	(dollars in thousands)		
	FY 2008	FY 2009	FY 2010

nominal or no cost, especially small businesses), and academia for use in solving complex materials problems. It develops cutting-edge analytical techniques to identify innovative materials for use in transportation applications.

Activities include the investigation and determination of the composition, structure, physical and chemical properties and performance characteristics of metals, alloys, ceramics, composites, and even novel nano-phase materials under development for vehicle applications. Experience has shown that technologies needed to enhance vehicle fuel and energy efficiency are often limited by the performance and cost of the materials needed to manufacture these technologies. Past increases in funding enabled the acquisition of new analytical capabilities at the HTML, including instruments and tools to characterize the properties and performance of new high efficiency thermoelectric materials (e.g., Seebeck Coefficient); deployment of an intense neutron flux diffractometer, VULCAN, enabling research on chemical reactions occurring in the solid state and rapidly occurring changes in materials subjected to stresses; and a special purpose scanning transmission electron microscope (STEM) modified for in-situ characterization of catalysts, advanced battery, and thermoelectric materials. These enhanced capabilities are now paying dividends by helping companies solve materials problems occurring from recent changes in fuel composition, such as the addition of ethanol to gasoline and the removal of sulfur from diesel fuel. The HTML user program also provides funding for some pre-competitive non-proprietary research projects submitted by academia and U.S. companies for the advancement of high efficiency vehicle transportation technologies in alignment with the goals of the FreedomCAR and 21st Century Truck partnerships. Typically, 100 projects are completed each year, with results published in peer reviewed journals, industry presentations, and trade press.

SBIR/STTR	**0**	**1,117**	**1,538**

In FY 2008, $911,000 and $109,000 were transferred to the SBIR and STTR programs respectively. The FY 2009 and 2010 amounts shown are estimated requirements for the continuation of the SBIR and STTR program.

Total, Materials Technology	**38,616**	**39,903**	**54,905**

Explanation of Funding Changes

	FY 2010 vs. FY 2009 ($000)
Propulsion Materials Technology	
The additional funds will be used to expand laboratory R&D in the areas of biofuels materials compatibility and high efficiency electric motor magnetic materials. The biofuels efforts will expand and accelerate efforts to mitigate interactions identified between biofuels and engine materials that impact the reliability of those systems. These efforts will be coordinated with OEMs, component suppliers, and other programs to ensure efficient technology transfer. A magnetic materials effort will be initiated to develop non-rare earth magnets for high efficiency electric motors. This work represents a critical issue for competitive production of domestic hybrid electric vehicles and will be conducted in concert with other programs, agencies, and industry partners to accelerate the market penetration of devices using these materials.	+2,924
Lightweight Materials Technology	
The increase will fund new development and demonstrations at pilot-scale of technologies for reducing the effective costs of automotive aluminum, magnesium, carbon-fiber and carbon-fiber composites and components and structures made from these materials.	+11,665
High Temperature Materials Laboratory	
No significant change.	-8
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.	+421
Total Funding Change, Materials Technology	**+15,002**

Fuels Technology
Funding Schedule by Activity

	(dollars in thousands)		
	FY 2008	FY 2009	FY 2010
Fuels Technology			
Advanced Petroleum Based Fuels (APBF)	6,466	5,808	6,780
Non-Petroleum Based Fuels and Lubricants (NPBFL)	10,910	13,751	17,639
SBIR/STTR	— [a]	563	703
Total, Fuels Technology	17,376	20,122	25,122

Description

The Fuels Technology subprogram supports R&D that will provide vehicle users with cost-competitive fuel options that enable high fuel economy with low emissions, and contribute to petroleum displacement. Tightening emissions standards present a challenge to advanced engine technologies which, even now, are more sensitive to variations in fuel composition than earlier engines. Different fuels meeting the same specifications can have widely varying impact on engine performance and emissions. This trend is likely to be accentuated as technology advances and emissions standards become progressively more stringent. Future refinery feedstocks may increasingly be from non-conventional sources including, but not limited to, oil sands, shale oil, and tar sands. The impact of changes in refinery feedstocks on finished fuels is an area of relatively new concern to engine manufacturers, regulators and users. Balance of refinery feedstocks also has to be considered to ensure that the slate of refining products matches end-use needs and is efficiently accommodated. In the nearer term, this subprogram addresses technology barriers associated with increased use of biomass-based fuels as blendstocks with conventional fuels.

Benefits

This subprogram supports the mission of the VT Program to develop more energy-efficient and environmentally-friendly highway transportation vehicles that enable America to use less petroleum. It consists of two activities, Advanced Petroleum-Based Fuels (APBF) and Non-Petroleum-Based Fuels and Lubricants (NPBFL). These activities have been coordinated with, and are supportive of, EPA’s fuels and emissions related activities.

The APBF and NPBFL activities are undertaken: (1) to enable advanced combustion regime engines and emission control systems to be more efficient while meeting future emission standards; and (2) to reduce reliance on petroleum-based fuels through direct fuel substitution by non-petroleum-based fuels. To differentiate these two activities, an advanced petroleum-based fuel is envisioned as consisting primarily of highly-refined, petroleum-derived base fuel comprising a likely-future mix of refinery feedstocks, possibly blended with performance-enhancing non-petroleum components derived from renewable resources such as biomass, or from non-petroleum or non-conventional fossil resources such as natural gas or coal. In contrast, a non-petroleum-based fuel consists of components derived primarily from non-crude-oil sources, such as agricultural products or other biomass. The APBF activity represents the

[a] SBIR/STTR funding was transferred to the Science Appropriation in FY 2008.

harmonization of the fuel requirements of advanced engine and vehicle manufacturers with the product specifications of future refineries. The additional benefit of NPBFL is that it will provide non-petroleum-based blendstock specifications to enable both high fuel economy and direct displacement of petroleum fuels.

Detailed Justification

(dollars in thousands)

	FY 2008	FY 2009	FY 2010
Advanced Petroleum Based Fuels (APBF)	**6,466**	**5,808**	**6,780**

The APBF activity develops petroleum-based fuels and lubricants that will enable extremely high efficiency engines for passenger and commercial vehicle applications. This effort employs the expertise and shared funding of the Federal government, energy companies, emission control manufacturers, and engine and vehicle manufacturers. The main goal is to identify and exploit fuel properties that can enable engines to operate in the highest-efficiency mode while meeting future emissions standards and to expand the operating conditions in which maximum efficiency is achievable. These activities are undertaken in close coordination with the Advanced Combustion Engine R&D subprogram.

In FY 2010, APBF will continue to study the effects of physical and chemical property variation in petroleum-based fuels on the performance and emissions of advanced combustion engines, in cooperation with the Advanced Combustion Engine subprogram.

Also in FY 2010, APBF will continue to monitor data in the open literature and within the VT technology portfolio resulting from use of fuels developed under the Fuels for Advanced Combustion Engines (FACE) activity to determine whether FACE fuels matrices require parametric revision based on FY 2009 data.

Also in FY 2010, APBF will initiate analysis of the flexibility of the U.S. petroleum fuel production, distribution, and retailing infrastructure with respect to changes in physical and chemical properties of gasoline and diesel fuel for transportation use and other petroleum-based products and fuels. This activity will begin with a broad literature review and research survey that includes input from the industries impacted. Affected industry participants and relevant issues will be identified through a series of technical workshops. In addition, these funds will support efforts such as peer reviews; data collection and dissemination; and technical, market, economic, and other analyses.

Non-Petroleum Based Fuels and Lubricants (NPBFL)	**10,910**	**13,751**	**17,639**

The NPBFL activity formulates and evaluates non-petroleum-based fuels and lubricants that can be used as neat (pure) alternative fuels or as blendstocks in transportation fuels. With a primary focus on biomass-based renewable and synthetic fuels, 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.

In FY 2010, the activity will continue studies of the effects of physical and chemical property variation in synthetic and renewable fuels on the performance and emissions of advanced combustion engines, in cooperation with the Advanced Combustion Engine subprogram. The activity also will continue to

	(dollars in thousands)	
FY 2008	FY 2009	FY 2010

monitor data in the open literature and within the VT technology portfolio on testing with FACE fuel formulations to determine whether the non-petroleum-containing FACE fuels within the matrices require parametric revision based on FY 2008 data.

In addition, the activity will:

- Complete work on ethanol-optimized engines aimed at minimizing the ethanol MPG efficiency penalty for second generation flexible-fuel vehicles (FFVs), so project partners can accelerate market introduction of improved engine & vehicle systems for renewable fuels.
- Continue testing intermediate ethanol blends (between 10 percent and 50 percent) to determine impact on emissions, fuel-system materials, control systems, operability, and durability of emission-control systems for automotive and non-road engines, and related fueling station components (in cooperation with EPA, the automotive industry, the non-road engine industry, and fuel providers). This work will help identify critical technical and safety issues that must be addressed before ethanol based fuels can be introduced in significant volumes to broader engine and vehicle markets; and
- Continue monitoring fuel quality and utilization for biomass-derived diesel fuels.
- Expand studies of the next generation of biomass-derived transportation fuels. Such fuels are more compatible with existing fuel production, distribution, and fueling infrastructure than the current generation of fuels (e.g., starch-derived ethanol and ester-type biodiesels). They enable a more-efficient use of current biomass feedstock resources and expand the potential resource base beyond starches and food oils. They are also more familiar from the perspective of consumers and therefore less likely to fail due to a lack of customer acceptance or poor compatibility with existing vehicles. Finally, many potential next generation biofuels have a vastly-better GHG profile than the current generation of biofuels. A comprehensive R&D and testing program will be developed to fully evaluate these fuels in cooperation with industry and other stakeholders.

In addition, these funds will support efforts such as peer reviews; data collection and dissemination; and technical, market, economic, and other analyses.

SBIR/STTR	**0**	**563**	**703**

In FY 2008, $411,000 and $49,000 were transferred to the SBIR and STTR programs respectively. The FY 2009 and 2010 amounts shown are estimated requirements for the continuation of the SBIR and STTR program.

Total, Fuels Technology	**17,376**	**20,122**	**25,122**

Explanation of Funding Changes

	FY 2010 vs. FY 2009 ($000)
Advanced Petroleum Based Fuels (APBF)	
The increased funding will allow initiation of a petroleum product infrastructure flexibility analysis.	+972
Non-Petroleum Based Fuels (NPBF)	
In FY 2010, NPBF will continue studies of the effects of physical and chemical property variation in synthetic and renewable fuels on the performance and emissions of advanced combustion engines, in cooperation with the Advanced Combustion Engine subprogram. The increase in this area reflects increased emphasis on the evaluation of intermediate blends of ethanol and renewed efforts to optimize the performance of engines and vehicle systems that use non-petroleum-based alternative fuels. The increase will also initiate evaluation of the next generation of biomass-derived fuels for diesel and gasoline vehicles.	+3,888
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.	+140
Total Funding Change, Fuels Technology	**+5,000**

Technology Integration
Funding Schedule by Activity
(Non-Comparable, or as-Appropriated, Structure)

	(dollars in thousands)		
	FY 2008	FY 2009	FY 2010
Technology Integration			
Graduate Automotive Technology Education (GATE)	496	950	1,000
Advanced Vehicle Competitions	1,387	1,750	2,000
Education	—	4,200[a]	—[b]
Safety and Code and Standards	—	12,238[c]	—[d]
Legislative and Rulemaking	1,986	1,804	2,004
Vehicle Technologies Deployment	12,481	25,000	25,510
Biennial Peer Reviews	495	500	500
SBIR/STTR	—[e]	262	0
Total, Technology Integration	16,845	46,704	31,014

[a] In FY 2009, the Education activity was transferred from the Hydrogen Technology Program (now the Fuel Cell Technologies Program) to the VT Program.
[b] In FY 2010, the Education activity is transferred from the VT Program to the Fuel Cell Technologies Program as part of a reprioritization of fuel cell and hydrogen-related R&D.
[c] In FY 2009, the Safety and Codes & Standards activity was transferred from the Hydrogen Technology Program (now the Fuel Cell Technologies Program) to the VT Program.
[d] In FY 2010, the Safety and Codes & Standards activity is transferred from the VT Program to the Fuel Cell Technologies Program as part of a reprioritization of fuel cell and hydrogen-related R&D.
[e] SBIR/STTR funding was transferred to the Science Appropriation in FY 2008.

Technology Integration
Funding Schedule by Activity
(Comparable Structure to the FY 2010 Request)

(dollars in thousands)

	FY 2008	FY 2009	FY 2010
Technology Integration			
Graduate Automotive Technology Education (GATE)	496	950	1,000
Advanced Vehicle Competitions	1,387	1,750	2,000
Education	—	*4,200*[a]	—
Safety and Code and Standards	—	*12,238*[b]	—
Legislative and Rulemaking	1,986	1,804	2,004
Vehicle Technologies Deployment	12,481	25,000	25,510
Biennial Peer Reviews	495	500	500
SBIR/STTR	—[c]	0	0
Total, Technology Integration	16,845	30,004	31,014

Description

Modifications were made to the budget structure to better reflect the Technology Integration subprogram's activities in FY 2010. The two tables above show a non-comparable and comparable funding profile for the subprogram. The non-comparable table presents the FY 2010 funding in the new budget structure only and FY 2008 and FY 2009 funding is shown as appropriated. The comparable table shows the FY 2008 and FY 2009 funding in the new budget structure to assist in comparing year-to-year funding trends.

The Technology Integration subprogram accelerates the adoption and use of alternative fuel and advanced technology vehicles, including fuel cell vehicles, to help meet national energy and environmental goals and accelerate dissemination of advanced vehicle technologies through demonstrations and education. These efforts follow successful research by industry and government and help to accelerate the commercialization and/or widespread adoption of technologies that are developed in other VT program areas. Deployment activities linked to R&D also provide early market feedback to emerging R&D.

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. The VT Program 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

[a] In FY 2009, the Education activity was transferred from the Hydrogen Technology Program (now the Fuel Cell Technologies Program) to the VT Program.
[b] In FY 2009, the Safety and Codes & Standards activity was transferred from the Hydrogen Technology Program (now the Fuel Cell Technologies Program) to the VT Program.
[c] SBIR/STTR funding was transferred to the Science Appropriation in FY 2008.

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.

The Education activity aids in overcoming institutional barriers to widespread use of advanced vehicle technologies and alternative fuels. Activities such as the Advanced Vehicle Competitions and 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 market place. The GATE effort also supports a pipeline into the auto industry of new engineers familiar with the most advanced technologies. In addition, unlike other more familiar alternative fuels and technologies, low awareness and false perceptions about safety risks of hydrogen threaten the success of demonstration projects and future commercialization. Education can overcome these significant challenges by training critical needs personnel, making available objective and technically-accurate information to decision-makers at the state and local levels, and building public confidence in the safe use of hydrogen and fuel cells, as well as other alternative fuels and advanced vehicle technologies.

Wide acceptance of hydrogen and other alternative fuel technologies depends on meeting safety standards in which the public has confidence. The Safety and Codes & Standards activity supports the establishment of a global technical regulation for hydrogen and fuel cell vehicles and infrastructure needed to allow the technologies to compete in a global market. To do this, the Safety and Codes & Standards activity funds research to provide the technical data on hydrogen technologies (such as fuel cells and hydrogen production, storage, and distribution systems) and other alternative fuels necessary to support and inform the codes and standards development process. Work includes fundamental studies to determine the flammability, explosive, reactive, and dispersion properties of hydrogen and other alternative fuels, and testing of components, subsystems, and systems to check design practices and verify failure-mode prediction analysis. The technical data obtained from these activities is provided to the appropriate codes and standards developing organizations (e.g., International Code Council, National Fire Protection Association) to write and publish applicable codes and standards. The subprogram will also support the development of passive and active safety systems based on new sensor technologies, and will fund comprehensive safety analysis of hydrogen components and systems.

The Legislative and Rulemaking activity implements a variety of statutory responsibilities placed on DOE by EPAct 2005 and other legislation. The main responsibilities include oversight and regulation of the requirements for States and alternative-fuel providers to operate AFV vehicle fleets.

Benefits

The Technology Integration subprogram contributes directly to the VT Program's climate benefits by accelerating the movement of advanced technologies into widespread usage. 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. Applied R&D benefits are not parsed to individual subprograms because of the interdependency of the research, development and technologies within the program. The VT Program 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 2008	FY 2009	FY 2010
Graduate Automotive Technology Education (GATE)	**496**	**950**	**1,000**

In FY 2010, this activity will fund GATE Centers of Excellence (competitively selected) to develop new curricula and provide research fellowships for approximately 30 students for research in advanced automotive 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.

Advanced Vehicle Competitions	**1,387**	**1,750**	**2,000**

In FY 2010, the Advanced Vehicle Competitions activity will conduct the second year of EcoCAR: the NeXt Challenge. Seventeen universities from North America are competing in EcoCAR to integrate advanced vehicle technologies (including fuel cells and PHEVs) and appropriate fuels to develop an approach that minimizes use of petroleum fuel. Many students who graduate from these vehicle competitions and from the GATE Program go on to jobs in the auto industry where they bring an unprecedented appreciation and understanding of advanced automotive efficiency technologies. In FY 2010 the program will also initiate planning for a follow-on advanced vehicle competition. 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.

Education	**—**	***4,200***	**—**

In FY 2010, the Education activity is transferred from the VT Program to the Fuel Cell Technologies Program as part of a reprioritization of fuel cell and hydrogen-related work. In FY 2009, the Education activity is collaborating with Safety and Codes and Standards (also transferred to the Fuel Cell Technologies Program in FY 2010) to provide training for first responders and code officials to facilitate the approval and implementation of hydrogen and alternative fuel vehicle and refueling projects. Key target groups include fire-fighters and fire department training coordinators, law enforcement personnel, and emergency medical technicians, as well as code officials, fire marshals, city planners, and other hydrogen users.

Safety and Codes & Standards	**—**	**12,238**	**—**

In FY 2010 the Safety and Codes & Standards activity is transferred from the Vehicle Technologies Program to the Fuel Cell Technologies Program as part of a reprioritization of fuel cell and hydrogen-related work. The activity provides the underlying research to enable the development of technically sound codes and standards for the safe use of alternative fuels (including hydrogen) in all applications. The effort also supports the development of a global technical regulation (GTR) for hydrogen fuel cell vehicles. Global consistency in standards will ensure that different technologies need not be developed for each region of the world. The drafting and adoption of alternative fuel codes and standards is supported through the development of alternative fuel characterization and behavior data and through limited direct support of Standards Development Organizations (SDOs) and Codes Development Organizations (CDOs). Alternative fuel release data and incident scenario analysis supports a quantitative risk assessment approach for codes and standards development activities focused on enabling technology readiness. DOE collaborates with DOT, EPA, NIST and other government agencies to ensure that vehicle and fuel standards development proceeds in

	(dollars in thousands)		
	FY 2008	FY 2009	FY 2010

agreement with existing regulatory authorities. The cooperating agencies maximize available resources and expertise in areas such as alternative fuel vehicle dispensing measurement (NIST), vehicle safety (DOT National Highway Traffic Safety Administration) and international standards development (DOT, EPA).

Legislative and Rulemaking	**1,986**	**1,804**	**2,004**

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 the impacts from 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 also 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.

Vehicle Technologies Deployment	**12,481**	**25,000**	**25,510**

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: AFVs, alternative fuel infrastructure development, idling reduction for commercial trucks and buses, expanded use of non-petroleum and renewable fuel blends, 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 also will 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 (transit, refuse trucks, school bus, delivery trucks, municipal fleets, etc.).

In support of the National Energy Policy, Section 405 of EPAct 1992, and Sections 721, 1001, and 1004 of EPAct 2005 that direct DOE to expand consumer education, to promote technology transfer, and to address implementation barriers, the program 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 ethanol 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 www.fueleconomy.gov website also 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.

	(dollars in thousands)		
	FY 2008	FY 2009	FY 2010
Biennial Peer Reviews	**495**	**500**	**500**

Funding is used to conduct biennial reviews of the FreedomCAR and Fuel Partnership and the 21st Century Truck Partnership by an independent third party, such as the National Academy of Sciences/National Academy of Engineering, to evaluate progress and program direction. Reviews will include evaluation of progress toward achieving the technical and program goals supporting each partnership, as well as an assessment of the appropriateness of Federal investment in each of the activities. The FreedomCAR and Fuel Partnership review to be held in FY 2010 will address relevant elements of the VT Program. Based on evaluations, resource availability, and other factors, the partners will consider new opportunities, make adjustments to technology specific targets, and set goals as appropriate.

SBIR/STTR	**—**	**262**	**0**

In FY 2008, no funding was transferred to the SBIR and STTR programs respectively. The FY 2009 and 2010 amounts shown are estimated requirements for the continuation of the SBIR and STTR program.

Total, Technology Integration	**16,845**	**46,704**	**31,014**

Explanation of Funding Changes

	FY 2010 vs. FY 2009 ($000)
Graduate Automotive Technology Education	
No significant change.	+50
Advanced Vehicle Competitions	
Funding for EcoCAR: the NeXt Challenge was increased in FY 2010 to sustain the activity at planned levels.	+250
Education	
This activity is transferred from the VT Program to the Fuel Cell Technologies Program as part of a reprioritization of fuel cell and hydrogen-related work.	-4,200
Safety and Codes and Standards	
This activity is transferred from the VT Program to the Fuel Cell Technologies Program as part of a reprioritization of fuel cell and hydrogen-related work.	-12,238
Legislative and Rulemaking	
Increased funding will maintain effort at levels consistent with the needs of EPAct and EISA.	+200

	FY 2010 vs. FY 2009 ($000)
Vehicle Technology Deployment	
Increased funding will be used to expand efforts in consumer awareness, education, and outreach to be performed in cooperation with the private sector.	+510
Biennial Peer Reviews	
No change.	0
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.	-262
Total Funding Change, Technology Integration	**-15,690**

Building Technologies
Funding Profile by Subprogram

	FY 2008 Current Appropriation[a]	FY 2009 Original Appropriation	FY 2010 Request
Building Technologies			
Residential Buildings Integration	23,725	21,900	40,000
Commercial Buildings Integration	11,891	33,000	40,000
Emerging Technologies	36,546	43,840	92,698
Technology Validation and Market Introduction	13,239	21,260	30,000
Equipment Standards and Analysis	21,981	20,000	35,000
Total, Building Technologies	107,382	140,000	237,698

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 Supply Act" (1987)
P.L. 100-357, "National Appliance Energy Supply Amendments" (1988)
P.L. 100-615, "Federal Energy Management Improvement Act" (1988)
P.L. 102-486, "Energy Policy Act" (1992)
P.L. 109-58, "Energy Policy Act of 2005" (2005)
P.L. 110-140, "Energy Independence and Security Act of 2007" (2007)

Mission

The mission of the Building Technologies Program (BT) is to provide clean, secure energy by changing the landscape of energy demand and driving energy efficiency to decrease energy use in homes and buildings, which will also lower greenhouse gas (GHG) emissions, foster economic prosperity and increase National energy security. BT brings together science, discovery and innovation to develop the technologies, techniques, and tools for making residential and commercial buildings more energy efficient, productive, and affordable.

Benefits

Buildings account for more than 70 percent of the electric energy consumed in the U.S.[b] BT is aligned with DOE's goal to provide clean, secure energy by developing reliable, affordable, and environmentally sound energy efficiency and renewable energy technologies that significantly reduce the energy consumption of residential and commercial buildings. BT strives to make net zero energy buildings (ZEB) a reality by taking a whole buildings approach through the systems integration of state-

[a] SBIR/STTR funding was transferred to the Science Appropriation in FY 2008, which includes a reduction of $1,443,000 that was transferred to the SBIR program, and $174,000 that was transferred to the STTR program
[b] U.S. DOE Energy Efficiency and Renewable Energy, *2008 Buildings Energy Databook*, September 2008.

of-the art energy efficient construction and appliances with commercially available renewable energy systems.

The program pursues its mission through complementary activities designed to improve the energy efficiency of buildings. These activities include Research and Development (R&D), Equipment Standards and Analysis, and Technology Validation and Market Introduction (TVMI). R&D activities research the most advanced energy efficiency technologies. Equipment Standards and Analysis activities eliminate the most inefficient existing technologies in the market by establishing new – and improving – existing energy efficiency standards. TVMI activities catalyze the introduction of new advanced technologies and the widespread use of highly efficient technologies already in the market.

In addition, BT's progress depends upon the coordination of other EERE program efforts. To achieve ZEB, the Solar Buildings Initiative will have to accelerate the R&D and large scale commercialization of distributed photovoltaic (PV) technology for buildings. The Weatherization and Intergovernmental Program (WIP) will provide consumers and decision makers with information on cost, performance, and financing of energy efficiency projects. The Federal Energy Management Program (FEMP) will promote energy efficiency at Federal facilities.

Climate Change

The U.S. building sector is responsible for 38 percent of total U.S. carbon dioxide emission.[a] BT contributes to the reduction of GHG by providing technologies that, when commercialized, will make the Nation's buildings more energy efficient. The efficiency gains from these advanced technologies will be integrated with renewable energy technologies to not only reduce buildings' overall energy demand but also reduce their consumption of electricity generated from fossil fuels. The use of energy efficient components and whole-building (systems integrated) design strategies will eventually permit carbon neutral buildings to become an everyday reality while keeping net costs of new components at the same level as existing technology. Achievement of program goals could result in the cumulative reduction of CO_2 emissions by 5 gigatons of CO_2 by 2030 and more than 18 gigatons of CO_2 by 2050.

Energy Security

By utilizing advanced efficiency technologies, oil use can be reduced, making the Nation less vulnerable to oil supply disruptions or price spikes. R&D activities in advanced envelope and windows technologies subprograms reduce heating loads in buildings, and space heating accounts for the primary end use of energy in homes. In certain regions of the U.S., homes are heated exclusively by petroleum derivatives.[b] By reducing their heating load, reducing demand through efficiency, and replacing petroleum with renewables as the source of space heat, BT reduces domestic dependence on petroleum.

Achievement of the program's goals is expected to displace 0.4 million barrels of imported oil in 2030 and 1.5 million barrels in 2050, based on energy-economy models. This displacement will yield energy security benefits by diversifying the energy base, making the economy and the American consumer more resilient to price and supply shocks by decentralizing a part of energy supply as consumers begin generating a greater percentage of electricity and heat on site via renewables. This will in turn, lower GHG, provide clean, secure energy, and stimulate economic prosperity.

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[a] U.S. DOE Energy Efficiency and Renewable Energy, *2008 Buildings Energy Databook*, September 2008.
[b] Ibid.

Economic Impacts

Reduced energy use in buildings can be expected to lead to reduced energy bills for American families and businesses. New technologies developed with the help of BT and manufactured by domestic industry will create jobs, spur economic growth, and restore 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. 'Nega-watts' will save power companies money, and these savings will flow through directly to electricity consumers. Savings experienced by power companies might also be spent modernizing the electric grid and on other needed energy infrastructure investments.

Achieving BT's goals of reducing the cost of advanced building technologies and homeowner energy bills will permit consumers to spend these saved dollars elsewhere, stimulating other parts of the economy and could result in cumulative net consumer savings of nearly $450 billion by 2030 and nearly $3.4 trillion by 2050. In addition, cumulative savings to the electric power industry are expected to be over $300 billion by 2030 and over $1 trillion by 2050.

The proposed FY 2010 Budget investments complement funds provided by the Recovery Act which support the development of advanced building technologies and deployment mechanisms to accelerate progress on achieving zero energy homes (ZEH) and ZEB construction goals, as well as initiate an aggressive effort to address the substantial energy savings in new and existing buildings. To enable decision makers and the public to follow performance and plans, the program will post its progress in these planned activities at: http://www.energy.gov/recovery/index.htm.

The primary benefits table below shows the primary estimated strategic security, economic and environmental benefits and supporting metrics from 2015 through 2050 that would result from realization of the program's goals. These benefits are achieved by targeted Federal investments in technology research and development in partnership with equipment manufacturers and equipment suppliers, energy companies, other Federal agencies, State government agencies, universities, National Laboratories, and other stakeholders. These partnerships facilitate the technical coordination of activities and attract cost sharing to provide leveraged benefits.

The benefits table also reflects the increasing penetration of the program's technologies over time, as BT's goals are met. Not included are any policies, regulatory mechanisms, or other incentives not already in existence that might be expected to support or accelerate the achievement of the program goals. The expected benefits reflect solely the achievement of the BT's goals. A more detailed summary of the quantified primary benefits appears below.

Primary Metrics for FY 2010 Budget Request
(Incorporates Approximate Impacts of EISA 2007)

	Metric[1]	Model	Year			
			2015	2020	2030	2050
Energy Security	Oil Imports Reduction, cumulative[2] (Bil bbl)	NEMS	ns	0.1	0.4	N/A
		MARKAL	0.1	0.2	0.4	1.5
	Natural Gas Imports Reduction, cumulative (Tcf)	NEMS	0.8	2.4	7.3	N/A
		MARKAL	2.7	8.0	22.5	65.6
	Reduction in Share of Highway Fuel Demand Derived from Crude Oil[3] (%)	NEMS	ns	ns	ns	N/A
		MARKAL	ns	ns	ns	ns
Environmental Impacts	CO_2 Emissions Reduction, cumulative (Mil mtCO_2)	NEMS	326	1258	5193	N/A
		MARKAL	292	999	4787	18919
	SO_2 Allowance Price Reduction[4] ($/ton)	NEMS	ns	ns	ns	N/A
		MARKAL	N/A	N/A	N/A	N/A
	NO_x Allowance Price Reduction ($/ton)	NEMS	ns	1420	1827	N/A
		MARKAL	N/A	N/A	N/A	N/A
	Hg Allowance Price Reduction (thousand $/lb)	NEMS	ns	ns	ns	N/A
		MARKAL	N/A	N/A	N/A	N/A
Economic Impacts	Consumer Savings, cumulative[5] (Bil $)	NEMS	53	148	439	N/A
		MARKAL	140	404	1250	3417
	Electric Power Industry Savings, cumulative (Bil $)	NEMS	42	118	338	N/A
		MARKAL	32	113	392	1050
	Household Energy Expenditures Reduction ($/household/yr)	NEMS	70	120	240	N/A
		MARKAL	143	254	447	577

1. "Reductions" and "savings" are calculated as the difference between results from the baseline case (i.e. no DOE technology) and the technology case (i.e. all DOE technology R&D programs are successful).
2. All cumulative metrics are based on results beginning in 2010.
3. Metric includes oil-derived fuel use by light-duty vehicles, commercial light trucks and freight trucks; the metric excludes buses. Reported oil use is adjusted to exclude ethanol, biodiesel and CTL.
4. All monetary metrics are in 2006$.
5. Cumulative monetary metrics are in 2006$ that are discounted to 2010 using a 3% discount rate.

ns - Not significant
NA - Not yet available
N/A - Not applicable

Secondary Metrics for FY 2010 Budget Request

(Incorporates Approximate Impacts of EISA 2007)

	Metric[1]	Model	Year 2015	Year 2020	Year 2030	Year 2050
Energy Security	Oil Imports Reduction, annual (Mbpd)	NEMS	ns	0.1	0.1	N/A
		MARKAL	ns	0.1	0.1	0.2
	Natural Gas Imports Reduction, annual (Tcf)	NEMS	0.2	0.4	0.6	N/A
		MARKAL	0.8	1.2	1.6	2.6
	MPG Improvement[2] (%)	NEMS	ns	ns	ns	N/A
		MARKAL	ns	ns	ns	ns
Environmental Impacts	CO_2 Intensity Reduction of US Economy (Kg CO2/$GDP)	NEMS	ns	0.02	0.02	N/A
		MARKAL	ns	0.01	0.03	0.02
	CO_2 Intensity Reduction of US Power Sector[3] (Kg CO2/kWh)	NEMS	ns	ns	ns	N/A
		MARKAL	ns	ns	ns	ns
	CO_2 Intensity Reduction of US Transportation Sector[4] (Kg CO2/mile)	NEMS	ns	ns	ns	N/A
		MARKAL	ns	ns	ns	ns
Economic Impacts	Consumer Savings, annual[5] (Bil $)	NEMS	17	32	69	N/A
		MARKAL	40	89	180	322
	Electric Power Industry Savings, annual (Bil $)	NEMS	14	25	47	N/A
		MARKAL	10	29	59	100
	Energy Intensity of US Economy (energy/$GDP)	NEMS	0.10	0.20	0.30	N/A
		MARKAL	0.11	0.20	0.35	0.30
	Net Energy System Cost Reduction, cumulative (Bil $)	NEMS	N/A	N/A	N/A	N/A
		MARKAL	585	1419	3479	7514

1. "Reductions" and "savings" are calculated as the difference between results from the baseline case (i.e. no DOE technology) and the technology case (i.e. all DOE technology R&D programs are successful).
2. Change in light duty vehicles miles traveled per gallon of oil, where oil is only that derived from petroleum.
3. Emissions include all power sector emissions. Generation calculated as total net generation adjusted for estimated T&D losses.
4. Emissions calculated using highway fuel use and related carbon emission factor. Miles calculated as highway miles traveled, excluding buses.
5. All monetary metrics are in 2006$.
ns - Not significant
NA - Not yet available
N/A - Not applicable

The following external factors could affect Building Technologies' ability to achieve its strategic goal:

- <u>Fragmented construction market.</u> There are several factors that can hinder the private sector making R&D investments in energy efficient building technologies. These include a highly diversified industry comprised of thousands of builders and manufacturers, none of which has the capacity to sustain research and development activities over multi-year periods.

- Communication between professional groups. The compartmentalization of the building professions, in which architects and designers, developers, construction companies, engineering firms, and energy services providers do not typically apply integrated strategies for siting, construction, operations and maintenance.[a]
- Upfront costs. The high initial cost of energy efficient building appliances can keep consumers from purchasing them even if they are cost effective in the long run.
- Housing market. Conditions in the housing market that would affect the number of new subdivisions being built would slow down research on ZEB. The last phase of research is having a builder construct a subdivision using technologies developed by BT in order to prove them in a real world setting. If fewer subdivisions are being constructed by more risk-adverse contractors, it could slow BT's research considerably.
- Unit price of renewable energy. ZEB goals are contingent upon the development of cost effective small scale renewable energy systems.

Contribution to the Secretary's Priorities

The BT Program contributes to the Secretary's priorities focusing on clean, secure energy by changing the landscape of energy demand and driving energy efficiency to decrease energy use in homes and buildings. By bringing together science, discovery, and innovation the gains achieved by BT, U.S. buildings will be significantly more efficient, productive, and affordable.

Priority 1: Science and Discovery – Invest in science to achieve transformational discoveries

The BT program connects basic and applied sciences by developing the next generation of highly efficient technologies and practices for both residential and commercial buildings through Emerging Technologies R&D activities. In addition, BT aims to create an effective mechanism to integrate National Laboratory, university, and industry activities through public/private alliances, cost share, and technical advisory efforts through BT R&D activities.

BT partners globally by providing technical R&D support to the International Energy Agency (IEA) and coordinating U.S. industry support, while also building research networks across departments, government, Nations and the globe, such as the ENERGY STAR® activity in partnership with the U.S. Environmental Protection Agency (EPA).

Priority 2: Clean, Secure Energy – Change the landscape of energy demand and supply

BT encourages technology and business model innovation by creating incentives for industry through the Builders' Challenge and motivating builders to build high performance homes. In addition, BT creates vehicles for novel government/university and industrial collaborations and intellectual property models for development, commercialization and deployment of efficient energy-using technologies and systems through zero energy buildings R&D. BT works to change behavior to "waste not, want not" via outreach efforts, marketing campaigns, green branding via the ENERGY STAR campaigns such as the Change a Light, Change the World or BT's work mobilizing a greening effort in the U.S. military through Operation Change Out.

Priority 3: Economic Prosperity – Create millions of green jobs and increase competitiveness

BT utilizes research on ventilation, controls, and lighting to reduce energy consumption in homes and commercial building to reduce energy demand. In addition, BT improves existing buildings through energy efficiency upgrades by investing in building component R&D to address the unrealized

[a] Scott Hassell, Anny Wong, Ari Houser, Debra Knopman, Mark Bernstein, RAND Corporation: *Building Better Homes: Government Strategies for Promoting Innovation in Housing, 2003*.

efficiency gains in America's stock of existing homes and buildings. BT will contribute to the development of America's new green workforce by training builders, home auditors, architects, engineers and others around the country to help the American middle class retrofit their homes through the Home Performance with ENERGY STAR activities.

Priority 5: Lower GHG Emissions – Position U.S. to lead on climate change policy, technology and science

BT is working to produce development and deployment pathways that will provide technologies that will reduce energy consumption in the U.S., permitting America to set a high standard on global environmental issues and lead by example. In addition, BT supports developing world clean energy by reducing energy consumption in the U.S. through R&D and deployment of energy efficient technologies in buildings, providing a source of clean, secure energy.

Contribution to GPRA Unit Program Goal 1.4.20.00

BT contributes to the following GPRA goal:

GPRA Unit Program Goal 1.4.20.00: Building Technologies - The BT program goal is to develop cost effective tools, techniques and integrated technologies, systems and designs for buildings that generate and use energy so efficiently that buildings are capable of generating as much energy as they consume.

Key technology pathways that contribute to achievement of the goal include:

- Residential Buildings Integration R&D Activities: Provide the energy technologies and solutions that will catalyze a 70 percent reduction in energy use of new prototype residential buildings that when combined with onsite energy technologies result in Zero Energy Homes by 2020, and when adapted to existing homes results in a significant reduction in their energy use. By 2010, develop, document and disseminate five cost effective technology packages that achieve an average of 40 percent reduction in whole house energy use.
- Commercial Buildings Integration R&D Activities: By 2010, collaborate with industry to 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 (12 packages) or 50 percent (4 packages) reduction in purchased energy use in new, small to medium-sized commercial buildings relative to the American Society of Heating, Refrigerating, and Air-Conditioning Engineer (ASHRAE) 90.1-2004 standards.
- Emerging Technologies Activities: Develop the next generation of highly efficient technologies and practices for both residential and commercial buildings. The emerging technologies activities support BT goals through R&D of advanced lighting, building envelope, windows, space conditioning, water heating and appliance technologies and analysis tools. In the area of Solid State Lighting (SSL), the goal is to achieve lighting technologies with double the efficiency of today's most efficient lighting sources. The goal of ZEB will not be met without advanced components and subsystems developed in the Emerging Technologies activities.
- Technology Validation and Market Introduction: Accelerate the adoption of clean and efficient domestic energy technologies through activities such as Rebuild America, ENERGY STAR and Building Energy Codes. By 2010, achieve market penetration target for ENERGY STAR-labeled windows of 20 percent (40 percent, 2003 baseline), 13 percent for CFLs (2 percent, 2003 baseline) and 33 percent (30 percent, 2003 baseline) for ENERGY STAR appliances. Rebuild America activities will work to remove technical, financial and institutional barriers to the widespread awareness, availability, and application of highly efficient building techniques including building design, construction, retrofit and operations practices. Building Energy Code activities will support

the development and adaptation of improved building energy codes that are 30 percent more efficient than the 2004 codes, which increases the energy efficiency of new and renovated buildings.

- Equipment Standards and Analysis: Increase minimum efficiency levels of buildings and equipment through standards that are technologically feasible, economically justified, and save significant energy. By 2010, issue 14 to 17 formal proposals, in accordance with legal mandates, for enhanced product standards and test procedures. By 2011, complete one rulemaking for every product in the backlog. Performance indicators include product standards and test procedures proposed/issued that will result in more efficient buildings energy use.

Means and Strategies

The BT program will use various means and strategies, as described below, to achieve its GPRA Unit Program goal. "Means" include operational processes, resources, information, and the development of technologies, and "strategies" include program, policy, management and legislative initiatives and approaches. Collaborations are integral to the planned investments, means and strategies, and to addressing external factors.

The Building Technologies Program will implement the following means:

The Residential Buildings Integration activity focuses on improving the efficiency of the approximately 1.5 to 2.0 million new homes built each year and 100+ million existing homes. These improvements are accomplished via RD&D and technology transfer activities. Overall, the program seeks to make improvements through the application of a systems engineering approach to optimize the technologies in whole buildings and concurrently ensure the health and safety of the buildings in addition to integrating renewable technologies into buildings;

The Commercial Buildings Integration activity addresses energy savings opportunities in new and existing commercial buildings ($307.1 billion spent annually for new building construction and over $190.5 billion for renovation in 2006[a]). This includes RD&D of whole building technologies, such as sensors and controls, design methods and operational practices. These efforts support the ZEB goal not only by reducing building energy needs, but also by developing design methods and operating strategies which seamlessly incorporate solar and other renewable technologies into commercial buildings;

The Emerging Technologies activity conducts R&D and technology transfer associated with energy-efficient products and technologies for both residential and commercial buildings. These efforts address high-impact opportunities within building components, such as lighting, building envelope technologies (including advanced windows), solar heating and cooling (SH&C), and analysis tools;

The Equipment Standards and Analysis activity leads to improved efficiency of appliances and equipment by conducting analyses and developing standards that are technologically feasible and economically justified by the Energy Policy and Conservation Act (EPCA), as amended. Analysis performed under this program will also support related program activities such as ENERGY STAR to ensure a consistent methodology is used in setting efficiency levels for related programs; and

The TVMI activity accelerates the adoption of clean, efficient, and domestic energy technologies. The three major initiatives within are ENERGY STAR, Rebuild America, and Building Energy Codes. ENERGY STAR is a joint DOE/EPA activity designed to identify and promote energy efficient products. Rebuild America is aligned with the Commercial Building Integration R&D activity to accelerate the adoption of advances in integrated commercial building design, software tools, practices and advanced controls, equipment and lighting. The activity will target decision-makers with national

[a] 2008 Buildings Energy Data Book.

and regional market scope such as multi-brand corporations in the retail, lodging, restaurant sectors, commercial property developers, owners, and operators as well as in the school and hospital sector. Building Energy Codes submits code proposals and supports the upgrades of the model building energy codes. The activity also provides technical and financial assistance to States to update, implement, and enforce their energy codes to meet or exceed the model codes, in support of Section 304 of Energy Conservation and Production Act (ECPA). It also promulgates standards for manufactured housing as required by Section 413 of the Energy Independence and Security Act of 2007 (EISA 2007).

BT's challenge is to address the opportunities with apt strategies and design programs that give appropriate consideration to the marketplace and barriers to energy efficiency. To accomplish this, the BT will implement the following strategies:

- Focus the R&D portfolios to ensure that the most promising and revolutionary technologies and techniques are being explored, align the Residential and Commercial Integration activities to a vision of ZEBs, appropriately exit those areas of technology research that are sufficiently mature or proven to the marketplace, and close efforts where investigations prove to be technically or economically infeasible ("off ramps");
- Use a "whole buildings" approach to energy efficiency that takes into account the complex and dynamic interactions between a building and its environment, among a building's energy systems, and between a building and its occupants. BT analysis suggests that this approach has achieved energy savings of 30 percent beyond those obtainable by focusing solely on individual building components, such as energy-efficient windows, lighting, and water heaters;
- Invest in collaborative research with the Solar Energy Program to reduce barriers to the installation and operation of photovoltaic technology on zero energy homes and buildings;
- Develop technologies and strategies to enable effective integration of energy efficiency and renewable energy technologies and practices;
- Increase minimum efficiency levels of buildings and equipment through codes, standards, and guidelines that are technologically feasible and economically justified. BT develops standards through a public process and submits code proposals to International Energy Conservation Code (IECC) and ASHRAE;
- Coordinate with other programs in EERE in support of a management strategy that achieves ZEB. The Solar Energy, Biomass and Biorefinery Systems R&D, Wind Energy, Water Power, Fuel Cell Technologies, FEMP, and WIP programs may have important technologies to contribute. BT also invests in technical program review, market analysis, and performance assessment in order to direct effective strategic planning; and
- Provide technical information to customers through deployment of cost-effective energy technologies, forming partnerships with private and public sector organizations.

These strategies can result in significant cost savings and a dramatic reduction in the consumption of energy, an increase in the substitution of clean and renewable fuels, and can cost effectively reduce demand for energy, thus lowering carbon emissions and decreasing energy expenditures.

In carrying out the program's mission, BT performs the following collaborative activities:

- Partnerships and cost share arrangements with industry and other Federal agencies which act as critical management tools that can build a critical mass to address these barriers. ENERGY STAR is a joint DOE/EPA program (EPAct 2005) with more than 4,000 retailers to label ENERGY STAR qualified appliances and energy efficient products. Rebuild America will partner with decision-makers with national and regional market scope such as multi-brand corporations in the retail, lodging, restaurant sectors, the schools and hospital sector, as well as commercial property developers, owners and operators. DOE coordinates its R&D, regulatory activities, and technology demonstrations with EPA's marketplace activities (http://www.energystar.gov/). Through these activities with EPA, BT contributes to the Administration's objective of reducing GHG emissions;

- In support of EISA 2007, BT is implementing a Commercial Buildings Initiative (CBI) which collaborates with National Laboratories, the private sector, other Federal agencies, and non-governmental organizations to advance high-performance commercial green buildings and produce market-ready commercial ZEB 2025. ZEBs are grid-integrated buildings capable of generating as much energy as they consume by using cutting-edge technologies and on-site generation systems, such as solar power and geothermal energy. In support of CBI, BT has launched programs and initiatives that will produce quick-hitting, practical results, including:
  - Commercial Building Energy Alliances (including retailers, commercial real estate owners, and institutions);
  - National Laboratory Collaborative on Building Technologies; and
  - National Account teams.
- The Building Energy Code activity works with National, regional, and State building code officials and stakeholders to help building owners, builders and the design community understand the science, benefits, and techniques for going significantly beyond code with added value strategies. BT also trains over 10,000 code officials, designers, and builders to implement these codes and updates and improves the core materials and code compliance software to reflect recent changes in the model energy codes and emerging energy efficiency technologies;
- Partners with EERE's Solar Energy Technologies Program to work toward the goal of ZEHs;
- Coordinates with the Office of Science in basic research on SSL technology;
- BT's management strategy involves four key elements: a customer-focused, team-based organization for greater accountability and improved results; systematic multi-year planning including collaboratively developed technology roadmaps to provide for a more integrated, customer driven R&D portfolio; utilization of stage-gate management processes to ensure progress and market relevance; greater competition in project solicitations to increase innovation and broaden research participation; and increased peer review to assure scientifically sound approaches; and
- BT interacts regularly with industry to ensure relevance of research, including R&D workshops (e.g., biennial reviews in solid state lighting and windows research) and peer reviews.

Validation and Verification

To validate and verify program performance, BT will conduct various internal and external reviews and audits. These programmatic activities are subject to continuing review by Congress, the General Accountability Office, the Department's Inspector General, the U.S. EPA, and State environmental agencies. The table below summarizes validation and verification activities.

Data Sources:	Energy Information Agency (EIA) Annual Energy Review (AER); Commercial Building Energy Consumption Survey (CBECS); Residential Energy Consumption Survey (RECS); and Annual Energy Outlook (AEO) ISTAR (ENERGY STAR database). U.S. Department of Commerce (DOC) Current Industrial Reports (CIR). Various trade publications. Information collected directly from BT performers or partners.
Baselines:	The following are key baselines used in the BT program: ▪ New Residential Buildings: Energy use varies by climate region, based on the

Building America Benchmark. The program will focus on creating design technology packages to reduce energy consumption from the Building America Benchmark. In 2003, 0 technology package research reports at 30/50/70 percent energy savings.

- New Commercial Buildings Energy Use Intensity: Varies by climate region and building type (ASHRAE 90.1-2004). The program will focus on creating design technology packages to reduce energy consumption by 30 and 50 percent for small commercial buildings (baseline 1 technology package for 30 percent and 0 technology option sets for 50 percent in 2005).
- Solid State Lighting (2002): 25 lumens/Watt efficacy (solid state lighting white light).
- Windows (2003): 0.33 to 0.75 U-values (varies by region).
- Residential Heating and Cooling (2003): Average total heating and cooling system energy use, defined by reported consumption in EIA for residential buildings and all existing buildings, and the Building America benchmark for new residential buildings, by climate region.
- New Residential Building Codes: 2003 International Energy Conservation Code (IECC), International Code Council.
- New Commercial Building Codes: ASHRAE 90.1-2004.
- ENERGY STAR: Federal appliance minimum standards and applicable national building codes (windows).

Frequency: Complete revalidation of assumptions and results can only take place every three to four years, due to the reporting cycle of two crucial publications: CBECS and RECS. However, updates of most of the baseline forecast and BT outputs will be undertaken annually.

Evaluation: In carrying out its mission, BT uses several forms of evaluation to assess progress and to promote program improvement:

- Technology validation and operational field measurement, as appropriate;
- Peer review by independent outside experts of both the program and subprogram portfolios;
- Annual internal technical and management reviews of program and subprogram portfolios;
- Specialized program evaluation studies to examine process, impacts, or market baseline and effects, as appropriate;
- Quarterly and annual assessment of program and management results based performance through Joule;
- Peer reviews as needed when evaluating go/no go decision points in each research area;
- Annual review of methods, and recomputation of potential benefits for the GPRA; and
- Continue to conduct and build upon the transparent oversight and performance management initiated by Congress and the Administration

Data Storage:	EIA and DOC data sources are publicly available. Trade publications are available on a subscription basis. BT output information is contained in various reports and memoranda.
Verification:	Calculations are based on assumptions of future market status, equipment or technology performance, and market penetration rates. These assumptions can be verified against actual performance through technical reports, market survey and product shipments.

Annual Performance Results and Targets

FY 2005 Results	FY 2006 Results	FY 2007 Results	FY 2008 Targets	FY 2009 Targets	FY 2010 Targets
GPRA Unit Program Goal 1.4.20.00 (Building Technologies)					
Residential Buildings Integration					
Complete the research for production-ready new residential buildings that are 30 percent more efficient than the whole-house Building America benchmark in 2 climate zones and document the results in Technology Package Research Reports. [MET]	Complete system research with lead builders in two climate zones demonstrating production-ready new residential buildings that are 30 percent more efficient than the whole-house Building America benchmark and document the results in Technology Package Research Reports. [MET]	Document in Technology Package Research Reports research results for production ready new residential buildings that are 30 percent more efficient in 1 climate zone and 40 percent more efficient in 1 climate zone than the whole-house Building America benchmark. [MET]	Complete one design technology package for new residential buildings (that is 40 percent more energy efficient relative to the 2004 Building America benchmark) at net zero financed cost to the homeowner for one climate zone. [MET]	Complete one design technology packages for new residential buildings (that are 40 percent more energy efficient relative to the 2004 Building America benchmark) at net zero financed cost to the homeowner for one climate zones.	Complete two design technology packages for new residential buildings (that are 40 percent more energy efficient relative to the 2004 Building America benchmark) at net zero financed cost to the homeowner for two climate zones.
Analyze and develop code change proposals that are expected to result in a cost-effective improvement in energy efficiency in residential buildings of approximately 1-2 percent. [MET]					
Commercial Buildings Integration					
Complete assessments of controls technology, optimization methods and market opportunities, with substantial input from designers and building owners, to establish a framework for development of programmatic pathways to achieve 50 percent or better energy performance in significant numbers of buildings enabling development of design and/or technology packages for new commercial buildings. [MET]	Complete the development of one design technology package to achieve 30 percent or better energy savings, focusing on a single, high priority building type, such as small commercial retail or office buildings, based on the technical and market assessments completed in 2005. [MET]	Complete the development of two new design technology packages for a second small to medium sized commercial building type to achieve 30 percent energy savings over ASHRAE 90.1-2004. . [MET]	Complete four additional design technology packages for new commercial buildings (that achieve 30 percent increase in energy efficiency relative to the ASHRAE 90.1-2004 benchmark) with five year or less payback. These design technology packages will be for small to medium-sized commercial buildings. [MET]	Complete four additional design technology packages for new commercial buildings (that achieve 30 percent increase in energy efficiency relative to the ASHRAE 90.1-2004 benchmark) with five year or less payback.	Complete four design technology packages for new commercial buildings (that achieve at least 50 percent increase in energy efficiency relative to the ASHRAE 90.1-2004 benchmark) with five year or less payback.
Analyze and develop code change proposals that are expected to result in a cost-effective improvement in energy efficiency in commercial buildings of approximately 1-2 percent. [MET]					

FY 2005 Results	FY 2006 Results	FY 2007 Results	FY 2008 Targets	FY 2009 Targets	FY 2010 Targets
Emerging Technologies					
Select five new competitively based research awards for cost-shared research on technology (such as optical materials and device structures) to achieve ≥65 lm/W white light from solid state devices with industry, National Laboratories, and universities. [MET]	Conduct cost-shared, competitively selected research on technology to achieve = 65 1m/W (in a laboratory device) of white light from solid state devices with industry, National Laboratories, and universities. [MET]	Achieve at least 86 lumens per Watt (in a laboratory device) of white light from solid state devices based on cost-shared research which is competitively selected. [MET]	Achieve efficiency of “white light” solid state lighting in a lab device, of at least 101 lumens per Watt. [MET]	Achieve efficiency of “white light” solid state lighting in a lab device, of at least 110 lumens per Watt.	Achieve efficiency of “white light” solid state lighting in a lab device, of at least 113 lumens per Watt.
Complete a prototype dynamic window that will have a Solar Heat Gain Coefficient (SHGC) in the range of 0.05 to 0.60 , while meeting American Society for Testing and Materials (ASTM) durability standards for cycling in a high temperature, high ultraviolet light environment. [MET]					
Complete a thermodynamic study of emerging refrigerants. Based on study results, make go/no-go decision on initiation of first stage development of a laboratory prototype, high efficiency residential 1-ton air-conditioning and heat pump unit that uses a novel approach to the vapor compression refrigeration cycle and has the potential for a Seasonal Energy Efficiency Ratio (SEER) of over 20. [MET]					

FY 2005 Results	FY 2006 Results	FY 2007 Results	FY 2008 Targets	FY 2009 Targets	FY 2010 Targets
Equipment Standards and Analysis					
Complete analytical and regulatory steps necessary for DOE issuance of 3-4 rules, consistent with the law, to amend appliance standards and test procedures that are economically justified and will result in significant energy savings. [MET]	Complete analytical and regulatory steps necessary for DOE issuance of 4 rules, consistent with the law, to amend appliance standards and test procedures that are economically justified and will result in significant energy savings. Develop for DOE issuance notices of proposed rulemaking (NOPRs) regarding energy conservation standards for electric distribution transformers, commercial unitary air conditioners and heat pumps, and residential furnaces and boilers. [MET]	Final rules will be issued for 3-5 product categories, consistent with the law, to amend appliance standards and test procedures that are economically justified and will result in significant energy savings. This includes final rules for distribution transformers and residential furnaces and boilers. [MET]	Complete 11-13 proposals to update appliance standards and test procedures publish in the Federal Register. Final rules will be issued for 1-2 of these product categories, consistent with the law, to amend appliance standards and test procedures that are economically justified and will result in significant energy savings For this measure “proposal” includes unique product inclusions in Advance Notice of Proposed Rulemakings ANOPRS, NOPRS, and Final Rules. Multiple proposals (covering a number of product categories) could be bundled in Federal Register Notices. [MET}	Complete 14-16 proposals to update appliance standards and test procedures publish in the Federal Register. Final rules will be issued for 4-6 of these product categories, consistent with the law, to amend appliance standards and test procedures that are economically justified and will result in significant energy savings. For this measure “proposal” includes unique product inclusions in ANOPRS, NOPRS, and Final Rules. Multiple proposals (covering a number of product categories) could be bundled in Federal Register Notices.	Complete 14-17 proposals to update appliance standards and test procedures publish in the Federal Register. Final rules will be issued for 10 of these product categories, consistent with the law, to amend appliance standards and test procedures that are economically justified and will result in significant energy savings. For this measure “proposal” includes unique product inclusions in ANOPRS, NOPRS, and Final Rules. Multiple proposals (covering a number of product categories) could be bundled in Federal Register Notices.
Technology Validation and Market Introduction/Rebuild America					
Help Rebuild America community partnerships to upgrade 60 million square feet of floor space in K-12 schools, colleges, public housing, and State/local governments, reducing the average energy used in these buildings by 18 percent. [MET]					

FY 2005 Results	FY 2006 Results	FY 2007 Results	FY 2008 Targets	FY 2009 Targets	FY 2010 Targets
Technology Validation and Market Introduction/ENERGY STAR					
Recruit 500 additional retail stores, 5 additional utilities and 10 additional manufacturers. Complete draft Commercial Window specification. Begin update of Residential Window specification. Expand coordination with all gateway activities. [MET]	Increase market penetration of appliances (clothes washers, dishwashers, room air conditioners and refrigerators) to 38 to 42 percent (baseline 30 percent calendar year 2003), to 2 to 3 percent for Compact Fluorescent Lamps (baseline 2 percent calendar year 2003) and 40 to 45 percent for windows (baseline 40 percent calendar year 2004). Estimated energy savings will be 0.030 Quads and $657 million in consumer utility bill savings. [MET]	Increase market penetration of appliances to 30 to 32 percent (baseline 30 percent calendar year 2003), to 2.5 to 4 percent for CFL's (baseline 2 percent calendar year 2003) and 45 to 50 percent for windows (baseline 40 percent for calendar year 2003). Estimated energy savings will be 0.032 Quads and $671 million in consumer utility bill savings. [MET]	Achieve market penetration target for ENERGY STAR appliances of 33 percent (baseline 30 percent in 2003), 6 percent for CFLs (baseline 2 percent in 2003), and 48 percent for windows (baseline 40 percent in 2003). [MET]	Achieve market penetration target for ENERGY STAR appliances of 39 percent (baseline 30 percent in 2003), 12 percent for CFLs (baseline 2 percent in 2003), and 56 percent for windows (baseline 40 percent in 2003). Revised criteria for clothes washers, refrigerators and windows Release criteria for photovoltaic systems. Complete evaluation for developing ENERGY STAR criteria for small wind turbines.	Achieve market penetration target for ENERGY STAR appliances of 33 percent, 13 percent for CFLs, and 20 percent for windows.[a]
Contribute proportionately to EERE's corporate goal of reducing corporate and program uncosteds to a range of 20-25 percent by reducing program annual uncosteds by 10 percent in 2005 relative to the program uncosted baseline in 2004 ($33,417k) until the target range is met. [NOT MET]	Maintain total administrative overhead costs (defined as Program Direction and Program Support excluding earmarks) in relation to total program costs of less than 12 percent. [MET]	Maintain total administrative overhead costs (defined as Program Direction and Program Support excluding earmarks) in relation to total program costs of less than 12 percent. [MET]	Maintain administrative costs as a percent of total program costs less than 12 percent. [MET]	Maintain administrative costs as a percent of total program costs less than 12 percent.	Maintain administrative costs as a percent of total program costs less than 12 percent[b].

[a] Revised criteria will take effect for Clothes Washers, Dishwashers, and Windows in 2010, with revised criteria for CFLs in 2009. Because of the increased stringency in the revised criteria, market share levels, particularly in the case of windows, will decrease.
[b] Administrative costs are comprised of Program Direction and elements of Program Support (Technology Advancement and Outreach; and Planning, Analysis and Evaluation), baseline and targets under development.

Residential Buildings Integration

Funding Schedule by Activity

(dollars in thousands)

	FY 2008	FY 2009	FY 2010
Residential Buildings Integration			
Research and Development Building America	23,725	21,900	40,000
Total, Residential Buildings Integration	23,725	21,900	40,000

Description

The long-term goal of the Residential Buildings Integration (RBI) subprogram is to develop cost effective, production ready systems in five major climate zones that result in houses that produce as much energy as they use on an annual basis. This Zero Energy Building (ZEB) initiative, referred to as Zero Energy Home (ZEH) initiative in residential sector research, is bringing a new concept to homebuilders across the U.S. A ZEH combines state-of-the-art, energy efficient construction and appliances with commercially available renewable energy systems such as solar water heating and solar electricity. This combination can result in a net zero energy consumption. A ZEH, like most houses, is connected to the utility grid, but can be designed and constructed to produce as much energy as it consumes on an annual basis. With its reduced energy needs and renewable energy systems a ZEH can, over the course of a year, give back as much energy to the utility as it takes. This ZEH also has a cost component goal of net zero financial cost to the home owner. The annual energy savings in utility bills will offset the annual financing cost of ZEH energy efficiency upgrades. In addition, as funding levels have increased, BT has begun to research multi-family housing, the Builders Challenge deployment activities, and research on energy efficient improvements in existing homes.

In order to achieve the technical capability for ZEH by 2020, BT will develop integrated cost-effective whole-building strategies to reduce the energy consumption of residential buildings by 70 percent (compared to the Building America Benchmark) and provide energy for the remaining 30 percent through the use of integrated onsite power systems.[a] 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. Together, they 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.

Building America also integrates energy efficiency and onsite/renewable power solutions, demonstrated on a production basis by building community subdivisions which will reduce whole-house energy use in new homes by an average of 50 percent by 2014, 70 percent by 2018, and ZEB by 2020 (compared to

[a] Whole house energy savings for all residential end uses are measured relative to the BA Research Benchmark Definition (Building America, Building America Research Benchmark Definition, Version 3.1, November 11, 2003, National Renewable Energy Laboratory). (www.buildingamerica.gov)

the Building America Benchmark[a]). ZEBs integrate energy efficiency gains with onsite renewable power solutions at net zero financial cost to the home owner to achieve the final goal of an annual net zero energy home.

To ensure meeting the performance goals, Building America specified the following interim performance targets for completion of technology package research reports for each climate region, shown below. The annual performance goals will be evaluated and adjusted due to market conditions and the degree of technical complexity involved in developing solutions for each climate.

Residential Integration Performance Targets by Climate Zone

Target (Energy Savings)	Marine	Hot-humid	Hot/Mixed Dry	Mixed Humid	Cold
30%	2006	2007	2005	2006	2005
40%	2008	2010	2007	2009	2010
50%	2012	2013	2011	2013	2014
70%	2017	2016	2015	2017	2018
ZEH[b]	2020	2020	2020	2020	2020

The Residential Buildings Integration subprogram is an integral part of the BT Program which evaluates research in the context of the market.

Benefits

Residential Buildings Integration R&D activities will provide the energy technologies and solutions that will catalyze a 70 percent reduction in energy use of new prototype residential buildings that, when combined with onsite energy technologies result in ZEH by 2020, and when adapted to existing homes results in a significant reduction in their energy use. By 2010, RBI will develop, document and disseminate five cost effective technology packages that achieve an average of 40 percent reduction in whole house energy use. These activities and outputs lead directly to decreased energy use in homes and reduced homeowner energy bills. BT activities also lead to investment in National Laboratories and R&D projects contributing to the deployment of science and basic research to create the energy technologies of the future.

[a] Whole house energy savings are measured relative to the BA Research Benchmark Definition (Building America, Building America Research Benchmark Definition, December 29, 2004, NREL) which consists of the 2000 IECC requirements plus lighting, appliances and plug load energy levels (www.buildingamerica.gov).

[b] This table reflects the energy efficient component of the ZEH goal and renewable energy systems integration. While 70 percent efficiency targets are expected by 2015 to 2018, additional research and time (with 2020 as a target) is needed to provide the remaining 30 percent through the integration of onsite renewable energy systems.

Detailed Justification

	(dollars in thousands)		
	FY 2008	FY 2009	FY 2010
Research and Development: Building America	**23,725**	**21,900**	**40,000**

The residential systems research, driven by the performance targets by climate zone and the financial constraint of zero or less net cash flow, is conducted in three stages for each climate zone.[a] During the three stages, Building America acts as a national residential energy systems test bed where homes with different system options are designed, built and tested at three levels of system integration, including technology pathways and research houses (Stage 1), production prototype houses (Stage 2), and community scale housing (Stage 3).

From technology package research reports developed in Stage 3, "Best Practices" manuals are designed for 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 three research stages currently take approximately four years. For more advanced energy efficiency levels at and above 50 percent whole house savings, the system research process is expected to take additional iterations of whole house testing before implementation in production ready homes.

In FY 2010, BT will continue research at the 40 percent efficiency level for the hot-humid and cold climates. Research at the 40 percent efficiency level for the mixed humid was completed in FY 2009. The specific climate zone targets may be adjusted due to market conditions and the degree of technical complexity involved in developing solutions for each climate.

During 2010, BT will begin testing strategies to achieve a 50 percent reduction in the energy used in a home. The 50 percent systems research will continue work to reduce the energy used to heat and distribute hot water, field test lower cost efficient windows, and methods of space heating and cooling in a very efficient home. Electric energy used by miscellaneous small appliances in the home will become a higher priority research area with a focus on home automation.

Additionally, BT will invest in collaborative research with the Solar Energy Program to reduce barriers to the installation and operation of solar systems on homes and buildings. The focus of BT efforts will be on the building/solar energy system interface and maximizing the amount of energy from the solar energy system that is actually delivered to meet electricity needs in the home.

In addition, these funds may be used to support efforts such as peer reviews; data collection and dissemination; and technical, market, economic, pilot deployment studies and other analyses.

Total, Residential Buildings Integration	**23,725**	**21,900**	**40,000**

[a] Building America deals with five climate zones in the U.S.: Marine, Hot-humid, Hot/Mixed Dry, Mixed Humid, and Cold. These climate zones require unique approaches to reach the 30-40-50 percent energy target savings.

Explanation of Funding Changes

	FY 2010 vs. FY 2009 ($000)
Research and Development: Building America	
The increase in funding will be used to continue research at the 40 percent efficiency level for the hot-humid climate, begin testing strategies to reduce energy use in multifamily buildings, and begin testing strategies to achieve a 50 percent reduction in energy use in single family homes. These strategies include research on high R wall systems, reduction of miscellaneous electric loads and home energy storage. Additionally, the increased funding will be used to support the Builders Challenge at 30 percent energy savings in thousands of new single family homes and to research strategies to support home performance contracting to achieve 30 percent reductions in energy use in existing homes. The increased funding will also allow evaluations of energy efficient retrofitted homes against control groups of unchanged homes. With the increased budget in FY 2010, BT will continue research and market transformation activities to improve the energy efficiency of existing homes by 25-30 percent. These research activities seek to improve the energy retrofit capabilities of contractors and explore cost effective ways to reach energy reductions greater than 50 percent in existing homes. The market transformation activities will spur innovation in information and service delivery approaches to reach an increasing number of existing middle class homeowners. In addition to supporting the Home Performance activity within the ENERGY STAR program, BT will also undertake to bring energy efficient retrofits to large numbers of homeowners via subdivision, city wide and utility wide efforts. Increased funding will also allow evaluations of energy efficient retrofitted homes against control groups of unchanged homes. In addition, BT will improve coordination with the Weatherization Assistance Program to disseminate R&D results to that user community and to learn best practices from them.	+18,100
Total Funding Change, Residential Buildings Integration	**+18,100**

Commercial Buildings Integration

Funding Schedule by Activity

(dollars in thousands)

	FY 2008	FY 2009	FY 2010
Commercial Buildings Integration			
Research and Development	11,891	32,454	38,502
SBIR/STTR	–[aa]	546	1,498
Total, Commercial Buildings Integration	11,891	33,000	40,000

Description

Sections 421 and 422 of EISA 2007 reauthorized the activities of the Commercial Buildings Integration subprogram, and specifically directed the establishment of a Net-Zero Energy Commercial Building Initiative (CBI). DOE launched the CBI on August 5, 2008, and is implementing a comprehensive program to achieve the CBI goals to develop and disseminate technologies, practices, and policies for the development and establishment of zero net energy commercial buildings for: (1) any commercial building newly constructed in the U.S. by 2030; (2) 50 percent of the commercial building stock of the U.S. by 2040; and (3) all commercial buildings in the U.S. by 2050.[b] The comprehensive program may include:

- R&D on building science, design, materials, components, equipment and controls, operation and other practices, integration, energy use measurement, and benchmarking;
- Pilot programs and demonstration projects to evaluate replicable approaches to achieving energy efficient commercial buildings for a variety of building types in a variety of climate zones;
- Deployment, dissemination, and technical assistance activities to encourage widespread adoption of technologies, practices, and policies to achieve energy efficient commercial buildings;
- Other RD&D, and deployment activities necessary to achieve each goal of the initiative;
- Development of training materials and courses for building professionals on achieving cost-effective high performance energy efficient buildings;
- Development and dissemination of public education materials to share information on the benefits and cost-effectiveness of high performance energy efficient buildings;
- Support of code-setting organizations and State and local governments in developing minimum performance standards in building codes that recognize the ready availability of many technologies utilized in high-performance, energy efficient buildings;
- Development of strategies for overcoming the split incentives between builders and purchasers, and landlords and tenants, to ensure that energy efficiency and high-performance investments are made that are cost-effective on a lifecycle basis; and
- Development of improved means of measurement and verification of energy savings and performance for public dissemination.[c]

[a] SBIR/STTR funding was transferred to the Science Appropriation in FY 2008.
[b] EISA 2007, Section 422(c)
[c] EISA 2007, Section 422(d)

The organization of the CBI involves significant engagement of private sector companies, public, non-government and trade organizations through Commercial Building Energy Alliances, formally recognized green building partnership consortia, and a competitively selected CBI supporting consortium. As directed by EISA 2007, BT consults with the supporting partnership consortium and others to establish priorities and plans for the CBI. Based on those plans, BT is executing a program of high-value RD&D and technology deployment, as well as 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, lodging), and Institutions (higher education, hospitals, State and local government) are vehicles for peer assistance, technology procurements, and sharing of technology assessments and best practices.

BT is also providing cost-shared research and technical assistance on a competitive basis to National Accounts (business entities with building portfolios of significant square-footage who regularly engage in new construction, and who also implement retrofit of existing buildings on a regular basis). National Accounts 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. National Account activities are enabling 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 the 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 National Account activities, BT 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.

Commercial Building Design Technology Packages Performance Targets

Characteristics	Units	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Small and Medium Sized Commercial Building Design Technology Packages	30% Energy Savings	0	1	1	2	4	4	–	–	–	–	–
Commercial Building Design Technology Packages	50% Energy Savings	0	0	0	0	0	0	4	–	–	–	–
Case Studies (Retrofit)	30% Energy Savings	0	0	0	0	–	–	–	5	10	10	10
Case Studies (New Buildings)	50% Energy Savings	0	0	0	0	0	0	0	5	10	10	10

The Commercial Buildings Integration subprogram is an integral part of the BT program which evaluates research in the context of the buildings market.

Benefits

By 2010, Commercial Buildings Integration 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 (12 packages) or 50 percent (4 packages) reduction in the purchased energy use in new, small to medium-sized commercial buildings relative to ASHRAE 90.1-2004. These activities and outputs lead directly to decreased energy use in commercial buildings and reduced energy bills for American businesses, with direct benefits to U.S. economy.

Detailed Justification

	(dollars in thousands)		
	FY 2008	FY 2009	FY 2010
Research and Development	**11,891**	**32,454**	**38,502**

In 2010, Building Technologies will continue R&D on new design guides that will help drive a net cost-effective increase (50 to 70 percent) in commercial building energy efficiency over ASHRAE 90.1-2004. Based on a series of design guides completed through 2009, BT began establishing public-private alliances with three major building segments of the commercial building market: retailers, commercial real estate, and hospitals. BT works with these alliances to develop highly efficient prototype designs, and challenges alliance members to build and demonstrate their version of these designs that are at least 50 percent more efficient than current designs.

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	**—**	**546**	**1,498**

In FY 2008, $669,408 and $80,719 were transferred to the SBIR and STTR programs respectively. The FY 2009 and 2010 amounts shown are estimated requirements of the continuation of the SBIR and STTR program.

Total, Commercial Buildings Integration	**11,891**	**33,000**	**40,000**

Explanation of Funding Changes

	FY 2010 vs. FY 2009 ($000)

Research and Development

Increases in FY 2010 funding will accelerate the RD&D of 50 to 70 percent reduced energy consumption through Commercial Building National Accounts and Energy Alliances in three commercial building segments: Retail, Commercial Real Estate, and Hospitals. Two additional Energy Alliances will be launched in FY 2010: colleges and universities, and State and local government. BT will work with these groups to

	FY 2010 vs. FY 2009 ($000)
identify new or underused energy efficiency technologies and for advancement in the marketplace. In addition, more technical assistance will be provided to the partnerships. Additional National Account teams will be selected to construct or retrofit buildings that achieve savings of 50 percent and 30 percent respectively above ASHRAE/IESNA Standard 90.1-2004. These cost-shared public-private partnerships have the potential to move several commercial building sectors rapidly forward towards the net zero energy goal. Additional Commercial Lighting Solutions will be developed by DOE in partnership with top lighting designers, architects, and commercial end users. These solutions will be delivered through an interactive web tool that will estimate energy savings based on project-specific inputs. Commercial Lighting Solutions have been developed and analyzed for five types of retail stores (big box, small box, grocery, specialty market, and pharmacy), and solutions for other sectors will be developed. The solutions are designed to meet or exceed the savings levels to qualify for EPAct 2005 tax incentives. New Technologies Solutions similar to the Commercial Lighting Solutions will also be initiated by DOE in partnership with the Commercial Building Energy Alliances on HVAC and refrigeration systems and equipment.	+6,048
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.	+952
Total Funding Change, Commercial Buildings Integration	**+7,000**

Emerging Technologies

Funding Schedule by Activity

	(dollars in thousands)		
	FY 2008	FY 2009	FY 2010
Emerging Technologies			
Lighting R&D	24,013	24,454	19,200
Space Conditioning and Refrigeration R&D	2,819	3,329	9,000
Building Envelope R&D	7054	8,652	16,000
Analysis Tools	2,660	3,149	5,500
Solar Heating and Cooling[a]	–	3,711	6,500
Energy Innovation Hub: Energy Efficient Building Systems Design	–	–	35,000
SBIR/STTR	–[b]	546	1,498
Total, Emerging Technologies	36,546	43,841	92,698

Description

The long-term goal of the Emerging Technologies subprogram is to develop cost effective advanced technologies (e.g., lighting, windows, and space heating and cooling) for residential and commercial buildings. Research will focus on developing technologies to support the residential and commercial building goal reducing the total energy use in buildings by up to 70 percent. BT is actively analyzing technology advancement in areas that will be required to reach the ZEB goals and using this analysis to inform the continued direction of the program and corresponding funding needs. The improvement in component and system energy efficiency, when coupled with research to integrate onsite renewable energy supply systems into the commercial and residential buildings, will establish the technologies from which to package marketable net zero energy designs.

Specifically, the Emerging Technologies subprogram will focus on:

- Solid State Lighting (SSL), which has long term efficiencies with the technical potential to approach 200 lumens per watt (lm/W), compared to most conventional technologies with maximum efficiencies in the 85 to 115 lm/W range;
- Heating and cooling systems with the technical potential to reduce annual heating, ventilation, and cooling (HVAC), dehumidification and water heating energy consumption by 50 percent aligned with advanced technology performance requirements of the Residential Integration activities;
- Advanced windows that incorporate advanced insulation materials and dynamic solar control, which have the potential to become net energy producers in many climates by harvesting passive heating, while dramatically reducing peak cooling loads; and
- EnergyPlus simulation tool with full capabilities to model whole-building integration of emerging energy-efficiency technologies and renewable energy systems into building design and operation.
- Technologies to support the thermal energy needs of a ZEB such as building end uses that can be met by solar thermal technologies, including domestic water heating, space heating, and space cooling.

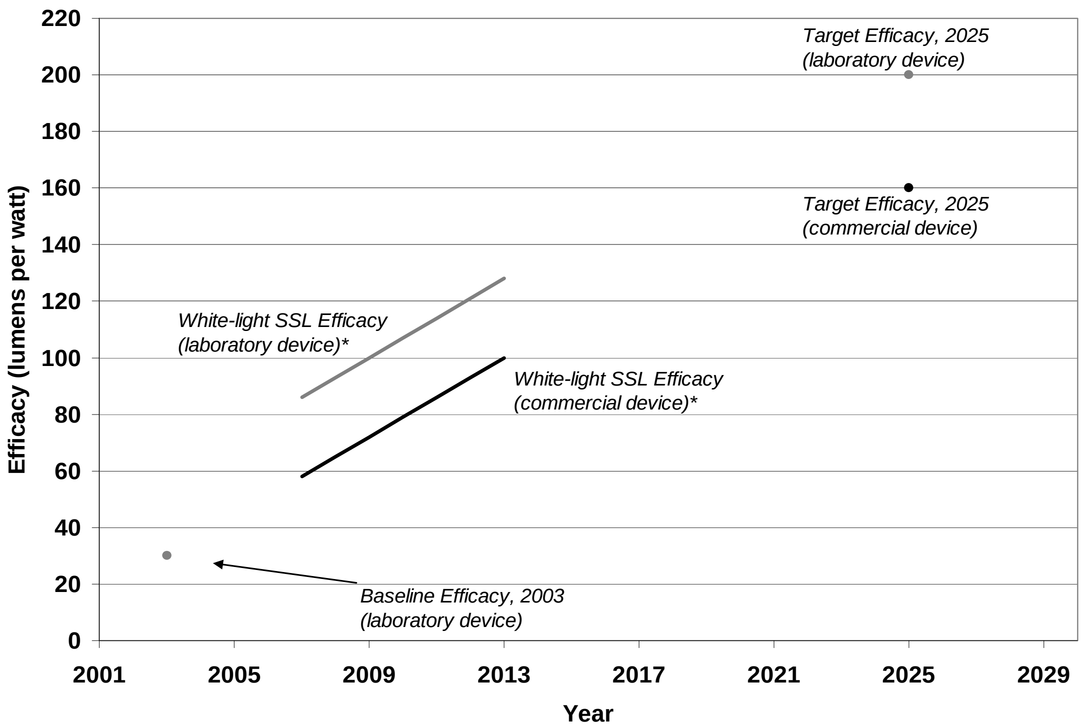
[a] Transferred from the EERE Solar Energy Program in FY 2009.
[b] SBIR/STTR funding was transferred to the Science Appropriation in FY 2008.

- Integrating smart materials, designs, and systems to tune building functionality for increased conservation of energy and well managed usage of lighting, heating, air conditioning, and electricity.

Lighting Research and Development

The goal of the Lighting Research and Development activity is to achieve lighting technologies with double the efficacy of today's most efficient lighting sources, linear and compact fluorescents.[a] The primary target is solid state lighting devices and technologies, both inorganic light emitting diodes (LEDs) and organic light emitting diodes (OLEDs), that can produce white light with efficacies in excess of 160 lm/W in commercial products, with an interim target of 119 lm/W projected for laboratory devices by 2012.[b] The anticipated rate of performance for LEDs is shown in the following diagram.

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.

[a] Linear fluorescent lamps offer efficacies as high as 80 lm/W. Compact fluorescent lamps, a derivative of this technology, are less efficient (approximately 60 lm/W); however they still offer a four-fold improvement over traditional incandescent bulbs.

[b] For solid-state lighting technologies, the performance target is focused on the energy efficiency rating "efficacy," of the device measured in lumens of light produced per Watt of energy consumed. Several lighting products, including fluorescent lamps and incandescent reflector lamps, are regulated using an efficacy target. The efficacy projections for solid-state lighting are generated for laboratory devices because the Lighting R&D portfolio does not have direct influence over commercially offered products.

Point Values of Efficacy Projections for White-Light SSL Laboratory Devices

Characteristics	Units	2003 (baseline)	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Solid State Lighting Performance Targets	Lumens/Watt	30	65	79	95	101	110	113	116	119	122	125
Actual		48	65	79	95	107	–	–	–	–	–	–

Space Conditioning and Refrigeration Research and Development

Space conditioning systems, which have transformed the 20th Century by enabling building users to become more productive and comfortable, will play a critical role in achieving BT's goal of ZEB. 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 the ZEB 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 ZEHs, the Space Conditioning R&D activity will reduce the energy consumption of HVAC, dehumidification and water heating equipment by 50 percent over baseline levels at net zero financed cost.

Space Conditioning System Performance Goals

Characteristics	2004 Status	2007 Target	2010 Target
Annual HVAC, Water Heating and Dehumidification Energy Consumption Reduction vs. Building America benchmark (demonstrated product)	Baseline	25%	50%

Building Envelope Research and Development

Thermal Insulation and Building Materials

The Building Envelope element will contribute to ZEB goals by advancing a portfolio of new insulation and membrane materials, including improved exterior insulation finishes, with both residential and commercial wall applications. The next generation of attic/roof systems integrating thermal mass, ventilation and advanced insulated roof structures will be applied to the residential new construction market.

The table below lists the performance goals for the Thermal Insulation activities. All performance measurements are relative to historical baselines that have been set as the Building America regional

[a] 2008 Buildings Energy Data Book, US Department of Energy, September 2008.

baseline new construction. Achieving cost-effectiveness and durability are critical aspects of these targets.

Thermal Insulation and Materials Performance Goals

Characteristics	2004 Status	2007 Target	2010 Target
	(units: R-Value*)	(units: R-Value*)	(units: R-Value*)
Advanced attic/roof system	30	35	Dynamic annual performance equal to conventional R-45
Wall insulation	10	Dynamic annual performance equal to conventional R-20[a]	Dynamic annual performance equal to conventional R-20[b]

***** 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

Windows Technologies

Window performance will also be vital to reaching residential and commercial buildings goals. Development of cost effective, highly efficient glazing and fenestration systems for all building types in all parts of the country will require a portfolio of technologies matched to those types and climatic conditions. The table below lists the performance measurement targets for the windows element. All performance measurements are relative to historical baselines that were set as the baseline for new construction in 2003.

Windows Performance Goals

Percent Reduction in Energy Use*

Characteristics	2003 Status	2007 Target	2010 Target	2015 Target	2020 Target
Energy Consumption Improvement	Base ENERGY STAR (Low E)	20-30%	30-40%	40-50%	40-60%

* 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.

Analysis Tools

BT established aggressive goals to create a new generation of residential and commercial building technologies by 2025 that will enable ZEB. Similar technologies and design approaches will also be applied to improve the performance of existing buildings. These ZEB goals cannot be met alone through research to significantly improve the performance of components (e.g., windows, appliances, heating and cooling equipment, and lighting). It also requires a revolutionary approach to building design and operation that can achieve up to 70 percent reductions in load, coupled with careful

[a] Interim target NOT subject to cost constraints and may not be in commercial production.
[b] Subject to no additional operating cost, within the traditional 3.5-in. wall dimension, with acceptable durability characteristics.

integration with onsite renewable energy supplies as well as thermal and electrical storage.[a] This in turn requires powerful simulation tools that support evaluation of new ZEB demand-reduction and energy-supply technologies throughout building design, operation, and retrofit.

Solar Heating and Cooling (SH&C)

The mission of SH&C is to provide the thermal energy needs of a ZEB. 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.[b] This is considered essential to attain the Building America Program's goal of ZEB by FY 2020 at neutral cost - whereby the added amortized cost of new home construction for energy efficiency and renewable energy measures are absorbed by the increased energy savings.

Energy Innovation Hub: Energy Efficient Building Systems Design

DOE proposes to establish multi-disciplinary Energy Innovation Hubs (Hubs) to address the basic science, technology, economic, and policy issues hindering the ability to become energy secure and economically strong while being good stewards of the planet by reducing GHG emissions. The main focus of the hub is to push the current state-of-the-art energy science and technology toward fundamental limits and support high-risk, high-reward research projects that produce revolutionary changes in how the U.S. produces and uses energy.

The hubs are inspired by the Bell Labs research model, which produced the transistor, the building block of modern computers. Their objective is to focus a high-quality team of researchers on a specific question and to encourage 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. The grants will not provide “bricks and mortar,” but up to $10 million of the $35 million award may be used for capital equipment.

In FY 2010, BT will establish an R&D Hub that focuses on energy efficient building systems design. This hub will work on integrating smart materials, designs, and systems to tune building usage to better conserve energy, as well as maximizing the functioning of lighting, heating, air conditioning, and electricity to reduce energy demand. Areas of interest include improved exterior shell materials, membranes of energy efficient windows, insulation, improved approaches to building design, systems control, and energy distribution networks.

Benefits

Emerging Technologies activities will accelerate the introduction of highly efficient technologies and practices for both new and existing residential and commercial buildings. The emerging technologies

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[a] Building energy performance, particularly in ZEB, 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 daylighting dimming controls on the electric lights with daylighting has several effects: lighting electricity use goes down as does the heat gain from lights. Lower heat from lights reduces cooling use (amount depends on cooling equipment efficiency) but in the winter it can significantly increase the heating energy. Thus, the annual impact of daylighting on energy use requires detailed calculations that consider these interactions. 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].

[b] 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.

activities support the BT goal through R&D of advanced lighting, building envelope, windows, space conditioning, water heating and appliance technologies and analysis tools. Without advanced components and subsystems developed in the Emerging Technologies activities, the goal of ZEB will not be met.

Detailed Justification

	FY 2008	FY 2009	FY 2010
	(dollars in thousands)		
Lighting R&D	**24,013**	**24,454**	**19,200**

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 four R&D classes: LED Core Technology, LED Product Development, OLED Core Technology, and OLED Product Development.

Product Development tasks are the systematic use of knowledge gained from basic and applied research to develop or improve commercially viable materials, devices, or systems. Technical activities focus on a targeted market application with fully defined price, efficacy, product concept modeling through to the development of test models and field ready prototypes, and other performance parameters necessary for success of the proposed product. Within each R&D class, there are active, detailed R&D pathways which contribute to the larger programmatic objective.

The SSL portfolio currently funds nine Core priority R&D topics and eleven Product Development priority R&D topics[a]. Each year, the 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.

[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 for these two documents (http://www.eere.energy.gov/buildings/about/mypp.html and www.netl.doe.gov/ssl)

In FY 2010, the program will continue the SSL R&D projects that have demonstrated progress and completed a peer review. These projects resulted from the competitive solicitations in 2007 and 2008 to develop and deploy SSL products for general illumination. These project topical areas are identified in the table on the following page.

Solid State Lighting 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

Activities will continue to analyze and address barriers to enable market introduction and commercialization of technologies resulting from these research projects.

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.

Space Conditioning and Refrigeration R&D	**2,819**	**3,329**	**9,000**

In FY 2010, BT will continue the development of an air-to-air integrated heat pump (IHP) system that can meet the air heating, cooling, dehumidifying, ventilating, and water heating requirements of a tight-envelope mechanically ventilated near-ZEH, and the development of a ground-source integrated heat pump (GS-IHP). In FY 2010, field experiments with prototype advanced HVAC/Water Heating (WH) systems will take place in research houses. This will demonstrate the performance of advanced prototype HVAC/WH systems including GS-IHPs and potentially high efficiency electric water heaters (HEWH) achieving 50 percent energy savings compared to the 2004 Building America baseline. It is further anticipated that air-source integrated heat pump (AS-IHP) systems will be demonstrated in FY 2011.

In FY 2009, BT completed an assessment of advanced heat pump technologies for ZEH applications. In FY 2010, research will start for technologies that have demonstrated through laboratory or field testing the long term potential (relative to Building America Benchmarks) to reduce annual HVAC, dehumidification and water heating energy consumption. This includes several different heat-pump based technology development options for ZEH applications, including but not limited to evaporative precooling and/or split-condensers into integrated heat pumps or integrated air-conditioners, and exploring the use of different working fluids in an integrated heat pump.

New strategies for achieving ZEH/ZEB will also be assessed, looking at the contribution to ZEH/ZEB, 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 ZEH, but which also have widespread application potential to existing buildings, will be a particular focus of the research.

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.

Building Envelope R&D

Thermal Insulation and Building Materials	**2,389**	**3,444**	**5,500**

Reducing energy losses through the building enclosure will contribute significantly to DOE's attainment of a practical ZEB. In pursuit of the next generation of attic/roof systems that will save 50 percent energy over the Building America baseline, BT will continue the integration and optimization of key technologies including cool roofs, thermal mass, radiant barriers, and above deck ventilation. From FY 2007 through FY 2009, peak heat flux through the roof was reduced by 90 percent in a test facility. Completion of the validation of optimized technologies for energy and cost performance in a whole house side-by-side demonstration with detailed monitoring in a hot climate zone will be a significant effort in FY 2010. Developmental systems will further be refined for mixed and cold climates, and evaluation in multiple, more challenging climate zones will be initiated.

BT is developing advanced envelope materials in response to needs identified in the Residential and Commercial Integration activities. In FY 2010, dynamic membranes will be further analyzed and evaluated in cooperation with private industry as a result of prior fundamental material science research and partnerships formed in FY 2009. The membranes will allow for greater performance of insulation while eliminating moisture issues. Whole house, full scale applications for insulation with phase change materials that offer thermal mass effects to dramatically reduce peak loading were evaluated in a mixed climate zone in FY 2009. The new experimental insulation passed critical fire code rating tests in FY 2008. In FY 2009, the first commercialized products entered the marketplace. In FY 2010, large scale whole house side by side evaluations will be conducted, continuing work from FY 2009. In FY 2010, the thermal material subprogram will initiate fundamental new research on basements for both existing and new construction.

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.

Windows Technologies	**4,665**	**5,208**	**10,500**
Total, Building Envelope R&D	**7,054**	**8,652**	**16,000**

In FY 2010, BT 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 cost for 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 in the 2011 to 2015 timeframe with substantially lower consumer prices. However, these initial second generation product offerings will not meet DOE long term price goals for ZEBs by 2020 and 2025.

Analysis Tools	**2,660**	**3,149**	**5,500**

In 2010, BT will continue to develop, improve, verify, and maintain software packages for researchers, engineers, architects, and builders who design or retrofit buildings to be energy efficient and comfortable. BT will also conduct research on, and incorporate additions to, EnergyPlus whole-building energy simulation software to allow building designers, operators, owners, and researchers to evaluate technologies for substantially improving the energy efficiency of buildings and reducing energy costs while maintaining comfort. BT will continue to focus on technologies, systems, and controls which are needed in low- and zero-energy buildings, incorporating new modules in EnergyPlus versions which specifically support BT residential and commercial building research, design, analysis and retrofit of low- and ZEBs. EnergyPlus module development research will focus on the top 30 to 40 features, completing new capabilities for recent state-of-the-art fenestration and envelope, daylighting, building controls and management systems, innovative low-energy HVAC equipment and systems, fuel cell systems, and renewable energy technologies such as solar and wind, as well as assistance with building code development.

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.

Solar Heating and Cooling (SH&C)	**0[a]**	**3,711**	**6,500**

Activities for SH&C in FY 2010 will include research on exemplary low-cost solar water heating systems for ZEH in cold climates and the development of prototype systems; R&D of combined solar heating, cooling, and water heating systems that utilize seasonal storage to achieve high solar fractions; continued development of dehumidification applications for combined photovoltaic/thermal systems for ZEH; and support of a solar rating and certification system. In addition, coordination with the Solar America Showcases project of the Solar Energy Program and with the prototype house evaluation process of the Building America program will accelerate deployment of solar thermal technologies into the marketplace.

In FY 2010, SH&C will also leverage research activities with similar R&D conducted through the International Energy Agency SH&C Program, including the development of advanced solar thermal testing and characterization procedures for certification of collectors and systems.

In addition, these funds may be used to support efforts such as peer reviews; data collection and

[a] The Solar Energy program was appropriated $1.954 million appropriated for Solar Heating and Cooling in FY 2008.

dissemination; and technical, market, economic, and other analyses.

Energy Innovation Hub: Energy Efficient Building Systems Design	**0**	**0**	**35,000**

In FY 2010, BT will establish an R&D Hub that focuses on integrating smart materials, designs, and systems to tune buildings to conserve energy and control the allocation of lighting, heating, air condiditioning, and electricity. A solicitation will be made to establish this hub on Energy Efficient Building Systems Design. A standard, peer-reviewed process will be held and a Board of Advisors will be established to review the progress of the hub. The grants will not provide "bricks and mortar," but up to $10 million of the $35 million award may be used for capital equipment.

SBIR/STTR	**—**	**546**	**1,498**

In FY 2008, $773,592 and $93,281 were transferred to the SBIR and STTR programs respectively. The FY 2009 and 2010 amounts shown are estimated requirements of the continuation of the SBIR and STTR program.

Total, Emerging Technologies	**36,546**	**43,841**	**92,698**

Explanation of Funding Changes

	FY 2010 vs. FY 2009 ($000)
Lighting R&D	
Decreases in funding in FY 2010 are due to increased focus on the most promising topics areas in progress and a down-selected portfolio of R&D projects; and reductions to joint projects such as the Bright Tomorrow Lighting Prize. Existing projects will continue advancements in device efficacy, durability, manufacturing, and cost needed to reach a commercially viable white light with efficacies meeting the 160 lm/W goal. Efforts to analyze and address barriers to enable market introduction and commercialization of technologies resulting from these research projects will continue.	-5,254
Space Conditioning and Refrigeration R&D	
Additional funds will focus on affordable advanced materials, components, refrigeration cycles and systems that improve system energy consumption (including CO_2 systems) and non-vapor compression technologies with humidity control to reduce the energy consumption of HVAC, dehumidification and water heating equipment by 50 percent over baseline levels.	
Additional R&D will include: 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.	+5,671

Building Envelope R&D

Thermal Insulation and Building Materials

Research will focus on high performance, low cost foundation systems and on roof systems that reduce heating and cooling loads — including a full demonstration, evaluation, and side by side whole house comparisons of the next generation attic/roof systems in a hot climate. The new fully code compliant systems will outperform the Building America team's best available technology. In addition, research will focus on higher performance envelope materials, and high performance retrofit-specific designed systems with reduced cost and easier installation.	+2,056

Windows Technologies

Increased funding will support a multiyear investment to achieve a fundamental technology and cost reduction for highly insulating windows with R7 to R10 performance. Research will continue on coating technologies and reduced cost for dynamic windows with solar heat gain coefficient range of 0.1 – 0.5, and easy to install daylighting systems and controls (research will investigate daylighting systems that are fully integrated with glazing façade systems and also integrated into the whole building design). Additionally, FY 2010 funding will be used to commercialize cost effective windows within the 2014 to 2017 timeframe. Funding will also be used to evaluate system performance of currently available R10 windows (non-cost effective) in a whole house cold climate research study.	+5,292
Total, Building Envelope R&D	+7,348

Analysis Tools

Additional funds will accelerate incorporation of building controls capabilities and refrigeration systems plug-ins into existing building simulation software, increasing the number of new components and features added by 25 percent. Efforts will be accelerated to develop and incorporate analysis and design tools that allow for simulation and modeling of emerging technologies. In addition, technical tools and other enabling technologies will be developed that establish accurate test procedures and verification tools to aid commercialization of technologies.	+2,351

Solar Heating and Cooling Systems

Additional funding will focus on combined solar heating, cooling, and water heating systems for ZEH, solar electric/solar thermal pathways to ZEH and development of the next generation of solar water heaters. Increased funding will also accelerate the development of manufacturing processes that lead to enhanced, building-integrated SHC products that are cost-effective and easy to install. Commercialization activities will be implemented, including: the establishment of initiatives, activities and studies that promote expanded utilization of SHC such as purchase agreements through utilities; the creation of one or more University Centers to support innovation and development of SHC products; and the formation of technical support teams that promote development, technical and market transformation assistance for SHC through collaboration with SHC RD&D and existing market transformation initiatives. BT will also be able to provide financial and technical support for establishing a National Administrator of Expertise in Solar Workforce Development. This effort is needed to manage operations of a National Consortium of 7-10 newly created Solar Resource Centers that will produce technical instruction materials and curricula to train a growing solar technology workforce. In turn, BT will establish up to 25 community-based solar installation workforce training programs across the U.S. to broaden the Nation's ability to provide quality solar installations, to create new jobs and to promote the expanded use of solar energy for a clean and reliable energy future.	+2,789
Energy Innovation Hub: Energy Efficient Building Systems Design	
This funding will establish a hub focusing on integrating smart materials, designs, and systems to tune buildings to conserve energy and control the allocation of lighting, heating, air conditioning, and electricity.	+35,000
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.	+952
Total Funding Change, Emerging Technologies	**+48,857**

Technology Validation and Market Introduction
Funding Schedule by Activity

(dollars in thousands)

	FY 2008	FY 2009	FY 2010
Technology Validation and Market Introduction			
Rebuild America	2,808	5,000	5,000
ENERGY STAR	6,714	7,484	10,000
Building Energy Codes	3,717	5,376	10,000
Solar Decathlon	–[a]	3,400	5,000
Total, Technology Validation and Market Introduction	13,239	21,260	30,000

Description

Technology Validation and Market Introduction (TVMI) accelerates the adoption of clean and efficient domestic energy technologies, including ENERGY STAR, Rebuild America, and Building Energy Codes. ENERGY STAR is a joint DOE/EPA activity designed to identify and promote energy efficient products. 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.

The Rebuild America Program activity is aligned with BT R&D activities to accelerate the adoption of advances in building integrated design, software tools, practices and advanced controls, equipment, and lighting. BT will continue implementation of the Commercial Lighting initiative, EnergySmart Hospitals, EnergySmart Schools, the National Builder's Challenge, and the Building Efficiency Application Centers. The National Builder's Challenge is a program designed to support America's homebuilding industry in its efforts to design, build, and sell 220,000 high performance homes by 2012. The Commercial Lighting Initiative is a high-profile campaign challenging commercial building owners to improve their building lighting efficiency by 30 percent or more. In FY 2010, BT will promote energy efficiency within existing homes by designing activities with local governments to help expand the availability of low cost financing for energy retrofits (e.g. using Energy Service Companies' experience) and with retailers to promote energy efficient home remodeling and retrofits through innovative financing. BT will also expand its outreach and educational efforts by developing guidance for energy audits at the time of home resale, including appropriate training materials for real estate agents and lenders. The Building Energy Codes activities support upgrading building industry model energy codes and standards and their adoption, implementation and enforcement by State and local jurisdictions.

[a] SBIR/STTR funding was transferred to the Science Appropriation in FY 2008.

Benefits

TVMI activities accelerate the adoption of clean, efficient, and domestic energy technologies. 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 through Home Performance with ENERGY STAR. The Rebuild America Program focuses on promoting energy efficiency to schools and hospitals. Building Energy Codes submits code proposals, supports the upgrading of the model building energy codes, and provides technical and financial assistance to States to update, implement, and enforce their energy codes to meet or exceed the model codes, in support of Section 304 of ECPA. It also promulgates standards for manufactured housing as required by Section 413 of EISA 2007. These activities and outputs increases the energy performance of homes and commercial buildings constructed today, targets consumer and assists them in reducing energy bills, and contributes to job creation in the construction industry.

Detailed Justification

(dollars in thousands)

	FY 2008	FY 2009	FY 2010
Rebuild America	**2,808**	**5,000**	**5,000**

The Rebuild America Program is aligned with BT R&D activities to accelerate the adoption of advances in building integrated design, software tools, practices and advanced controls, equipment and lighting. The program will expand and update its technical assistance, delivery mechanisms, and partners to effectively transfer the technological advances in R&D. In particular, to promote energy efficiency within the large number of existing homes, the program will begin designing marketing activities (e.g., retailer partnerships to promote energy efficient home remodeling and retrofits through innovative financing).

The EnergySmart Schools activity collaborates with national and regional stakeholders to assist school decision makers in planning and financing energy-efficient high-performance schools, as well as provide education and training for building professionals. EnergySmart Schools promotes the building of new schools that exceed code by 50 percent or more. In addition, it promotes a 30 percent improvement in the energy efficiency of existing schools. In FY 2008 and FY 2009, the BT program invested resources to launch the EnergySmart Schools initiative, develop the 30 percent Advanced Energy Design Guide for K-12 School Buildings, Get Smart About Energy CD-Rom, the Guide to Financing EnergySmart Schools and initiate development of an Operations and Maintenance Manual for K-12 School Buildings. In FY 2010, BT will provide support for implementation of the 50 percent ASHRAE Advanced Energy Design Guide for K-12 School Buildings and develop and disseminate information on the Operations and Maintenance Manual for K-12 School Buildings.

Through targeted partnerships, design support, training, and marketing, EnergySmart Hospitals advances efficient and renewable energy technologies as highly effective strategies for hospitals to reduce energy usage while meeting mission critical goals. In FY 2008 and FY 2009, BT invested resources to launch the EnergySmart Hospitals initiative and the development of a suite of tools and technical resources. In FY 2010, the program will emphasize technical training for existing facilities and new hospital design and construction, as well as the development of targeted technology assessments and technical case studies.

(dollars in thousands)

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.

	FY 2008	FY 2009	FY 2010
ENERGY STAR	**6,714**	**7,484**	**10,000**

DOE will continue its focus on raising the efficiency targets of ENERGY STAR products. The DOE ENERGY STAR team will also continue to work with EPA to help promote its current labeled products. A three-pronged strategy will be deployed in FY 2010 to support the portfolio of existing technologies: 1) developing and updating efficiency criteria for DOE-managed products to keep the label relevant and meaningful in the market; 2) working with EPA and participating manufacturers, retailers, and energy efficiency program sponsors on product marketing and deployment activities; and 3) working with EPA to conduct outreach campaigns and initiatives to educate consumers about the benefits of select products and technologies. DOE will work through regional and national organizations to disseminate information throughout the U.S., create inter- and intra-State partnerships to promote best practices and increase the number of ENERGY STAR State Partners, as well as fund Energy Efficiency Partnerships.

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.

	FY 2008	FY 2009	FY 2010
Building Energy Codes	**3,717**	**5,376**	**10,000**

In FY 2010, BT will initiate analyses and support to upgrade 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. DOE will conduct the analysis needed to support an increased code stringency of five percent in the next residential model building energy code (the 2012 International Energy Conservation Code (IECC)). 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. It will improve energy code compliance tools, integrating them with the design process and non-energy code enforcement. Technical assistance will be provided to States to update, implement, and enforce their energy codes to update their residential code 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 International Energy Conservation Code.

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.

	FY 2008	FY 2009	FY 2010
Solar Decathlon	**0**	**3,400**	**5,000**

The Solar Decathlon, transferred from the Solar Energy Program to BT in FY 2008, is a high-profile university competition held in Washington, D.C., that promotes public awareness of highly efficient building technologies and ZEHs using solar energy. The competition also fosters innovation and encourages incorporation of new building technologies and design practices into engineering and

	(dollars in thousands)		
	FY 2008	FY 2009	FY 2010

architecture university curricula.

The Solar Decathlon is held in September/October every other year. Activities in FY 2010 will start with concluding the 2009 event in October and recruiting new teams for the 2011 Solar Decathlon. A request for proposals will be issued in October 2009 to all universities throughout the country. The proposals will be reviewed and ranked, and the top twenty universities will be selected and each awarded grants to support their projects. New participants will be announced in January 2010. Activities in FY 2010 will also include monitoring the 2009 competition houses to gain long-term performance data after the homes are relocated to a permanent site.

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.

	FY 2008	FY 2009	FY 2010
Total, Technology Validation and Market Introduction	**13,239**	**21,260**	**30,000**

Explanation of Funding Changes

	FY 2010 vs. FY 2009 ($000)
Rebuild America	
No change.	0
ENERGY STAR	
Increased funds will be used to assess possible approaches and develop a standardized portfolio of product testing and performance verification of ENERGY STAR technologies conducted in partnership with current testing programs (windows, CFLs, SSL, etc.) and other stakeholders to include complementary appliance standards test procedures and correcting confusion in the marketplace. BT will also revise window, door, and skylight program requirements and ENERGY STAR criteria for appliances starting August 2009, based on the President Obama's memorandum dated February 5, 2009. The memo states that DOE take all necessary steps, consistent with the consent decree, EPAct 2005, and EISA 2007, to finalize legally required efficiency standards as expeditiously as possible in a manner consistent with all applicable judicial and statutory deadlines.	+2,516
Building Energy Codes	
In FY 2010 BT will use increased funds to improve code compliance tools and deployment of code compliance evaluation assistance to States, in support of their compliance plans. It will also be used to shift model code focus to development of	+4,624

	FY 2010 vs. FY 2009 ($000)
performance criteria and to enable the setting of realistic new efficiency targets for the next generation model codes.	
Solar Decathlon	
The increase in funding will be used for long-term performance monitoring of the 2009 Solar Decathlon homes after the competition.	+1,600
Total Funding Change, Technology Validation and Market Introduction	**+8,740**

Equipment Standards and Analysis

Funding Schedule by Activity

	(dollars in thousands)		
	FY 2008	FY 2009	FY 2010
Equipment Standards and Analysis	21,981	20,000	35,000
Total, Equipment Standards and Analysis	21,981	20,000	35,000

Description

The goal of the Equipment Standards and Analysis subprogram is to develop minimum energy efficiency standards that are technologically feasible and economically justified. During FY 2005 and FY 2006, DOE identified and implemented significant enhancements to the implementation of rulemaking activities. DOE committed to clearing the backlog of delayed actions that accumulated during prior years, while simultaneously implementing all new requirements instituted by EPAct 2005. In FY 2010, DOE will continue to implement productivity enhancements that will allow multiple rulemaking activities to proceed simultaneously while maintaining the rigorous technical and economic analysis required by statute.

Appliance and equipment standards help drive energy savings. It is estimated that Federal residential energy efficiency standards that took effect by the end of 2007 will save a cumulative total of 34 quads of energy by 2020, and 54 quads by 2030. Comparably, the total U.S. consumption of primary energy was about 100 quads in 2004. Standards scheduled to be issued in 2009 have the potential to save an additional 25.5 quads of energy cumulatively over 30 years.

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 by EPCA, as amended. Analyses performed under this program will also support related program activities such as ENERGY STAR to ensure consistent methodology is used in setting efficiency levels for related programs. These activities raise the bar on energy performance in appliances and equipment, thus leading directly to decreased energy use in buildings and reduced energy bills.

Detailed Justification

	(dollars in thousands)		
	FY 2008	FY 2009	FY 2010
Equipment Standards and Analysis	**21,981**	**20,000**	**35,000**

In 2010, DOE will continue to take all necessary steps, consistent with the consent decree, EPAct 2005, and EISA 2007, to finalize legally required efficiency standards consistent with all applicable judicial and statutory deadlines. The Equipment Standards and Analysis subprogram will continue ongoing rule-makings or begin rulemakings for the following product categories in FY 2010:

- Residential Water Heaters
- Direct Heating Equipment
- Pool Heaters
- Small Electric Motors
- 1-500 hp Electric Motors
- Fluorescent Lamp Ballasts
- Clothes Dryers
- Room Air Conditioners
- Central Air Conditioners and Heat Pumps
- Battery Chargers
- External Power Supplies
- Residential Clothes Washers
- Walk-In Coolers and Freezers
- Residential Refrigerators
- Lighting Products
- Elliptical Reflector (ER)/Bulged Reflector (BR)/Reflector (R) Lamps
- Metal Halide Lamp Fixtures
- Microwave Ovens
- Commercial Refrigeration Equipment
- Furnace Fans
- High Intensity Discharge Lamps

The specific standards and test procedure activities listed above have been identified considering existing obligations and new legislative directives. To meet these deadlines in 2009, DOE initiated standards rulemakings for four products (ER/BR/R lamps, walk-in coolers and freezers, metal halide lamp fixtures, and residential clothes washers) and test procedure rulemakings for six products (battery chargers, external power supplies, clothes washers, fluorescent ballasts, and central air-conditioners, 1-500 hp electric motors).

In accordance with EISA 2007, DOE will continue work on incorporating standby and off mode power consumption into test procedures for residential products. In addition to increasing the number of products for which DOE must develop standards, EISA 2007 significantly alters the scope of certain rulemakings by authorizing DOE to consider regional standards for certain space conditioning products. The central air conditioning rulemaking will explore an expanded scope of the analysis to consider the potential impacts of regional standards, including the impact on consumers, manufacturers, distributors, contractors, and installers.

Activities in FY 2010 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 becomes critical to minimize delays and availability conflicts of DOE staff and contractor

	(dollars in thousands)		
	FY 2008	FY 2009	FY 2010

support. 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 addition, these funds may be used to support efforts such as: peer reviews; data collection and dissemination; and technical, market, economic, and other analyses.

Total, Equipment Standards and Analysis	**21,981**	**20,000**	**35,000**

Explanation of Funding Changes

	FY 2010 vs. FY 2009 ($000)
Equipment Standards and Analysis	
In FY 2010, DOE will initiate energy conservation standard rulemakings on furnace fans, 1-500 hp electric motors, and commercial refrigeration equipment.	
Additionally, on February 5, 2009, the President issued a Memorandum to the Secretary of Energy requesting that DOE “work to complete prior to the applicable deadline those standards that will result in the greatest energy savings.” DOE will initiate and accelerate up to three additional rulemakings not currently on its multi-year schedule and consider the potential energy savings when evaluating which products to accelerate. This could include products such as televisions, commercial automatic ice makers, and/or plumbing products.	+15,000
Total Funding Change, Equipment Standards and Analysis	**+15,000**

Industrial Technologies

Funding Profile by Subprogram

	(dollars in thousands)			
	FY 2008 Current Appropriation[a]	FY 2009 Original Appropriation	FY 2009 Additional Appropriation	FY 2010 Request
Industrial Technologies				
Industries of the Future (Specific)	10,969	15,575	–	12,627
Industries of the Future (Crosscutting – Including Inventions and Innovations)	52,223	74,425	–	87,373
Efficiency of Information and Communications Technology and Standards	–	–	50,000	–
Total, Industrial Technologies	63,192	90,000	50,000	100,000

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. 95-619, "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" (1992)
P.L. 109-58, "Energy Policy Act of 2005" (2005)
P.L. 110-140, "Energy Independence and Security Act of 2007" (2007)

Mission

The mission of the Industrial Technologies Program (ITP) is to significantly reduce the intensity of energy use (energy per unit of output) by the U.S. industrial sector through research, development, and demonstration (RD&D) of next-generation manufacturing technologies.

Benefits

Reducing energy intensity leads to lower greenhouse gas (GHG) emissions as 94 percent of industrial carbon emissions are the direct result of energy use.[b] Improving industry's energy efficiency directly supports the Secretarial goals of stimulating the Nation's economy, mitigating climate impacts, and achieving a clean, secure energy future. ITP is leading the Federal Government's efforts in industrial energy efficiency, leveraging the knowledge and expertise of the National Laboratories and broadening existing private-sector partnerships. The program's activities help our Nation's industries advance their global competitiveness, keeping jobs in America and reducing reliance on imported oil and other goods while also abating GHG emissions.

ITP estimates that technologies developed and activities undertaken since 1977 have cumulatively saved more than 103 million metric tons of carbon equivalent (MMTCe). Cumulative tracked energy savings over that period are estimated to be over 5.6 Quads. In 2006, the most recent year for which complete

[a] SBIR/STTR funding was transferred to the Science Appropriation in FY 2008, which includes a reduction of $1,084,000 that was transferred to the SBIR program, and $132,000 that was transferred to the STTR program.
[b] Emissions of Greenhouse Gases in the United States 2007 report, December, 2008.

data are available, the program directly contributed to industrial energy savings of almost 500 trillion Btu worth about $5.5 billion.[a b] The direct reduction in both total industrial energy use and the use of fossil fuels contributes to the goal of Section 106 of the Energy Policy Act of 2005 (EPACT 2005), which mandates a 25-percent reduction in industrial energy intensity by 2020

ITP's RD&D activities heavily leverage the intellectual property and knowledge at the National Laboratories. ITP also leverages its resources with DOE's Office of Science Basic Energy Sciences to translate scientific discoveries in nanotechnology, chemistry, and materials science into technology solutions for the Nation's manufacturers. The program also partners with other EERE programs to develop viable manufacturing technologies for advanced energy technologies, including Wind Energy and Vehicle Technologies. ITP participates with the National Science and Technology Council interagency working group on nanomanufacturing, and with NIST, DOD, and other agencies on areas of common interest such as advanced materials like titanium and carbon fiber composites.

In addition to RD&D, the program works with industrial companies, trade and technical associations, states, utilities, and other stakeholders to accelerate adoption of proven technologies and practices through cost-shared, energy-saving plant assessments and other technology delivery activities.

The FY 2010 Budget investments complement Recovery Act funds that are accelerating achievement of program goals. For current and specific Recovery Act project information, please visit DOE's Recovery Website at: http://www.energy.gov/recovery/index.htm

ITP pursues its mission through the set of integrated activities proposed in this budget that are designed to increase the use of energy efficiency technologies and domestic renewable resources. We expect that these improvements will continue to provide concomitant economic, environmental and security benefits. We expect the most significant benefits to be a growth of innovative crosscutting technologies that deliver significant impacts across diverse industries, including high-efficiency steam generation, cost-effective waste heat recovery and reuse, and advanced materials.

Climate Change

ITP RD&D activities support the achievement of a national reduction in greenhouse gas (GHG) emissions. ITP's approach is designed to deliver increased benefits to the U.S. industry in the form of energy cost savings, carbon reduction, and enhanced competitiveness. The program will continue to leverage the program's strong industrial and National Laboratories partnerships to transform the way industry uses energy, thereby reducing reliance on imported oil and cutting emissions of GHGs. As shown in the table below, EERE's GPRA models currently predict a cumulative reduction by 2030 of more than 3 Gigatons of CO_2 due to ITP efforts.

Energy Security

Through its targeted efforts to reduce energy consumption associated with industrial processes, ITP reduces national dependence on foreign energy sources. The technical and process innovation resulting from program efforts also enhances domestic economic security through efficiency and self-reliance, providing our domestic partners with a competitive edge in the green industrial revolution underway. As shown in the modeling data displayed below, it is currently projected that by 2030 a cumulative

[a] See 2008 Impacts report at http://www1.eere.energy.gov/industry/about/pdfs/impacts2006_intro.pdf

[b] Constant 2006 dollar values for energy savings shown in this budget are based upon Energy Information Administration data from the State Energy Data System 2006: Prices and Expenditures report. Average industrial energy prices per million Btu were $11.33 for 2006 (Source: Table S4A, available at http://www.eia.doe.gov/emeu/states/sep_sum/html/pdf/sum_pr_ind.pdf).

reduction of up to 12.7 trillion cubic foot (Tcf) in natural gas and 800 million barrels in oil imports will result from ITP efforts.

Economic Impact

As shown in the tables below, it is currently projected that ITP activities result in a cumulative consumer savings of roughly $300 billion and cumulative savings in the electric power industry of approximately $125 billion.

The benefits tables following show the estimated benefits from 2015 through 2050 that would result from realization of the program's goals. These benefits are achieved by targeted Federal investments in technology research and development through industrial partnerships with major energy-consuming sectors such as steel and chemicals, integrated manufacturing industries such as automobile and aerospace equipment manufacturers, technology and equipment suppliers, other Federal agencies, State government agencies, universities, National Laboratories, and other stakeholders. These partnerships facilitate the technical coordination of activities and attract cost sharing to provide leveraged benefits.

The benefits table also reflects the increasing market share of advanced-technology industries over time as their projected incremental cost relative to conventional industries declines, and as their efficiency relative to conventional industries increases. The expected benefits reflect solely the achievement of the program's goals. Not included are any policies, regulatory mechanisms, or other incentives not already in existence that might be expected to support or accelerate the achievement of the program goals. In addition, some technologies show diminishing annual benefits by 2050 due to the assumption built into the analysis that industry progress, as reflected in the baseline, will eventually catch up with the more accelerated progress associated with EERE program success.

The program goal case is modeled along with a "baseline" case in which no DOE R&D exists. The baseline case is intended to represent the future without the effect of the Industrial Technologies Program, and is identical for all DOE applied energy R&D programs, thereby ensuring that all program benefits are estimated using the same assumptions for external factors such as economic growth, energy prices, and levels of energy demand. The expected outcome benefits are calculated using the same fundamental methodology across EERE and across all of DOE's applied energy R&D programs, and the metrics by which expected outcome benefits are measured are identical. This standardization of method and metrics has been undertaken as part of DOE's efforts to make all program stated benefits comparable.

Prospective benefits are calculated as the arithmetic difference between the baseline case and the program goal case, and the resulting economic, environmental and security benefits attributed to the program's activities. This approach of calculating the benefits as an incremental improvement to the baseline helps ensure that improvements in industrial technologies that would occur in the absence of the program are not counted as part of the program's benefits. In addition to technology and process advances due to the program's activities, energy market policies, such as state and Federal tax policies, facilitate the development and deployment of clean energy technologies. The expected impacts of current legislated policies in the baseline case are included so that the expected benefits calculated reflect as much as possible the effects of activities funded by the program.

The benefits are generated by modeling both the program goal and baseline cases within two energy-economy models: NEMS-GPRA10 for benefits through 2030, and MARKAL-GPRA10 for benefits through 2050. The full list of modeled benefits appears below.

Primary Metrics for FY 2010 Budget Request
(Incorporates Approximate Impacts of EISA 2007)

	Metric[1]	Model	Year 2015	2020	2030	2050
Energy Security	Oil Imports Reduction, cumulative[2] (Bil bbl)	NEMS	ns	ns	0.4	N/A
		MARKAL	ns	ns	0.8	3.7
	Natural Gas Imports Reduction, cumulative (Tcf)	NEMS	0.7	2.4	9.5	N/A
		MARKAL	1.9	5.1	12.7	34.9
	Reduction in Share of Highway Fuel Demand Derived from Crude Oil[3] (%)	NEMS	ns	ns	ns	N/A
		MARKAL	ns	ns	ns	ns
Environmental Impacts	CO_2 Emissions Reduction, cumulative (Mil mtCO_2)	NEMS	226	950	3760	N/A
		MARKAL	207	886	3579	11286
	SO_2 Allowance Price Reduction[4] ($/ton)	NEMS	ns	ns	ns	N/A
		MARKAL	N/A	N/A	N/A	N/A
	NO_x Allowance Price Reduction ($/ton)	NEMS	ns	353	649	N/A
		MARKAL	N/A	N/A	N/A	N/A
	Hg Allowance Price Reduction (thousand $/lb)	NEMS	ns	ns	ns	N/A
		MARKAL	N/A	N/A	N/A	N/A
Economic Impacts	Consumer Savings, cumulative[5] (Bil $)	NEMS	36	101	293	N/A
		MARKAL	34	122	333	792
	Electric Power Industry Savings, cumulative (Bil $)	NEMS	18	50	124	N/A
		MARKAL	12	48	126	269
	Household Energy Expenditures Reduction ($/household/yr)	NEMS	ns	40	50	N/A
		MARKAL	7	18	17	ns

1. "Reductions" and "savings" are calculated as the difference between results from the baseline case (i.e. no DOE technology) and the technology case (i.e. all DOE technology R&D programs are successful).
2. All cumulative metrics are based on results beginning in 2010.
3. Metric includes oil-derived fuel use by light-duty vehicles, commercial light trucks and freight trucks; the metric excludes buses. Reported oil use is adjusted to exclude ethanol, biodiesel and CTL.
4. All monetary metrics are in 2006$.
5. Cumulative monetary metrics are in 2006$ that are discounted to 2010 using a 3% discount rate.

ns - Not significant
NA - Not yet available
N/A - Not applicable

Secondary Metrics for FY 2010 Budget Request

(Incorporates Approximate Impacts of EISA 2007)

	Metric[1]	Model	Year			
			2015	2020	2030	2050
Energy Security	Oil Imports Reduction, annual (Mbpd)	NEMS	ns	ns	0.2	N/A
		MARKAL	ns	0.1	0.3	0.4
	Natural Gas Imports Reduction, annual (Tcf)	NEMS	0.2	0.4	0.8	N/A
		MARKAL	0.6	0.7	0.8	1.0
	MPG Improvement[2] (%)	NEMS	ns	ns	ns	N/A
		MARKAL	ns	ns	ns	ns
Environmental Impacts	CO_2 Intensity Reduction of US Economy (Kg CO2/$GDP)	NEMS	ns	ns	ns	N/A
		MARKAL	ns	0.01	0.02	0.01
	CO_2 Intensity Reduction of US Power Sector[3] (Kg CO2/kWh)	NEMS	ns	ns	ns	N/A
		MARKAL	ns	ns	0.02	0.01
	CO_2 Intensity Reduction of US Transportation Sector[4] (Kg CO2/mile)	NEMS	ns	ns	ns	N/A
		MARKAL	ns	ns	ns	ns
Economic Impacts	Consumer Savings, annual[5] (Bil $)	NEMS	12	23	37	N/A
		MARKAL	13	30	41	76
	Electric Power Industry Savings, annual (Bil $)	NEMS	7	10	13	N/A
		MARKAL	4	13	15	24
	Energy Intensity of US Economy (energy/$GDP)	NEMS	0.08	0.18	0.23	N/A
		MARKAL	0.07	0.17	0.24	0.18
	Net Energy System Cost Reduction, cumulative (Bil $)	NEMS	N/A	N/A	N/A	N/A
		MARKAL	122	310	647	1159

1. "Reductions" and "savings" are calculated as the difference between results from the baseline case (i.e. no DOE technology) and the technology case (i.e. all DOE technology R&D programs are successful).
2. Change in light duty vehicles miles traveled per gallon of oil, where oil is only that derived from petroleum.
3. Emissions include all power sector emissions. Generation calculated as total net generation adjusted for estimated T&D losses.
4. Emissions calculated using highway fuel use and related carbon emission factor. Miles calculated as highway miles traveled, excluding buses.
5. All monetary metrics are in 2006$.

ns - Not significant
NA - Not yet available
N/A - Not applicable

The following external factors could affect ITP’s ability to achieve its goals:

- Industry’s economic health and profit margins;
- Rates of market growth/technology adoption and adoption rates of technologies;
- Labor and material costs, capital investment requirements, and cost of technologies;
- Foreign competition;
- Energy supply markets and prices; and
- Safety and environmental regulations; and environmental policies at the National and State level, including Federal efforts to reduce carbon and criteria emissions that might affect the choice of energy sources.

Contribution to the Secretary’s Priorities

ITP contributes to several of the Secretary’s priorities as enumerated below. The principal focus areas are:

Priority 1: Science and Discovery – Invest in science to achieve transformational discoveries

ITP brings together the top minds, facilities, and resources from industry, National Laboratories, and academia to spur innovations that provide tangible energy efficiency improvements in real industrial environments. The program’s National Laboratory teams maximize the synergy inherent in cooperative projects with industry and academia, while the program also leverages competitive awards and cost-sharing to magnify its impact. Through the forging of such strong industry partnerships, the Industrial Technologies Program ensures the relevance of the technology in real-world application (e.g., effective operation in harsh industrial environments) critical for accelerating technology commercialization.

ITP is working with a range of countries to support international training initiatives, the development of an independent (ANSI/ISO) plant energy certification program. In addition, the program partners with the World Bank (discussion on plant assessments in Latin America) and IEA (Industrial Energy Related Technologies & Systems), while also supporting targeted training exercises in developing Nations such as India and China that focus on energy savings. For example, ITP is engaged in a bilateral agreement with China on Energy Savings Assessments that will create a model to transfer to the top 1,000 plants.

ITP builds research networks across departments, government, Nations and the globe, and is working with the Wind and Vehicles Technologies Programs to develop new manufacturing processes for advanced wind and auto technology, in addition to partnering with other agencies (National Nanotechnology Initiative) to help emerging technologies bridge the gap between mission-oriented science and real world industrial use.

Priority 2: Clean Energy – Change the landscape of energy demand and supply

ITP’s key contribution to achieving a clean, secure energy future is through improving energy efficiency and directly reducing the demand for oil and other fuels. Industrial energy savings stimulate economic activity and reduce carbon impacts on climate today, while building U.S. technology leadership and contributing to improved energy and carbon management in the future. Significant gaps between current energy use and the practical minimum energy use for most industrial processes suggest that the industrial sector will continue to offer excellent opportunities to change the landscape of domestic energy demand through industrial energy efficiency.

The program's Industries of the Future partnerships with the most energy-intensive industries result in tangible improvements demonstrating the power of such innovation. At the same time, the ITP technology deployment activities and extensive outreach, communication, and training efforts cultivate a corporate culture of energy efficiency within the Nation's manufacturing sector.

ITP advances next generation energy technology innovation at the cutting edge in areas such as nanomanufacturing, waste heat recovery and reuse, novel chemical production routes, fuel and feedstock flexibility, and a host of other potentially revolutionary technologies. These innovations eliminate process steps, advance the use of non-fossil fuel feedstocks, or, in the case of nanomanufacturing, represent an entirely new paradigm for industrial processes.

ITP focuses on areas in industry where targeted RD&D can help science find application in the market (chemical synthesis, nanomanufacturing, etc.). Through strong collaborative partnerships that link scientists at the National Laboratories and in academia with industry, the economic fruits of successful real-world application are brought to bear.

Priority 3: Economic Prosperity – Create millions of green jobs and increase competitiveness

Reduce energy demand

Through tangible industrial energy efficiency and demand reduction improvements ITP supports the development of cost-effective technology solutions for direct real-world industrial application (in combustion, distributed generation, nanomanufacturing, and other specific industrial processes).

ITP is training the next-generation of energy engineers at university-based Industrial Assessment Centers (IACs) and supporting qualified expert training for industrial plant personnel in areas such as steam systems, motors, process heating, and compressed-air. The program's IACs send engineering students into the field to work with established experts and plant personnel to perform energy efficiency audits of a wide variety of industrial facilities. A large percentage of these students have gone on to work as industrial energy engineers, helping to found the green workforce of the future. The program also conducts training of plant staff and others to become "qualified experts" in performing energy assessments.

Priority 5: Lower GHG Emissions – Position U.S. to lead on climate change policy, technology, and science

ITP is currently developing highly energy efficient technologies that result in tangible carbon emission decreases. In addition, ITP is working to develop an ANSI/ISO standard that would independently certify the energy efficiency performance of industrial facilities.

ITP participates in international efforts to transfer certain best energy management practices to the most energy intensive sectors in China and other developing nations, while also participating in IEA annexes on industrial energy efficiency (separations, benchmarking, combustion, membranes).

Contribution to GPRA Unit Program Goal 1.3.19.00 (Industrial Technologies)

Between 2002 and 2015, industrial technologies will contribute to an 14.9 percent reduction in energy intensity (Btu per unit of industrial output as compared to 2002) in the energy-intensive Industries of the Future (a potential savings of 2.7 quads, an additional 1.0 quads above projected baseline efficiency improvements); between 2004 and 2012, target industries and RD&D partners will commercialize over 35 energy-efficiency technologies developed through the ITP partnerships.

ITP develops real-world energy solutions throughout the manufacturing value chain and helps American manufacturers uncover affordable energy saving and carbon reducing opportunities. For example, ITP's

Save Energy Now effort conducted 2,053 assessments from 2006 through March 2009 that identified large energy and cost savings for all types of manufacturers. The 1,873 plants with completed reports identified more than $1.2 billion in cost savings per year, with $190 million per year already implemented and $372 million per year underway or scheduled.

ITP continues to reduce energy use through efficiency improvements and concurrent activities that are sponsored by ITP. The program's goal reflects the increasing adoption of technologies by industry from the program's research, development and deployment portfolio over time, as the program's goals are met. The table below illustrates ITP's continuing contribution to the commercialization of technologies that result in a reduction in industrial energy intensity.

Performance Indicators:

	Historic						Planned	
	2003	2004	2005	2006	2007	2008	2009	2010
Performance Indicators								
Annual number of technologies commercialized (after 2006, that achieve 10 percent improvement in energy efficiency)								
Target	–[a]	-4	3	3	3	3	3	2
Actual	–	-6-	3	7	3	3	–	–
Annual energy savings from Industrial Technologies Program activities in partnership with industry (trillion Btu)								
Target	290	220	220	180	180	180	180	180
Actual	352	366	402	489	533	–	–	–
Annual energy savings from ITP technical assistance activities (trillion Btu)								
Target	200	200	200	200	200	100	100	100
Actual	231	255	303	399	450	–	–	–
Annual number of energy-intensive plants impacted by the program[b]								
Target	600	600	200	200	1,000	400	600	600
Actual	1,647	2,089	2,634	2,146	1,407	–	–	–
Percentage change in energy intensity from 2002								
Target	-1.2	-2.4	-3.7	-4.8	-6.0	-7.2	-8.3	-9.4
Actual	-1.3	-5.1	-8.7	-9.6	-9.1	-8.1 Est.	–	–

[a] For the purpose of establishing PART goals, the cumulative count of commercialized technologies from ITP R&D efforts was restarted, beginning with 2004 efforts. There were actually 5 commercialized technologies in 2003.
[b] "Impacted" refers to the number of unique plants receiving EERE energy efficiency information or applying EERE energy technologies and practices.

Means and Strategies

ITP's activities stimulate innovative technology research and accelerate market uptake of highly energy-efficient industrial technologies and practices. "Means" include operational processes, resources, information, and the development of technologies, and "strategies" include program, policy, management and legislative initiatives and approaches. ITP's three-part strategy is to:

- Sponsor collaborative RD&D of high risk, high impact industrial technologies and processes that radically reduce energy intensity and carbon emissions;
- Conduct technology delivery activities to help plants access and apply today's most efficient technologies and energy management practices, while at the same time training engineering students to build a green workforce for the future; and
- Promote a corporate culture of energy efficiency and carbon management within industry.

ITP implements its R&D portfolio through the following means:

- Investing in pre-competitive and high-risk RD&D that individual companies are unable to undertake without Government support;
- Cost-sharing of projects with multiple industrial and academic partners. Sharing project costs (industrial partners typically contribute 30 to 50 percent) leverages public investment with private resources, increases access to scientific capabilities, increases industry commitment to achieving R&D success, shortens the technology development and commercialization cycle, and facilitates technology delivery. ITP activities are moving from a focus on predominantly industry-specific R&D toward more technology development applicable to multiple industries; and
- Using expert technical staff from the National Laboratories to help identify priorities and develop strategies within their areas of expertise.

The program implements the following strategies to achieve its goals:

- Identify industrial energy savings opportunities with the highest potentials for saving energy and reducing carbon;
- Collaborate with industries on the development of technology roadmaps that identify their top priorities, and determine where those priorities align with ITP's mission and goals;
- Cost-sharing for reduced private partner risk in high-return R&D to innovate transformational technologies such as an entirely new processing route to achieve much lower energy use than current processes; and
- Conduct market transformation activities to accelerate the adoption of combined heat and power and other clean energy technologies.

Validation and Verification

To validate and verify program performance, ITP will report and manage its performance plan and conduct internal and external reviews and audits. These programmatic activities are subject to continuing review by, for example, the Congress, the General Accountability Office, the DOE Inspector General, the U.S. Environmental Protection Agency, and state environmental agencies. ITP will also undertake analyses to address Government Performance and Results Act (GPRA).

The table below summarizes validation and verification activities. Progress toward annual performance targets and results are also tracked on a quarterly basis through the DOE management system, Joule.

Data Sources: Energy intensity is calculated from the Energy Information Administration's (EIA's) Annual Energy Outlook, Manufacturing Energy Consumption Survey (MECS), and Department of Commerce data. The number of technologies and their energy savings are ascertained through interviews with technology developers and suppliers. Energy savings for the technical assistance programs are estimated based upon past reported participant data. Project financial data is tracked through the EERE Corporate Planning System.

Evaluation: In carrying out the program's mission, the Industrial Technologies Program uses several forms of evaluation to assess progress and to promote program improvement.

- Technology validation and operational field measurement, as appropriate;
- Peer review by independent outside experts of both the program and subprogram portfolios;
- Annual internal Technical Program Review of the Industrial Technologies Program;
- Specialized program evaluation studies to examine process, impacts, or market baseline and effects, as appropriate;
- Quarterly and annual assessment of program and management results based performance through Joule (the DOE quarterly performance progress review of budget targets); annual departmental and Program Secretarial Officer (PSO) based goals whose milestones are planned, reported and reviewed quarterly); and
- Annual review of methods, and re-computation of benefits for GPRA.

Baselines: The following are the key baselines used in ITP for contributions to its program goal:

- Industrial energy intensity (2002) 14,000 Btu/$1996 value of shipments of energy intensive industry output; and
- The baseline for the cumulative count of new commercialized technologies that achieve 10 percent improvement in energy efficiency is zero in 2003.

Frequency: EIA/MECS collects energy intensity data once every 4 years, and ITP makes annual estimates based upon data from annual Department of Commerce surveys. ITP collects data on energy savings and technologies commercialized annually.

Data Storage: Energy intensity information is contained in EIA's computer database. Data on energy savings and technologies commercialized are stored in ITP's Impacts Database and are available on the internet at http://www1.eere.energy.gov/industry/about/pdfs/impacts2006_intro.pdf. Data on the counts and impacts of plants contacted is collected by Oak Ridge National Laboratory.

Verification: ITP uses prospective and retrospective peer reviews to evaluate project performance and to adjust support. To verify program performance and results, ITP tracks all technologies commercialized (and the extent of their use) by industry through an analysis of program impacts conducted by Pacific Northwest National Laboratory. ITP also provides EIA quality control and outside peer review of the Manufacturing Energy Consumption Survey. Industry representatives review data on energy savings and technologies commercialized. ITP has conducted reviews of the impacts of several technical programs and assistance programs have also been reviewed several times.

Annual Performance Results and Targets

FY 2005 Results	FY 2006 Results	FY 2007 Results	FY 2008 Targets	FY 2009 Targets	FY 2010 Targets
GPRA Unit Program Goal 1.3.19.00 (Industrial Technologies)					
Industries of the Future (Specific)					
Commercialize 3 new technologies in partnership with the most energy-intensive industries. [MET]	Commercialize 3 new technologies in partnership with the most energy-intensive industries. [MET]	Commercialize 3 new technologies in partnership with the most energy-intensive industries that improve energy efficiency of an industrial process or product by at least 10 percent. [MET]	Commercialize 3 new technologies in partnership with the most energy-intensive industries that improve energy efficiency of an industrial process or product by at least 10 percent. [MET]	Commercialize 3 new technologies in partnership with the most energy-intensive industries that improve energy efficiency of an industrial process or product by at least 10 percent.	Commercialize 2 new technologies in partnership with the most energy-intensive industries that improve energy efficiency of an industrial process or product by at least 10 percent.
Industries of the Future (Crosscutting)					
An additional 200 (leading to a cumulative 7,000) energy intensive U.S. plants will apply EERE technologies and services. [MET]	An additional 200 (leading to a cumulative 8,600) energy intensive U.S. plants will apply EERE technologies and services contributing to the goal of a 20 percent reduction in energy intensity from 2002 levels by 2020. [MET]	An estimated 125 trillion Btus saved by an additional 1,000 energy intensive U.S. plants applying EERE technologies and services [MET]	An estimated 100 trillion Btus energy savings from applying EERE technologies and services to 400 energy-intensive U.S. plants. [MET]	An estimated 100 trillion Btus energy savings from applying EERE technologies and services to 600 energy-intensive U.S. plants.	An estimated 100 trillion Btus energy savings from applying EERE technologies and services to 600 energy-intensive U.S. plants.
Contribute proportionately to EERE's corporate goal of reducing corporate and program adjusted uncosted obligated balances to a range of 20-25 percent by reducing program annual adjusted uncosteds by 10 percent in 2005 relative to the program FY 2004 end of year adjusted uncosted baseline ($40,741K) until the target range is met. [MET]	Maintain total administrative overhead costs (defined as Program Direction and Program Support excluding earmarks) in relation to total program costs of less than 12 percent. [MET]	Maintain total administrative overhead costs (defined as Program Direction and Program Support excluding earmarks) in relation to total program costs of less than 12 percent. [MET]	Maintain administrative costs as a percent of total program costs less than 12 percent. [MET].	Maintain administrative costs as a percent of total program costs less than 12 percent.	Maintain administrative costs as a percent of total program costs less than 12 percent[a].

[a] Administrative costs are comprised of Program Direction and elements of Program Support (Technology Advancement and Outreach; and Planning, Analysis and Evaluation), baseline and targets under development.

Industries of the Future (Specific)

Funding Schedule by Activity

(dollars in thousands)

	FY 2008	FY 2009	FY 2010
Industries of the Future (Specific)			
Forest and Paper Products Industry	1,742	1,449	1,488
Steel Industry	3,576	4,380	4,500
Aluminum Industry	1,741	2,139	1,922
Metal Casting Industry	192	1,946	0
Glass Industry	0	973	0
Chemicals Industry	3,718	4,273	4,390
SBIR/STTR	—[a]	415	327
Total, Industries of the Future (Specific)	10,969	15,575	12,627

Description

The Industries of the Future (IOF) (Specific) subprogram supports cost-shared RD&D of advanced technologies to improve the energy and environmental performance of America's most energy-intensive industries. ITP partners with the most energy-intensive U.S. industries – industries that are also critical to the Nation's economic prosperity and national security – to develop solutions to their top technological challenges.

The IOF Specific subprogram has a history of strong partnerships with its industry partners - individual companies as well as trade and technical associations - that contributes to its success. These partnerships produced technology roadmaps that helped identify top industrial energy efficiency R&D priorities to pursue. Industry-specific projects sponsored by ITP have won 12 prestigious *R&D 100* awards in the past five years. Award-winners are selected by an independent panel of judges under the aegis of R&D Magazine based on the technical significance, uniqueness and usefulness of projects and technologies from across industry, government, and academia. The IOF Specific subprogram also has an excellent track record of moving innovative energy-efficient technologies from R&D through demonstration and eventual introduction to their respective markets.

In FY 2010, ITP will continue conducting critical industry-specific RD&D in partnership with key domestic industries, developing transformational technologies that dramatically reduce the energy and carbon intensity of commonly used energy-intensive processes. Specifically, the program's FY 2010 activities will include:

- Transformational RD&D on next-generation manufacturing technologies that eliminate energy-intensive process steps, including cokeless iron making, grand challenge project to create a carbon-neutral pulp mill by decreasing or eliminating fossil fuels in pulping operations, high efficiency water removal for pulp, microchannel reactors for producing high value chemicals, and hybrid membrane/distillation technologies for chemical production;

[a] SBIR/STTR funding was transferred to the Science Appropriation in FY 2008.

- Development of low- and zero-carbon processes such as carbon-neutral pulping to help key domestic industries compete in a carbon-constrained world; and
- RD&D on new high-yield, low-waste methods of manufacturing commodities like chemicals and metals, as well as metal parts and other components for downstream industries like auto manufacturing.

Energy, environmental, and productivity improvements resulting from IOF Specific RD&D will enhance the competitive position of our Nation's critical industries, and preserve jobs while significantly contributing to mitigating global climate change.

Benefits

ITP's IOF Specific RD&D is reducing the energy intensity and carbon emissions of some of the most energy-intensive processes in the Nation's major industries. The combined 2025 energy savings for IOF Specific is estimated at 266 trillion Btus. Carbon savings for that same year are estimated at 2.37 million metric tons of carbon equivalent (MMTCe).

Based on DOE modeling, by 2015 ITP will contribute to a 14.9 percent reduction in energy intensity as compared to 2002 in the energy-intensive Industries of the Future (primarily chemicals, steel, and forest products).

Detailed Justification

(dollars in thousands)

	FY 2008	FY 2009	FY 2010
Forest and Paper Products Industry	**1,742**	**1,449**	**1,488**

In FY 2010, this activity will continue to focus on accelerating the completion of research including high efficiency pulping. In addition, this key activity will focus on a grand challenge project to create a carbon-neutral pulp mill by decreasing or eliminating fossil fuels in pulping operations. Estimated annual energy savings in the year 2025 are 34 trillion Btus with carbon savings of 0.23 MMTCe.

The activity will continue to support the American Forest & Paper Association and other industry organizations to improve their member companies' energy efficiency and environmental performance through the industry's Agenda 2020 partnership. Collaborative activities will include the continuation of cost-shared RD&D, as well as the utilization of new and improved energy technologies, industrial energy efficiency tools, and energy management best practices.

	FY 2008	FY 2009	FY 2010
Steel Industry	**3,576**	**4,380**	**4,500**

In FY 2010, this activity will continue to improve energy efficiency in iron- and steel-making and to investigate recovery of valuable components of steel industry wastes, through continuing projects that were initiated in FY 2009 through competitively-selected awards. The activity will continue developing cokeless iron making technologies and will conduct advanced process development for improvements in steel manufacturing that can be broadly adopted. Activities range from blast furnace optimization to transformational iron making processes to thermochemical energy recovery in high temperature steel furnaces. Estimated annual energy savings in 2025 are 33 trillion Btus with carbon savings of 0.64 MMTCe.

	FY 2008	FY 2009	FY 2010

(dollars in thousands)

The activity will continue to support the American Iron and Steel Institute, the Steel Manufacturers' Association, and other industry organizations to improve their member companies' energy efficiency and environmental performance. The collaborative activities will include the continuation of cost-shared RD&D on, as well as the utilization of, new improved energy technologies, industrial energy efficiency tools, and energy management best practices.

	FY 2008	FY 2009	FY 2010
Aluminum Industry	**1,741**	**2,139**	**1,922**

In FY 2010, key activities will focus on the areas of efficient melting and forming. Estimated annual energy savings in 2025 are 13 trillion Btus with carbon savings of 0.12 MMTCe.

	FY 2008	FY 2009	FY 2010
Metal Casting Industry	**192**	**1,946**	**0**

In FY 2010, this activity will complete ongoing development of advanced melting technologies, efficient net-shape manufacturing processes, and technologies and practices that reduce scrap generation and increase process yields.

	FY 2008	FY 2009	FY 2010
Glass Industry	**0**	**973**	**0**

In FY 2010, ITP will complete efforts to advance next generation melting and refining systems for glassmaking.

	FY 2008	FY 2009	FY 2010
Chemicals Industry	**3,718**	**4,273**	**4,390**

In FY 2010, this key activity will focus on projects addressing alternative processes for chemical production, oxidation reactions, hybrid distillation processes, and micro-reactors. New activities will include work on game-changing technology for dramatic efficiency improvements for industrial process equipment, alternative chemical feedstocks, leveraging scientific discovery of new chemistries and its potential applications for chemical processes. RD&D in these areas will result in improved conversion of chemical processes, reduced feedstock consumption, and reduced generation of unneeded by-products and wastes. Estimated annual energy savings in 2025 are 178 trillion Btus and carbon savings of 1.31 MMTCe.

	FY 2008	FY 2009	FY 2010
SBIR/STTR	**—**	**415**	**327**

In FY 2008, $246,000 and $30,000 were transferred to the SBIR and STTR programs respectively. The FY 2009 and 2010 amounts shown are estimated requirements for the continuation of the SBIR and STTR program.

	FY 2008	FY 2009	FY 2010
Total, Industries of the Future (Specific)	**10,969**	**15,575**	**12,627**

Explanation of Funding Changes

	FY 2010 vs. FY 2009 ($000)
Forest and Paper Products Industry	
No significant change.	+39
Steel Industry	
This increase reflects increased funding to accommodate projects selected in FY09 to improve energy recovery in steel furnaces.	+120
Aluminum Industry	
This decrease reflects reduced funding levels for advanced melting technology development currently in demonstration testing.	-217
Metal Casting Industry	
This decrease is due to decreased FY 2010 project needs given the cost schedules of ongoing mutli-year projects and a FY 2010 focus on other ITP priorities for new project initiation.	-1946
Glass Industry	
This decrease is due to decreased FY 2010 project needs given the cost schedules of ongoing mutli-year projects and a FY 2010 focus on other ITP priorities for new project initiation.	-973
Chemicals Industry	
This increase would support new awards resulting from a FY 2010 solicitation focused on reducing chemical industry dependency on imported energy sources.	+117
SBIR/STTR	
Changes in the SBIR/STTR funding are a direct result of changes in the funding of program activities.	-88
Total Funding Change, Industries of the Future (Specific)	**-2,948**

Industries of the Future (Crosscutting)

Funding Schedule by Activity (Non-Comparable, or as-Appropriated, Structure)

	(dollars in thousands)		
	FY 2008	FY 2009	FY 2010
Industries of the Future (Crosscutting)			
Industrial Materials of the Future	4,727	4,653	4,781
Combustion	643	814	–[a]
Sensors and Automation	1,808	0	0
Industrial Technical Assistance			
Industrial Assessment Centers	3,998	4,035	4,035
Best Practices	8,753	15,532	28,125
Total, Industrial Technical Assistance	12,751	19,567	32,160
Energy-Intensive Process R&D	7,201	14,847	15,252
Fuel and Feedstock Flexibility	2,811	3,889	3,889
Nanomanufacturing and Other Interagency Manufacturing R&D	4,833	4,861	4,861
Industrial Distributed Energy	14,498	24,405	25,000
Energy Efficient Information Technologies	2,950	0	0
SBIR/STTR	–[b]	1,389	1,430
Total, Industries of the Future (Crosscutting)	52,222	74,425	87,373

Description

Modifications were made to the budget structure to better reflect the Industries of the Future (Crosscutting) subprogram's activities in FY 2010. The Combustion key activity is proposed to be transferred to the crosscutting Energy-Intensive Process R&D activity in FY 2010 to better integrate combustion R&D throughout Waste Energy Minimization and Recovery activities.

Industries of the Future (IOF) Crosscutting R&D provides the means for developing technologies with broad benefit across a wide base of industries, as well as for RD&D of enabling technologies not within practical developmental reach of an individual industry. These technologies continue to be used across multiple industries, providing widespread economic, energy and environmental benefits. In just the past three years, crosscutting technologies developed by ITP have won 7 prestigious *R&D 100* awards. ITP's partners on these crosscutting activities include the National Laboratories, academia, industrial companies, and equipment suppliers across many industries.

In FY 2010, ITP will:

- Accelerate the adoption of Combined Heat and Power (CHP) in industry, a technology that can improve energy efficiency, simultaneously creates green jobs, reduce GHG emissions, and improve the efficiency of U.S. industry.

[a] Prior to FY 2010, Combustion was funded as a key activity under Industries of the Future (Crosscutting). The work under this activity will be transferred to the crosscutting Energy-Intensive Process R&D activity in FY 2010.
[b] SBIR/STTR funding was transferred to the Science Appropriation in FY 2008.

- Support cutting-edge research in the Energy Intensive Processes (EIP) portfolio, initiated in 2008, to develop transformational technologies with applications across a broad spectrum of markets.
- Continue Industrial Materials of the Future RD&D.
- Focus Nanomanufacturing and Other Interagency Manufacturing RD&D activities on enabling processes for building on scientific discoveries from the National Laboratories and DOE's Basic Energy Sciences, including the mass production and application of nano-scale materials, structures, devices and systems.
- Conduct Fuel and Feedstock Flexibility activities leading to the development and adoption of alternative fuel and feedstock technologies to reduce reliance on imported oil.

ITP will also continue to promote the use of energy-efficient technologies and practices throughout industry. Deployment efforts such as the university-based Industrial Assessment Centers (IACs) and the Best Practices activities will continue conducting plant energy assessments and audits, and delivering other ITP services, technologies, and products to industrial plants nationwide. Along with transferring energy-efficient, environmentally sound practices and technologies to U.S. industries, the IACs are also preparing world-class engineers for the U.S. workforce. The program will continue coordinating the development of a voluntary accredited certification process for plant energy management, as well as energy efficiency improvement, and will continue working with the International Organization for Standardization (ISO) to develop a new international energy management standard (ISO 50001).

Benefits

ITP's IOF Crosscutting RD&D achieves energy savings and carbon reductions by:

- Improving the efficiency of widely used industrial processes (e.g., steam generation, water removal);
- Accelerating the adoption of clean, efficient distributed energy systems like CHP;
- Developing innovative new materials that can be used to make more durable manufacturing equipment and new high-value products;
- Developing economically viable nanomanufacturing methods for advanced clean energy technologies through applied RD&D on recent scientific discoveries in the field of nanotechnology; and,
- Helping companies across the country identify and address affordable energy-saving and carbon-reducing opportunities in their plants through the Save Energy Now (SEN) initiative.

Between Save Energy Now's inception in 2006 and February 2009, the initiative has conducted over 2,000 assessments at the Nation's most energy-intensive industrial facilities. For the nearly 1,875 assessments where reporting is available, opportunities were identified that could save more than 131 trillion Btus of natural gas, the amount used by nearly 2 million average U.S. homes. If fully implemented, the improvements could save over $1.2 billion dollars per year and reduce carbon dioxide emissions by 10.3 MMTCe annually.

The combined 2025 energy savings for IOF Crosscutting is estimated at 3,628 trillion Btus, or 3.63 quads. Carbon savings for that same year are estimated at 61.80 MMTCe. Of the total 2025 energy savings, 34 percent will come from longer-term research including crosscutting R&D (including EIP, industrial materials, combustion, nanomanufacturing, information technologies, industrial distributed energy and fuel and fuel/feedstock flexibility and SBIR); and 66 percent from nearer-term Industrial Technical Assistance activities.

Detailed Justification

	(dollars in thousands)		
	FY 2008	FY 2009	FY 2010
Industrial Materials of the Future	**4,727**	**4,653**	**4,781**

In FY 2010, ITP will continue to develop nanocomposites and nanocoatings, materials for energy systems and materials for separations, and advanced materials solutions such as membranes for waste energy recovery; and, refractories for industrial systems. ITP will also conduct RD&D on new high temperature corrosion-resistant materials for energy intensive applications and advanced manufacturing processes such as low-cost titanium production. New activities will include advanced energy-efficient methods for manufacture of carbon fiber composites at reduced energy and cost. Estimated potential energy savings per year from these activities in 2025 are 73 trillion Btus and carbon savings of 1.32 MMTCe.

Combustion	**643**	**814**	**–**

In FY 2010, work in this activity to develop and demonstrate ultra-high efficiency industrial boiler systems will be transferred to the crosscutting Energy-Intensive Process R&D activity.

Sensors and Automation	**1,808**	**–**	**–**

Sensors and automation projects are now covered under the crosscutting Energy-Intensive Process R&D activity, which focuses on crosscutting RD&D.

Industrial Technical Assistance

▪ **Industrial Assessment Centers (IAC)**	**3,998**	**4,035**	**4,035**

The IAC 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. This activity also supports the President's goal of training more engineers and scientists in the energy field. IAC alumni are very much in demand by top firms as energy managers with real-world knowledge and experience, ready to work on projects immediately and improve the bottom line.

In FY 2010, this activity is expected to yield annual energy savings of 119 trillion Btus in 2025 and carbon savings of 2.49 MMTCe.

▪ **Best Practices**	**8,753**	**15,532**	**28,125**

Through the SEN initiative, ITP continues to partner with leading industrial companies, plants, and supply chains to reduce their energy intensity by 25 percent over a 10 year period in alignment with EPACT 2005, Section 106 (reduce energy intensity by 2.5 percent per year from 2006 to 2016). SEN will help energy-intensive plants and new emerging sectors (such as data centers) implement cost-effective energy-saving and carbon-reducing technology solutions through the dissemination of energy assessments, 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 700 completed Energy Savings Assessments (ESAs), which have identified nearly $1 billion per year in potential energy cost savings since 2006.

	(dollars in thousands)		
	FY 2008	FY 2009	FY 2010

In FY 2010, ITP will expand its partnership with leading corporations in energy management and pilot a new voluntary ANSI-accredited[a] standard to certify a manufacturing facility for energy efficiency through a third-party verification process. As part of SEN, ITP will continue sending energy experts to the Nation's most energy-intensive manufacturing facilities to identify immediate opportunities for saving energy and money. Best Practices activities are estimated to result in energy savings in 2025 of 2,269 trillion Btus and carbon savings of 47.5 MMTCe.

	FY 2008	FY 2009	FY 2010
Total, Industrial Technical Assistance	**12,751**	**19,567**	**32,160**
Energy-Intensive Process R&D	**7,201**	**14,847**	**15,252**

In FY 2008, ITP began to transition from predominantly industry-specific R&D to more crosscutting research. To help establish priorities for this activity, ITP conducted a collaborative program planning effort with the DOE National Laboratory system and industry stakeholders to identify the major technological challenges for manufacturers. The results helped to create the EIP R&D activity, which capitalizes on the institutional knowledge and expertise of the National Laboratories, builds cross-lab teams with appropriate industry partners, and leverages industry resources to exploit opportunities. The EIP activity supports multi-industry R&D in four platform areas: Waste Energy Minimization and Recovery (this type of work used to be done under the Combustion Key Activity and includes high efficiency steam generation and improved energy recovery technologies); Industrial Reaction and Separation (including advanced water removal); High-Temperature Processing (including low-energy, high-temperature materials processing); and, Sustainable Manufacturing (including near net shape casting and forming). This shift toward larger targets of energy savings opportunities will benefit a broad set of industries, including those identified by the National Association of Manufacturers as contributing significantly to U.S. GDP (e.g., food & beverage, computer and electronic, and fabricated metal products), in the near- to mid-term time horizon (3 to 10 years). Estimated annual energy savings in 2025 are 353 trillion Btus and carbon savings of 3.16 MMTCe.

	FY 2008	FY 2009	FY 2010
Fuel and Feedstock Flexibility	**2,811**	**3,889**	**3,889**

ITP will seek to displace industrial petroleum and natural gas use through a targeted, application-focused technology development and demonstration initiative that links industrial users with advanced fuel development activities taking place throughout DOE (EERE's Biomass Program, the Office of Fossil Energy, etc.) and the National Laboratories. This activity will assist industry in integrating alternative fuels into manufacturing processes; improving fuel flexibility to reduce the damaging effects of fossil fuel price hikes; facilitate the manufacture, handling, and processing of alternative feedstocks; developing technologies that facilitate the use of alternative feedstocks by industry; and, demonstrating the feasibility of using alternative feedstocks in industrial processes. In 2010, the Fuel and Feedstock Flexibility effort will continue work initiated in earlier years. Estimated annual energy savings in 2025 are 90 trillion Btus and carbon savings of 0.81 MMTCe.

	FY 2008	FY 2009	FY 2010
Nanomanufacturing and Other Interagency Manufacturing R&D	**4,833**	**4,861**	**4,861**

ITP is helping lead the charge to transform nanotechnology science into real-world energy solutions.

[a] ANSI refers to the American National Standards Institute

	(dollars in thousands)		
	FY 2008	FY 2009	FY 2010

As part of the 25-agency National Nanotechnology Initiative, ITP complements DOE's significant investment in nanoscience by focusing on bridging the divide between mission-oriented science and the applied research necessary to catalyze market innovation and enhance the competitiveness of American manufacturers. The early success of ITP's Nanomanufacturing Initiative positions the new program as a crucial link between the National Laboratories and research universities and, a market eager to lay a new foundation for national prosperity.

Twenty projects (9 concept definition studies and 11 process/prototype projects) were selected for funding in a FY 2008 solicitation. This initial work includes development of new technologies and techniques to manufacture novel nano-catalysts and -lubricants, nano-coatings, and nano-composites; and nano-enabled processes for photovoltaic material production, and energy storage applications. Estimated annual energy savings in 2025 are 113 trillion Btus and carbon savings of 1.01 MMTCe.

Industrial Distributed Energy	**14,498**	**24,405**	**25,000**

In FY 2008, Congress re-established a distributed energy (DE) activity within ITP, including Combined Heat and Power (CHP).

In FY 2010, ITP will support the development and adoption of DE technologies to include research for clean, efficient and fuel-flexible DE/CHP systems for non-traditional CHP applications, and untapped markets in the industrial sector, including food processing plants and the growing data center sector. ITP will also pursue the growth opportunity in traditional industry CHP applications below 20 MW, including medium-sized plants that require both power and process heat. Specific activities will include the development of alternative/dual fuel capability for turbines and engines that meet the most stringent NOx and CO regulations (e.g., those in southern California); development of thermally activated technologies such as heat pumps; absorption cooling/refrigeration to address food processing and data center industry cooling needs; advanced microturbine R&D and demonstration; and innovative systems integration to optimize overall CHP system efficiency and reduce capital and O&M costs by 20 to 30 percent. Market transformation would be accomplished through a comprehensive public-private strategic partnership for CHP led by ITP, including expansion of the DOE Clean Energy Application Centers, and more aggressive use of existing partnerships (and development of new state, local, and utility partnerships) to address market, regulatory, and policy barriers. These activities are estimated to contribute as much as 579 trillion Btus of displaced energy and 5.18 MMTCe in carbon savings per year by 2025.

Energy-Efficient Information Technologies	**2,950**	**0**	**0**

Recovery Act funds will be used to collaborate with the information and communications technology industry to increase the energy efficiency of this high growth industry and to improve its energy footprint for processes ranging from equipment hardware manufacture to data center application. Activities aimed at improving the energy efficiency of data centers will continue through the Best Practices activity.

SBIR/STTR	**—**	**1,389**	**1,430**

In FY 2008, $839,000 and $101,000 were transferred to the SBIR and STTR programs respectively. The FY 2009 and 2010 amounts shown are estimated requirements for the continuation of the SBIR

	(dollars in thousands)		
	FY 2008	FY 2009	FY 2010
and STTR program.			
Total, Industries of the Future (Crosscutting)	**52,223**	**74,425**	**87,373**

Explanation of Funding Changes

	FY 2010 vs. FY 2009 ($000)
Industrial Materials of the Future	
The increase will enable increased R&D on carbon fibers, a critical material for improving the performance capabilities and efficiency of multiple advanced renewable and energy efficiency technologies.	+128
Combustion	
The decrease reflects a transition of efforts to the Energy-Intensive Process R&D activity.	-814
Sensors and Automation	
No change.	0
Industrial Technical Assistance	
▪ **Industrial Assessment Centers**	
No change.	0
▪ **Best Practices**	
This increase reflects a strategic expansion of Save Energy Now (SEN) activities through new targeted corporate outreach efforts with the most energy intensive industries in order to achieve significantly enhanced results.	+12,593
Energy Intensive Process R&D	
This increase reflects expanded activities transferred from other program elements.	+405
Fuel and Feedstock Flexibility	
No change.	0
Nanomanufacturing and Other Interagency Manufacturing R&D	
No change.	0
Industrial Distributed Energy	
This decrease reflects an expansion of activities by the DOE CHP Regional	+595

	FY 2010 vs. FY 2009 ($000)
Application Centers.	
Energy-Efficient Information Technologies	
No change.	0
SBIR/STTR	
Changes in the SBIR/STTR funding are a direct result of changes in the funding of program activities.	+41
Total Funding Change, Industries of the Future (Crosscutting)	**+12,948**

Federal Energy Management Program

Funding Profile by Subprogram

(dollars in thousands)

	FY 2008 Current Appropriation	FY 2009 Original Appropriation	FY 2010 Request
Federal Energy Management Program			
Project Financing	8,606	8,000	12,072
Technical Guidance and Assistance	8,153	4,000	8,000
Planning, Reporting and Evaluation	3,059	2,000	3,000
Federal Fleet	0	2,000	3,000
DOE Specific Investments	0	6,000	6,200
Total, Federal Energy Management Program	19,818	22,000	32,272

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" (1992)
P.L. 109-58, "Energy Policy Act of 2005" (2005)
P.L 110-140, "Energy Independence and Security Act of 2007" (2007)

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, leading by example, will reduce its greenhouse gas (GHG) emissions and will meet more of its energy requirements from clean and secure sources.

Benefits

FEMP program activities, supporting Federal agencies, would result in carbon emissions reductions near 50 million metrics tons of CO_2 by 2030 and nearly twice that by 2050. FEMP's activities will contribute to reducing the energy intensity at Federal facilities, lowering their energy bills and providing environmental benefits.

FEMP will achieve these benefits by facilitating the use of alternative financing mechanisms for Federal agencies that include energy saving performance contracts (ESPCs), utility energy service contracts (UESCs), power purchase agreements and enhanced use leases. In addition, FEMP will accelerate deployment of DOE energy efficiency and renewables technology to the Federal Government, provide technical assistance to Federal agencies, impart guidance on Federal vehicle fleet activities and report and evaluate agency progress each year. The program facilitates the award of Energy Savings Performance Contracts (ESPCs) and Utility Energy Service Contracts (UESCs) for multiple Federal agencies. These contracts between Federal agencies and the private sector fund energy efficiency improvements through the use of guaranteed energy savings on future energy bills. FEMP provides technical guidance and assistance to all Federal agencies and reports to Congress on Federal energy efficiency, renewable electric power and agency compliance with relevant public law and Executive Order requirements. For DOE, FEMP promotes internal energy management policies and planning efforts following DOE Order 430.2b which will put the Department in the forefront of implementing Federal best practices in the areas of environmental, energy, and transportation management.

FEMP directly supports the 22 Federal Agencies that report annual energy consumption to DOE and the OMB and assists OMB in assessing their performance. FEMP collaborates with agency leadership, energy and facility managers from other Federal agencies, and state and industry partners to identify key opportunities for enhancing energy efficiency and the use of renewable energy at Federal facilities. At DOE, FEMP helps program offices develop energy performance plans with their respective "landlord" sites in order to achieve energy management goals and measure progress. FEMP facilitates regular meetings among Federal agencies and industry partners; these include the Federal Interagency Energy Management Task Force, Interagency Sustainable Working Group, and the Federal Utility Partners Working Group.

The proposed FY 2010 Budget investments complement funds provided by the Recovery Act that enhance and accelerate FEMP service functions to the Federal Government, expand and enhance FEMP's data collection and project tracking activity and develop an energy use, GHG accounting protocol and tool set for Federal agencies. To enable decision makers and the public to follow performance and plans, the program will post its progress in these planned activity areas at: http://www.energy.gov/recovery/index.htm.

FEMP activities provide substantial Climate Change , Energy Security, and Economic benefits. By providing needed interagency coordination, technical expertise, training, financing resources and contracting support, FEMP helps agencies make cost-effective investments in energy efficiency and renewable energy technologies at Federal facilities which result in strategic benefits in:

<u>Climate Change</u>

Estimated CO_2 reductions near 50 million metrics tons by 2030 and twice that by 2050.

<u>Energy Security</u>

By promoting the use of alternative fuel in the fleets of Federal agencies, the Federal Fleet subprogram decreases our Nation's dependence on foreign oil, enhancing the Nation's energy security; and

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.

<u>Economic Impact</u>

FEMP facilitated investments in energy efficiency and renewable energy also increase our Nation's energy productivity, increase "green sector" jobs as well as help the economy grow; and

Estimated economic benefits show the potential to reduce cumulative net consumer expenditures by more than $20 billion by 2030 and nearly $40 billion by 2050.

The benefit tables below shows the preliminary strategic estimated benefits from 2015 through 2050 and related metrics that would result from realization of the program's goals. These benefits are achieved by assisting Federal agencies through ESPC and UESC program support, accelerating deployment of DOE energy efficiency and renewables technology to the Federal government, technical assistance to Federal agencies, guidance on Federal vehicle fleet activities, and reporting and evaluating agency progress annually on energy and transportation.

The program goal case is modeled along with a "baseline" case in which no DOE R&D exists. The baseline case is intended to represent the future without the effect of FEMP, and is identical for all DOE applied energy R&D programs, thereby ensuring that all program benefits are estimated using the same assumptions for external factors such as economic growth, energy prices, and levels of energy demand. The expected outcome benefits are calculated using the same fundamental methodology across EERE and across all of DOE's applied energy R&D programs, and the metrics by which expected outcome benefits are measured are identical. This standardization of method and metrics has been undertaken as part of DOE's efforts to make all program stated benefits comparable.

Prospective benefits are calculated as the arithmetic difference between the baseline case and the program goal case, and the resulting economic, environmental and security benefits attributed to the program's activities. This approach of calculating the benefits as an incremental improvement to the baseline helps ensure that improvements in FEMP activities that would occur in the absence of the program are not counted as part of the program's benefits. In addition to technology and process advances due to the program's activities, energy market policies, such as state and Federal tax policies, facilitate the development and deployment of clean energy technologies. The expected impacts of current legislated policies in the baseline case are included so that the expected benefits calculated reflect as much as possible the effects of activities funded by the program.

The benefits are generated by modeling both the program goal and baseline cases within two energy-economy models: NEMS-GPRA10 for benefits through 2030, and MARKAL-GPRA10 for benefits through 2050. The full list of modeled benefits appears below.

Primary Metrics for FY 2010 Budget Request

(Incorporates Approximate Impacts of EISA 2007)

	Metric[1]	Model	Year			
			2015	2020	2030	2050
Energy Security	Oil Imports Reduction, cumulative[2] (Bil bbl)	NEMS	ns	ns	ns	N/A
		MARKAL	ns	ns	ns	ns
	Natural Gas Imports Reduction, cumulative (Tcf)	NEMS	NA	NA	NA	N/A
		MARKAL	0.0	0.1	0.2	0.2
	Reduction in Share of Highway Fuel Demand Derived from Crude Oil[3] (%)	NEMS	ns	ns	ns	N/A
		MARKAL	ns	ns	ns	ns
Environmental Impacts	CO_2 Emissions Reduction, cumulative (Mil mtCO_2)	NEMS	4	16	50	N/A
		MARKAL	8	18	48	107
	SO_2 Allowance Price Reduction[4] ($/ton)	NEMS	NA	NA	NA	N/A
		MARKAL	N/A	N/A	N/A	N/A
	NO_x Allowance Price Reduction ($/ton)	NEMS	NA	NA	NA	N/A
		MARKAL	N/A	N/A	N/A	N/A
	Hg Allowance Price Reduction (thousand $/lb)	NEMS	NA	NA	NA	N/A
		MARKAL	N/A	N/A	N/A	N/A
Economic Impacts	Consumer Savings, cumulative[5] (Bil $)	NEMS	1	2	6	N/A
		MARKAL	6	12	23	37
	Electric Power Industry Savings, cumulative (Bil $)	NEMS	1	1	3	N/A
		MARKAL	6	10	12	17
	Household Energy Expenditures Reduction ($/household/yr)	NEMS	ns	ns	ns	N/A
		MARKAL	1	1	1	3

1. "Reductions" and "savings" are calculated as the difference between results from the baseline case (i.e. no DOE technology) and the technology case (i.e. all DOE technology R&D programs are successful).
2. All cumulative metrics are based on results beginning in 2010.
3. Metric includes oil-derived fuel use by light-duty vehicles, commercial light trucks and freight trucks; the metric excludes buses. Reported oil use is adjusted to exclude ethanol, biodiesel and CTL.
4. All monetary metrics are in 2006$.
5. Cumulative monetary metrics are in 2006$ that are discounted to 2010 using a 3% discount rate.

ns - Not significant
NA - Not yet available
N/A - Not applicable

Secondary Metrics for FY 2010 Budget Request

(Incorporates Approximate Impacts of EISA 2007)

	Metric[1]	Model	Year 2015	2020	2030	2050
Energy Security	Oil Imports Reduction, annual (Mbpd)	NEMS	ns	ns	ns	N/A
		MARKAL	ns	ns	ns	ns
	Natural Gas Imports Reduction, annual (Tcf)	NEMS	NA	NA	NA	N/A
		MARKAL	0.01	0.01	0.01	ns
	MPG Improvement[2] (%)	NEMS	ns	ns	ns	N/A
		MARKAL	ns	ns	ns	ns
Environmental Impacts	CO_2 Intensity Reduction of US Economy (Kg CO2/$GDP)	NEMS	NA	NA	NA	N/A
		MARKAL	ns	ns	ns	ns
	CO_2 Intensity Reduction of US Power Sector[3] (Kg CO2/kWh)	NEMS	NA	NA	NA	N/A
		MARKAL	ns	ns	ns	ns
	CO_2 Intensity Reduction of US Transportation Sector[4] (Kg CO2/mile)	NEMS	NA	NA	NA	N/A
		MARKAL	ns	ns	ns	ns
	Consumer Savings, annual[5] (Bil $)	NEMS	NA	NA	NA	N/A
		MARKAL	2	2	2	2
Economic Impacts	Electric Power Industry Savings, annual (Bil $)	NEMS	0.2	0.2	0.3	N/A
		MARKAL	2.2	0.3	0.3	0.4
	Energy Intensity of US Economy (energy/$GDP)	NEMS	NA	NA	NA	N/A
		MARKAL	0.002	0.003	0.002	0.001
	Net Energy System Cost Reduction, cumulative (Bil $)	NEMS	ns	ns	ns	N/A
		MARKAL	16	32	50	72

1. "Reductions" and "savings" are calculated as the difference between results from the baseline case (i.e. no DOE technology) and the technology case (i.e. all DOE technology R&D programs are successful).
2. All cumulative metrics are based on results beginning in 2010.
3. Metric includes oil-derived fuel use by light-duty vehicles, commercial light trucks and freight trucks; the metric excludes buses. Reported oil use is adjusted to exclude ethanol, biodiesel and CTL.
4. All monetary metrics are in 2006$.
5. Cumulative monetary metrics are in 2006$ that are discounted to 2010 using a 3% discount rate.

ns - Not significant
NA - Not yet available
N/A - Not applicable

The following external factors could affect FEMP's ability to achieve its strategic goal:

- Mission changes at Federal sites that would change building usage;
- Availability of energy management personnel at Federal sites; and
- Energy price increases that could help focus attention on energy conservation.

Contribution to the Secretary's Priorities

The FEMP Program contributes to several of the Secretary's priorities as enumerated below. The principal focus area is Priority 2, Economic Prosperity.

Priority 1: Clean Energy ─ Change the landscape of energy demand and supply

FEMP activities support the Clean Energy priority supporting energy efficiency deployment to decrease energy use in the Federal sector by providing needed interagency coordination, technical expertise, training, financing resources and contracting support, FEMP helps agencies make cost-effective investments in energy efficiency and renewable energy technologies at Federal facilities through reducing energy demand and deploying low-carbon energy technologies. Also, FEMP supports the priority of Lower GHG Emissions through facilitating deployment pathways for clean energy.

Priority 2: Economic Prosperity ─ Create millions of green jobs and increase competitiveness

FEMP's priorities are best matched with the Secretarial priority of improving our Nation's economic prosperity through reducing energy demand and deploying low-carbon energy technologies at Federal agencies. FEMP enables the Federal Government to meet relevant energy, water, and transportation goals of EISA 2007, EPAct 2005, and Executive Orders by providing needed interagency coordination, technical expertise, guidance, training, financing resources and contract program support.

Priority 5: Lower GHG Emissions ─ Position U.S. to lead on climate change policy, technology, and science

FEMP supports the priority of Lower GHG emissions through facilitating deployment pathways for clean energy through its activities across the Federal Government that help institute energy efficient, low GHG emission technologies, assistance in planning and instituting ESPC-UESC program support, energy conservation measures (ECM), and training. FEMP facilitated investments in energy efficiency and renewable energy increase our Nation's energy productivity, increase "green sector" jobs and help the economy grow.

Contribution to GPRA Unit Program Goal 1.4.07.00 (Federal Energy Management Program)

FEMP contributes to the Program Goal by assisting Federal agencies through ESPC-UESC program support, technical guidance and assistance, guidance on Federal vehicle fleet activities and reporting and evaluating agency progress each year. FEMP's assistance will help agencies reach the goals set forth by the EPAct 2005 and E.O. 13423, and EISA 2007. Current government-wide goals include:

- Improve energy efficiency and reduce GHG emissions of the agency, through reduction of energy intensity by 3 percent annually through the end of fiscal year 2015, or 30 percent by the end of fiscal year 2015, relative to the baseline of the agency's energy use in fiscal year 2003;
- Ensure that at least 3 percent of Federal electricity consumption is generated from renewable sources in the years FY 2007 through FY 2009; 5 percent in the years FY 2010 through FY 2012; and 7.5 percent in FY 2013 and each fiscal year there after.
- Ensure that at least half of the statutorily required renewable energy consumed by the agency in a fiscal year comes from new renewable sources (after 1999), and to the extent feasible, the agency implements renewable energy generation projects on agency property for agency use;
- Reduce water consumption intensity by 2 percent annually or 16 percent by the end of the FY 2015 as compared to the FY 2007 base year.
- Ensure that, if the agency operates a fleet of at least 20 motor vehicles, the agency, relative to agency baselines for fiscal year 2005, (1) reduces the fleet's total consumption of petroleum products by 2 percent annually through the end of fiscal year 2015, (2) increases the total fuel consumption that is non-petroleum-based by 10 percent annually, and (3) uses plug-in hybrid electric vehicles (PHEVs) when PHEVs are commercially available at a cost reasonably comparable, on the basis of life-cycle cost, to non-PEHVs.

Means and Strategies

The FEMP Program will use various means and strategies to achieve its GPRA Unit program goals as described below. "Means" include operational processes, resources, information, and the development of technologies, and "strategies" include program, policy, management and legislative initiatives and approaches.

FEMP will implement the following means:

- Develop policy and guidance to achieve Executive Order and legislative requirements;
- Facilitate use of ESPC-UESC programs within Federal agencies;
- Evaluate the potential of new, innovative technologies for use in the Federal sector;
- Report progress with respect to energy conservation at the Federal agencies;
- Provide oversight and approval of DOE utility contracts and support utility rate interventions; and
- Provide analysis and reporting on Federal vehicle fleet management activities to identify issues and problem areas that present challenges. FEMP works with agencies to develop strategies for addressing those issues and shares the lessons learned with other vehicle fleets.

FEMP will implement the following strategies:

- Identify high impact opportunities across Federal agencies for energy efficiency improvements and to increase the use of renewable energy;
- Identify opportunities for widespread use of energy efficient and renewable energy technologies in the Federal sector and deploy these technologies through coordinated procurement, alternative financing, or other means; and
- Recommend strategies for improved energy security for critical needs at Federal facilities.

These strategies will result in significant cost and/or energy savings and improved energy security at Federal facilities.

Validation and Verification

To validate and verify programs, FEMP conducts ongoing internal reviews of its program activities each year. In addition, external peer reviews are conducted. FEMP provides a report to Congress every year on the progress of Federal agencies on reaching their energy efficiency and renewable energy goals.

Data Sources:	Agencies submit annual reports to DOE documenting energy use in buildings, cost, gross square footage and exempt facilities and FEMP compiles this information in a report to Congress each year. For the Federal vehicle fleet activity, agencies enter fleet and fuel use data into the Federal Automotive Statistical Tool (FAST) database.
Baselines:	The baseline for the energy efficiency goal for Federal facilities of EPAct 2005, the E.O. 13423 and the Transformation Energy Action Management (TEAM) initiative is the FY 2003 energy intensity of standard and energy intensive Federal buildings – 127,015 Btu per square foot (for the entire Government). As established by E.O. 13423 (which also applies to the DOE Order 430.2b), the baseline for the Federal vehicle fleet was the amount of Federal petroleum usage in 2005 – 420 million gallons of gasoline equivalent.

Frequency: Annual.

Evaluation: In carrying out the program's mission, FEMP uses several forms of evaluation to assess progress and to promote program improvement:

- Peer review by independent outside experts of both the program and subprogram portfolios;
- Annual internal program reviews.
- Quarterly and annual assessment of program and management results based performance through Joule (the DOE quarterly performance progress review of budget targets); and
- Annual review of methods, and recomputation of potential benefits for the Government Performance and Results Act (GPRA).

Data Storage: FEMP maintains a database of reported information. Agencies maintain their own, more detailed data.

Verification: External audits are conducted each year. Reporting anomalies are identified and resolved during the annual reporting cycle.

Annual Performance Results and Targets

FY 2005 Results	FY 2006 Results	FY 2007 Results	FY 2008 Targets	FY 2009 Targets	FY 2010 Targets
GPRA Unit Program Goal 1.4.07.00 (/FEMP)					
Project Financing/Technical Guidance and Assistance/Departmental Energy Management					
		Complete ESPC and UESC contract awards, fund DOE retrofit projects and provide technical assistance that will result in lifecycle Btu savings of 17.1 trillion. [MET]	Estimated lifecycle energy savings expected in Federal agencies' facilities as a result of FEMP activities are 20.2 trillion Btus (TBtu). FEMP's facilitation activities include alternative financing, technical assistance, and directly funded energy efficiency projects within the Department. These savings should result in about a 0.4 percent annual reduction in energy intensity. [MET]	Estimated lifecycle energy savings expected in Federal agencies' facilities as a result of FEMP activities are 34.4 trillion Btus (TBtu). FEMP's facilitation activities include alternative financing, technical assistance, and directly funded energy efficiency projects within the Department. These savings should result in about a 0.5 percent annual reduction in energy intensity.	Estimated lifecycle energy savings expected in Federal agencies' facilities as a result of FEMP activities are 50.0 trillion Btus (TBtu). FEMP's facilitation activities include alternative financing and technical assistance. These savings should result in about a 0.7 percent annual reduction in energy intensity.
Project Financing					
Will achieve between $80 and $120 million in private sector investment through Super ESPCs which will result in about a 0.2 percent annual reduction in energy intensity. These projects are cost-effective resulting in a positive net present value gain for the tax payer. [NOT MET. MET reduced goal of $60 million -- $73 million in private sector investment].	Will achieve between $80 and $120 million in private sector investment through Super ESPCs and/or UESCs which we expect to result in about a 0.2 percent annual reduction in energy intensity. These projects are cost-effective resulting in a positive net present value gain for the tax payer. [MET]				

FY 2005 Results	FY 2006 Results	FY 2007 Results	FY 2008 Targets	FY 2009 Targets	FY 2010 Targets
Technical Guidance and Assistance					
Will provide technical and design assistance for 60 Federal projects which include energy efficiency, renewable energy, O&M, Distributed Energy Resources, Combined Heat and Power, SAVEnergy Audits, ALERTS and water conservation projects. These projects are cost-effective, because the technologies applied have been shown to be cost-effective by the supporting EERE programs. [MET: 73 energy efficiency and renewable projects]	Provide technical and design assistance for 27 Federal projects (e.g., energy efficiency, renewable energy, Operations and Maintenance, Distributed Energy Resources, Combined Heat and Power, Assessment of Load and Energy Reduction Techniques (ALERTS) and water conservation projects) which are expected to result in energy savings of about 60 billion Btus. [MET]				
Train 4,000 Federal energy attendees in energy management best practices supporting National Energy Policy education goals. [MET: 4844 personnel trained]					
Departmental Energy Management					
Complete the selection for funding of 4 to 13 energy efficiency projects through a competitive selection process that chooses those projects with the greatest return on investment. [MET: 13 projects selected.]	Complete the selection for funding of 3 energy retrofit projects that will provide the required dollar savings to achieve a 20 percent return on the investment of the DEMP funding. These projects will save over 12 billion Btus per year. [MET]				

FY 2005 Results	FY 2006 Results	FY 2007 Results	FY 2008 Targets	FY 2009 Targets	FY 2010 Targets
Contribute proportionately to EERE's corporate goal of reducing corporate and program adjusted uncosted obligated balances to a range of 20-25 percent by reducing program annual adjusted uncosteds by 10 percent in 2005 relative to the FEMP/DEMP Program FY 2004 end of year adjusted uncosted baseline ($11,266K) until the target range is met. [NOT MET]	Maintain total administrative overhead costs (defined as Program Direction and Program Support excluding earmarks) in relation to total program costs of less than 12 percent. [MET]	Maintain total administrative overhead costs (defined as Program Direction and Program Support excluding earmarks) in relation to total program costs of less than 12 percent. [MET]	Maintain administrative costs as a percent of total program costs less than 12 percent. [MET]	Maintain administrative costs as a percent of total program costs less than 12 percent.	Maintain administrative costs as a percent of total program costs less than 12 percent[a].

[a] Administrative costs are comprised of Program Direction and elements of Program Support (Technology Advancement and Outreach; and Planning, Analysis and Evaluation), baseline and targets under development.

Project Financing

Funding Schedule by Activity

(dollars in thousands)

	FY 2008	FY 2009	FY 2010
Project Financing	8,606	8,000	12,072
Total, Project Financing	8,606	8,000	12,072

Description

FEMP facilitates Federal agencies access to private sector financing to fund energy efficiency improvements through its Energy Savings Performance Contracts (ESPCs), public benefit funds, and Utility Energy Service Contracts (UESCs) program support. It provides guidance, documentation and individual project assistance to Federal agencies that utilize these programs which help develop and finance energy improvements at Federal facilities that are in need of significant energy system retrofits.

Benefits

These programs for 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 energy investments through the ESPC and UESC programs that will result in lifecycle Btu savings of 30.1 trillion in FY 2010, which is equivalent to displacing the energy use of about 22,000 households over the lifetime of the investment.

Detailed Justification

(dollars in thousands)

	FY 2008	FY 2009	FY 2010
Project Financing	**8,606**	**8,000**	**12,072**

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 Savings Performance Company (ESCO) through energy cost savings over the life of the projects. ESPC and UESC projects can include energy-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 will continue to add services that address the full lifecycle of FEMP facilitated alternative finance to include a determination of whether the pricing of energy conservation measures

(dollars in thousands)

	FY 2008	FY 2009	FY 2010

by an ESCO or other third parties is fair and reasonable. Project facilitators will continue to provide ESPC and UESC assistance, including identifying and screening projects and evaluating proposals. They will provide technical and contracting expertise for issues such as interest rates, competitive financing, and utility rates to support the negotiation process.

In FY 2010, FEMP will support a greater use of ESPCs by Federal agencies with a larger, more coordinated team of project facilitators, Federal financial specialists, and other technical expertise. Increased support will be provided for contracts that are awarded but need additional assistance to enforce the terms of the ESPC contract over its lifetime in areas such as providing expert witnesses in measurement and verification.

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.

	FY 2008	FY 2009	FY 2010
Total, Project Financing	**8,606**	**8,000**	**12,072**

Explanation of Funding Changes

	FY 2010 vs. FY 2009 ($000)
Project Financing	
To help meet the more aggressive goals of the National Energy Conservation Policy Act (NECPA) as amended by the Energy Independence and Security Act (EISA 2007), increased funding will support a greater use of ESPCs by Federal agencies with a larger, more coordinated team of project facilitators, Federal financial specialists, and other technical expertise. Increased funding will support services that address the full lifecycle of FEMP facilitated transactions. Regarding applicable public law and E.O., these services include assessments of Federal agency compliance needs and support for agency planning to meet those needs. In addition, these services include follow-up activities of the project financing process such as project reviews, client feedback and assistance with measurement and verification.	+4,072
Total Funding Change, Project Financing	**+4,072**

Technical Guidance and Assistance
Funding Schedule by Activity

	(dollars in thousands)		
	FY 2008	FY 2009	FY 2010
Technical Guidance and Assistance			
Direct Technical Assistance	8,153	4,000	8,000
Total, Technical Guidance and Assistance	8,153	4,000	8,000

Description

Technical Guidance and Assistance helps Federal agencies take advantage of innovative technologies, tools, and best practices in the areas of energy efficiency, renewable energy and water conservation. These activities support agency development of new and existing high performance buildings that are moving toward the goal of consuming no more energy than the energy produced at the site (a net zero energy building).

In FY 2010, FEMP will expand its assistance to Federal agencies in the procurement of energy efficient products, updating the product specifications annually and providing dedicated training and outreach to Federal procurement officials. Additional assistance will be provided to help other agencies develop more aggressive and comprehensive planning and internal processes to reduce their energy use and to achieve Federal water consumption goals.

Benefits

Technical Guidance and Assistance supports FEMP’s mission by helping 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 will result in lifecycle Btu savings of 11.1 trillion, which is equivalent to displacing the energy use of about 8,000 households over the lifetime of the investment.

Detailed Justification

	(dollars in thousands)		
	FY 2008	FY 2009	FY 2010
Direct Technical Assistance	**8,153**	**4,000**	**8,000**

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 and comprehensive planning and internal processes to reduce their energy use and to achieve the water consumption.

Technology areas include lighting, renewable energy and Combined Heat and Power (CHP) technologies. The EPAct 2005 and EISA 2007 establish FEMP's responsibility for carrying out a number of activities, including developing product specifications and issuing regulations on metering, new construction, and other energy-related building topics. FEMP will continue to update its specifications for highly energy efficient products and provide them to the General Services Administration and Defense Logistics Agency as required by the Federal purchase requirement set forth in the EPAct 2005, as well as, provide Program-specific technical training and information.

Total, Technical Guidance and Assistance	**8,153**	**4,000**	**8,000**

Explanation of Funding Changes

	FY 2010 vs. FY 2009 ($000)
Technical Guidance and Assistance	
Increased funding will support expanded assistance to Federal agencies in the procurement of energy efficient products by updating the product specifications annually and providing dedicated training and outreach to Federal procurement officials. FEMP will also expand assistance to help other agencies develop more aggressive and comprehensive planning and internal processes to reduce energy use and achieve Federal water consumption goals.	+4,000
Total Funding Change, Technical Guidance and Assistance	**+4,000**

Planning, Reporting and Evaluation
Funding Schedule by Activity

	(dollars in thousands)		
	FY 2008	FY 2009	FY 2010
Planning, Reporting and Evaluation	3,059	2,000	3,000
Total, Planning, Reporting and Evaluation	3,059	2,000	3,000

Description

NECPA (as amended by EISA 2007) requires the Department to collect, verify and report on progress by the Federal agencies (including the DOE) toward the goals that address energy efficiency in facilities. FEMP will collect and publish data for the Annual Report to Congress and respond to inquiries to help ensure accuracy in reporting and analysis of trends. Through its awards program, FEMP recognizes energy efficiency and renewable energy champions at Federal agencies.

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.

Detailed Justification

	(dollars in thousands)		
	FY 2008	FY 2009	FY 2010
Planning, Reporting and Evaluation	**3,059**	**2,000**	**3,000**

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 facilities information and developing annual plans and reports.

Information will be made available on Federal progress toward public law and E.O. goals on the FEMP website and technical updates to web-based materials will continue for the Federal sector.

FEMP activities will include strategic communications and marketing, improved analysis of investments and financing, training for FEMP personnel and critical contractor support staff and support for the GovEnergy conference.

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 the public law and E.O. goals, as well as recognizing progress

	(dollars in thousands)		
	FY 2008	FY 2009	FY 2010
through the Presidential and Federal awards programs.			
Total, Planning, Reporting and Evaluation	**3,059**	**2,000**	**3,000**

Explanation of Funding Changes

	FY 2010 vs. FY 2009 ($000)
Planning, Reporting and Evaluation	
Increased funding will support the development of a strategic communications and marketing function with an expanded range of products tailored by customer and market needs; improved analysis of investments and financing; and the expansion of training for FEMP personnel and critical contractor support staff. In addition, the GovEnergy conference will be expanded with additional training tracks, a high profile media presence and an international component.	+1,000
Total Funding Change, Planning, Reporting and Evaluation	**+1,000**

Federal Fleet

Funding Schedule by Activity

	(dollars in thousands)		
	FY 2008	FY 2009	FY 2010
Federal Fleet	0	2,000	3,000
Total, Federal Fleet	0	2,000	3,000

Description

Federal vehicle fleet activities include the required tracking and reporting activities for the Federal fleet that were previously covered under Planning, Reporting and Evaluation. Additional activities include the promotion of the increased use of alternative fuel for Federal Agency sites, Federal vehicle fleet activities support the integration of buildings, electricity and electric vehicles (EVs) or plug-in hybrid electric vehicles (PHEVs). FEMP will demonstrate opportunities for increased petroleum displacement to increase alternative fuel use and its fueling infrastructure.

Benefits

By promoting the use of alternative fuel in the fleets of Federal agencies, this program decreases our Nation's dependence on oil, enhancing the Nation's energy security, reducing emissions of GHGs, and provides leadership and examples for other large fleet operations. 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. These activities support the Bioenergy Initiative, led by EERE's Office of Biomass.

Detailed Justification

	(dollars in thousands)		
	FY 2008	FY 2009	FY 2010
Federal Fleets	**0**	**2,000**	**3,000**

Activities will include aggregating alternative fuel vehicles (AFVs) to support private sector development of alternative fuel (AF) stations and demonstrating the potential for integration of buildings, electricity and EVs or PHEVs. FEMP will demonstrate opportunities for increased petroleum displacement to increase alternative fuel and its fueling infrastructure, use of electric vehicles, use of geographic analysis for maximization of use, and specifically issues related to use of renewable electricity generation, utility integration, time-of-day charging, and potential impacts on Federal facilities.

FEMP will continue reporting on and conducting analysis of the Federal vehicle fleet activities and to implement compliance measures in each agency's fleet activity. The Federal vehicle fleet activities provide guidance and support to each agency toward compliance with legislative and E.O. requirements to reduce dependence on foreign sources of oil.

	(dollars in thousands)		
	FY 2008	FY 2009	FY 2010
Total, Federal Fleets	**0**	**2,000**	**3,000**

Explanation of Funding Changes

	FY 2010 vs. FY 2009 ($000)
Federal Fleet	
Increased funding supports enhanced communications and outreach materials, fleet tool kits for fleet managers and procurement officials, further enhancements to the web-based FAST and analysis critical to deployment of alternative fuel infrastructure.	+1,000
Total Funding Change, Federal Fleet	**+1,000**

Detailed Justification

	(dollars in thousands)		
	FY 2008	FY 2009	FY 2010
DOE Specific Investments	**0**	**6,000**	**6,200**

Activities include establishing alternative fuels infrastructure for DOE vehicle fleets; supporting use of ESPCs and UESCs at DOE facilities; providing technical guidance and assistance to DOE offices; establishing incentive awards; training DOE senior management and staff on E.O., EPAct 2005 and EISA 2007 compliance; establishing sustainable principles; identifying and deploying energy efficiency, water and renewable energy technologies; providing information and outreach; assisting with development and implementation of site energy and water plans; supporting ESPC and UESC projects, training, renewable power purchase agreements, project development and implementation assistance; and supporting deployment of smart meters on all DOE buildings.

FEMP will provide assistance to other DOE program offices to support the use of the ESPC-UESC programs, maximize direct purchases that facilitate new renewable energy projects, maximize use of DOE land for new renewable energy projects and incorporate renewable technologies into new construction where feasible.

Total, DOE Specific Investments	**0**	**6,000**	**6,200**

Explanation of Funding Changes

	FY 2010 vs. FY 2009 ($000)
DOE Specific Investments	
Increased funding will support energy assessments of significant DOE buildings to help meet Federal energy and environmental requirements.	+200
Total Funding Change, DOE Specific Investments	**+200**

DOE Specific Investments

Funding Schedule by Activity

	(dollars in thousands)		
	FY 2008	FY 2009	FY 2010
DOE Specific Investments	0	6,000	6,200
Total, DOE Specific Investments	0	6,000	6,200

Description

DOE Specific Investments includes activities designed to implement Federal environmental, energy, and transportation management goals at DOE sites. These activities support DOE Order 430.2b, which will put DOE in the forefront of implementing Federal best practice in the areas of environmental, energy, and transportation management. Since a core mission and responsibility of the DOE is to lead the Nation in promoting and utilizing the best available energy management technologies and practices, binding agreements will be set up throughout the DOE program offices in order to enable the agency to meet, exceed and lead in the implementation of Federal environmental, energy, and transportation management goals. FEMP efforts will include establishing an alternative fuel infrastructure for DOE vehicle fleets and furthering deployment of advanced energy efficiency, renewable energy and water technologies. As DOE makes further progress toward meeting its own goals, it will broaden its efforts to enable other Federal Agencies meet these goals by employing lessons learned from DOE's experience. These funds do not serve as a capital budget investment line item for Departmental infrastructure, but to allow FEMP to provide the best service possible and a strong coordination role for other DOE program offices making capital investments.

Benefits

The activities further the DOE's strategic goal of energy security by increasing the energy productivity and energy diversity and reducing the GHG emissions of energy use at the Department, while enhancing FEMP's ability to lead by example. These activities support the goal which calls for a reduction of energy intensity by 30 percent by the end of fiscal year 2015. In FY 2010, FEMP's goal is to provide assistance to DOE that will result in lifecycle Btu savings of 9.1 trillion which is equivalent to displacing the energy use of about 6,600 households over the lifetime of the investment.

REgaining our ENERGY Science and Engineering Edge (RE-ENERGYSE)
Funding Profile by Subprogram

	(dollars in thousands)		
	FY 2008 Current Appropriation	FY 2009 Original Appropriation	FY 2010 Request
RE-ENERGYSE			
Higher Education	–	–	80,000
Technical Training and K-12 Education	–	–	35,000
Total, RE-ENERGYSE	–	–	115,000

Public Law Authorizations:

Public Law 95–91, "Department of Energy Organization Act", 1977
Public Law 101–510, "DOE Science Education Enhancement Act," 1991
Public Law 109–58, "Energy Policy Act of 2005"
Public Law 110–69, "America COMPETES Act of 2007"
Public Law 110-140, "Energy Independence and Security Act of 2007" (2007)

Mission

The mission of the RE-ENERGYSE: REgaining our ENERGY Science and Engineering Edge is to educate the future leaders in energy science and technology and build a highly skilled U.S. workforce who will help develop affordable, abundant and clean energy, thus accelerating the transition to a low carbon economy.

Benefits

The United States is on the cusp of transformational changes in how energy is produced and used. Major investments are being made by the Federal government and industry in clean energy technologies that will create entirely new industries, expand markets for solar, wind and other clean energy sources, and support weatherization and other energy efficiency efforts.

A critical component of a national "green industries/green jobs" effort is to motivate our citizenry to become proficient in science, technology, engineering and mathematics (STEM) and associated energy fields and trades thus ensuring we have a 21st century workforce. The institutions that train that workforce, however, have not yet made the transition that will be required to educate the skilled U.S. workers for emerging trades and research efforts.

At the university level, for example, most of the Nation's 2,500 undergraduate and graduate programs are focused on developing general skills in STEM, and have not seen the kind of enrollment increases we need for a technically literate citizenry over the past thirty years. Very few universities have dedicated programs that will produce highly trained STEM workers with the specific skills and knowledge required by the solar, wind, biofuels and other clean energy industries. The American Association of Community Colleges estimates that less than 10 percent of the Nation's 1,700 community colleges have begun to develop curricula for renewable energy and energy efficiency career tracks, and these programs generally lack national standards and accreditation processes[a]. At all levels, from elementary school to post-doctorate programs,

[a] American Association of Community College, 2009.

interest in energy and the environment is becoming a critical issue, but students and educators do not have the resources to develop curricula, educational programs, and research opportunities to meet this need.

These shortfalls in education and training are potentially dangerous for the U.S. The Administration identified emerging energy and environmental industries and markets as the leading edge of the U.S. economic recovery effort, as well as the need to train U.S. citizens for the high wage jobs that will become available as DOE's R&D investments create new products, manufacturing/installation processes, and energy infrastructure needs.

However, training each skilled worker takes up to two years at community colleges or up to 10 years at the undergraduate and graduate levels. Furthermore, as the economy evolves, workers from industries of the past need to retrain to deliver adaptive technologies and take advantage of opportunities in clean energy trades. Today's prospering industries can also benefit from technical training that helps "green" these trades so as to efficiently evolve and apply clean energy technologies and processes in their work. Investments must be made now to develop the skilled workforce needed today and in the coming decades. These investments in human capital are essential to ensuring U.S. competitiveness and leadership on clean energy and climate change mitigation.

Other nations are not standing still and are developing industries and training programs designed to support their green energy industries. European countries, for example, control 80 percent of the wind technology market; and most of our toughest competitors are ramping up programs in solar energy, including China, which is projected to become the world's largest supporter of solar with three years.[a] On the other hand, the U.S. leads the world in wind installations but has no Masters or PhD program in wind energy, as in Europe. If the U.S. does not begin supporting the workforce that underpins these emerging technologies and markets, the Nation risks becoming a second tier producer of these products on the global market. Such an outcome could also result in the U.S. shifting dependency from one energy input to others.

Contribution to the Secretary's Priorities

RE-ENERGYSE contributes to three of the Secretary's priorities:

Priority 1: Science and Discovery – Invest in science, engineering and technology innovation to achieve transformational discoveries

RE-ENERGYSE addresses basic and applied science through the support of research fellowships and internships at DOE National Laboratories, universities, other research institutions, and the private sector. These fellowships will provide the U.S. research community with a major influx of highly specialized technical expertise that can be brought to bear on bringing new technologies to the marketplace.

Priority 2: Clean Energy – Change the landscape of energy demand and supply

RE-ENERGYSE will help create leading scientists, engineers and technicians who can accelerate the adoption and improve the reliability and performance of clean energy technologies. This will lead to transformational changes in U.S. energy demand and supply that enables the U.S. to achieve a low carbon future.

Priority 3: Economic Prosperity – Create millions of green jobs and increase competitiveness

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[a] Worldwatch Institute, *"Green Jobs: Towards Decent Work in a Sustainable, Low-Carbon World,"* September 2008

RE-ENERGYSE will educate and train Americans to adapt green technology to their industry/trade, and to enter thousands of green jobs and increase U.S. competitiveness. This effort will help universities and community colleges develop leading edge programs, with redesigned and new curricula to produce tens of thousands of other highly skilled U.S. workers who can sustain American excellence in clean energy in industry, trades, academia, the Federal government, and the DOE National Laboratories.

The Higher Education subprogram will result in the development of leading edge undergraduate and graduate programs and between 5,000 and 8,500 highly educated scientists, engineers, and other professionals to enter the clean energy field by 2015; and approximately 10,000 to 17,000 professionals by 2020. By 2015, the Technical Training and K-12 Education subprogram will result in the development of between 200 and 300 community college and other training programs to equip thousands of technically skilled workers for clean energy jobs.

Means and Strategies

RE-ENERGYSE will use various means and strategies to achieve its GPRA Unit Program goals as described below. "Means" include operational processes, resources, information, and the development of technologies; "strategies" include program, policy, management and legislative initiatives and approaches. Various external factors, as listed above, may impact the ability to achieve the program's goals.

RE-ENERGYSE will use the following means and strategies:

- Strategically plan and implement activities by coordinating with experts in education, such as DOE's Office of Science, the Department of Labor, the Department of Education, the National Science Foundation, and the American Academy of Community Colleges, to ensure that this program fills educational gaps and does not duplicate efforts;
- Leverage the capacity of universities, the DOE National Laboratories, and industry to offer educational and research opportunities that will make a critical difference in informing and inspiring students to pursue careers in clean energy;
- Reach out broadly to universities, community colleges, and other relevant institutions to encourage widespread involvement of diverse communities as well as constructive competition to stimulate the development of outstanding programs; and
- Issue competitive solicitations to ensure that high quality institutions have the means and interest to create and sustain education and training efforts.
- Dedicate up to 10 percent of each subprogram to program evaluation activities and peer reviews.

Validation and Verification

To validate and verify program performance, RE-ENERGYSE will:

- Conduct rigorous reviews of individual performance, program effectiveness, and overall programmatic accomplishment of goals.
- Use effective evaluation processes such as pre- and post-program surveys of participants, longitudinal workforce studies to determine program effectiveness, and external reviews conducted by experts in education and training.
- Conduct technical workshops with key stakeholder groups to inform priorities and implementation. Representatives from academia, industry, the Federal government,

professional societies and other stakeholder groups will provide input needed to help effectively carry out and monitor programs.

Following is a summary of validation and verification activities:

Data Sources:	A wide range of education and science organizations (e.g., National Science Foundation, National Center for Education Statistics, National Science Board, Department of Education) to inform the development of program priorities and set specific milestones. To verify the accomplishment of goals and milestones, the program will rely on data collected from grant recipients and other sources as needed, such as pre and post program surveys.
Baselines:	Baselines will be established in FY 2010 through additional analysis.
Frequency:	Annual
Evaluation:	In carrying out the program's mission, RE-ENERGYSE will use several forms of evaluation to assess progress and to promote program improvement: ▪ Critical peer review of both the program and subprogram portfolios and activities by independent outside experts; ▪ Specialized program field metrics and evaluation studies to examine process, impacts, or market baseline and effects, as appropriate; ▪ Quarterly and annual assessment of program and management results based performance through Joule (the DOE quarterly performance progress review of budget targets); and ▪ Annual review of methods, and re-computation of potential benefits for the Government Performance and Results Act (GPRA).
Data Storage:	On DOE web site
Verification:	Peer reviews and program evaluations

Annual Performance Results and Targets

FY 2005 Results	FY 2006 Results	FY 2007 Results	FY 2008 Targets	FY 2009 Targets	FY 2010 Targets
GPRA Unit Program Goal 1.1.60.00 (REgaining our ENERGY Science and Engineering Edge)					
Higher Education					*Provide education opportunities for approximately 250 to 500 university students.*
Technical Training and K-12 Education					*Initiate the development of approximately 25 clean energy technical programs at community colleges and training centers*
Other Program Goals					
REgaining our ENERGY Science and Engineering Edge Financial Efficiency Measure					
					Maintain administrative costs at less than 12 percent of total program costs.[a]

[a]Administrative costs are comprised of Program Direction and elements of Program Support (Technology Advancement and Outreach; and Planning, Analysis and Evaluation), baseline and targets under development.

Higher Education
Funding Schedule by Activity

(dollars in thousands)

	FY 2008	FY 2009	FY 2010
Higher Education			
Higher Education	–	–	80,000
Total, Higher Education	–	–	80,000

Description

The Higher Education subprogram will support fellowships, internships, post-doctoral opportunities and the development of interdisciplinary masters programs in the area of clean energy. In particular, this subprogram will offer up to 200, three-year fellowships for graduate students in engineering and other relevant fields. This subprogram will also fund up to 200 post-doctoral opportunities that will allow exceptional students to apply their skills in a laboratory setting devoted to clean energy topics. It will also fund up to 1,000 assistantships for undergraduate students to support a summer research project as well as continued study in the clean energy field with participating faculty members. Additionally, this subprogram will support the development of approximately four interdisciplinary masters programs in clean energy.

Benefits

These efforts will result in hundreds of highly qualified candidates entering into the clean energy field through various disciplines. These activities will make competitive awards to ensure support for the superior proposals, programs, and individuals. The development of an effective education pipeline will serve the needs of a growing clean energy field to ensure U.S. leadership in energy and climate change mitigation.

These opportunities for undergraduates, graduate, and post-doctoral students will support between 900 and 1,600 U.S. citizens per year who will contribute to the invention and commercialization of advanced clean energy technologies, including net zero energy buildings; inexpensive nanotechnology-based solar cells; energy storage for advanced electric cars; and smart grid technologies. Higher education programs focused on clean energy, along with funded research opportunities, will encourage students to pursue careers in clean energy research, industry, academia, and government.

Undergraduate internships for U.S. students are vital to ensuring U.S. leadership in STEM fields. Enrollment by U.S. students in STEM graduate programs from 1996 to 2006 has been relatively flat (less than one percent increase in 10 years), while foreign student enrollment in U.S. graduate programs increased by 31 percent during the same time period.[a] This subprogram's efforts in increasing the supply of U.S. STEM undergraduates interested in energy and environmental research is critical to developing a sustained pipeline of skilled energy workers for U.S. industry, academia, and U.S. research institutions.

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[a] National Science Foundation, Division of Science, Resources and Statistics, "*Survey of Graduate Students in Post-Doctorate in science and Engineering,*" Table 1, 2007

Detailed Justification

(dollars in thousands)

	FY 2008	FY 2009	FY 2010
Higher Education	–	–	**80,000**

The Higher Education subprogram is dedicated to the development of scientists, engineers, and other professionals with the skills needed to enter into the clean energy field. For all of the competitive activities funded under this subprogram, widespread outreach will be conducted at U.S. universities, scientific professional societies, and other organizations with relevant student populations. Priority will be placed on recruiting applicants from under-represented populations and applicants attending Minority Serving Institutions (MSIs). Activities within this subprogram include post-doctoral fellowships, graduate fellowships, interdisciplinary masters program, and undergraduate research internships.

The Post-Doctoral Fellowships will support between 150 and 200 post-doctoral one-year fellowships in various energy science and technology fields, with particular emphasis on energy efficiency, renewable energy, and other clean energy topics, at DOE National Laboratories, research institutions, and industry. Eligible applicants will include recent graduates as well as other professionals with a relevant Ph.D. who are interested in moving into the clean energy field. Therefore, this represents an opportunity for the clean energy sector to attract not only new doctoral students but also highly educated scientists in related fields.

These post-doctoral fellowships will fill a compelling need within clean energy and DOE workforce development pipeline. A 2008 NSF survey[a] found that of the 1,718 postdoctoral students working at DOE National Laboratories, only 39% (664) were U.S. citizens. This confirms recent reports by the National Academies of Science[b] that U.S. citizens are not pursuing STEM careers in numbers equal to those of other nations. The goal of the post-doctoral fellowships is to increase the number of U.S. citizens pursuing and obtaining STEM degrees and careers.

The Graduate Research Fellowships will support between 150 and 200, three-year fellowships leading to a Ph.D. in science, engineering and other fields such as chemistry, materials science, or computational sciences, with a particular emphasis on clean energy topics. Fellowships will provide up to three years of support over a maximum of five years, and will pay for tuition and fees at a U.S. university, travel associated with the student's research, and an annual stipend. Research fellowships will be encouraged at DOE National Laboratories, other research institutions, and at industries that conduct research in clean energy technologies. Applicants will be competitively selected by external reviewers based on an evaluation of each application against established criteria, such as the student's academic performance and interest in clean energy research.

The Masters Program in Interdisciplinary Energy Studies will solicit applicants through a competitive process offered only to U.S. universities. This activity will also support the

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[a] National Science Foundation, *"Survey of Postdoctorates at Federally Funded Research and Development Centers,"* November 2008

[b] National Academies of Science, *"Rising Above the Gathering Storm: Energizing and Employing America for a Brighter Future,"* 2005

	(dollars in thousands)	
FY 2008	FY 2009	FY 2010

development of approximately four Clean Energy University Collaborations (CEUCs) per year across the U.S. These CEUCs will develop and offer two-year programs of study in various fields including science, engineering, public policy, economics, architecture, and business. The CEUCs will support curriculum development, equip laboratories, train students, develop faculty lecture series, and dedicate specific resources to encourage innovation in the clean energy field. In addition, each CEUC will participate in an annual national student business plan competition project.

Each CEUC will offer a master's degree in "Interdisciplinary Energy Studies" related to the solution of energy problems and the advancement of energy efficiency and clean energy. The interdisciplinary master's program will require coursework in the selected discipline as well as courses focusing on public policy and economics, specialized study in energy engineering or a related energy field, energy laboratory experience, completion of a final year business plan competition project, and a part-time or summer student internship at a DOE National Laboratory, a private sector research firm, or other laboratory. Given high and growing industry demand for professionals with cross-cutting energy training, these graduates will be particularly valuable.

Currently, 143 professional science master degree programs exist at 70 U.S. universities, but none of these programs focus on interdisciplinary energy studies. The professional science masters was first introduced in 2000 in the U.S. and is one of the fastest growing segments of STEM graduate education, currently producing more than 3,000 graduates per year. Ninety percent of those graduates are recruited immediately into industrial or government employment, with the rest pursuing PhDs. This activity would support the development of professional science masters programs, specifically dedicated to clean energy studies.

The Undergraduate Internships will support up to 1,000 research appointments for undergraduate students. This activity will make competitive awards to students to participate in individually mentored research in the clean energy field. Internships can be carried out at universities, industry, and DOE National Laboratories. Through these internships, students will become a part of the research community and a source of energy innovation for DOE and the U.S.

Students will apply on a competitive basis, and will then be matched with mentors working in the student's fields of interest. The participating students will spend an intensive 10 to 16 weeks working under the individual mentorship of resident scientists, produce a peer-reviewed abstract and research paper, and attend seminars that broaden their view of energy science careers and help them understand how to become members of the energy research community. Students must also develop a coordinated plan to continue their work during the academic year, at their host university, at a DOE National Laboratory, or through a private-sector opportunity. This activity will provide hands-on experience and academic mentoring for a large group of students to improve their expertise and ability to make early contributions as they move toward careers in the clean energy field.

In FY 2010, activities will focus on setting up the process and structure of the subprogram and developing the process for issuing competitive solicitations for all of the higher education efforts for implementation in the 2010/2011 academic calendar year.

	FY 2008	FY 2009	FY 2010
Total, Higher Education	–	–	**80,000**

Explanation of Funding Changes

	FY 2010 vs. FY 2009 ($000)
Higher Education	
The increase reflects the proposed initiation of the new program.	+80,000
Total Funding Change, Higher Education	**+80,000**

Technical Training and K-12 Education
Funding Schedule by Activity

	(dollars in thousands)		
	FY 2008	FY 2009	FY 2010
Technical Training and K-12 Education			
Technical Training and K-12 Education	–	–	35,000
Total, Technical Training and K-12 Education	–	–	35,000

Description

The Technical Training and K-12 Education subprogram will support the development of effective training programs at community colleges and other training centers. Competitively-selected community colleges and other training institutions will develop up-to-date, technically accurate, curricula as well as faculty training that will focus on solving the Nation's energy challenges. Training and educational programs will be designed to meet current and near-term local market needs for a green workforce. This subprogram will also include activities designed to engage and empower K-12 students and educators to help meet the Nation's energy and environment challenges.

Benefits

Community colleges account for over 40 percent of U.S. undergraduate enrollment and enroll a majority of under-represented students in STEM. However, less than 10 percent of the Nation's 1,700 community colleges offer courses in "green technology." Those that do offer such courses, with the exception of the solar industry, lack national certification processes.

Expanding the ability of community colleges and other institutions to provide technical training and certification is a critical factor in ensuring that American workforce is scaled up and adequately trained to implement new and advanced energy technologies. Furthermore, community colleges and training centers remain a largely untapped but highly viable avenue to increase participation of under-represented as well as lower-income populations in STEM clean energy careers.

As Silicon Valley took advantage of the technical education provided by the California Community College system, the Nation must now look to community colleges to provide American workers with the necessary skills to advance energy efficiency and clean energy in the marketplace. This subprogram will ensure excellence in technical training for workers interested in entering clean energy trades. Approximately 35 to 55 technical training programs will be established each year with the capacity to train up to 3,000 highly skilled technicians each year to enter the clean energy field.

The subprogram will also reach thousands of K-12 students and educators with campaigns, curricula, competitions, and other efforts aimed at inspiring students to pursue clean energy careers and adopt sustainable energy practices that are necessary to mitigate climate change.

Detailed Justification

	(dollars in thousands)		
	FY 2008	FY 2009	FY 2010
Technical Training and K-12 Education	–	–	**35,000**

Technical training grants will be awarded through both competitive and peer reviewed processes. This subprogram will offer competitive grants to between 35 and 55 community colleges and other training institutions to develop certificate programs to train up to 3,000 U.S. technicians and faculty per year in STEM subjects with a focus on clean energy technologies, processes, and applications. Selected institutions will develop appropriate curriculum, equip laboratories, train students and faculty in clean energy fields. In addition, students and faculty at these institutions will be eligible for research internships at DOE National Laboratories, industry, and academic institutions. In FY 2010, activities will focus on setting up the structure for the competitive grants, including the development of application criteria, establishing a review process, and outreach to community colleges and other training institutions,

The K-12 Education activity will work with U.S. K-12 students and educators who are eager to contribute their ideas to the solution of long-term environment and energy challenges, but often do not have adequate knowledge about the issues or potential career opportunities. These activities will be aimed at inspiring the next generation of Americans to pursue careers in science and energy, as well as teach young students the importance of sustainable energy use in their daily lives and choices.

At the onset, DOE will seek input from a wide range of stakeholders and experts to formulate a strategy specifically targeted at enhancing K-12 interest in and understanding of science, technology, and clean energy more specifically. All K-12 targeted activities will be coordinated with educational efforts across DOE and other federal agencies. In addition to the federal sector, DOE will reach out to private and non-profit organizations involved in science education to avoid duplication and build on other effective programs.

One objective will be to excite K-12 students about how energy professionals are developing solutions to important problems associated with energy use such as climate change. Through real world examples, students will enhance their scientific literacy; and learn how they can help solve the tough challenges ahead by considering careers in energy and science.

This effort will rely on innovative approaches to engage the nation's K-12 students and teachers. For example, activities might take advantage of multimedia and modern communication technologies that younger generations most commonly use (e.g., text messaging, Twitter, You-tube, video games). As another example, DOE may issue a challenge to students and educators to identify and implement creative ways to reduce the energy use of their schools and move toward zero-carbon footprint and energy efficient buildings. Such a challenge or competition could culminate with a national showcase at a public event (e.g. Earth Week) where school teams would display their ideas, share results and experiences, learn from experts, and celebrate their successes.

Total, Technical Training and K-12 Education	–	–	**35,000**

Explanation of Funding Changes

	FY 2010 vs. FY 2009 ($000)
Technical Training and K-12 Education	
The increase reflects the proposed initiation of the new program.	+35,000
Total Funding Change, Technical Training and K-12 Education	**+35,000**

Facilities and Infrastructure
Funding Profile by Subprogram

	(dollars in thousands)			
	FY 2008 Current Appropriation	FY 2009 Original Appropriation	FY 2009 Additional Appropriation	FY 2010 Request
Facilities and Infrastructure				
National Renewable Energy Laboratory	76,176	76,000	100,700	63,000
Total, Facilities and Infrastructure	76,176	76,000	100,700[a]	63,000

Public Law Authorizations:

P.L. 95-91, "Department of Energy Organization Act" (1977)
P.L. 109-58, "Energy Policy Act of 2005" (2005)
P.L. 110-140, "Energy Independence and Security Act of 2007" (2007)

Mission

The National Renewable Energy Laboratory (NREL) is a single-purpose National Laboratory 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), as well as expert and objective counsel on energy efficiency and renewable energy matters. NREL also provides this expertise to the Offices of Electricity Delivery and Energy Reliability, Science, and Nuclear Energy, the Nuclear Security and Safety Administration.

Benefits

This Facilities and Infrastructure budget funds capital investments necessary to provide the Nation with a vibrant world-class R&D program to advance the Administration's energy policy. Included in this budget are:

- General Purpose Equipment investments that acquire shared science and support capabilities and maintains EERE's current equipment portfolio at NREL at a level of 50 percent (average) remaining portfolio value to ensure the portfolios 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 to accommodate accelerated growth consistent with the EERE approved Ten Year Site Plan; and
- General Plant Projects investments that support the safe and efficient operation of NREL and EERE programs and provide for recapitalization of real property assets in support of changing mission needs.

All these projects support and enable the Administration's energy efficiency and renewable energy priorities, EERE mission needs, DOE Directives, and the safe and efficient operation of NREL. Funding ensures the Laboratory's readiness to conduct renewable energy research in the biofuels, wind, and solar technology arenas.

The proposed FY 2010 Budget investments complement funds provided by the Recovery Act that accelerate several facilities and projects: Integrated Biorefinery Research Facility ($13.5 million);

[a] Includes $13.5 million in Biomass-related projects for the Integrated Biorefinery Research Facility

Renewable Energy and Site Infrastructure ($19.2 million), and the Research Support Facility ($68 million). To enable decision makers and the public to follow performance and plans, the program will post its progress in these planned activities at: http://www.energy.gov/recovery/index.htm.

National Renewable Energy Laboratory Funding Schedule by Activity

(dollars in thousands)

	FY 2008	FY 2009	FY 2010
National Renewable Energy Laboratory			
Operation and Maintenance			
General Plant Projects	3,331	7,000	10,000
GPP - Upgrade East Access to STM	0	0	4,000
Total, General Plan Projects	**3,331**	**7,000**	**14,000**
General Capital Equipment	3,587	3,000	5,000
GPE - Scientific Computing at Sandia National Laboratory	0	12,000	0
GPE - Science and Technology Facility (STF)/Solar Energy Research Facility (SERF) Equipment	7,927	0	0
Total, General Capital Equipment	11,514	15,000	5,000
Total, Operation and Maintenance	**14,845**	**22,000**	**19,000**
Total, Project Engineering and Design	0	0	0
Construction			
South Table Mountain Infrastructure, Zone I	6,831	0	0
South Table Mountain Infrastructure, Zone II	0	13,000	0
STM Ingress/Egress and Traffic Capacity Upgrades	0	0	44,000
Energy Systems Integration Facility	54,500	41,000	0
Total, Construction	61,331	54,000	44,000
Total, National Renewable Energy Laboratory	**76,176**	**76,000**	**63,000**

Detailed Justification

	(dollars in thousands)		
	FY 2008	FY 2009	FY 2010
Operation and Maintenance	**14,845**	**22,000**	**19,000**
▪ **General Plant Projects**	**3,331**	**7,000**	**10,000**

The Plant Projects request supports a portion of the annual investment used to upgrade and maintain the capabilities of 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 small projects include: safety and security improvements; replacement of building systems and components; replacement, maintenance, 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; and, other site improvements to maintain the viability of EERE's capital investments at NREL.

▪ **Upgrade East Access to STM (GPP)**	**0**	**0**	**4,000**

Upgrade and reconfigure 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.

▪ **General Capital Equipment**	**3,587**	**3,000**	**5,000**

The Capital Equipment (General Purpose Equipment) request maintains EERE's general scientific and administrative equipment to a minimum corporate standard of 50 percent (average) remaining portfolio value through maintenance, repair, or replacement. 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.

▪ **GPE - Scientific Computing at Sandia National Laboratory**	**0**	**12,000**	**0**

Provides funding to SNL to acquire additional high performance computing capability to ensure NREL priority access to critical computational science resources in support of NREL R&D.

▪ **GPE - Science and Technology Facility (STF)/Solar Energy Research Facility (SERF) Equipment**	**7,927**	**0**	**0**

The last installment of the previously approved Solar Energy Program equipment recapitalization project in FY 2008. This investment replaced existing equipment essential for ongoing R&D that was at or near the end of its lifetime at the Solar Energy Research Facility (SERF) and completed planned post-construction outfitting of the new Science and Technology Facility (STF).

Construction	**61,331**	**54,000**	**44,000**
▪ **South Table Mountain Infrastructure, Zone I**	**6,831**	**0**	**0**

This limited project supported approved growth at NREL's STM site through FY 2009 prior to receipt of accelerated funding. This project provides Zone I basic site infrastructure improvements necessary to efficiently and effectively accommodate current projects within the 30-year old STM utility infrastructure. This project provides minimum upgrades to site roads, water, sewer, heating and cooling systems, and communications in support of approved projects.

▪ **South Table Mountain Infrastructure, Zone II**	**0**	**13,000**	**0**

The accelerated development of NREL requires expansion of site utilities to previously undeveloped portions of the STM site. This project provides the Zone II basic site infrastructure improvements necessary to efficiently and effectively reconfigure and upgrade the 30-year old STM utility infrastructure and to add new capacity to enable accelerated implementation of the Ten Year Site Plan. EERE's current and recently approved capital projects at NREL will significantly expand site population, necessitating significant changes to current site operations including electrical service, fiber optic network and telecommunications services, water, sewer, storm water, natural gas, heating and cooling water distribution, roads and walkways, and renewable energy technologies. This project was fully funded in FY 2009.

▪ **STM Ingress/Egress and Traffic Capacity Upgrades**	**0**	**0**	**44,000**

EERE's recently approved and proposed capital projects at NREL will triple the STM site population by 2011 (adding 1,400 FTEs) necessitating significant changes to current site operations including external access, parking, and traffic flow. This project acquires an additional external site ingress/egress route for normal traffic and emergency access, stacked parking for 1,500 vehicles to preserve valuable land for R&D use, and supporting roadway reconfigurations and improvement of existing drainages necessary to accommodate the new site traffic patterns and future site development. This project is critical to the safe and cost-effective expansion of the fundamental access and traffic capacity on the NREL site.

▪ **Energy Systems Integration Facility**	**54,500**	**41,000**	**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. The ESIF enables the development of new approaches to integrate renewable into existing energy systems to accelerate the deployment of renewable energy technologies.

Total, National Renewable Energy Laboratory	**76,176**	**76,000**	**63,000**

Explanation of Funding Changes

	FY 2010 vs. FY 2009 ($000)
Operation and Maintenance	
▪ **General Plant Projects**	
Activity increases to meet the capital asset reinvestment objectives and to address backlog of deferred maintenance. Provides small projects to reconfigure current laboratory space to keep pace with new research requirements. GPP provides reconfiguration of current laboratory space to keep pace with new research requirements (+$3,000). The upgrade east access to STM (+$4,000) will provide a safer access to the STM site at the main entrance and reduce traffic concerns.	**+7,000**
▪ **General Capital Equipment**	
Activity decreases in FY 2010 due to the one time FY 2009 investment in high performance computer capability at SNL.	**-10,000**
Total, Operation and Maintenance	**-3,000**
Construction	
▪ **South Table Mountain Infrastructure, Zone II**	
This project was fully funded in FY 2009.	**-13,000**
▪ **STM Ingress/Egress and Traffic Capacity Upgrades**	
This project acquires an additional external site ingress/egress route for normal traffic and emergency access, stacked parking for 1,500 vehicles to preserve valuable land for R&D use, and supporting roadway reconfigurations and improvement of existing drainages necessary to accommodate the new site traffic patterns and future site development. This project is critical to the safe and cost-effective expansion of the fundamental traffic capacity of the NREL site.	**+44,000**
▪ **Energy Systems Integration Facility**	
In FY 2008 and FY 2009 Congress provided funding to commence design and construction of the ESIF at NREL. Request for final funding installment is deferred.	**-41,000**
Total, Construction	**-10,000**
Total Funding Change, National Renewable Energy Laboratory	**-13,000**

Capital Operating Expenses and Construction Summary
Capital Operating Expenses

(dollars in thousands)

	FY 2008	FY 2009	FY 2010
General Plant Projects	3,331	7,000	10,000
GPP – Upgrade East Access to STM	0	0	4,000
Capital Equipment	3,587	3,000	5,000
GPE - Science and Technology Facility (STF)/Solar Energy Research Facility (SERF) Equipment	7,927	0	0
GPE - Scientific Computing at Sandia National Laboratory	0	12,000	0
South Table Mountain Infrastructure, Zone I	6,831	0	0
South Table Mountain Infrastructure, Zone II	0	13,000	0
STM Ingress/Egress and Traffic Capacity Upgrades	0	0	44,000
Energy Systems Integration Facility	54,500	41,000	0
Total, Capital Operating Expenses	76,176	76,000	63,000

Construction Projects

(dollars in thousands)

	Total Estimated Cost (TEC)	Prior-Year Appropriation	FY 2008	FY 2009	FY 2010	Unappropriated Balance
Research Support Facility*	127,900	72,900	0	0	0	0
Integrated Biorefinery Research Facility*	33,500	20,000	0	0	0	0
Renewable Energy and Supporting Site Infrastructure*	17,200	0	0	0	0	0
South Table Mountain Infrastructure, Zone I	6,831	0	6,831	0	0	0
South Table Mountain Infrastructure, Zone II	13,000	0	0	13,000	0	0
STM Ingress/Egress and Traffic Capacity Upgrades	44,000	0	0	0	44,000	0
Energy Systems Integration Facility	135,000	0	54,500	41,000	0	39,500
Conference and Learning Center	25,000	0	0	0	0	0
Total, Construction Projects	**402,431**	**92,900**	**61,331**	**54,000**	**44,000**	**39,500**

*Includes Recovery Act Funding

Major Items of Equipment

(dollars in thousands)

	Total Project Cost (TPC)	Other Project Cost	Total Estimated Cost (TEC)	Prior-Year Appropriations	FY 2008	FY 2009	FY 2010	Completion Date
STF/SERF Process Development and Integration Lab	19,680	0	19,680	19,672	7,927	0	0	FY 2008
Scientific Computing at Sandia National Laboratory	12,000	0	12,000	0	0	12,000	0	FY 2009
Total, Major Items of Equipment	31,680	0	31,680	19,672	7,927	12,000	0	

10-EE-01, South Table Mountain (STM)
Ingress/Egress and Traffic Capacity Upgrades
National Renewable Energy Laboratory, Golden, Colorado

1. Significant Changes

The initial DOE O 413.3A, Critical Decision (CD-0) was approved on April 23, 2009. This project provides stacked parking, additional road access, and roadway and associated infrastructure realignments and improvements to accommodate the safe and efficient movement of vehicles and pedestrians to support consolidation of employees onto the STM site from leased facilities.

A Federal Project Director with certification Level 1 has been assigned to this project.

This Project Data Sheet (PDS) is the initial request for funding with a preliminary estimated total project cost (TPC) range of $38 to $50 Million. Project completion is expected to be completed in the 1st Quarter of FY 2012 if funding level of $44.0M is made available in FY 2010.

2. Design, Construction, and D&D Schedule[1]

(fiscal quarter or date)

	CD-0	CD-1 (Design Start)	(Design/PED Complete)	CD-2	CD-3 (Construction Start	CD-4 (Construction Complete)	D&D Start[2]	D&D Complete
FY 2010	4/23/2009	1QFY2010	TBD	3QFY2010	3QFY2010	TBD	NA	NA
FY 2011		1QFY2010	1QFY2011	3QFY2010	3QFY2010	TBD	NA	NA
FY 2012		1QFY2010	1QFY2011	3QFY2010	3QFY2010	4QFY2012	NA	NA

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

3. Baseline and Validation Status[3]

(dollars in thousands)

	TEC, PED[4]	TEC, Construction	TEC, Total	OPC Except D&D	OPC, D&D	OPC, Total	TPC	
FY 2010	TBD	TBD	TBD	TBD	NA	TBD	TBD	
FY 2011	TBD	TBD	TBD	TBD	NA	TBD	TBD	
FY 2012	TBD	TBD	TBD	TBD	NA	TBD	TBD	

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[1] Schedules are to be determined upon completion of a validated Performance Baseline. Preliminary schedule for CD-4 is approximately in the 4th quarter of FY 2012.
[2] Project is for infrastructure improvements and additions and will not result in additional facility square footage.
[3] Costs are to be determined. Preliminary cost estimate range is $38 to $50 Million (TPC).
[4] No specific PED funds have been requested. This project is being acquired using a Design-Build contracting effort.

4. Project Description, Justification, and Scope

EERE has accelerated development of NREL at the STM site to provide the research and support capabilities necessary to support its mission. EERE's current and recently approved capital projects at NREL will significantly expand site population necessitating significant changes to current site operations including parking, access, and traffic flow. This project acquires the parking, access, and roadway improvements necessary to efficiently and effectively support EERE's capital investments at NREL.

This project will provide:

- Stacked parking for 1,500 vehicles that supports a coordinated site circulation pattern and preserves land for high-value future capabilities;
- An additional site access to the south to improve site traffic flow capacity and safety response; and
- Relocation and improvement of existing site roadways, utilities, and drainages necessary to accommodate the new site traffic patterns and future site development.

This project is consistent with and supports implementation of the NREL 10-Year Site Plan.

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.

5. Financial Schedule[5]

	(dollars in thousands)		
	Appropriations	Obligations	Costs
Total Estimated Cost (TEC)			
Design[6]			
FY 2010	4,350	4,350	3,825
FY 2011	0	0	525
FY 2012	0	0	0
Total, Design	4,350	4,350	4,350
Construction			
FY 2010	38,350	38,350	3,400
FY 2011	0	0	25,225
FY 2012	0	0	9,725
Total, Construction	38,350	38,350	38,350

[5] Project does not have CD-2 approval. Costs are estimate only.
[6] No specific PED funds have been requested. This project is being acquired using a Design-Build contracting effort. Appropriations required to begin Engineering, Design and Construction.

(dollars in thousands)	Appropriations	Obligations	Costs
TEC			
FY 2010	42,700	42,700	7,225
FY 2011	0	0	25,750
FY 2012	0	0	9,725
Total, TEC	**42,700**	**42,700**	**42,700**
Other Project Cost (OPC)			
OPC except D&D			
FY 2010	625	625	625
FY 2011	235	235	235
FY 2012	440	440	440
Total, OPC except D&D	**1,300**	**1,300**	**1,300**
D&D[7]			
FY 2010	0	0	0
FY 2011	0	0	0
FY 2012	0	0	0
Total, D&D	0	0	0
OPC			
FY 2010	625	625	625
FY 2011	235	235	235
FY 2012	440	440	440
Total, OPC	**1,300**	**1,300**	**1,300**
Total Project Cost (TPC)			
FY 2010	44,000	44,000	7,850
FY 2011	0	0	25,985
FY 2012	0	0	10,165
Total, TPC[8]	**44,000**	**44,000**	**44,000**

6. Details of Project Cost Estimate

(dollars in thousands)	Current Total Estimate	Previous Total Estimate	Original Validated Baseline[9]
Total Estimated Cost (TEC)			
Design [10]			
Design	4,060	NA	TBD
Contingency	290		
Total Design	**4,350**	**NA**	TBD

[7] Project is for infrastructure improvements and additions and will not result in additional facility square footage.
[8] TPC is $42.7M of capital construction funding and $1.3M of direct funded operating dollars.
[9] Project does not have CD-2 approval. Costs are estimate only.
[10] No specific PED funds have been requested. This project is being acquired using a Design-Build contracting effort. Appropriations have been received to begin Engineering, Design and Construction.

(dollars in thousands)	Current Total Estimate	Previous Total Estimate	Original Validated Baseline[9]
Construction			
Site Preparation	1,600	NA	TBD
Equipment	0	NA	TBD
Other Construction	33,750	NA	TBD
Contingency	3,000	NA	TBD
Total, Construction	**38,350**	**NA**	TBD
Total, TEC	42,700	NA	TBD
Contingency, TEC	3,290	NA	TBD
Other Project Cost (OPC)			
OPC except D&D			
Conceptual Planning	200	NA	TBD
Conceptual Design	950	NA	TBD
Start-Up	80	NA	TBD
Contingency	70	NA	TBD
Total, OPC except D&D	1,300	NA	TBD
D&D[11]	0	NA	TBD
D&D	0	NA	TBD
Contingency	0	NA	TBD
Total, D&D	0	NA	TBD
Total, OPC	**1,300**	**NA**	TBD
Contingency, OPC	70	NA	TBD
Total, TPC	**44,000**	**NA**	TBD
Total, Contingency	3,360	NA	TBD

7. Schedule of Project Costs

For schedule of project costs, see Section 5, "Financial Schedule."

8. Related Operations and Maintenance Funding Requirements

Start of Operation or Beneficial Occupancy (fiscal quarter or date)	4QFY2012
Expected Useful Life (number of years)	50
Expected Future Start of D&D of this capital asset (fiscal quarter)	NA

[11] Project is for infrastructure improvements and additions and will not result in additional facility square footage.

(Related Funding requirements)

(dollars in thousands)

	Annual Costs		Life Cycle Costs	
	Current Total Estimate	Previous Total Estimate	Current Total Estimate	Previous Total Estimate
Operations	74	NA	6,531	NA
Maintenance	95	NA	8,345	NA
Total, Operations & Maintenance	169	NA	14,876	NA

9. Required D&D Information[12]

Area	Square Feet
Area of new construction	NA
Area of existing facility(s) being replaced	NA
Area of additional D&D space to meet the "one-for-one" requirement	NA

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 design-build strategy in which design and construction services are performed by an integrated design/construction team. The design/construction team will be selected via competition using best value contracting procedures. A Guaranteed Maximum Price will be negotiated to limit the Government's risk.

[12] Project is for infrastructure improvements and additions and will not result in additional facility square footage.

Weatherization and Intergovernmental Activities

Funding Profile by Subprogram

(dollars in thousands)

	FY 2008 Current Appropriation	FY 2009 Original Appropriation [a]	FY 2009 Additional Appropriation	FY 2010 Request
Weatherization and Intergovernmental Activities				
Weatherization Assistance Grants	227,222	450,000	5,000,000	220,000
State Energy Program	44,095	50,000	3,100,000	75,000
International Renewable Energy Program	0	5,000	−	0
Tribal Energy Activities	5,945	6,000	−	6,000
Renewable Energy Production Incentive	4,955	5,000	−	0
Energy Efficiency and Conservation Block Grants	−	−	3,200,000	−
Energy Efficient Appliance Rebate Program	−	−	300,000	−
Total, Weatherization and Intergovernmental Activities	282,217	516,000	11,600,000	301,000

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" (1992)
P.L. 109-58, "Energy Policy Act of 2005" (2005)
P.L. 110-140, "Energy Independence and Security Act of 2007"(2007)
P.L. 111-5, "American Recovery and Reinvestment Act of 2009" (2009)

Mission

The mission of the Weatherization and Intergovernmental Activities Program (WIP) is to accelerate the adoption of energy efficiency, renewable energy, and oil displacement technologies and practices by a wide range of government and business stakeholders, while promoting clean and secure energy.

Benefits

Accomplishing the Weatherization and Intergovernmental Activities' mission benefits both the supply and demand sides of DOE's clean energy security goal, enabling more productive use of energy consumption and accelerating the arrival and use of clean, affordable domestic fuels and technologies

[a] Includes $250.0 million in emergency funding for the Weatherization Assistance Grants program provided by P.L. 111-6, "The Continuing Appropriations Resolution, 2009."

that are needed to reduce dependency on foreign oils. Weatherization activities promote energy efficiency and the use of renewable energy resources at the community, state, and tribal levels enabling and effecting the incorporation of the technologies into government programs.

Weatherization activities provide benefits on multiple levels. Specifically, Weatherization Assistance Grants reduce national energy consumption while concurrently reducing energy costs for low-income families. Tribal Energy Activities, in partnership with tribal energy governments, are particularly valuable in advancing sustainable clean energy development and deployment on tribal lands. The State Energy Program (SEP) serves as a critical force in reducing energy use and costs, developing environmentally conscious economies, and increasing renewable energy generation.

The proposed FY 2010 Budget investments complement funds provided by the Recovery Act that contribute to weatherizing hundreds of thousands of low-income residences, train and provide technical assistance to states and the weatherization workforce, and contribute to reaching the SEP strategic goal (as mandated by EPACT 2005) to improve energy efficiency 25 percent by 2012. To enable decision makers and the public to follow performance and plans, the program will post its progress in these planned activities at: http://www.energy.gov/recovery/index.htm.

Weatherization and Intergovernmental Activities provide substantial climate change benefits by accelerating the deployment of clean energy technologies and sustainable energy policies. Accelerated deployment is accomplished by providing an effective combination of technical and financial assistance to program participants. The assistance results in increased adoption of energy efficiency and renewable energy technologies and implementation of policies and practices by a wide range of stakeholders, including States, local weatherization agencies, communities, institutions, companies, private citizens, and Indian tribes. Specific strategic benefits include:

<u>Climate Change</u>

Carbon savings of over 200 million metric tons of CO_2 by 2020 and more than 550 million metric tons of CO_2 by 2030.

<u>Economic Impact</u>

Cumulative consumer savings nearing $15 billion by 2015 and about half that savings to the electric power industry, thus consumer savings could double by 2030.

The benefits tables below display the estimates of primary strategic and supporting secondary benefits from 2015 through 2050 that would result from realization of Weatherization's goals. These benefits are achieved by developing and sustaining partnerships with state, local, and tribal governments, equipment suppliers, fuel and energy companies, other Federal agencies, universities, National Laboratories, and other stakeholders. These partnerships facilitate the technical coordination of activities and attract cost sharing to provide leveraged benefits. The expected benefits solely reflect the achievement of Weatherization's goals.

Prospective benefits are calculated as the arithmetic difference between the baseline case and the program goal case, and the resulting economic, environmental and security benefits attributed to the program's activities. This approach of calculating the benefits as an incremental improvement to the baseline helps ensure that improvements in training and technical assistance would occur in the absence of the program are not counted as part of the program's benefits. In addition to technology and process advances due to the program's activities, energy market policies facilitate the deployment of clean energy technologies. The expected impact of current legislated policies is included in the baseline case so that the expected benefits calculated reflect as much as possible the effects of activities funded by the program.

The benefits are generated by modeling both the program goal and baseline cases within two energy-economy models: NEMS-GPRA10 for benefits through 2030, and MARKAL-GPRA10 for benefits through 2050[a]. The following tables display the full list of modeled benefits.

Primary Metrics for FY 2010 Budget Request

(Incorporates Approximate Impacts of EISA 2007)

	Metric[1]	Model	Year			
			2015	2020	2030	2050
Energy Security	Oil Imports Reduction, cumulative[2] (Bil bbl)	NEMS	ns	0.1	0.2	N/A
		MARKAL	ns	ns	ns	0.3
	Natural Gas Imports Reduction, cumulative (Tcf)	NEMS	0.1	0.3	1.2	N/A
		MARKAL	0.3	0.9	2.2	3.9
	Reduction in Share of Highway Fuel Demand Derived from Crude Oil[3] (%)	NEMS	ns	ns	ns	N/A
		MARKAL	ns	ns	ns	ns
Environmental Impacts	CO_2 Emissions Reduction, cumulative (Mil mtCO_2)	NEMS	64	205	593	N/A
		MARKAL	95	204	552	1339
	SO_2 Allowance Price Reduction[4] ($/ton)	NEMS	ns	ns	ns	N/A
		MARKAL	N/A	N/A	N/A	N/A
	NO_x Allowance Price Reduction ($/ton)	NEMS	ns	ns	ns	N/A
		MARKAL	N/A	N/A	N/A	N/A
	Hg Allowance Price Reduction (thousand $/lb)	NEMS	ns	ns	ns	N/A
		MARKAL	N/A	N/A	N/A	N/A
Economic Impacts	Consumer Savings, cumulative[5] (Bil $)	NEMS	13	26	60	N/A
		MARKAL	44	91	193	365
	Electric Power Industry Savings, cumulative (Bil $)	NEMS	7	14	29	N/A
		MARKAL	18	39	76	131
	Household Energy Expenditures Reduction ($/household/yr)	NEMS	ns	ns	10	N/A
		MARKAL	ns	ns	ns	ns

1. "Reductions" and "savings" are calculated as the difference between results from the baseline case (i.e. no DOE technology) and the technology case (i.e. all DOE technology R&D programs are successful).
2. All cumulative metrics are based on results beginning in 2010.
3. Metric includes oil-derived fuel use by light-duty vehicles, commercial light trucks and freight trucks; the metric excludes buses. Reported oil use is adjusted to exclude ethanol, biodiesel and CTL.
4. All monetary metrics are in 2006$.
ns - Not significant
ns - Not significant
NA - Not yet available
N/A - Not applicable

Secondary Metrics for FY 2010 Budget Request

[a] Integrated energy models are used to analyze the benefits of achieving the program's technical goals. The use of integrated models provides a consistent economic framework and incorporates the interactive effects among the various programs. Interactive effects result from (1) changes in energy prices resulting from lower energy consumption, (2) the interaction between supply programs affecting the mix of generation sources and the end-use sector programs affecting the demand for electricity, and (3) additional savings from reduced energy production and delivery. Final documentation on the analysis and modeling, including all of the methodologies and underlying assumptions, is expected to be completed and posted on the web by June 15, 2009. GPRA modeling and analysis documentation for prior budget years can be found at http://www1.eere.energy.gov/ba/pba/program_benefits.html.

(Incorporates Approximate Impacts of EISA 2007)

	Metric[1]	Model	Year 2015	Year 2020	Year 2030	Year 2050
Energy Security	Oil Imports Reduction, annual (Mbpd)	NEMS	ns	0.0	0.1	N/A
		MARKAL	ns	ns	ns	ns
	Natural Gas Imports Reduction, annual (Tcf)	NEMS	0.0	0.1	0.1	N/A
		MARKAL	0.1	0.1	0.1	ns
	MPG Improvement[2] (%)	NEMS	ns	ns	ns	N/A
		MARKAL	ns	ns	ns	ns
Environmental Impacts	CO_2 Intensity Reduction of US Economy (Kg CO2/$GDP)	NEMS	ns	ns	ns	N/A
		MARKAL	ns	ns	ns	ns
	CO_2 Intensity Reduction of US Power Sector[3] (Kg CO2/kWh)	NEMS	ns	ns	ns	N/A
		MARKAL	ns	ns	ns	ns
	CO_2 Intensity Reduction of US Transportation Sector[4] (Kg CO2/mile)	NEMS	ns	ns	ns	N/A
		MARKAL	ns	ns	ns	ns
Economic Impacts	Consumer Savings, annual[5] (Bil $)	NEMS	2	5	5	N/A
		MARKAL	11	13	19	26
	Electric Power Industry Savings, annual (Bil $)	NEMS	2	2	3	N/A
		MARKAL	5	6	5	6
	Energy Intensity of US Economy (energy/$GDP)	NEMS	ns	ns	ns	N/A
		MARKAL	0.03	0.03	0.03	0.01
	Net Energy System Cost Reduction, cumulative (Bil $)	NEMS	N/A	N/A	N/A	N/A
		MARKAL	168	310	507	725

1. "Reductions" and "savings" are calculated as the difference between results from the baseline case (i.e. no DOE technology) and the technology case (i.e. all DOE technology R&D programs are successful).
2. Change in light duty vehicles miles traveled per gallon of oil, where oil is only that derived from petroleum.
3. Emissions include all power sector emissions. Generation calculated as total net generation adjusted for estimated T&D losses.
4. Emissions calculated using highway fuel use and related carbon emission factor. Miles calculated as highway miles traveled, excluding buses.
5. All monetary metrics are in 2006$.
ns - Not significant
NA - Not yet available
N/A - Not applicable

The following external factors could affect the achievement of these benefits:

- Rates of market growth/technology adoption;
- Capital investment requirements;
- Energy supply markets and prices;
- Costs and adoption of technologies;
- Partner cost share and participation rates; and
- Geopolitical changes.

Contribution to the Secretary's Priorities

Weatherization and Intergovernmental Program's objectives complement and support Secretarial clean energy and economic prosperity priorities.

Priority 2: Clean Energy Priority - Change the landscape of energy demand and supply

WIP's clean energy efforts include driving energy efficiency to decrease energy use in homes, industry and transportation by shifting electric utility emphasis towards energy efficiency. Additionally, WIP deploys clean, safe, low carbon energy supplies, including deploying demonstrated renewable energy technologies (e.g., wind, solar, geothermal) at scale and cost-effectively in low-income households; developing and sharing effective energy technology assessment and planning tools and policies; and facilitating the standardization of renewable energy certificate trading programs through program technical assistance.

Priority 3: Economic Prosperity Priority - Create millions of green jobs and increase competitiveness

In an effort to enhance economic prosperity, creating millions of green jobs and increasing competitiveness, WIP reduces energy demand by sponsoring near term residential energy retrofits for low-income residents; expanding the infrastructure for distribution of alternative fuels; and fostering national effort to increase Energy Savings Performance Contracting (EPSC). WIP contributes to creating a green workforce by preparing thousands of workers for careers in the residential energy retrofit field.

Contribution to GPRA Unit Program Goal 1.4.21.00 (Weatherization Assistance Grants)

Weatherization Assistance Grants contribute to Strategic Goal 1.4 (Energy Security, Energy Productivity) by providing cost-effective energy efficiency improvements to low-income households through the weatherization of more than forty thousand homes annually.

Contribution to GPRA Unit Program Goal 1.4.22.00 (State Energy Programs)

The State Energy Program contributes to Strategic Goal 1.4 by facilitating the deployment of energy efficiency and renewable energy technologies and sustainable energy policies.

Contribution from additional Intergovernmental Activities

Intergovernmental activities managed by Weatherization contribute to Strategic Goal 1.4 by encouraging energy efficiency and renewable energy investments through incentives and technical assistance.

Means and Strategies

WIP will use various means and strategies to achieve its GPRA Unit program goals as described below. Collaborations are integral to the planned investments, means and strategies, and will provide avenues to address external factors. "Means" include operational processes, resources, information, and the development of technologies, and "strategies" include program, policy, management and legislative initiatives and approaches.

WIP will implement the following means:

- Provide technical assistance targeting high priority energy needs and expanding clean energy choices for citizens and businesses;
- Use competitive grants to support high impact and innovative clean energy projects;
- Use formula grants to support national energy and weatherization office infrastructure;

- Assist with feasibility studies and implementation planning of energy efficiency and renewable energy resources; and
- Develop assessment, planning, and decision-making tools to facilitate clean energy technology delivery.

WIP will implement the following strategies:

- Form partnerships with program participants with an emphasis on energy market transformation, sustainable energy integration, and clean energy deployment;
- Leverage federal dollars by requiring or attracting state, local and private sector matching funds on a more than one to one basis;
- Establish policies and practices that encourage conservation and the expansion of renewable energy through collaborations with national and regional organizations representing key decision-makers (e.g., governors, mayors, state legislators, end users, and product and service providers); and
- Improve cost effectiveness and technological innovation for residential energy retrofits.

In carrying out the program's mission, Weatherization and Intergovernmental Activities collaborates with several groups on its key activities including:

- Weatherization Assistance and the State Energy Program work closely with all 50 U.S. States, the District of Columbia, and U.S. territories; and
- The Tribal Energy subprogram coordinates with the Bureau of Indian Affairs, Department of Interior, Department of Justice, and the Environmental Protection Agency through the Federal Interagency Working Group on Environmental Justice (IWG).

Validation and Verification

To validate and verify program performance, the Weatherization and Intergovernmental Activities Program will conduct internal and external reviews and audits. These programmatic activities are subject to continuing review as described below. The table below summarizes validation and verification activities.

Data Sources:	The Energy Information Administration's (EIA) Annual Energy Review (AER), Renewable Energy Annual and Annual Energy Outlook, International Energy Annual, World Energy Outlook, Country Analysis Briefs, Commercial Building Energy Consumption Survey (CBECS), Residential Energy Consumption Survey (RECS); Central Intelligence Agency (CIA) The World Factbook; U.S. Department of Commerce (DOC) Current Industrial Reports (CIR); the Golden Field Office REPI Reimbursement tracking system; NREL and various trade publications; and information collected directly from WIP performers or partners.
Baseline:	▪ The Weatherization baseline is based on market penetration of technologies after the year 2005. Savings are relative to what energy consumption would have been in the absence of this additional market penetration. ▪ The SEP baseline is state energy consumption in 1990. This baseline will be updated as part of the findings from a major national evaluation scheduled for completion in FY 2012. ▪ Tribal Energy 2003 baseline is 750kW of renewable generation capacity on tribal

lands.

Frequency: Annual (complete revalidation of assumptions and results take place every 3 to 4 years, due to the reporting cycle of two critical publications, CBECS and RECS. However, updates of most of the baseline forecast and WIP outputs will be undertaken annually).

Evaluation: In carrying out the program's mission, WIP uses several forms of evaluation to assess progress and to promote program improvement.

- Operational field measurement as appropriate;
- Peer review by independent outside experts of both the program and subprogram portfolios;
- Specialized program evaluation studies to examine process, impacts, or market baseline and effects, as appropriate;
- Quarterly and annual assessment of program and management results based performance through Joule (the DOE quarterly performance progress review of budget targets); Annual Departmental and Program Secretarial Officer (PSO) based goals whose milestones are planned, reported and reviewed quarterly); and Annual review of methods, and recomputation of potential benefits for the Government Performance and Results Act (GPRA); and
- Continue to conduct and build upon the transparent oversight and performance management initiated by Congress and the Administration.

Data Storage: EIA data sources are available on line. Trade publications are available on a subscription basis. WIP output information is contained in various reports and memoranda. Reviews and analyses conducted by Oak Ridge National Laboratory are available on line at http://www.ornl.gov/info/reports/ORNL_reports.shtml.

Verification: Calculations are based on assumptions of future market status, equipment or technology performance, and market penetration rates. These assumptions can be verified against actual performance through technical reports, market surveys and product shipments. SEP based results on an assessment of program outcomes conducted by Oak Ridge National Laboratory whose methodology was independently reviewed in FY 2005 by the Board of Directors of the International Energy Program Evaluation Conference.

Tribal Energy subprogram maintains project information and receives data from individual tribal governments.

EIA and CIA data undergo regular verification reviews.

Annual Performance Results and Targets

FY 2005 Results	FY 2006 Results	FY 2007 Results	FY 2008 Targets	FY 2009 Targets	FY 2010 Targets
GPRA Unit Program Goal 1.4.21.00 (Weatherization)					
International Renewable Energy Program					
Provide technical analysis and reviews, data access, training and project support for 7 international clean energy projects which includes: developing 2 components for GIS tools to analyze U.S. EERE technology export markets; provide phase 1 technical assistance to secure access for EERE technologies to build 1,000 MW of generation globally over 10 years. [MET]					
Tribal Energy Activities					
Tribal Energy will provide direct technical assistance to tribal Nations including: 4 development workshops, 2-3 economic development projects, 8-10 "first steps" efforts, and 6-10 feasibility studies, working toward the goal of 100 MW of generation in Indian country by 2010. [PARTIALLY MET]					
GPRA Unit Program Goal 1.4.21.00 (Weatherization)					
Weatherization Assistance Grants					
Weatherize 92,500 homes, with DOE funds, and support the weatherization of approximately 100,000 additional homes with leveraged funds. [MET]	Weatherize 97,300 low-income family homes weatherized with DOE funds. [MET]	Weatherize 70,051 low-income family homes weatherized. [MET]	94,487 low-income family homes weatherized. [MET]	Weatherize 52,360 low-income family homes. [a]	Weatherize 21,829 low-income family homes. [a]

[a] These targets do not reflect the potential impacts of funding through the Recovery Act.

FY 2005 Results	FY 2006 Results	FY 2007 Results	FY 2008 Targets	FY 2009 Targets	FY 2010 Targets
Program will update the energy savings benefit-cost ratio and savings per DOE dollar invested as part of a national evaluation of the program. This will allow the program to track an annual performance efficiency of Btus per Federal dollar invested. [MET]	The program will complete planning for and initiate implementation of the new comprehensive national evaluation of the Weatherization Assistance Program. The evaluation is a multi-year task that will provide new, accurate baselines for average energy savings, benefit cost ratios, and Btu energy savings per Federal dollar expended. [PARTIALLY MET]				
GPRA Unit Program Goal 1.4.22.00 (State Energy Program)					
State Energy Program					
Achieve an annual energy savings of 10,250,000 source Btus and $64,780.000 in annual energy cost savings with DOE funds. Achieve an annual energy savings 36,695,000 source Btus and $231,912.400 in annual energy cost savings with leveraged funds. [MET] Program will update Btu to dollar calculation derived from 2003 metrics study to establish new baseline. [MET]	Achieve an average annual energy savings of 8-10 trillion source Btus (an estimated $50-60 million in annual energy cost savings) with DOE funds. Achieve an additional average energy savings of 26-30 trillion source Btus (an estimated $190-$200 million in annual energy cost savings) from leveraged funds. [MET]	Achieve an average annual energy savings of 12-14 trillion source Btus (an estimated $72-78 million in annual energy cost savings) with DOE funds. [MET]	Achieve an average annual energy savings of 10-12 trillion source Btus (an estimated $60-70 million in annual energy cost savings) with DOE funds. [MET]	Achieve an average annual energy savings of 6-7 trillion source Btus (an estimated $45 million in annual energy cost savings) with DOE funds.[a]	Achieve an average annual energy savings of 9-10 trillion source Btus (an estimated $65-70 million in annual energy cost savings) with DOE funds. [a]

[a] These targets do not reflect the potential impacts of funding through the Recovery Act.

FY 2005 Results	FY 2006 Results	FY 2007 Results	FY 2008 Targets	FY 2009 Targets	FY 2010 Targets
Other Program Goals					
Weatherization and Intergovernmental Activities Financial Efficiency Measure					
Contribute proportionately to EERE's corporate goal of reducing corporate and program adjusted uncosted obligated balances to a range of 20-25 percent by reducing program annual adjusted uncosteds by 10 percent in 2005 relative to the program FY 2004 end of year adjusted uncosted baseline ($21,257K) until the target range is met. [MET]	Maintain total administrative overhead costs (defined as Program Direction and Program Support excluding earmarks) in relation to total program costs of less than 12 percent. [MET]	Maintain total administrative overhead costs (defined as Program Direction and Program Support excluding earmarks) in relation to total program costs of less than 12 percent. [MET]	Maintain administrative costs at less than 12 percent of total program costs. [MET]	Maintain administrative costs at less than 12 percent of total program costs.	Maintain administrative costs at less than 12 percent of total program costs.[a]

[a] Administrative costs are comprised of Program Direction and elements of Program Support (Technology Advancement and Outreach; and Planning, Analysis and Evaluation), baseline and targets under development.

Weatherization Assistance Grants

Funding Schedule by Activity

(dollars in thousands)

	FY 2008	FY 2009	FY 2010
Weatherization Assistance Grants			
Weatherization Assistance	222,713	436,770	216,700
Training and Technical Assistance	4,509	13,230	3,300
Total, Weatherization Assistance Grants	227,222	450,000	220,000

Description

Weatherization Assistance Grants increase residential energy efficiency and reduce energy costs of low-income families. The grants provide technical and financial assistance in support of state and local weatherization agencies throughout the U.S. This network of approximately 900 local agencies provides trained crews to perform residential weatherization services for eligible households. Elderly people with special needs or people with disabilities occupy approximately 49 percent of the homes weatherized annually.

States utilize portions of Weatherization Assistance Grants for training and technical support. This includes managerial and hands-on technical training, state-level energy saving evaluations, and updates to health, safety, and client education protocols. In addition, DOE, in collaboration with program stakeholders, conducts regional and national training and technical assistance activities that benefit all States.

Recent legislative changes include:

- Increasing the allowable investment per home from $2,500 to $6,500;
- Raising income eligibility from a maximum of 150 percent to 200 percent of the poverty level;
- Increasing the maximum training and technical assistance funding from 10 to 20 percent;
- Adding American Samoa, Guam, Commonwealth of the Northern Mariana Islands, Commonwealth of Puerto Rico, and the U.S. Virgin Islands as recipients; and
- Allowing renewable energy measures to be utilized.

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 funding survey. Information is generally updated in June of each year. The following table displays the most current information:

Weatherization Assistance Funding

(whole dollars)

State/Territory	Source of Non-Federal Funds	FY 2009 Federal DOE Funds	FY 2007 Non-Federal Funds[a]
Alabama	N/A	$5,459,000	$300,000
Alaska	Alaska Housing Finance Corp (State)	$2,554,000	$4,200,000
Arizona	Utility funds	$4,079,000	$0
Arkansas	Utility funds	$4,032,000	$407,437
California	(Utility funds operated at local level)	$14,161,000	$0
Colorado	Utility funds	$9,122,000	$2,700,000
Connecticut	(Utility funds operated at local level)	$5,315,000	$4,739,332
Delaware	Utility funds	$1,183,000	$1,034,000
Dist. Columbia	Utility Funds	$999,000	$3,545,000
Florida	State Funds for WAP Repair Program	$9,885,000	$3,000,000
Georgia	Utility funds	$8,295,000	$1,900,000
Hawaii	N/A	$394,000	$0
Idaho	Utility funds and private sources	$3,366,000	$1,932,033
Illinois	State public benefit funds	$24,070,000	$7,500,000
Indiana	(Utility funds operated at local level)	$12,342,000	$2,500,000
Iowa	Utility funds	$8,579,000	$4,823,114
Kansas	N/A	$5,002,000	$0
Kentucky	N/A	$7,641,000	$0
Louisiana	N/A	$3,623,000	$0
Maine	State Public Utility Commission funds	$4,925,000	$0
Maryland	(Utility funds operated at local level)	$5,280,000	$2,039,500
Massachusetts	(Utility funds operated at local level)	$11,795,000	$22,000,000
Michigan	N/A	$25,950,000	$9,000,000
Minnesota	Utility funds and special State funds	$15,973,000	$1,535,556
Mississippi	N/A	$3,744,000	$0
Missouri	Utility funds	$11,566,000	$2,908,869
Montana	Utility funds	$3,760,000	$2,100,000
Nebraska	N/A	$4,372,000	$0
Nevada	Utility funds	$2,548,000	$3,757,000

[a] FY 2008 non-Federal funding data not available until June, 2009

(whole dollars)

State/Territory	Source of Non-Federal Funds	FY 2009 Federal DOE Funds	FY 2007 Non-Federal Funds[a]
New Hampshire	Utility funds	$2,534,000	$2,117,349
New Mexico	Utility funds	$3,224,000	$823,000
New York	Utility funds, landlord contributions, other private funds	$36,654,000	$10,000,000
North Carolina	N/A	$9,767,000	$0
North Dakota	N/A	$3,679,000	$0
Ohio	Utility funds, landlord contributions, other private funds	$25,174,000	$18,000,000
Oklahoma	Landlord contributions, other private funds	$5,150,000	$500,000
Oregon	Utility funds	$4,563,000	$7,462,152
Pennsylvania	(Utility funds operated at local level)	$25,401,000	$0
Rhode Island	Utility funds	$2,023,000	$1,812,000
South Carolina	N/A	$4,242,000	$50,000
South Dakota	N/A	$3,020,000	$0
Tennessee	N/A	$8,571,000	$0
Texas	Utility funds	$19,794,000	$2,049,865
Utah	Utility funds, TANF	$3,818,000	$1,191,000
Vermont	VT Weatherization Trust Fund	$2,021,000	$6,741,517
Virginia	Emergency Home Repair funds	$8,026,000	$0
Washington	Utility funds and State capital funds	$7,244,000	$7,200,000
West Virginia	Utility funds	$4,818,000	$1,748,650
Wisconsin	Utility funds	$14,966,000	$50,972,792
Wyoming	N/A	$1,696,000	$2,876,678
American Samoa	N/A	$197,000	$0
Guam	N/A	$199,000	$0
Puerto Rico	N/A	$453,000	$0
Northern Mariana Islands	N/A	$197,000	$0
Virgin Islands	N/A	$200,000	$0
Headquarters Training and Technical Assistance		$22,230,000	$0
Total, Weatherization Assistance Funding		$450,000,000	$200,191,844

[a] FY 2008 non-Federal funding data not available until June, 2009

Benefits

Weatherization Assistance contributes to the Secretarial goals of reducing energy demand and creating a green workforce. Since 1976, the program has helped 6.2 million American families, resulting in an average reduction of their 2008 energy costs by $413 ($358 in 2007) and increasing the comfort and safety of their homes. Weatherization returns $1.65[a] ($1.54 in 2007) in energy-related benefits for every $1 invested. The program also provides specialized training and career development opportunities to thousands of workers in the residential home energy audit and retrofit field.

Detailed Justification

(dollars in thousands)

	FY 2008	FY 2009	FY 2010
Weatherization Assistance	**222,713**	**436,770**	**216,700**

The Weatherization Assistance Program is one of the largest and most technically advanced residential energy retrofit providers. Funds are allocated on a formula basis and awarded to States, U.S. Territories, 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.

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 funded training allows for the introduction advanced assessment and installation techniques and continuing professional development for workers.

The FY 2009 target is to weatherize 52,360 low-income homes. The majority of the Weatherization Assistance funding is allocated to the States as operating funds for this purpose, i.e., for labor, materials, equipment and administrative systems. The Recovery Act increased the percentage (approximately twice as much as previous years) of the total program funding allocated for state-based training and technical assistance to maintain a high standard of technology application, effectiveness and results. Most training and technical assistance is performed at state and local levels.

[a] Assuming $5,274 savings, with twenty year life of measures, discounted at OMB mandated rates. ORNL Study, *"Estimating The National Effects Of the U.S. Department of Energy's Weatherization Assistance Program With State-Level Data"*, 2005.

	FY 2008	FY 2009	FY 2010
	(dollars in thousands)		
Training and Technical Assistance	**4,509**	**13,230**	**3,300**

DOE directed weatherization training and technical assistance activities improve the effectiveness and efficiency of the Weatherization Assistance Program. These resources support strategic planning and analysis; measuring and documenting program performance; and facilitating (e.g., through pilot programs, publications, training programs, workshops and peer exchange) the utilization of advanced techniques and collaborative strategies. In FY 2006, a national evaluation to assess the overall energy savings and cost-effectiveness of the program was initiated.

Total, Weatherization Assistance Grants	**227,222**	**450,000**	**220,000**

Explanation of Funding Changes

	FY 2010 vs. FY 2009 ($000)
Weatherization Assistance	
The decrease is due to the availability of funding from the Recovery Act, which is available for obligation through September 2010.	-220,070
Technical and Training Assistance	
The decrease is due to the availability of funding from the Recovery Act, which is available for obligation through September 2010.	-9,930
Total, Weatherization Assistance Program	**-230,000**

State Energy Program

Funding Schedule by Activity

	(dollars in thousands)		
	FY 2008	FY 2009	FY 2010
State Energy Program			
State Energy Program Formula Grant	34,186	25,000	37,500
State Energy Program Special Projects	9,909	25,000	37,500
Total, State Energy Program	44,095	50,000	75,000

Description

The State Energy Program (SEP) reduces energy use and cost, increases renewable energy capacity and production, and lessens dependence on foreign oil. The program provides technical and financial resources to help States develop and manage a variety of high impact energy programs. Financial assistance is provided in the form of formula grants and competitive clean energy project grants. States often combine many sources of funding for their projects, including DOE and private industry.

Formula grants allow state energy offices the flexibility to develop energy projects focused on the buildings, electric power, industry, and/or transportation sectors, as well as crosscutting policy initiatives and public information campaigns. The SEP competitive grants allow DOE to target high impact projects aimed toward critical policy and regulatory changes, including the adoption of advanced building codes, prioritization of energy efficiency in resource planning and decoupling of utility earnings from volumetric energy sales. Major energy efficiency efforts can reduce transmission grid bottlenecks and congestion, provide ongoing support to the economy in the form of reduced and more affordable energy costs, increase U.S. international competitiveness and improve the comfort and quality of life for millions of people.

A portion of program funding is used for: 1) outreach and technical assistance to States, such as, development of state and regional best practices; 2) innovative sustainable energy initiatives; and 3) performance management.

Benefits

The program contributes to the Secretarial goals of increasing energy efficiency and clean energy deployment. SEP helps state and local governments make investments, which result in greater energy efficiency, expanded renewable energy capacity, and reduced carbon emissions. Examples of supporting activities include: 1) Facilitating a robust national renewable energy certificate trading program; 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; and 3) Initiating a national effort with States and the energy services industry to accelerate the use of ESPCs in state and local government buildings, schools, universities and hospitals.

Detailed Justification

	(dollars in thousands)		
	FY 2008	FY 2009	FY 2010
State Energy Program Formula Grant	**34,186**	**25,000**	**37,500**

Formula-based grants allow States (States, the District of Columbia, and U.S. Territories) to address their energy priorities through the design and implementation of renewable energy and energy efficiency programs. These grants also support the development and maintenance of energy emergency planning at the state and local levels, a critical security benefit and maintain the viability of the state energy office network.

State Energy Program Special Projects	**9,909**	**25,000**	**37,500**

SEP competitive Special Projects focus on specific high impact market transformation and crosscutting solutions, and also provide valuable technical assistance to States. The most recent solicitation cycle resulted in the award of $6.6 million in competitive grants for 15 state-level projects, nine of which focused on developing policy and regulations to support gigawatt-scale clean energy capacity, and six of which focused on developing advanced building codes. Additional areas of interest include: 1) expanding work with States and utilities to improve the liquidity of renewable power as a commodity of high market value to consumers; and 2) scale up the use of ESPCs in state and local buildings.

DOE also conducts analysis, outreach, and technical assistance to increase program efficiency and effectiveness. These resources are used for: 1) tools development and other technical assistance provided to States; 2) national energy initiatives and strategic partnerships; and 3) 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 and enhancing web-based reporting and monitoring systems.

Total, State Energy Program	**44,095**	**50,000**	**75,000**

Explanation of Funding Changes

	FY 2010 vs. FY 2009 ($000)
State Energy Program Formula Grants	
The increase will support the expansion of state capabilities to deploy energy efficiency and renewable energy technology to local government, businesses, and consumers.	+12,500
State Energy Program Special Projects	
The increase will support enhanced technical assistance to States, continued development of web-based reporting and monitoring systems, and additional competitive grants for high impact and crosscutting state energy projects.	+12,500
Total Funding Change, State Energy Program	**+25,000**

International Renewable Energy Program

Funding Schedule by Activity

(dollars in thousands)

	FY 2008	FY 2009	FY 2010
International Renewable Energy Program			
International Renewable Energy Program	0	5,000	0
Total, International Renewable Energy Program	0	5,000	0

Description

The International Renewable Energy Program (IREP) was reestablished in FY 2009 to expand international clean energy technology deployment through environmentally effective and economically sustainable climate change projects. These efforts broaden EERE participation in international climate change initiatives, such as the U.S. Israel cooperative agreement, the Western Hemisphere Energy Cooperation Initiative, and the International Partnership for Energy Efficiency Cooperation. The program also shares effective energy efficiency and renewable energy technology tools and policies with a larger number of countries than in prior years. EERE proposes to transfer this subprogram from Weatherization and Intergovernmental Activities to the Program Support line item in FY 2010.

Benefits

International activities managed by Weatherization also contribute to the Secretarial Clean and Secure Energy priority by encouraging energy efficiency and renewable energy investments through incentives and technical assistance. IREP provides technical assistance through National Laboratories and outside experts, helping meet specific commitments contained in bilateral and multilateral agreements. IREP provides technical assistance to foreign governments and companies that design and install renewable energy technologies. This program encourages ongoing pipeline development and maintains global partnerships.

Detailed Justification

(dollars in thousands)

	FY 2008	FY 2009	FY 2010
International Renewable Energy Program	**0**	**5,000**	**0**

EERE proposes to transfer this subprogram from the Weatherization and Intergovernmental Activities Program to the Program Support line item in FY 2010. In FY 2009, IREP addressed increasingly important international climate change activities. The program assisted in clean energy technology deployment through sharing effective technology tools and policies with a larger number of countries than in prior years. The program also facilitated EERE participation in the International Partnership for Energy Efficiency Cooperation (IPEEC) and other international climate change efforts.

The IPEEC was established in 2008 and serves as a high-level forum for facilitating a broad range of actions that yield high efficiency gains. The partnership supports ongoing work of the participating countries and relevant organizations, exchanging information of best practices, policies, and measures, and developing public partnerships in key energy-consuming sectors as well as on a cross-sectoral basis.

	FY 2008	FY 2009	FY 2010
Total, International Renewable Energy Program	**0**	**5,000**	**0**

Explanation of Funding Changes

	FY 2010 vs. FY 2009 ($000)
International Renewable Energy Program	
EERE proposes to transfer this subprogram from Weatherization and Intergovernmental Activities to the Program Support line item in FY 2010. EERE intends to implement these efforts from the corporate level in the future to better serve, coordinate, and integrate international activities across the EERE portfolio.	-5,000
Total Funding Change, International Renewable Energy Program	**-5,000**

Tribal Energy Activities

Funding Schedule by Activity

	(dollars in thousands)		
	FY 2008	FY 2009	FY 2010
Tribal Energy Activities			
Tribal Energy Activities	5,945	6,000	6,000
Total, Tribal Energy Activities	5,945	6,000	6,000

Description

Tribal Energy Activities build partnerships with tribal governments to address Native American energy needs for residential, commercial and industrial uses. The program provides financial and technical assistance to tribes for the evaluation and development of clean energy resources. Financial grants support the most promising tribal proposals. Technical assistance objectives include the development of model financial solutions and legal frameworks to spur broader project development and expanded outreach to Native Americans.

Benefits

The Tribal Energy Activities promote tribal energy sufficiency, economic development, and employment using renewable energy and energy efficiency technologies. This program helps tribes address clean energy needs collaboratively with the Department of Interior and the Department of Housing and Urban Development. Low-cost energy efficiency technologies significantly reduce the energy costs of low-income Native Americans. The Tribal Energy Activities continue to address the unique project development concerns of tribal governments. For example, awards from this program have included funding the Augustine Band of Cahuilla Mission Indians to explore their energy options. As a result of the DOE funding and their adoption of a five-year development plan, the Tribe installed a 1 MW solar electric system.

The Tulalip Tribe of Washington, in order to alleviate environmental concerns, partnered with the Lower Skykomish River Habitat Conservation Group, Northwest Chinook Recovery, and Washington State Dairy Federation to assess the feasibility of developing a biogas generation facilities to convert manure and other biomass resources into electricity to help meet the tribe's energy needs from a renewable energy source. Funding from DOE coupled with leveraged resources were used to conduct the feasibility study which led to a land grant from the State of Washington, a grant from the U.S. Department of Agriculture and the use of a Clean Renewable Energy Bond to install an operating biogas facility in Snohomish County, Washington.

Detailed Justification

	(dollars in thousands)		
	FY 2008	FY 2009	FY 2010
Tribal Energy Activities	**5,945**	**6,000**	**6,000**

The Tribal Energy subprogram helps create sustainable renewable energy installations on their lands. Technical and financial assistance is used to assist the development of energy efficiency and renewable energy projects. Between FY 2002 and FY 2008, 93 tribal energy projects totaling $16.5 million, leveraged by $6.4 million cost-shared by the tribes, were awarded on a competitive basis.

A key area of emphasis focuses on ways to better leverage existing public and private financing to accelerate the deployment of tribal energy projects. The tools developed will increase private sector funding and accelerate deployment. These tools will 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. In FY 2010, the subprogram will distribute these tools through the EERE website and training sessions.

Total, Tribal Energy Activities	**5,945**	**6,000**	**6,000**

Renewable Energy Production Incentive (REPI)

Funding Schedule by Activity

	FY 2008	FY 2009	FY 2010
	(dollars in thousands)		
Renewable Energy Production Incentive			
Renewable Energy Production Incentive	4,955	5,000	0
Total, Renewable Energy Production Incentive	4,955	5,000	0

Description

The Renewable Energy Production Incentive (REPI) increases the generation and utilization of electricity from renewable energy sources. Initially the program spurred the deployment and continued operation of renewable energy facilities by publically owned and not-for-profit utilities. These utilities are not eligible for the renewable energy production tax credit available to private companies.

Benefits

The recent growth in the size and number of new renewable energy facilities has significantly reduced the subsidy per kilowatt-hour of electricity produced. This, coupled with the uncertainty about future funding, limits the impact of the program.

Detailed Justification

	FY 2008	FY 2009	FY 2010
	(dollars in thousands)		
Renewable Energy Production Incentive	**4,955**	**5,000**	**0**

The Renewable Energy Production Incentive was created by the Energy Policy Act of 1992, amended in 2005, to provide financial incentives for renewable energy electricity produced and sold by qualified renewable energy generation facilities. Eligible electric production facilities include: 1) not-for-profit electrical cooperatives; 2) public utilities; 3) State governments; 4) Territories of the U.S., the District of Columbia, Indian tribal governments, or a political subdivision within; and 5) Native Corporations. The annual incentive payments are based on kilowatt-hours generated and the amount of the fiscal year appropriation.

Total, Renewable Energy Production Incentive	**4,955**	**5,000**	**0**

Explanation of Funding Changes

	FY 2010 vs. FY 2009 ($000)
Renewable Energy Production Incentive	
The incentive value of REPI has diminished over time as renewable energy technologies have become more competitive. Additionally, the steadily growing pool of applicants has resulted in increasingly smaller resources available for individual payouts, given the limited availability of funds to distribute.	-5,000
Total Funding Change, Renewable Energy Production Incentive	**-5,000**

Program Direction

Funding Profile by Category

	FY 2008	FY 2009	FY 2009 Additional Appropriation	FY 2010
Headquarters (HQ)				
Salaries and Benefits	42,693	50,968	–	79,437
Travel	2,917	3,626	–	4,183
Support Services	14,319	19,534	–	30,720
Other Related Expenses	9,644	12,717	–	21,387
Total, Headquarters	69,573	86,845	–	135,727
HQ Full Time Equivalents	338	355	–	497
Golden Field Office (GO)				
Salaries and Benefits	16,532	20,515	–	36,640
Travel	649	780	–	2,100
Support Services	1,330	1,807	–	12,230
Other Related Expenses	3,213	3,442	–	10,940
Total, Golden Field Office	21,724	26,544	–	61,910
GO Full Time Equivalents	141	162	–	243
National Energy Technology Laboratory (NETL)				
Salaries and Benefits	6,612	7,243	–	15,040
Travel	350	366	–	1,300
Support Services	5,641	6,462	–	23,147
Other Related Expenses	157	160	–	993
Total, National Energy Technology Laboratory	12,760	14,231	–	40,480
NETL Reimbursable Full Time Equivalents	(66)	(70)	–	(100)
Total Program Direction				
Salaries and Benefits	65,837	78,726	–	131,117
Travel	3,916	4,772	–	7,583
Support Services	21,290	27,803	–	66,097
Other Related Expenses	13,014	16,319	–	33,320
Total, Program Direction	104,057	127,620	50,000	238,117
Total, EERE Full Time Equivalents	479	517	–	740
Total, NETL Reimbursable Full Time Equivalents[a]	(66)	(70)	–	(100)

[a] Fossil Energy Employees

	(dollars in thousands)		
	FY 2008	FY 2009	FY 2010

Mission

Program Direction provides the Federal staffing resources and associated costs required for the overall direction and execution of the Office 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 of EERE technologies that address energy security, economic stability, and the environment with unprecedented transparency, accountability and oversight.

Detailed Justification

Salaries and Benefits	**65,837**	**78,726**	**131,117**
Total, Salaries and Benefits	**65,837**	**78,726**	**131,117**

EERE plans to ramp up its Federal workforce to execute, monitor, and evaluate more than 6,900 active contracts, grants and agreements in excess of $4 billion. The number of transactions are expected to double by FY 2010. This funding supports a base of 587 Federal employees, and an increase of 253 EERE Federal employees at Headquarters (142), the Golden Field Office (81) and 30 reimbursable Fossil Energy employees at the National Energy Technology Laboratory (NETL), for a total of 840 Federal staff (including 100 reimbursable FTEs). These employees provide expertise in implementing and integrating technology programs through comprehensive program management, technical assistance and oversight. This request also provides business administration expertise in the areas of personnel, budget and financial management, procurement, contract administration, legal services, information technology (IT) business systems, and information services management with an emphasis on transparency and accountability. Funding includes OMB annual baseline salary increase factor of 1.051, which covers cost-of-living allowances, promotions, within-grade-increases and relocation allowances for current and new employees.

Travel	**3,916**	**4,772**	**7,583**

Provides necessary travel for proper management and oversight of all Federally-funded projects, including additional audits and on-site monitoring of expanding technology programs, Weatherization Assistance and State Energy Program grants to ensure that Federal investments with a value of more than $3 billion (expected to rise to $4 billion by FY 2010). Supports expanding international activities necessary to address global climate change and supports a number of key bilateral and multilateral initiatives that further the research, demonstration, and deployment goals of DOE. This request also supports continued work on-site with member countries to develop the International Partnership for Energy Efficiency Cooperation and lead the Energy Development in Island Nations initiative. Funding also includes a higher amount of travel due to anticipated escalation of costs in airfare, per diem, and the annual OMB baseline travel adjustment factor of 1.010.

	(dollars in thousands)		
	FY 2008	FY 2009	FY 2010
Support Services	**21,290**	**27,803**	**66,097**

Automated Data Processing requirements continue to increase to provide state-of-practice functionality for the staffing increase of 253 Federal staff, plus additional support staff. Support of these additional personnel requires substantial expansions of IT, communications, and network systems, including connectivity to separate office building locations, as well as the purchase and installation of additional desktop systems to ensure rapid response, accurate reports and analyses, and critical information for decision-making. The request provides support for DOE's iManage Suite of Technology Program, a collaborative effort to define and provide a modern, integrated corporate business system. The Project Portfolio is comprised of enterprise-wide systems initiatives including: the Standard Accounting and Reporting System (STARS), iManage Data Warehouse (IDW), iBudget, Strategic Integrated Procurement Enterprise System (STRIPES), Corporate Human Resource Information System (CHRIS), and the E-Travel System (eTS). Additionally, this budget provides training, education, safety and health support, facility safeguards and security, and computer hardware and software installation, configuration, and maintenance

This request also provides for a 67 percent indirect overhead charge amounting to $10.1 million for NETL. This charge provides for support services for administrative and editorial assistance to the NETL project managers and includes funding for landlord services, IT services, and local-area network operations. Support service assistance is utilized in activities that are not inherently Federal, such as: preparation of draft administrative paperwork, technical editing of contract and technical review documents and summary reports to management; funding of outside technical reviewers; and routine status tracking of contracts, outreach and communications.

Reports and Analysis, Management and General Administrative Services also expand due to the new and rapidly evolving requirements for project planning, analysis, management, oversight and reporting. These requirements, characterized by the increase in accountability and transparency exemplified by Congress and the Administration 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 anticipated but unspecified requirements for both corporate level planning, reporting, analysis and administrative services.

Other Related Expenses	**13,014**	**16,319**	**33,320**

Increase provides for the acquisition of additional office space at Headquarters and the Project Management Center for 253 new Federal employees plus additional support staff. This category funds the DOE Working Capital Fund for activities such as administrative services, rent, automated office support, contract close out, telephone services, postage, printing, graphics and similar services, the Forrestal safe havens, shuttle bus, logistics support services contract, courier/messenger service, operations, and the on-line learning center. Also includes GSA rent for the Golden Field Office, as well as supplies and materials for both Golden Field Office and NETL, to include 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	**104,057**	**127,620**	**238,117**

Explanation of Funding Changes

	FY 2010 vs. FY 2009 ($000)
Salaries and Benefits	+52,391
The increase is due to hiring 253 additional Federal employees required to advance the Presidential and Secretarial priorities for research, development and deployment of EERE programs, and business administration and increased project management and oversight. The increase also reflects cost-of-living increases, in-grade increases, and increased costs to the government portion of personnel benefits. This request includes annual baseline salary increase factor of 1.051, which includes cost-of-living, promotions, within-grade-increases, and relocation allowances for new employees.	
Travel	+2,811
The increase is for Federal staff to conduct site visits, project coordination and project oversight in carrying out technical and administrative responsibilities, as well as to increase collaboration with stakeholders to sustain unprecedented management and oversight of projects to ensure transparency and accountability. The number of EERE projects are increasing from 2,864 in FY 2009 to more than 6,900 in FY 2010, a workload increase of 242 percent. This increase also reflects higher air-travel ticket prices due to inflation and to support additional mission-related work and improve project oversight. This request includes OMB annual baseline travel increase of 1.010.	
Support Services	+38,294
The increase is for the hiring of additional supporting contractor staff, services, and substantial expansions of IT, communications, and network systems, to include connectivity to separate locations, as well as the purchase and installation of additional desktop systems for Federal and contractor staff. 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 request includes OMB annual baseline support services increase factor of 1.010.	
Other Related Expenses	+17,001
The increase is due to the necessity to contract additional workspace and the corresponding support systems required for new Federal and contractor staff, both at Headquarters and at the Project Management Centers. The increase also reflects higher per capita space and infrastructure costs. This request funds increased DOE Working Capital Fund activities and other indirect and overhead costs such as: building management, security, mail, IT hardware, software and licenses, utilities, communications, printing, copy centers, etc. This request includes OMB annual baseline other related expenses increase factor of 1.010.	
Total Funding Change, Program Direction	**+110,497**

Support Services by Category

	(dollars in thousands)		
	FY 2008	FY 2009	FY 2010
Technical Support			
Feasibility of Design Considerations	900	1,400	3,500
Development of Specifications	1,400	2,100	5,100
System Definition	800	1,400	3,200
System Review and Reliability Analyses	500	1,050	2,000
Trade-off Analyses	300	900	1,900
Economic and Environmental Analyses	500	600	850
Surveys or Reviews of Technical Operations	1,200	1,400	1,900
Total, Technical Support	5,600	8,850	18,450
Management Support			
Analyses of Workload and Work Flow	450	550	950
Directives/Management Studies	125	250	1,200
Automated Data Processing	6,950	8,500	21,000
NETL Reimbursable Overhead Services	4,430	4,853	10,077
Preparation of Program Plans	175	350	1,800
Training and Education	740	802	1,700
Analyses of DOE Management Processes	150	300	1,000
Reports and Analyses, Mgt & Gen Admin Services	2,670	3,348	9,920
Total, Management Support	15,690	18,953	47,647
Total, Support Services	21,290	27,803	66,097

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Other Related Expenses by Category

	FY 2008	FY 2009	FY 2010
Other Related Expenses			
Rent to GSA	1,141	1,220	2,800
Rent to Others	0	0	0
Communications, Utilities, Miscellaneous	485	685	2,090
Printing and Reproduction	351	451	884
Other Services	330	430	1,614
Purchases from Govt Accounts	162	320	850
Operation and Maintenance of Equipment	350	450	970
Supplies and Materials	768	2,368	3,181
Equipment	750	405	1,282
Working Capital Fund	8,677	9,990	19,649
Total, Other Related Expenses	13,014	16,319	33,320

Program Support

Funding Profile by Subprogram

(dollars in thousands)

	FY 2008 Current Appropriation[a]	FY 2009 Original Appropriation	FY 2010 Request
Program Support			
Planning, Analysis and Evaluation	7,333	10,078	11,000
Technology Advancement and Outreach	3,468	8,079	11,000
Strategic Priorities and Impact Analysis	–	–	43,000
Commercialization	–	–	45,000
International	–	–	10,000
Total, Program Support	10,801	18,157	120,000

Public Law Authorizations:

P.L. 95-91, "Department of Energy Organization Act" (1977)
P.L. 109-58, "Energy Policy Act of 2005" (2005)
P.L. 110-140, "Energy Independence and Security Act of 2007"

Mission

The mission of the Program Support function is to enable management at all levels of the Office of Energy Efficiency and Renewable Energy (EERE) to achieve program goals and contribute to DOE goals. This is done by providing forward looking and current corporate and integrated information and multidisciplinary analysis to inform decisions for portfolio investment and market adoption of EERE based processes, individual technologies, and energy systems.

Modifications were made to the budget structure to better reflect Program Support activities in FY 2010. Additional subprograms are being established to consolidate activities formerly funded within program line items to improve integration, functionality, management, and transparency.

Benefits

The Program Support function advances Presidential and Secretarial objectives in science and discovery, clean and secure energy, economic prosperity and climate change. EERE implements a complex, multifaceted portfolio of programs with many distinctly different purposes and requirements. Corporate-level, integrated input, analysis and support guide the portfolio to effectively achieve goals and meet external requirements in these areas. Program Support activities provide unique best-in-class, strategic, and integrated products in performance-based management and outreach. These mechanisms and products enables effective internal and external EERE stakeholder collaboration and informed decisions based on analysis and information about issues affecting stakeholder and EERE goals, operations, planning and program progress. Program support actively coordinates with the DOE Offices

[a] Includes reduction of $1,904,000 which was transferred to the SBIR program and $299,000 which was transferred to the STTR program.

of Chief Financial Officer (CFO), Policy and International (PI), Science (SC), and the Office of Management and Budget (OMB), Congress and the White House.

The Planning, Analysis, and Evaluation subprogram (PAE) supports science and discovery by providing credible, reliable and independent insight and feedback necessary to develop, direct, defend and manage EERE's budget portfolio at all decision making levels. PAE, in concert with the Strategic Priorities and Impact Analysis (SPIA) and the Commercialization subprograms, establishes, maintains and corporately implements the methods, information base, and standards for portfolio planning and policy analysis, budget formulation, performance management and evaluation. The PAE subprogram provides direct expertise, management, and funds activities that provide technical, economic, and policy analyses and support for strategic and multi-year planning, performance and budget integration, Government Performance and Results Act (GPRA) benefit estimation, and scenario analysis for all DOE Energy Efficiency (EE) and Renewable Energy (RE) programs. PAE provides core estimates of integrated 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 estimates provide the substance of the benefits sections in the overview and program budget chapters. Each of these activities is central to achieving the goals of the Administration and key to ensuring the effective management of EERE. Each activity also informs decisions on the optimal allocation of resources among the EERE 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.

The Technology Advancement and Outreach subprogram (TAO) provides communications and outreach support for EERE's scientific and technology achievements and continued support of higher education outreach. TAO manages and creates outreach mechanisms and products that keep EERE stakeholders advised of the status of EERE programs 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. TAO also coordinates and manages efforts to make all of EERE's work, results and potential known to the public. This contributes both to the EERE programs' deployment goals and to E-government initiatives to make government more transparent and accessible to the public. To accomplish these objectives, TAO ensures information is available on request to the general public and other stakeholders through web-based and toll-free telephone services. Through partnerships with industry, state and local governments, and non-government organizations (NGOs), TAO also produces and disseminates documents in both English and Spanish to educate homeowners on energy saving techniques and technologies. TAO supports career development resources and materials for K-12 and higher education institutions, and provides timely and relevant information so that consumers make informed energy choices to reduce energy use, demand and associated costs. TAO leverages public communication assets to raise public energy awareness and improve energy use behaviors by providing unbiased, decision-quality information and education to inform public and private energy decisions.

The Strategic Priorities and Impact Analysis subprogram provides strategic analysis of technology and policy innovation. SPIA, in concert with PAE, provides senior EERE management with credible, reliable, and independent analysis that is essential for making decisions across the broad set of technology programs' challenges. Activities will focus primarily on climate change, market, policy, and energy-systems whose impacts depend upon successful EERE clean energy technologies.

Strategic Priorities and Impact Analysis activities will:

- Assess the challenges and opportunities associated with achieving a carbon free or carbon neutral energy system;
- Understand and assess options for the transformation of energy consumption in the transportation sector from liquid biofuels and efficient light duty vehicles to greatly increased system energy efficiency, electrification, and additional renewable fuels; and
- Understand how to best integrate EERE technologies with a stronger and smarter electric grid by connecting renewable resources to distant loads, actively managing the use of energy through demand response and efficiency, and integrating new electric transportation technologies into the operation of the electric power system.

The cross-cutting nature of the energy challenges facing the U.S. requires that Strategic Priorities and Impact Analysis activities include collaborative efforts with programs across the Federal Government to successfully integrate EERE work with other elements of DOE, other agencies, state and local governments, and countries. The same foundation of unbiased, quality information created and used by EERE to make decisions will be made available to external stakeholders to inform policy decisions at all levels of government and private investment. These policy and investment decisions will lead to the transformation in energy systems needed to simultaneously address workforce, economic, climate, environment, and security issues.

Strategic priorities and impact analysis work provides decision makers with high-level, cross-cutting perspectives on the current and future environmental and economic impacts of EE and RE technologies. The driver for many analysis products is the identification of the potential impacts of EE and RE renewable energy policies, activities, and programs on the reduction of GHG emissions, reduction of oil consumption, and future economic growth. Strategic priorities activities provide guidance on how efficiency and renewable technology investments and activities can progress related national and international goals. Systematic characterization of the technology opportunities related to climate change provides a platform for effective and thorough decision making. This work includes analysis of cost and potential contribution of technology that policy could effect such as the potential carbon supply curve for a suite of energy technologies.

The Commercialization subprogram focuses on the finance industry, equipment suppliers, and energy companies to help bridge the valley of death that impedes commercialization of many EERE energy technology and system innovations. Commercialization activities develop and manage initiatives to accelerate the growth of U.S. markets for renewable and efficiency technologies, and to more effectively transfer technologies developed in the DOE National Laboratories to commercial applications that will enhance national energy security and environmental quality while increasing the productivity of the U.S. economy. The commercialization activity serves as EERE's primary connection to private-sector financial markets, ranging from venture capital and private equity to institutional and corporate investment firms. Efforts focus on accelerating commercialization of EERE technologies and interfacing with financial markets, while supporting all EERE programs. To accomplish these objectives, commercialization builds upon existing efforts and fosters a number of initiatives and innovations geared toward transferring and integrating technology, connecting private capital with Federal energy projects, and bridging the commercial innovation "valley of death". These initiatives include the Entrepreneur-in-Residence program; the Technology, Commercialization, and Development Fund; business plan competitions; and, venture forums. The commercialization activity facilitates the market uptake of EE and RE technologies. Use of these technologies reduces GHG emissions, reduces oil consumption, and provides future economic growth. Through this linkage, work on commercialization provides an enhanced opportunity for all EERE technologies to address climate change. Movement from RD&D to commercialization makes the realization of technology benefits possible.

EERE's International subprogram coordinates a variety of international initiatives, partnerships, and events that promote greater understanding and utilization of renewable energy and energy efficiency worldwide. The goals of the International subprogram are to advance EERE's mission globally by promoting U.S. global climate change, energy security, and economic goals; accelerating clean energy innovation and cost reductions; and transforming RE and EE markets in key developing countries. Making use of public-private partnerships, EERE aims to advance these goals through RD&D; market transformation; and, global clean energy assessment. EERE implements these programs 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 and enhancing U.S. energy security and economic vitality.

The international activity also addresses climate change through three approaches: (1) leveraging U.S. investments through bilateral and multilateral R&D partnerships to accelerate RE and EE technology innovation; (2) assisting key countries (China, India, Brazil and regional efforts) in strengthening policies and programs that lay the groundwork for accelerated deployment of RE and EE technologies; and (3) developing and maintaining tools, data and analysis to support decision-making around clean energy such as comprehensive data on technology costs, environmental and economic impacts, market potential, policy impacts, and analytic tools. These policies and standards help mobilize large-scale international clean energy investment (including enhanced investment by U.S. firms) and leverage U.S. investments with partner country resources and market transformation actions and support for international donors and private firms for maximum impact. Analyses include life-cycle costs and environmental and economic impacts, market potential and penetration scenarios for different world regions and major countries, status of policies and data on policy impacts and best practices, and data on clean energy investment trends and drivers.

Planning, Analysis and Evaluation

Funding Schedule by Activity

	(dollars in thousands)		
	FY 2008	FY 2009	FY 2010
Planning, Analysis and Evaluation	7,333	10,078	11,000
Total, Planning, Analysis and Evaluation	7,333	10,078	11,000

Description

Planning, Analysis, and Evaluation (PAE) provides senior and program management with timely, high quality, and program independent analyses that is guided, managed and integrated to inform program and budget formulation decisions. PAE also manages EERE-wide requests and requirements from the Government Performance and Results Act (GPRA), the Office of Management and Budget (OMB), the EPAct 2005, EISA 2007 and other departmental and external Administration authorities that demand coordination or integration. Finally, PAE develops corporate approaches to planning, analysis, and evaluation that help improve the EERE portfolio and enable effective collaboration and implementation of strategic management at the departmental level (e.g. CFO, PI, and SC) which enables EERE to best advance DOE's goals.

Detailed Justification

	(dollars in thousands)		
	FY 2008	FY 2009	FY 2010
Planning, Analysis and Evaluation	**7,333**	**10,078**	**11,000**

PAE delivers management support through planning, analysis and evaluation activities by providing technical support staff that respond to external inquiries and requirements. PAE's planning efforts focus on improving program planning and developing EERE-wide approaches to strategic and multi-year program planning and portfolio analysis. A key component of PAE's efforts is to work with the programs to develop multi-year plans that link DOE's Strategic Plan to a program's performance management, Joule and activity targets. PAE's planning and analysis activities seek to improve the understanding, methodology, and treatment of benefits, risk, and uncertainty, and to help advance Budget-Performance Integration.

PAE's analysis activities focus on providing forward-looking and current multidisciplinary cross-cutting, multi-program, and integrated technical and market analysis to inform EERE corporate and program budget decisions and to meet the requirements of the GPRA. PAE's approach to integrated analysis includes a focus on developing open, transparent, well-documented, and 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 working with OMB, the National Academy of Sciences (NAS), and other DOE applied R&D offices to provide increasingly comparable estimates of the potential impacts of each program's

	(dollars in thousands)		
	FY 2008	FY 2009	FY 2010

investment and to move effectively and practically to incorporate the Benefits Analysis framework recommendations developed by the NAS.

PAE also develops and maintains independent, objective analytical capabilities to assess externalities, to answer senior management questions, to better account for technical risk and uncertainty, and to examine how benefits change under different future scenarios. As required by OMB, 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 evaluation component works with the programs to proactively address performance management requirements and to prepare EERE's submissions for integrated performance reporting such as required by OMB and the Recovery Act. PAE's evaluation team also provides a full range of evaluation technical assistance, processes, and tools to help senior management and programs monitor and measure success, increase program effectiveness, and meet OMB requirements for objective and independent assessment.

Total, Planning, Analysis and Evaluation	**7,333**	**10,078**	**11,000**

Explanation of Funding Changes

Planning, Analysis and Evaluation	FY 2010 vs. FY 2009 ($000)
Increased funding will expand capacity of existing activities to incorporate the growth and integration in program activities; provide the ability to flexibly respond to changes in the Administration priorities and pace incumbent in the new energy economy; and specifically develop capacity to estimate job benefits and impacts of consumer choice.	+922
Total Funding Change, Planning, Analysis and Evaluation	**+922**

Technology Advancement and Outreach

Funding Schedule by Activity

	(dollars in thousands)		
	FY 2008	FY 2009	FY 2010
Technology Advancement and Outreach	3,468	8,079	11,000
Total, Technology Advancement and Outreach	3,468	8,079	11,000

Description

Public information, technology awareness and outreach activities in EERE are carried out by the Office of Technology Advancement and Outreach (TAO). TAO communicates the EERE mission, program plans, accomplishments, and technology capabilities to a variety of stakeholder audiences including Congress, the public, educational institutions, industry, and other government and non-government organizations (NGOs).

The TAO subprogram coordinates and manages efforts to make all of EERE's work and results known to the public and provides a regular, consistent outreach mechanism that keeps EERE stakeholders apprised of corporate issues and technology opportunities. This contributes both to the EERE programs' deployment goals and to E-government initiatives to make government more transparent and accessible to the public.

Detailed Justification

	(dollars in thousands)		
	FY 2008	FY 2009	FY 2010
Technology Advancement and Outreach	**3,468**	**8,079**	**11,000**

TAO will continue its support of the corporate EERE webpage, the consumer guide on that webpage, and will operate the EERE Information Center which answers requests from consumers and users of technology submitted via toll free telephone or the Internet. Increased demand for website information requires increased web-server operations and maintenance and enhancement and acceleration of content creation and updates.

TAO maintains a catalogue of all EERE information products, including publications, CDs, and analytic tools, and makes that information available on-line. Working with a five-year strategic outreach plan, TAO will leverage the resources of other agencies by promoting collaborations between state, Federal and local entities to promote alternative energy sources and energy efficiency and provide interactive technology on-line to educate consumers in the use of these technologies. TAO will implement programs to disseminate information through new technology avenues such as streaming video, podcasting and on-line analysis and training tools. The growing volume of calls to the information center and requests for printed documents are raising the printing budget and increasing costs for the operation of the center.

(dollars in thousands)		
FY 2008	FY 2009	FY 2010

In addition, TAO will continue to seek partnerships with industry and NGOs. Supporting EPAct 2005 through the dissemination of information energy efficiency and renewable energy technologies, TAO seeks additional partnerships with corporations, trade associations, and other government agencies to promote EERE technologies and leverage resources of partners to deploy EERE technologies.

During FY 2010, TAO will continue the redesign of the EERE website and expand mechanisms for electronic outreach. The upgraded EERE website redesign will include more interactive components, streaming video, and user friendly capabilities. Additional new approaches will be pursued by developing, maintaining and utilizing a podcast, webinar and webcast program to proactively promote EERE technologies through internet technology. TAO will also pursue increased use of social networking media outreach to reach non-traditional audiences.

TAO will continue support of its multi-year public information campaign in partnership with the Ad Council. The campaign is focused on improving awareness of energy efficiency among children and parents. TAO will continue to seek out high-impact events and opportunities to educate the general public on renewable energy and efficiency technologies, both on-line and in-person. TAO will continue to engage the public through exhibitions, community associations, and stakeholder events.

TAO will also 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 27,000 phone inquiries annually, and mails and distributes more than 300,000 publications per year. In FY 2010, TAO will improve web-integration, upgrade equipment, and continue development of a virtual publications catalog that helps improve public access to relevant program documents. With continued demand growth for these services, the TAO produces and disseminates documents in both English and Spanish to educate homeowners on energy savings techniques and technologies. TAO will also continue efforts to accelerate information dissemination, broaden access, and leverage resources to form partnerships with industry, state and local governments, and (NGOs).

Total, Technology Advancement and Outreach	**3,468**	**8,079**	**11,000**

Explanation of Funding Changes

	FY 2010 vs. FY 2009 ($000)
Technology Advancement and Outreach	
The increased focus on energy efficiency and renewable energy has heightened public and stakeholder demand for TAO's services, requiring the subprogram to handle greatly expanded levels of information. Additional funding for this task area will help improve web-integration, upgrade equipment, and continue development of a virtual publications catalog that helps improve public access to relevant program documents. Additionally, some technology advancement and outreach related efforts previously funded through individual programs, will be consolidated at the corporate level to improve integration, functionality, management, and transparency	+2,921
Total Funding Change, Technology Advancement and Outreach	**+2,921**

Strategic Priorities and Impact Analysis

Funding Schedule by Activity

(dollars in thousands)

	FY 2008	FY 2009	FY 2010
Strategic Priorities and Impact Analysis	–	–	43,000
Total, Strategic Priorities and Impact Analysis	–	–	43,000

Description

The Strategic Priorities and Impact Analysis subprogram is a new subprogram proposed for FY 2010. This modification was made to better reflect Program Support activities in FY 2010.

EERE focuses on broad market adoption of clean energy technologies. The Strategic Priorities and Impact Analysis subprogram will help drive market-relevant EERE technology innovations by funding insightful, thorough, cross-cutting technology analyses and reports to Congress. In FY 2010, this subprogram will elevate and expand its activities consistent with new legislative imperatives, Administration priorities, and international climate efforts.

EERE's strategic priorities and impact analysis activities focus primarily on climate change, market, policy, and energy-systems and supply chain issues that impact and are impacted by EERE clean energy technologies. Analytic efforts are carried out consistent with an office-wide methodology and are coordinated with technical analysis work being done by PAE, the DOE offices of Policy, and Science, the Chief Financial Office, the National Laboratories, and the programs. Technical support staff funded by this activity coordinate technical analysis with the relevant EERE technology programs to ensure that technology-specific inputs are accurately reflected and that analysis products and findings can directly inform technology decision-makers. In a number of analytic areas, multiple-laboratory teams are formed along with outside expert organizations to ensure that expertise is being tapped both within the DOE National Laboratory system and within the broader analytic community. Increasingly, consistency and transparency in the underlying data, assumptions and methods used for analysis is being achieved through development of a knowledge management system that provides broad access to information, as well as through active engagement between EERE and the broader energy analysis community both within and outside of DOE.

This funding will support existing and new priority cross-cutting tasks that involve technologies from multiple EERE programs, promote innovative strategies for market adoption, and demonstrate integrated application of EERE technologies to maximize energy savings and carbon emission reductions. For example, many EERE technologies reduce criteria pollutants that contribute to urban level ozone. EERE has worked with States and the EPA to demonstrate how integrated applications of EERE technologies, such as building efficiency, solar photovoltaic, and combined heat and power systems can reduce urban emissions that contribute to ozone formation while also saving energy. Another cross-cutting example are investments made in disaster recovery areas to provide technical assistance to community leaders that want to rebuild with more efficient construction techniques and integrate renewable generation to supplement or replace traditional generation technologies. Future efforts are expected to address cross-cutting issues such as: information and communication technologies to enhance EERE technologies; cross-cutting manufacturing initiatives; market transformation activities; consumer behavior and demand response issues; and, cross-cutting interagency cooperation.

Detailed Justification

	(dollars in thousands)		
	FY 2008	FY 2009	FY 2010
Strategic Priorities and Impact Analysis	–	–	**43,000**

Strategic Priorities and Impact Analysis activities include but are not limited to the following in FY 2010.

Climate/Carbon Analysis: Climate and carbon analysis supports EERE analysis in understanding the interactions between carbon mitigation objectives and energy efficiency and renewable energy technologies, as well as provides technical support staff. A better understanding of these issues positions EERE's work to be a valuable, leading source in support of the design of a national carbon mitigation framework and helps inform program strategy for EERE programs. A more informed analytic basis for impacts of EERE technologies relative to their contribution to climate mitigation strategies at the national level will inform DOE's approach to evaluating near and longer term objectives for low carbon initiatives that may incorporate multiple EERE technologies. In addition, activities will use existing tools to conduct assessment of the carbon mitigation potential of EE and RE technologies under alternative policy scenarios to support global climate change dialogue, including scenario analysis with integrated assessment models and analysis of specific proposed legislation. Analysis will be coordinated internally, including with EERE PA&E, DOE PI, Science, CFO, as well as externally to address the impact of proposed climate change policies and legislation on the RD&D and commercialization of renewable energy and energy efficiency technologies, including understanding the interaction of carbon-specific instruments with existing incentives. The climate change analytic activities and technical support staff for FY 2010 will expand upon the efforts of FY 2009 to reflect the requirements of proposed U.S. legislation and increased international engagement in the area.

Market Analysis: The objective of market and financial analysis is to improve the understanding of implications of supporting markets, industries, and critical materials for EE and RE technology deployment. Efforts include the development of uniform market reports that compile critical information about target markets for EERE technologies and discuss key changes in the target markets and emerging trends each year. Market analysis addresses up-to-date market data relevant to EERE's technologies and makes this information available to senior management for use in speeches, testimony, briefings and presentations. Work includes analysis of proposed EE and RE technology financing structures, documentation of financing for recent large-scale projects and capital markets in general, establishment of project financing assumptions for specific system owners, initial extension of Solar Advisor Model to address other technologies (common project financing tool), application of emerging valuation techniques to renewable energy assets, and implementation of renewable financing web portal. A systematic methodology, data and tools for analyzing target market conditions and developing near-term technology deployment projections (up to ten years) for EE and RE technologies is being developed and implemented, including implications for manufacturing and supporting industries. Critical information about target markets and discussions of key recent and emerging developments in the target markets will be compiled and easily accessible.

Energy Policy and Systems Analysis: The energy policy area analyzes and reports on policy prescriptions and legislative proposals. This work includes clarification of assumptions, documentation of deployment projections, and consideration of supply chain issues in order to better understand the challenges of achieving policy goals given current market conditions and the potential role EERE's portfolio could play. The energy policy work incorporates collaboration with DOE’s Office of Policy and International Affairs on supporting model development and analysis in support of clean energy rulemaking. Multi-model analyses of key types of policy options are conducted including exploring sensitivity to key assumptions (e.g., fuel price forecasts) to map the associated outcome space. This task area develops new and strengthens existing models to support near term policy analyses.

Energy systems analysis provides understanding of the decision process and basic motivations of various energy market participants to broaden the characterization of energy efficiency technologies and markets within energy models beyond technology cost and performance. New analytic products, tools, and methodologies to support EERE’s integrated approach to the energy systems will be developed and implemented. Seminal studies of complex issues require engaging the capabilities of multiple institutions to deliver comprehensive, unassailable results. Analysis provides understanding of the implications of EE and RE technology deployment, markets, and enabling policies on the broader U.S. economy in terms of the Gross Domestic Product (GDP) enhancement and job creation. This task area develops an initial impact index from literature and modeling, and develops common metrics and methodology for evaluation of economic impacts of clean energy investment and deployment. Analysis of different options for surmounting known barriers to the development of physical infrastructure is necessary to enable widespread deployment of renewable electricity and transportation technologies, including consideration of different concepts of the Federal role and regulatory regimes with respect to transmission and pipelines.

Data and Analysis Foundation and Dissemination: This task area focuses on strengthening the value of EERE’s corporate data and analysis by reducing the “noise to signal” ratio in publicly available data and analytic results regarding EE and RE resources, technologies, and markets. This process involves engaging the analysis community in setting analysis standards and protocols, 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 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 will be based on best practices from the EERE programs and laboratories. For each major analysis product, this task area develops 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.

<u>Evaluation, Monitoring, and Verification Assets Strategy:</u> This activity will leverage and further data collection efforts to create a usable knowledge base to inform policy, RD&D, investment, and technical decision-making about EE and RE technologies. Building from other reporting requirements and performance metrics, the effort will significantly improve the quality of existing energy-related empirical data to quantify the job creation, energy savings, GHG emission reductions, economic, environmental, and other real-world impacts of EE and RE options. This EERE-wide emphasis on optimizing return on investment through best-in-class evaluation, measurement, and verification efforts and accountability in program evaluation represents an unprecedented opportunity to identify and collect key data required to support decisions. This effort will ensure that high-quality data and analysis are available to decision-makers in accessible, timely, and usable formats, and will help improve programmatic performance and fine-tune future investments. This task area involves work with programs, DOE and OMB to coordinate quality assurance on data collection and dissemination.

Total, Strategic Priorities and Impact Analysis	**–**	**–**	**43,000**

Explanation of Funding Changes

Strategic Priorities and Impact Analysis	FY 2010 vs. FY 2009 ($000)
This subprogram will focus on completing strategic analysis that incorporates all program related technologies and their interactions, and on bridging the gap between RD&D, and commercialization. In prior years, EERE programs have collaborated to complete similar efforts. Given new legislative imperatives, priorities, and international climate efforts, needs and flexibility requirements for activities in this subprogram have vastly expanded. In order to address this growth, be more responsive to the immediate and long-term needs of DOE and the public, and increase transparency, EERE proposes to establish a corporate level subprogram focusing specifically on strategic priorities and impact analysis.	+43,000
Total Funding Change, Strategic Priorities and Impact Analysis	**+43,000**

Commercialization

Funding Schedule by Activity

	(dollars in thousands)		
	FY 2008	FY 2009	FY 2010
Commercialization	–	–	45,000
Total, Commercialization	–	–	45,000

Description

The Commercialization subprogram is a new subprogram proposed for FY 2010. This modification was made to better reflect Program Support activities in FY 2010.

The Office of Energy Efficiency and Renewable Energy (EERE) is focused on broad market adoption of clean energy technologies. The Commercialization subprogram will accelerating technology commercialization and deployment by working with the finance industry, equipment suppliers, and energy companies to help bridge the valley of death that impedes commercialization of many innovations.

EERE's commercialization activities seek to increase the speed and scale of energy efficiency and renewable energy technology penetration born out of EERE's investment in its National Laboratories. The activity funds multiple strategies that serve to accelerate specific technologies to increase the overall yield, or a combination of the two. EERE is developing an energy efficiency and renewable energy specific workforce development initiative is aimed at ensuring the development of a well-trained U.S. professionals capable of significantly expanding use of EERE technologies and processes in response to climate change and clean energy goals.

This funding will support new and existing corporate priority requirements that were previously supported through multi-program collaborations. The consolidation and integration at the corporate level enhances overall efficacy, increases transparency, and permits for economies of scale and scope to be more readily achieved.

The motto of commercialization, "Out of the Labs and Into the Market," guides our mission. The individual initiatives seek to increase the flow through the product pipeline to market by enhancing the view towards market demand earlier in the Lab development process. Commercialization will enhance both market "push" on the supply side and market "pull" on the demand side. All efforts carry the secondary benefits of maximizing energy savings and reducing carbon emissions, yet the primary focus remains one of interfacing with the capital markets.

Detailed Justification

	(dollars in thousands)		
	FY 2008	FY 2009	FY 2010
Commercialization	–	–	**45,000**

Commercialization includes but are not limited to the following activities in FY 2010:

National Lab Technology Portal: National Labs are complex organizations formed on a myriad of research pathways. Identifying technologies to license and matching them with market needs and private sector opportunities has traditionally been a substantial barrier for investors and commercial partners. The goal of the portal is to increase significantly the ability for the external private-sector financial and retail markets to learn what technologies are available for licensing. A web-based Technology Portal will bridge this information gap by providing access to a wide variety of energy efficiency and renewable energy technologies. Seekers will be able to streamline their search for technologies of interest, foregoing the painstaking process of separately contacting each Lab and Principle Investigator. The Portal will also be a powerful mechanism for synergizing disparate technologies into coherent solutions. EERE will build upon and expand preliminary efforts initiated at NREL to speed progress in the Portal development and upgrade the quality of the Portal content. Intellectual Property security will be of primary concern for this task.

Direct commercialization: Commercialization will identify market-ready products and solution sets for widespread adoption. The FY 2010 request will leverage resources already dedicated in National Labs and within EERE Programs to lay out pathways for market growth and economic stimulus. This will entail writing technology summaries and business plans, evaluating lab technologies for stage gate review, and connecting manufacturers with private capital and National Lab resources. Key to this process is intellectual property acceleration enhanced by examining the practices of the Project Management Center (PMC) to learn what practices impede and what practices could further technology transfer.

Human-Centered Energy Designs: Technology transfer is as much about market pull as it is about market push. A focus on human-centered design, creating the products, processes, and services that people and markets need and want will help bridge the gulf between Lab investment and market fruition. EERE Commercialization will conduct a follow-on study with a design-engineering firm in order to create one new initiative and revise one existing initiative both with the goal in mind of scaling up commercialization. Numerous non-governmental organizations, National Lab Tech Transfer Officers, and private-sector financial representatives have expressed interest in participating and in applying the results of this study. This study will help Commercialization to grow specific industry sectors, which will be identified following intense review of research investments. Potential areas include windows, ground-source heat pumps, and other specific products to which relatively little research funding is dedicated, because the technology challenges have largely been met and the missing element for full market penetration is the extent to which the technology is answering the needs of the market.

	(dollars in thousands)		
	FY 2008	FY 2009	FY 2010

Linking Technology and Finance: Commercialization will create substantive links that create measurable economic value among the scientific and financial communities. Among the initiatives that support these links are the Entrepreneur-In-Residence Program (EIR) and the Technology Commercialization Fund (TCF). The EIR Program pairs a competitively awarded venture capital firm and the entrepreneur it names with a National Lab selected by the Secretary. Each firm is given one year to mine the technology available for licensing in that Lab, with firm constraints driven by existing CRADAs, Federal work, and homeland security access restrictions. TCF poises DOE as the limited partner of a venture capital firm. TCF is competitively awarded to EERE National Labs' Technology Transfer Office with the express purpose to undergo a stage-gated process to select technologies for licensing with a 50/50 cost-share with industry. In addition, we will continue our work advising senior leadership on the development of policy for clean energy financing.

Hawaii Clean Energy Initiative (HCEI): HCEI includes a Memorandum of Understanding (MOU) a multiyear initiative with the state of Hawaii that provides technical support as Hawaii moves toward a self-imposed goal of 70 percent clean energy use through renewable energy resources and efficiency for the electricity and transportation sectors by the year 2030. The integrated work plan developed in 2009 maximizes the efficacy of resources and minimizes duplication of DOE, State, and stakeholder efforts. A signed agreement between the State and Hawaiian Electric Industries, Inc. (HEI) is evidence of the strong commitment by the State and HEI to work towards the HCEI goals; it illustrates the extensive need for technical support going forward in the areas of decoupling, feed-in tariffs, inter-island cables, a commitment to wind, and an overall commitment to 40 percent renewable electricity by 2030. Critical and overarching activities have been launched by DOE in 2009 that require continuity. A technical review committee is ensuring analyses assumptions and methods are sound. Important analyses and studies are underway such as mesoscale modeling for wind and solar, study of renewable integration and transmission, and study of grid integration. Through HCEI, DOE is supporting extensive background for regulatory and legislative recommendations currently being considered by the state legislators. FY 2009 efforts also include multiple "in the ground" type projects such as net-zero energy communities. These activities will be expanded and extended through FY 2010.

Total, Commercialization	–	–	**45,000**

Explanation of Funding Changes

	FY 2010 vs. FY 2009 ($000)
Commercialization	
This subprogram will focus on bridging the gap between research, development, and deployment, and commercialization. In prior years, EERE programs have collaborated to complete similar efforts. Given new legislative imperatives, Administration priorities, and international climate efforts, needs and flexibility requirements for activities described in this subprogram have vastly expanded. In order to address this growth, increase transparency, and be more responsive to the immediate and long-term needs of the Department, Administration, and the public, EERE is proposing to establish a corporate level subprogram focusing specifically on commercialization. Timely, significant decisions about the future of EE and RE technologies require a foundation of unbiased, quality information and effective strategies for commercialization.	+45,000
Total Funding Change, Commercialization	**+45,000**

International

Funding Schedule by Activity

	(dollars in thousands)		
	FY 2008	FY 2009	FY 2010
International	–	–	10,000
Total, International	–	–	10,000

Description

EERE proposes to shift the International subprogram from the Weatherization and Intergovernmental Program as a key activity to a subprogram within Program Support in FY 2010. This modification was made to better coordinate activities and interests across the entire portfolio of its technology programs.

EERE regularly engages in a number of key bilateral and multilateral initiatives to further the RD&D goals of its programs. Cooperation on clean energy RD&D also hastens the reduction of global greenhouse gas (GHG) emissions, promotes U.S. energy security, and expands foreign markets for U.S. clean energy exports.

EERE's International Subprogram seeks to achieve three objectives:

- Advance U.S. global climate change, energy security and economic goals**:** A primary driver for advancing clean energy technologies is to deploy applications for 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. Also, providing access to clean energy in the developing world enhances local and regional stability through improved living standards. 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.
- Accelerate clean energy innovation and cost reductions: Through partnerships with other countries at the cutting edge of clean energy R&D, EERE's goal is to leverage DOE resources to spur development of energy efficiency (EE) and renewable energy (RE) technologies. These partnerships can serve as a force multiplier in more rapidly achieving EERE's RD&D technical and cost goals, thereby directly supporting EERE's mission.
- Transform EE and RE markets in key developing countries: 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.

In coordination with the DOE Office of Policy and International Affairs (PI), EERE will partner with other DOE offices, other U.S. agencies, and the private sector, to implement market transformation partnerships, R&D partnerships, and conducting analyses relating to RE and EE potential, costs, and lifecycle emissions.

Detailed Justification

	(dollars in thousands)		
	FY 2008	FY 2009	FY 2010
International	–	–	**10,000**

Market Transformation Partnerships with Key Developing Countries: EERE will 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, implementing demonstration and deployment projects, and attracting investment and business partnerships (especially with U.S. firms). EERE will also play a lead role in key multilateral initiatives to accelerate market penetration of EE and RE technologies. EERE may also support regional programs to advance EE and RE use in Africa, Latin America, Asia, the Middle East, and the newly independent states and could support focused work in other countries of strategic importance.

EERE's existing Market Transformation activities focus on promoting best practices for building and industrial plants, the large-scale deployment of RE resources, and in advancing high-efficiency vehicles. EERE is also working with member countries of the G8+5 to develop the International Partnership for Energy Efficiency Cooperation (IPEEC), a high-level forum for the promotion of EE and energy savings.

Research, Development, and Demonstration Cooperation: EERE will partner 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) that are playing increased roles in R&D. Cooperation will focus on non-competitive topics where international partnerships can serve as force multiplier in more rapidly achieving EERE's technology RD&D goals.

Specific examples of EERE bilateral relationships include: Brazil, where work focuses on the development of advanced biofuel technologies and methodologies for conducting economic and sustainability analyses; Sweden, where cooperation includes environmentally-friendly commercial vehicle technologies; and, Israel, where areas of collaborative research include solar energy, electric vehicle and plug-in electric vehicle battery technologies, and biofuel production and use. In late 2008, EERE, in conjunction with Australia and Iceland, launched a partnership focused on the development of advanced geothermal technologies. In addition, EERE is working with Brazil, the UK, and China to develop an ISO standard for energy efficient industrial plant management.

Global Energy Assessment. On a strategic basis, EERE will consider teaming with other international institutions in conducting and disseminating assessments of EE and RE technical and market potential, life cycle emissions and costs, and policy, technology transfer, and financing best practices. Such assessments would be conducted in partnership with the Intergovernmental Panel on Climate Change, the IEA, U.N. Agencies, and other countries. EERE will also support broad use of EE and RE energy analysis and decision tools that can inform government and industry policy and investment decisions.

Total, International	–	–	**10,000**

Explanation of Funding Changes

	FY 2010 vs. FY 2009 ($000)
International	
EERE proposes to move the International Subprogram from the Weatherization and Intergovernmental Program to the Program Support line item in FY 2010. This move will allow EERE to coordinate activities and interests across the entire portfolio of its technology programs. Consolidating management of International activities at the corporate level will also facilitate coordination with senior management in EERE and DOE, other agencies, and provide a focal point for interaction with senior-level counterparts from other countries.	+10,000
Total Funding Change, International	**+10,000**

Congressionally Directed Projects

Funding Profile By Subprogram

	(Dollars In Thousands)		
	FY 2008	FY 2009	FY 2010
Congressionally Directed Projects	186,664	228,803	0

Description

The FY 2008 Current Appropriation and FY 2009 Original Appropriation included 181 and 222 Congressionally Directed Projects respectively within the Office of Energy Efficiency And Renewable 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.

Detailed Justification

	(Dollars In Thousands)		
	FY 2008	FY 2009	FY 2010
Fuel Cell Technologies (Formerly Hydrogen Technology)			
Alternate Fuel Cell Membranes For Energy Independence At Usm (Ms)	984	952	0
Biomass Fuel Cell Systems (Co)	0	1,665	0
Center For Renewable Energy, Science And Technology (Tx)	984	1,403	0
City Of Chula Vista, Alternative Fuels Pilot Project (Ca)	738	0	0
City Of Tallahassee Innovative Energy Initiatives (Fl)	0	571	0
Cu-Icar Hydrogen Infrastructure (Sc)	836	0	0
Fuel Cell Optimization And Scale-Up (Pa)	0	351	0
Fuel Cells For High Altitude Airship (Oh)	787	0	0
High Performance, Low Cost Hydrogen Generation From Renewable Energy (Ct)	0	952	0
Hydrogen Energy Production And Storage Phase Iv (Oh)	984	0	0
Hydrogen Fuel Cell Development In Columbia (Sc)	1,476	0	0
Hydrogen Optical Fiber Sensors (Ca)	0	952	0
Hydrogen Storage System For Vehicular Propulsion (De)	0	1,427	0
Manufacturing Industrial Development For The Hydrogen Economy (Mi)	0	761	0
Martin County Hydrogen Fuel Cell Project (Nc)	492	1,427	0
Michigan Tech. Nanostructured Materials (Mi)	1,230	0	0
Modular Energy Storage System For Fuel Cells (Mi)	1,181	0	0
Nano-Structured Fuel Cell Membrane Electrode Assembly (Ca)	984	0	0
Nasi And Na-Sg Powder Hydrogen Fuel Cells (Ny &Nj)	1,476	952	0
One Kilowatt Biogas Fueled Solid Oxide Fuel Cell Stack (Ny)	984	952	0

	(Dollars In Thousands)		
	FY 2008	FY 2009	FY 2010
Solar Lighting Demonstration Project (Nv)	0	761	0
Solar Panels And Environmental Education (Nj)	0	951	0
Solar Panels For The Haverhill Citizens Energy Efficiency (Ma)	0	238	0
Solar Power Generation (Nj)	0	285	0
Solar Thermal Demonstration Project (Nv)	0	1,189	0
St. Clair Community College (Mi)	0	190	0
St. Petersburg Solar Pilot Project (Fl)	0	1,427	0
Sustainable Buildings Project At The University Of Louisville (Ky)	394	0	0
Tsec Photovoltaic Innovation (Ny)	0	1,903	0
University Of Arizona Photovoltaic Concentrator Development (Az)	984	0	0
University Of Nebraska, Cibs Solar Cell Development (Ne)	937	0	0
University Of Nevada, Solar Cell Nanotechnology (Nv)	738	0	0
Wisdom Way Solar Village - Rural Development Incs (Ma)	394	571	0
Wind Energy			0
Casper College Renewable Energy Program (Wy)	295	0	0
Cloud County Community College Wind Turbine (Ks)	984	0	0
Coastal Wind Ohio (Oh)	590	952	0
Columbia Gorge Community College Wind Energy Workforce Training Nacelle (Or)	0	238	0
Great Plains Wind Power Test Facility (Tx)	1,968	1,903	0
Harlem United Supportive Housing Fund Wind Power Project (Ny)	0	48	0
Hull Municipal Light Plant Offshore Wind Project (Ma)	0	952	0
Kansas Wind Energy Consortium (Ks)	0	714	0
Kotzebue Electric Wind Power System (Ak)	148	0	0
Michigan Alternative And Renewable Energy Center Offshore Wind Demonstration Project (Mi)	0	1,427	0
National Wind Energy Center (Tx)	0	2,379	0
Redirection Of FY 2008 For Biodiesel Injection Blending Facilities (Pa)	0	-702	0
Renewable Energy For Rural Economic Development Program (Ut)	984	0	0
Western Massachusetts Collaborative Wind Project (Ma)	0	1,189	0
White Earth Tribal Nation Wind Energy (Mn)	984	0	0
Wichita State University Sustainable Energy Solutions (Ks)	984	0	0
Wind Spires As An Alternative Energy Source (Oh)	1,082	0	0
Wind Turbine Electric High-Speed Shaft Brake Project (Oh)	0	476	0
Wind Turbine Model And Pilot Project For Alternative Energy (De)	0	1,427	0
Wyandotte Green Windpower On Brownfields Project (Mi)	984	0	0
Geothermal Technology			0
Alternative Energy Geothermal Technology Demonstration Program (Ny)	295	0	0
Boise City Geothermal System Expansion (Id)	0	1,427	0

	(Dollars In Thousands)		
	FY 2008	FY 2009	FY 2010
Purdue Hydrogen Technologies Program (In)	984	952	0
Renewable & Logistic Fuels For Fuel Cells At The Colorado School Of Mines (Co)	1,476	0	0
Renewable Energy Development Venture (Hi)	0	3,799	0
Rit Integrated Power Microsystems (Ny)	984	0	0
Safe Detector Systems For Hydrogen Leaks (Ca)	984	0	0
Silicon Based Solid Oxide Fuel Cell Chip (Ma)	492	0	0
Solid Acid Fuel Cell Research (Ca)	492	0	0
Solid Oxide Fuel Cell Systems Development (Oh)	984	0	0
Sustainable Hydrogen Fueling Station, California State University Los Angeles (Ca)	0	476	0
Tanadgusix Foundation Hydrogen Project (Ak)	246	0	0
Texas Hydrogen Highway (Tx)	383	0	0
University Of Akron Carbon Based Fuel Cell (Oh)	1,181	0	0
Biomass And Biorefinery Systems R&D			0
Advancing Texas Biofuel Production (Tx)	492	0	0
Algal-Based Renewable Energy For Nevada (Nv)	0	714	0
Alternative Biofuel Infrastructure In Central Georgia (Ga)	344	0	0
Alternative Crops And Biofuels Production (Ok)	0	285	0
Alternative Energy School Of The Future, Clark County (Nv)	0	1,189	0
Alternative Fuel For Cement Processing At Auburn University (Al)	1,476	0	0
Anaerobic Digester And Combined Heat Power Project (Mo)	0	571	0
Anchorage Regional Landfill (Ak)	0	714	0
Appalachian State University Biofuels And Biomass Research Initiative (Nc)	295	0	0
Arkansas State University Ethanol Fuel Development (Ar)	1,476	0	0
Auburn Regional Bioenergy Enterprise (Ny)	492	0	0
Auburn University Bioenergy And Bioproducts Laboratory (Ny)	0	951	0
Bio-Diesel Cellulosic Ethanol Research Facility (Fl)	0	951	0
Biodiesel Injection Blending Facilities (Pa)	738	0	0
Bioeconomy Initiative At Mbi International (Mi)	492	476	0
Bioenergy Cooperative Ethanol Biomass Fuel Plant (In)	1,476	0	0
Bioenergy Demonstration Project: Value-Added Products From Renewable Fuels (Ne)	0	1,903	0
Bioethanol Collaborative (Sc)	984	0	0
Biofuel Production Initiative Claflin (Sc)	492	0	0
Biofuels Development At Texas A&M (Tx)	984	951	0
Biofuels Research And Development Infrastructure (Wa)	0	476	0
Biogas Center Of Excellence (Mi)	0	951	0
Biomass Energy Generation Project (Ia)	0	285	0
Biomass Energy Resource Center (Vt)	0	1,427	0

(Dollars In Thousands)	FY 2008	FY 2009	FY 2010
Biomass Gasification Research And Development Project (Wa)	0	951	0
Biorefinery Demonstration Project, Uga, Athens (Ga)	0	1,189	0
Biorefinery For Ethanol, Chemicals, Animal Feed And Biomaterials From Sugarcane Bagasse (La)	0	951	0
Biorefining For Energy Security At Ohio University (Oh)	984	0	0
Biorefining For Energy Security Project, Ou-Lancaster (Oh)	0	951	0
Cayuga County Regional Digester Facility (Ny)	0	476	0
Center For Clean Fuels And Power Generation At The University Of Houston (Tx)	0	476	0
Center For Integrated Biomass Research (Nc)	0	1,208	0
Center For Producer-Owned Energy (Mn)	984	0	0
Central Vermont Recovered Biomass Facility (Vt)	0	951	0
Chariton Valley Densification - Phase Ii (Ia)	0	951	0
Chariton Valley R.C.&D., Chariton Valley Biomass For Rural Development (Ia)	492	0	0
Chautauqua County - Methane Gas Utilization Project From Landfill At Ellery (Ny)	492	0	0
Clemson University Cellulosic Biofuel Pilot Plant In Charleston (Sc)	0	951	0
Closed Loop Woody Biomass Project (Ny)	492	476	0
Compact Membrane Systems, Inc. - Applied Membrane Technology For Processing Ethanol For Biomass (De)	492	0	0
Connecticut Biodiesel Power Generator (Ct)	738	0	0
Consortium For Plant Biotechnology Research (Ga)	3,936	0	0
Consortium For Plant Biotechnology Research (Nc, Ga, Ky, Ny, Mi, Hi, So, Fl)	0	3,806	0
Controlled Environmental Agriculture And Energy Project (Ny)	0	476	0
Costilla County Economic Development Council, Inc., Biodiesel Project (Co)	271	0	0
Dakota Gold Research Association Sioux Falls (Sd)	1,476	0	0
Dbs Energy Inc., Glastonbury, Ct Biofuels Technology Project In Suffield (Ct)	984	0	0
Developing New Alternative Energy In Virginia: Bio-Diesel From Algae (Va)	0	714	0
Development Of Biofuels (Nv)	0	1,024	0
Development Of High Yield Feedstock And Biomass Conversion Technology For Renewable Energy Production And Economic Development (Hi)	0	1,427	0
Driftless Area Initiative (Il, Ia, Mn, Wi)	608	0	0
Energy And Environmental Research Center For Biomass Utilization (Nd)	0	2,000	0

	(Dollars In Thousands)		
	FY 2008	FY 2009	FY 2010
Ethanol From Agriculture For Arkansas And America (Ar)	0	951	0
Ethanol Pilot Plant (Ma, Ct)	0	2,664	0
Florida Renewable Energy Program (Fl)	738	714	0
Forestry Biofuel Statewide Collaboration Center (Mi)	0	1,427	0
Foster-Glocester Regional School District, Ponaganet Alternative Energy Lab And Biomass Facilities Project (Ri)	984	0	0
Genetic Improvements Of Switchgrass (Ri)	0	1,427	0
Hidalgo County Waste-To-Energy Project (Tx)	0	119	0
High Carbon Fly Ash Use For The Us Cement Industry (Ut)	0	951	0
Illinois State University-Biomass Research Project (Il)	0	476	0
Integrated Biomass Refining Institute At North Carolina State University (Nc)	984	0	0
Intermediary Biochemicals (Mi)	246	0	0
Iowa Central Community College Renewable Fuels Lab (Ia)	0	476	0
Jefferson County Bioenergy Initiative Plant (Co)	492	0	0
Kansas Biofuels Certification Laboratory (Ks)	0	990	0
Kentucky Rural Energy Consortium At The University Of Louisville (Ky)	1,968	0	0
King County Biogas And Nutrient Reduction Project (Wa)	492	0	0
Koochiching County, Renewable Energy Clean Air Project (Recap), Plasma Gasification Waste-To-Energy Project (Mn)	394	952	0
Landfill Gas Utilization Plant (Ny)	0	1,903	0
Laurentian Energy Authority (Mn)	984	0	0
Louisiana State University Alternative Energy Research (La)	984	0	0
Marquette University Anaerobic Biotechnology (Wi)	0	476	0
Mbi International Biomass Research (Mi)	492	0	0
Messiah College Biodiesel Fuel Generation Project (Pa)	492	0	0
Midsouth/Southeast Bioenergy Consortium (Ar, Ga)	1,968	1,903	0
Mill Seat Landfill Bioreactor Renewable Green Power (Ny)	738	0	0
Minnesota Center For Renewable Energy (Mn)	492	714	0
Munster Waste-To-Energy Cogeneration Project (In)	0	951	0
National Agriculture-Based Industrial Lubricants (Nabl) (Ia)	0	571	0
Northeast Texas Community College Biodiesel (Tx)	492	0	0
Ou Center For Biofuels Refining Engineering (Ok)	0	714	0
Pecos Valley Biomass Energy Project (Nm)	0	2,379	0
Pierce County, Landfill Gas-To-Clean Fuel Project (Wa)	3,739	0	0
Placer County Biomass Utilization Pilot Project (Ca)	492	1,427	0
Port Of Umatilla Biodiesel Refining Plant (Or)	492	0	0

	(Dollars In Thousands)		
	FY 2008	FY 2009	FY 2010
Raceland Raw Sugar Corporation, Bio-Renewable Ethanol And Co-Generation Plant (La)	1,476	0	0
Renewable Energy Biomass Utilization Program (Ak)	492	0	0
Renewable/Sustainable Biomass Project (Ak)	0	476	0
San Francisco Biofuels Program (Ca)	0	951	0
Sapphire Algae To Fuel Demonstration Project Portales (Nm)	0	951	0
Snohomish County Biodiesel Project (Wa)	344	0	0
Sorghum To Ethanol Research (Co)	984	0	0
South Dakota State University, Sun Grant Initiative, Regional Biomass Feedstock Development Partnership (Sd)	3,936	0	0
Southeast Bioenergy Initiative (Al)	492	0	0
Southern Illinois University, Carbondale, Biofuels Research (Il)	492	0	0
Stamford Waste-To-Energy Project (Ct)	1,476	1,903	0
Storage Tanks And Dispensers For E85 And Bio-Diesel (Il)	0	376	0
Strategic Biomass Initiative (Ms)	492	476	0
Sun Grant Initiative (Sd)	0	3,806	0
Suny Cobleskill Bio-Waste To Bio-Energy Project (Ny)	1,279	0	0
Sustainable Energy Center Biodiesel From Algae (Mi)	984	0	0
Sustainable Energy Research Center (Ms)	10,824	10,466	0
The Ohio State University-Ohio Agricultural Research And Development Center (Oh)	0	381	0
Trenton Fuel Works Biofuels Plant Re-Construction (Nj)	1,476	0	0
Trenton Fuel Works Cellulosic Diesel Biorefinery (Nj)	0	476	0
U. Of Florida, Gainesville, With The Earth University Foundation Biofuel Project (Fl)	984	0	0
University Of Georgia Biorefinery And Fuel Cell Research (Ga)	1,230	0	0
University Of Hawaii, College Of Tropical Agriculture And Human Resources, Development Of High Yield Tropical Feedstock (Hi)	492	0	0
University Of Kentucky Biofuels Research Laboratory (Ky)	492	0	0
University Of Kentucky Bio-Fuels Research Laboratory (Ky)	0	428	0
University Of Nebraska, Lincoln, Bioenergy Demonstration Project: Value-Added Products From Renewable Fuels (Ne)	1,968	0	0
University Of North Dakota, Grand Forks, Center For Biomass Utilization (Nd)	1,968	0	0
University Of Northern Iowa, National Agriculture-Based Industrial Lubricants (Ia)	984	0	0
University Of Oklahoma Biofuels Refining (Ok)	738	0	0
University Of Rhode Island, Research And Technology Development For Genetic Improvement Of Switchgrass (Ri)	1,476	0	0
Urban Wood-Based Bio-Energy System In Seattle (Wa)	0	476	0

(Dollars In Thousands)	FY 2008	FY 2009	FY 2010
Vermont Biofuels Initiative (Vt)	0	1,427	0
Vermont Biomass Energy Resources Center (Vt)	984	0	0
Vermont Public Power Supply Authority, Renewable Energy From Animal (Vt)	492	0	0
Vermont Sustainable Jobs Fund, Central Vermont Recovered Biomass Facility (Vt)	492	0	0
Vermont Sustainable Jobs Fund, Vermont Biofuels Initiative (Vt)	984	0	0
Waste-To-Energy Cogeneration Project, Munster (In)	1,968	0	0
Woody Biomass Project At Suny-Esf (Ny)	738	714	0
Solar Energy			0
Bexar County Photovoltaic Panels (Tx)	0	476	0
Center For Nanoscale Energy (Nd)	0	4,757	0
Conductive, Transparent Coatings Solar Cell Research Project (Ma)	1,968	0	0
Flexible Thin-Film Silicon Solar Cells (Oh)	0	1,189	0
Green Energy, Arts & Education Center (Ny)	492	0	0
Greenfield Community College - Sustainable Energy Model (Ma)	394	0	0
High Efficiency Cascade Solar Cells (Nm)	984	0	0
Integrated Power For Microsystems At Rochester Institute Of Technology (Ny)	0	951	0
Isles. Inc. Solar And Green Retrofits (Nj)	0	238	0
La Samilla Solar Trough Storage Project (Nm)	0	1,903	0
Lehigh Valley Hospital Photovoltaic Panel Installation (Pa)	0	951	0
Low Cost Thin Filmed Silicon Based Photovoltaics (Ny)	0	476	0
Maret Center (Mo)	984	951	0
Multifunctional Solar Energy Systems Research (Ut)	0	1,332	0
Nanostructured Solar Cells For Increased Efficiency And Lower Cost (Ar)	1,181	1,189	0
Nevada Institute For Renewable Energy Commercialization (Nv)	0	476	0
North Dakota State University, Center For Nanoscale Energy (Nd)	5,904	0	0
Omega Optical Solar Power Generation Development (Vt)	0	1,427	0
Oregon Solar Highway (Or)	0	951	0
Photovoltaic Demonstration Project (Ct)	492	0	0
Photovoltaic System At Town Landfill In Islip (Ny)	0	476	0
San Francisco Muni Solar Energy Facility (Ca)	610	0	0
Sandia National Lab Concentrating Solar (Nm)	2,952	2,855	0
Solar Consortium Of New York Photovoltaic Research And Development Center (Ny)	1,476	0	0
Solar Demonstration And Research Facility (Fl)	0	238	0
Solar Electric Power System (Ny)	0	67	0
Solar Energy Windows And Smart Ir Switchable Buildings (Pa)	0	1,189	0

	(Dollars In Thousands)		
	FY 2008	FY 2009	FY 2010
Cleary University Geothermal Energy Retrofit (Mi)	0	476	0
Geothermal Energy Project At Roberts Wesleyan College (Ny)	0	476	0
Geothermal Power Generation Plant (Or)	0	1,522	0
Great Basin Center For Geothermal Energy (Nv)	0	683	0
Middlesex Community College's Geothermal Project (Ma)	0	238	0
Notre Dame/Nisource Geothermal Ionic Liquids Research Collaborative (In)	984	952	0
Oregon Institute Of Technology Geo-Heat Center (Or)	984	0	0
Snohomish County Pud No. 1 Geothermal Energy Study (Wa)	0	476	0
Southwest Alaska Regional Geothermal Energy Project (Ak)	0	2,855	0
Town Of Mexico Geothermal Project (Ny)	0	142	0
Unalaska Geothermal Energy (Ak)	0	952	0
Water Power			0
Ann Arbor Wind Generator For Water Treatment Plant (Mi)	0	952	0
Center Of Excellence In Ocean Energy Research And Development, Florida Atlantic University (Fl)	0	1,189	0
Hydro Partners In Brazil (Oh)	984	0	0
Hydroelectric Power Generation, Quincy (Il)	0	476	0
Hydropower From Wastewater Advanced Energy Project (Ny)	0	476	0
Maine Tidal Power Initiative (Me)	0	952	0
Marine Renewable Energy Center (Ma)	0	952	0
Niagara River Hydropower (Ny)	0	476	0
Tidal Energy Study (Wa)	0	476	0
Wave Energy Research And Demonstration Center (Or)	0	2,331	0
Wave Power Demonstration Project, Reedsport (Or)	1,968	0	0
Vehicle Technologies			0
Anti-Idling Lithium Ion Battery Program (Ca)	0	952	0
Biopolar Water Cell Nimh Ion Battery (Ct)	984	0	0
Center For Advanced Vehicular Systems (Cavs) At Msu (Ms)	3,936	0	0
Center For International Intelligent Transportation Research (Tx)	0	523	0
City Of Las Vegas Plug-In Hybrid Vehicle Demonstration Program (Nv)	0	142	0
Clean And Efficient Diesel Engine (Pa)	0	1,189	0
Dueco Plug-In Hybrid Engines (Wi)	0	1,903	0
Energy Efficient Press And Sinter Of Titanium Powder (Il)	492	0	0
Green Vehicle Depot (Ny)	0	285	0
High Energy Batteries For Hybrid Buses (In)	984	0	0
Hybrid Hydraulic Drivetrain Demonstration (Oh)	1,968	0	0
Hypercast R&D Funding For Vehicle Energy Efficiency Through Cast Metal Auto-Combustion Synthesis (Ma)	0	1,427	0

(Dollars In Thousands)	FY 2008	FY 2009	FY 2010
Iowa Central Community College Renewable Fuels Testing Lab (Ia)	984	0	0
Juniata Ultra Low Emission Locomotive Demonstrator (Pa)	590	714	0
Kansas City Area Transportation Authority, Demonstration Of Plug-In Vehicles (Ks)	984	0	0
Lightweight Composites For Heavy-Duty Vehicles And Hydrogen Storage (Wv)	0	476	0
Michigan State University, Advanced Hybrid Vehicle Technology, Hybrid Electric Vehicle Group (Mi)	394	0	0
Modular Energy Storage System For Hydrogen Fuel Cell (Mi)	0	1,189	0
National Center For Manufacturing Sciences Light - Weight Vehicle Materials (Mi)	1,968	1,903	0
Macomb Community College Transportation And Energy Technology (Mi)	0	476	0
North Carolina Center For Automotive Research (Nc)	0	476	0
Plug-In Hybrid And Ethanol Research Platforms (Nc)	0	809	0
Plug-In Hybrid Electric Vehicle Demonstration (Ca)	984	0	0
Transpo Bus Operations And Maintenance Center, South Bend (In)	0	952	0
Transportable Emissions Testing Lab (Wv)	984	952	0
West Virginia University, Lightweight Composite Material For Heavy Duty Vehicles (Wv)	492	0	0
Building Technologies			0
Adaptive Liquid Crystal Windows (Oh)	0	952	0
Advanced Engineered Rapidly Deployable Manufacturing Methods And Materials For Environmentally Benign And Energy Efficient Housing (Va)	0	476	0
Advanced Green Design For Museum Of National History (Mn)	787	0	0
Affordable, Energy Efficient, Self Help Housing (Ms)	295	0	0
Atlanta International Terminal Leed Certification (Ga)	0	476	0
Building Materials Reclamation Program (Nc)	492	0	0
Building-Integrated Photovoltaic Solar Energy System (Pa)	295	0	0
Center For Energy Efficient Design (Va)	197	0	0
Energy Efficient Buildings, Salt Lake County, Utah (Ut)	0	618	0
Energy Efficient Electronics Cooling Project (In)	0	952	0
Energy Efficient Lighting Project (Ky)	0	190	0
First Responder "Green" House (Ny)	98	0	0
Frostburg State University Sustainable Energy Research Facility Equipment And Staffing (Md)	0	856	0
Green Buildings - Bradley University (Il)	0	476	0
Green Buildings - Lakeview Museum (Il)	0	238	0
Green Roof Project Southwest Brooklyn (Ny)	246	0	0

	(Dollars In Thousands)		
	FY 2008	FY 2009	FY 2010
Green Visitor Center, Brooklyn Botanic Green (Ny)	590	0	0
Intelligent Controls For Net-Zero Energy Buildings (Ne)	0	476	0
Intelligent Facades For High Performance Green Buildings (Ny)	0	714	0
Jackson Park Hospital Green Medical Office Building (Il)	984	0	0
Lake Land College Energy Efficient Buildings (Il)	0	1,332	0
Miami Science Museum Renewable Energy Research Project (Fl)	738	714	0
Nccr "Green" Building (La)	738	0	0
New School "Green" Building (Ny)	0	1,903	0
Nyit Building Efficiency Demonstration Project (Ny)	492	0	0
Pinellas County Regional Urban Sustainability Demonstration And Education Facility (Fl)	0	476	0
Pittsburgh Green Innovators Synergy Center (Pa)	0	571	0
Senior Housing Project Green Building, Cerritos (Ca)	0	381	0
Springfield Hospital Green Building (Oh)	0	3,806	0
Sustainable Energy Research Facility Construction (Md)	738	0	0
Sustainable Fluorescent Light Replacement Technology (Mi)	590	0	0
Texas A&M Green Campus Research Initiative (Tx)	492	0	0
University Of Nevada, Las Vegas, Lighting Emitting Diode Display Engineering (Nv)	590	0	0
University Of Nevada, Las Vegas, National Center On Energy Management (Nv)	492	0	0
University Of North Alabama Green Campus Initiative (Al)	984	951	0
Vermont Independent Colleges Zero-Energy Campaign (Vt)	1,476	0	0
Western North Carolina Clean Energy Business Incubator (Nc)	354	0	0
Winooski Community Greening Project (Vt)	0	114	0
York College National Energy Resource Center (Sc)	197	0	0
Industrial Technologies			0
Alternative Energies Workforce Applications Education And Training Program (Oh)	819	952	0
Clean Power Energy Research Consortium - Nicholls State University (La)	984	1,903	0
Cooling Heating And Power And Bio-Fuel Application Center (Ms)	1,968	1,903	0
Fluid Flow Optimization Of Aerogel Blanket Manufacturing Process (Ma)	0	1,427	0
Great Lakes Energy Research Park (Mi)	492	0	0
Nanostructural Materials For Safe Alternative Energy (Nc)	984	952	0
Northwest Regional Planning Commission, Manufacturing Conversion For Energy Efficiency (Wi)	4,920	0	0
Ohio Advanced Energy Manufacturing Center (Oh)	0	952	0
The Greenville Steam Efficiency Project (Me)	886	0	0

	FY 2008	FY 2009	FY 2010
	(Dollars In Thousands)		
Tools For Nanotechnology Education (Or)	984	0	0
Truckee Meadow Water Reclamation Facility (Nv)	984	0	0
University Of Southern Indiana Advanced Manufacturing And Engineering Equipment Project (In)	0	952	0
Water-To-Water Heat Pump Chillers, Phoenix Children, (Az)	0	1,952	0
Weatherization And Intergovernmental Activities			0
Council Of Energy Resource Tribes (Co)	492	0	0
Department Of Energy's Clean Energy Technology Export Program To Export U.S. Clean Energy Technologies (Cete) (Unknown)	590	0	0
Navaho Hopi Land Commission Renewable Development (Nm)	295	0	0
Crosscut			
Advanced Power Batteries For Renewable Energy Applications (Pa)	0	351	0
Alternative Energy Engineering Technology (Va)	0	95	0
Alternative Energy For Higher Education (Ne)	0	1,142	0
Carbon Neutral Green Campus (Nv)	0	381	0
Center For Efficiency In Sustainable Energy Systems (Oh)	0	1,903	0
Christmas Valley Renewable Energy Development (Or)	0	381	0
City Of Grand Rapids Building Green Roof Demonstration (Mi)	0	142	0
City Of Louisville Energy Conservation Initiative (Ky)	0	142	0
City Of Markham Community Center (Il)	0	238	0
City Of Miami Green Initiative (Fl)	0	951	0
Clean And Efficient Diesel Engine (Pa)	984	0	0
Clean Technology Commercialization Initiative (Pa)	0	951	0
Clean Technology Evaluation Program (Ma)	0	476	0
Downtown Detroit Energy Efficiency Street Lighting (Mi)	0	951	0
Ecologically Sustainable Campus-New England College (Nh)	0	300	0
Energy And Sustainability Institute, Illinois Institute Of Technology (Il)	246	0	0
Energy Efficiency/Sustainable Energy Project (Nc)	0	951	0
Energy Production Through Anaerobic Digestion (Nj)	0	476	0
Environmental System Center At Syracuse University (Ny)	0	714	0
Great Lakes Institute For Energy Innovation (Oh)	0	951	0
Green Collar And Renewable Energy Training Program, Ab Technical Community College (Nc)	0	666	0
Green Energy Job Training Initiative (Ca)	0	238	0
Green Power Initiative (Ia)	0	951	0
Green Roof Project - Greene County (Mo)	0	476	0
Hawaii Natural Energy Institute, Hawaii-New Mexico Sustainable Energy Security Partnership (Hi)	1,968	0	0
Hawaii-New Mexico Sustainable Energy Security Partnership (Hi)	0	3,116	0

	(Dollars In Thousands)		
	FY 2008	FY 2009	FY 2010
Hollow Glass Microspheres (Nv)	0	523	0
Integrated Sustainability Initiative (Nv)	0	951	0
Iowa Lakes Community College Sustainable Energy Edu. Center (Ia)	0	476	0
Kansas State University Center For Sustainable Energy (Ks)	0	714	0
Nevada Institute For Renewable Energy Commercialization (Nv)	1,476	0	0
Nevada Virtual Renewable Energy Integration And Development Center (Nv)	0	2,560	0
Nye County Renewable Energy Feasibility Study (Nv)	492	0	0
Pacific International Center For High Technology Research, Renewable Energy Development Venture (Hi)	1,230	0	0
Pope/Douglas Third Combustor Expansion (Mn)	0	951	0
Renewable Energy Center (Nv)	0	476	0
Renewable Energy Feasibility Study (Nj)	0	476	0
Renewable/Alternative Energy Center (Fl)	0	951	0
Rhode Island Ocean Special Area Management Plan (Ri)	0	666	0
Risk-Based Data Management System (Ok)	492	0	0
Southern Regional Center For Lightweight Innovative Design (Ms)	0	3,806	0
Suny-Oswego Energy Independence (Ny)	295	0	0
Sustainable Energy For Homes And Businesses (Vt)	0	714	0
Sustainable Energy For Vermont Schools Competition (Vt)	0	856	0
Sustainable Las Vegas (Nv)	0	951	0
The Institute For Energy, Environment, And Sustainability (Ks)	0	714	0
U. Of Maryland Energy Research Center (Md)	743	0	0
Umass Renewable Energy Economy Expansion Project (Ma)	197	0	0
Usd Catalysis Group For Alternative Energy (De)	0	1,047	0
Total, Congressionally Directed Projects	186,664	228,803	0

Explanation Of Funding Changes

	FY 2010 Vs. FY 2009 ($000)
Congressionally Directed Projects	
No Funding Requested.	-228,803
Total Funding Change, Congressionally Directed Projects	**-228,803**

Electricity Delivery and Energy Reliability

Electricity Delivery and Energy Reliability

Table of Contents

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, [$137,000,000] *$208,008,000*, to remain available until expended [: *Provided*, That, of the amount appropriated in this paragraph, $19,648,475 shall be used for projects specified in the table that appears under the heading "Congressionally Directed Electricity Delivery and Energy Reliability Projects" in the text and table under this heading in the explanatory statement described in section 4 (in the matter preceding division A of this consolidated Act)]. (*Energy and Water Development and Related Agencies Appropriations Act, 2009.)*

Explanation of Change

Changes are proposed to reflect the FY 2010 funding.

Electricity Delivery and Energy Reliability
Office of Electricity Delivery and Energy Reliability

Overview

Appropriation Summary by Program

(dollars in thousands)

	FY 2008 Current Appropriation	FY 2009 Original Appropriation	FY 2009 Additional Appropriation	FY 2010 Request
Electricity Delivery and Energy Reliability				
Research and Development	82,826	84,721	0	174,000
Operations and Analysis	11,451	11,451	0	0
Permitting, Siting, and Analysis	0	0	0	6,400
Infrastructure Security and Energy Restoration	0	0	0	6,188
Program Direction	17,603	21,180	0	21,420
Congressionally Directed Projects	24,290	19,648	0	0
American Recovery and Reinvestment Act			4,500,000	
Total, Electricity Delivery and Energy Reliability	136,170	137,000	4,500,000	208,008

Preface

Our Nation's ability to meet the growing demand for reliable electricity is challenged by an aging electricity transmission and distribution system and by vulnerabilities in our energy supply chain. Despite increasing demand, we have experienced a long period of underinvestment in power generation, power transmission, and infrastructure maintenance. The majority of the power delivery system was built on technology developed in the 1960s, 70s and 80s and is limited by the speed with which it can respond to disturbances. This limitation increases the vulnerability of the power system to a greater number of outages that can spread quickly and have regional effects.

Major hurricanes, energy disruptions, and increased congestion in major transmission corridors are costing taxpayers billions of dollars each year and jeopardize the safety and well-being of millions of Americans and U.S. industry. The electric grid is also becoming increasingly vulnerable to cyber attacks against control systems; in addition, as deployment of smart grid technologies grow, the importance of building cyber security into digital control systems has never been greater. Since electricity is vital to nearly every aspect of life, from powering our electronics and heating our homes to supporting commerce, transportation, finance, food and water systems, and ensuring national security, any disruption can have major consequences to the economy and public health and safety.

New infrastructure improvements and vulnerability assessments are needed to maintain reliability and resiliency, to ensure security, and to drive down costs to consumers. Our grid infrastructure has aged and become more constrained, which will result in higher costs to consumers. Regulatory uncertainty has prevented the private sector from investing in some projects. Siting and permitting concerns slow or prevent new electricity infrastructure, such as transmission lines, from being built. Both these issues drive up the costs of new infrastructure, which is ultimately passed on to consumers.

The Office of Electricity Delivery and Energy Reliability (OE) is the focal point for securing energy supplies (electricity, oil, and gas) and providing leadership in developing the “next generation” electric delivery infrastructure in the U.S. that enables clean energy choices, automated grid operations, and flourishing markets.

Achieving the President’s goal to create a clean energy future, “Ensuring 10 percent of Our Electricity Comes from Renewable Sources by 2012, and 25 percent by 2025,” will require a modern and efficient electricity transmission and distribution system.

Within the Electricity Delivery and Energy Reliability Appropriation, the Office of Electricity Delivery and Energy Reliability has four programs: Research and Development (4 subprograms); Permitting, Siting and Analysis; Infrastructure Security and Energy Restoration; and Program Direction.

Mission
The mission of OE is to lead national efforts to modernize the electric grid, to enhance the security and reliability of the energy infrastructure, and to facilitate recovery from disruptions to the energy supply.

Benefits
The benefits of OE stem from improving the reliability, security and efficiency (operations) of the nation’s electric system. Disruption of energy supplies can be the result of security/reliability concerns stemming from physical/cyber attack, change in generation/spike in demand, technical/operational failures, market manipulation, or natural disasters. As a result, the Office focuses on long-term system requirements through our research investments in the electricity delivery system and near-term energy vulnerability assessments/disaster recovery.

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); and
- Reduced peak demand and price volatility of electricity through increased asset utilization (capacity factor of transmission and distribution), and improved accessibility to a variety of energy sources that generate electricity (reliability and system efficiency).

Benefits of the operational activities include:
- A hardened energy infrastructure that detects, prevents, and mitigates external disruptions to the U.S. energy sector (reliability);
- Competitively priced and environmentally responsible electricity through cross-border trade (system efficiency);
- Facilitated activities with the States to develop energy security and reliability plans, energy efficiency plans (grid), and generation/demand response investment strategies (system efficiency); and
- Coordinated response for energy emergencies (resiliency).

The electric transmission and distribution system plays an important role in climate change control in realizing reductions in greenhouse gas emissions, and in implementing carbon management strategies for the electricity sector. This role has two aspects: (1) improvements in the energy efficiency of the electric transmission and distribution system itself, with resulting reductions in power delivery losses and greenhouse gas emissions, and (2) enabling the installation of renewable and other clean power systems; energy efficient buildings, appliances, and industrial equipment; and potentially low-carbon transportation alternatives such as electric vehicles.

American Recovery and Reinvestment Act

The American Recovery and Reinvestment Act (Recovery Act) included $4.5 billion for Electricity Delivery and Energy Reliability activities. It directed the funds to modernize the electric grid, enhance the security and reliability of the electric infrastructure, and to implement smart grid activities authorized under the Energy Independence and Security Act of 2007 (EISA).

The Department plans to devote almost $4 billion to implementing smart grid programs authorized by EISA that will support the deployment of smart grid technologies across the transmission and distributions system. Smart grid technologies enable real time monitoring of energy usage and automated adaptation of energy flow to save energy and reduce costs. Much like the addition of information technology to the automobile, smart grid technologies provide enhanced data through constant feedback from the electrical system, allowing operators to gain a complete picture of grid status and increase both stability and efficiency. Enhanced data will not only let operators analyze the roots of any problems and increase stability but, through computer control and energy management, will also monitor energy usage in real time, enabling consumers to better control their use of energy and reduce costs. Recovery funding will support regional demonstrations of smart grid technologies, as well as grid monitoring devices, called "synchrophasors," and energy storage (EISA section 1304). It will also provide for a Federal cost share of investments planned by utilities and other entities to implement smart grid upgrades to the electric grid (section 1306).

Recovery funds will also fund the development of industry-based interoperability standards that can help the many different devices involved in smart grid, and their ability to communicate with each other in an efficient and secure manner, become more interoperable than they are today. This will result in an effective and consistent application of smart grid technologies. The National Institute of Standards and Technology, working with the Department, will help facilitate this effort.

The Recovery Act also directed funds to develop a resource assessment and analysis of future demand and transmission requirements, in support of regional transmission planning, a critical element of the nation's transition to a clean energy future. Similarly, the Act provided funds for workforce training to ensure the skilled electric power system workforce needed to modernize the grid is available. The Department continues its efforts to develop all these initiatives.

The table below shows the current allocation of Recovery Act funds. Additional initiatives and administrative support requirements utilizing the remaining funds are currently under review within the Department.

American Recovery and Reinvestment Act	(dollars in thousands)
	FY 2009 Additional Appropriations
Electricity Delivery and Energy Reliability	
Smart Grid Investment Program (EISA 1306)	3,375,700
Smart Grid Regional Demonstrations (EISA 1304) and completion of ongoing demonstration projects (1)	700,000
Interoperability Standards (2), (3)	10,288
Workforce Development (3)	100,000
Interconnection Planning and Analysis (3)	80,000
Program Direction	22,500
Other	211,512
Total, Electricity Delivery and Energy Reliability	4,500,000

(1) Provides a maximum of $85M to complete ongoing smart grid demonstration.
(2) Includes $288,000 for SBIR/STTR requirement.
(3) Directed in the Act.

The Department of Energy's Recovery website (http://www.energy.gov/recovery) contains current information on activities and funding opportunities.

Significant Changes

The FY 2010 Budget includes a revised budget structure to better reflect the Department's priorities, and a changing emphasis in OE's work.

- The Research and Development program's portfolio has been restructured to provide a sharpened focus on the Administration's commitment to increase the electricity derived from renewable clean energy by developing the needed transmission grid modernization through the development of advanced transmission-driven technologies, smart-grid technologies, and improving cyber security on the grid. The new subprograms are:

  - <u>Clean Energy Transmission and Reliability</u> includes activities to develop advanced transmission-driven technologies that will improve grid reliability, efficiency, and security. It incorporates phasor development and wide area measurement formerly funded under Visualization and Controls subprogram, and high temperature superconducting activities.
  - <u>Smart Grid Research and Development</u> subprogram reflects an increased emphasis on research that promotes the development of an efficient, fully integrated "smart grid" system. These activities were previously funded within the Renewable and Distributed Systems Integration. The new subprogram will also incorporate power electronic activities previously funded within Energy Storage and Power Electronics.

  - Energy Storage activities, previously funded within Energy Storage and Power Electronics, will now be a separate subprogram, reflecting its increased importance as a potential solution to many of the problems being experienced on the electric grid.
  - Cyber Security for Energy Delivery Systems will include research activities to address the vulnerabilities within the electric distribution system, of increasing importance as utilities begin to deploy smart grid technologies. Cyber security activities were previously funded under the Visualization and Controls subprogram.

- The Permitting, Siting and Analysis subprogram and Infrastructure Security and Energy Restoration subprogram, will become separate programs, reflecting their distinct activities and purpose. These activities were previously funded under the Operations and Analysis program.

Energy Innovation Hubs
OE takes part in the Department's multi-disciplinary Energy Innovation Hubs (Hubs), which focus on critical science and technology for high-risk, high-reward research to revolutionize how the U.S produces, distributes, and uses energy. The Hubs will promote energy security and reduce greenhouse gas emissions. They will also strengthen the Nation's economy by coordinating teams of experts from multiple fields to blend technology development, engineering design, and energy policy. Finally, they will develop the critical areas of expertise needed for the green economy. OE will support one hub that specifically focus on Grid Materials, Devices and Systems. This is a new activity and is contained in the Smart Grid Research and Development subprogram.

Strategic Themes, Goals and the Secretary's Initiatives
A new DOE strategic plan has not yet been established and approved by the Secretary of Energy. The Secretary has established major priorities and initiatives.

The Secretary's top ten initiatives are:

- Energy Efficient Homes and Businesses: Funding provided through the states for homeowners and businesses to take immediate steps toward energy efficiency – reducing heating and air conditioning bills and creating jobs.

- Greening Federal Buildings: Provide funding for the federal government to improve the efficiency of offices and buildings, reducing energy bills and creating jobs.

- Renewable Energy Projects: Accelerate the construction of solar, wind, geothermal and other renewable energy generation facilities through a combination of loans and grants, creating jobs immediately and provide the United States with clean energy supply for the long term.

- SmartGrid Technology and Transmission Infrastructure: Build the wires and infrastructure needed to transport electricity across the country – from renewable energy plants to population centers, reducing congestion and allowing for more clean energy – and improve the efficiency and reliability of the existing grid.

- Clean Coal Technology: Develop and pilot innovative technologies for the emission-free coal plants of the future, allowing our nation to safely utilize our abundant coal resources.

- Next Generation Biofuels: Provide loans and grants to accelerate the research and deployment of cellulosic biofuels technologies to provide a clean alternative to imported fossil fuel sources.

- Science and Basic Research in the Energy Technologies of the Future: Investments in building and renovating laboratories and scientific research facilities that will create jobs immediately and enable the research on for technologies and innovations that will sustain American industry and provide new energy and climate solutions over the longer term.

- Battery Research and Advanced Vehicle Technologies: Loans and grants to support the development of advanced vehicle batteries and battery systems to reinvigorate the U.S. auto industry, reduce the U.S. dependence on foreign oil and transforming the way automobiles are powered.

- Advanced Research Project Agency-Energy (ARPA-E): Jump start advanced energy technologies by funding high-risk, high-payoff research in collaboration with industry.

- Cleanup of Nuclear Legacy: Redouble the ongoing projects to clean up the radioactive waste from cold war nuclear project sites, creating jobs and reclaiming lands for communities across the country.

The following chart aligns the current Strategic Plan with the Secretary's priorities:

Strategic Theme	Strategic Goal Title	Secretary's Priorities	GPRA Unit Program Number	GPRA Unit Program Title	Office
1. Energy Security	3. Energy Infrastructure	Economic Prosperity	16	Electric Delivery and Energy Reliability	OE

Basic and Applied R&D Coordination

OE coordinates and collaborates with the Office of Science on its applied projects to ensure the products of their basic research and science capabilities are productively designed and developed to help address the technology barriers and opportunities the program faces.

Cooperative areas include the Energy Storage program, which is critical to integrating renewable energy into the grid. The Energy Storage Program pursues a portfolio of technological options for energy storage devices and systems as well as basic applied research in the development of storage devices with lower cost, longer lifetime, greater energy density, and increased safety and environmental impact. In coordination with the Office of Basic Energy Sciences (BES) and the Vehicle Technologies program in Energy Efficiency and Renewable Energy (EERE), the OE Energy Storage Program participates in integrated activities in the area of nano-structured electrodes and advanced organic electrolytes. While nanomaterials exhibit attractive characteristics on the laboratory scale, incorporation into cost-effective devices is a complex and difficult process. Much basic materials research will be required to obtain a better understanding of the underlying processes. OE has collaborated with BES in the establishment of goals and priorities for its Energy Storage Frontier Research Centers and has ongoing joint SBIR topics on electrodes and electrolytes. BES provides peer reviewers and attends the annual Energy storage Program Review. Closer collaboration is expected in FY 2010 upon establishment of the new Science-sponsored Frontier Research Center, which will be formed as a consortium with teams of top researchers from National Laboratories, academia, private research institutes, and industry.

In FY 2010, OE will establish the Grid Materials, Devices and Systems Hub, one of several new innovation hub's across the Department, to enable the future power grid to advance to the next level through the development of new "smart" materials for conductors, insulators, power electronics and other elements of the electric system. This research will be done in collaboration with the Office of Science and EERE. The innovation hub could, for example, leverage BES activities seeking to understand materials properties and behavior and how to make materials perform better at acceptable cost through innovative materials design.

	(dollars in thousands)		
	FY 2008	*FY 2009*	*FY 2010*
Electrical Energy Storage			
Energy Storage and Power Electronics	*6,741*	*6,552*	*0*
Energy Storage			*15,000*
Total, Electrical Storage			
Smart Grid Research and Development			
Grid Material, Devices and Systems Hub			*35,000*
Total, Basic and Applied R&D Coordination	*6,741*	*6,552*	*50,000*

Regaining ENERGY Science and Engineering Edge (RE-ENERGYSE)
The Department is undertaking a broad educational effort that cuts across program offices to inspire students and workers to pursue careers in science, engineering, and entrepreneurship related to clean energy and other fields important to the Department's mission. RE-ENERGYSE is a new initiative to focus on a number of critical areas that will build the foundation of a vibrant American workforce to participate in the green economy and advance science and innovation in the U.S. The Office of Electricity Delivery and Energy Reliability will participate in this initiative.

Electricity Delivery and Energy Reliability
Office of Electricity Delivery and Energy Reliability

Funding by Site by Program

	(dollars in thousands)		
	FY 2008	FY 2009	FY 2010
Argonne National Laboratory			
Research and Development	1,044	1,025	875
Operations and Analysis	638	90	0
Permitting, Siting, and Analysis	0	0	90
Total, Argonne National Laboratory	1,682	1,115	965
Brookhaven National Laboratory			
Research and Development	350	350	350
Total, Brookhaven National Laboratory	350	350	350
Chicago Operations Office			
Research and Development	4,500	1,200	0
Program Direction	387	361	365
Total, Chicago Operations Office	4,887	1,561	365
Golden Field Office			
Research and Development	154	700	0
Program Direction	10	0	0
Total, Golden Field Office	164	700	0
Idaho National Laboratory			
Research and Development	2,830	2,400	10,000
Program Direction	10	0	0
Congressionally Directed Activities	379	0	0
Total, Idaho National Laboratory	3,219	2,400	10,000
Lawrence Berkeley National Laboratory			
Research and Development	1,876	3,000	3,000
Operations and Analysis	3,035	3,283	0
Permitting, Siting, and Analysis	0	0	4,338
Total, Lawrence Berkeley National Laboratory	4,910	6,283	7,338

	(dollars in thousands)		
	FY 2008	FY 2009	FY 2010
Los Alamos National Laboratory			
Research and Development	5,750	5,500	5,500
Total, Los Alamos National Laboratory	5,750	5,500	5,500
National Energy Technology Laboratory			
Research and Development	26,965	34,036	71,025
Operations and Analysis	5,197	5,699	0
Permitting, Siting, and Analysis	0	0	1,102
Infrastructure Security and Energy Restoration	0	0	4,748
Program Direction	4,638	5,185	5,244
Congressionally Directed Activities	21,451	17,745	0
Total, Idaho National Laboratory	58,251	62,655	82,118
National Renewable Energy Laboratory			
Research and Development	1,850	2,805	2,350
Operations and Analysis	0	20	0
Total, National Renewable Energy Laboratory	1,850	2,825	2,350
Oak Ridge National Laboratory			
Research and Development	18,609	17,360	23,000
Operations and Analysis	159	0	0
Permitting, Siting, and Analysis	0	0	159
Congressionally Directed Activities	492	476	0
Total, Oak Ridge National Laboratory	19,260	17,836	23,159
Pacific Northwest National Laboratory			
Research and Development	7,225	8,365	23,000
Richland Operations Office			
Operations and Analysis	900	1,204	0
Infrastructure Security and Energy Restoration	0	0	845
Total, Richland Operations Office	900	1,204	845

	(dollars in thousands)		
	FY 2008	FY 2009	FY 2010
Sandia National Laboratory			
Research and Development	8,943	7,230	31,900
Congressionally Directed Activities	1,968	1,427	0
Total, Sandia National Laboratory	10,911	8,657	31,900
Washington Headquarters			
Research and Development	2,730	750	3,000
Operations and Analysis	1,523	1,155	0
Permitting, Siting, and Analysis	0	0	711
Infrastructure Security and Energy Restoration	0	0	595
Program Direction	12,559	15,634	15,812
Total, Washington Headquarters	16,811	17,539	20,618
Total, Electricity Delivery and Energy Reliability	136,170	137,000	208,008

Major Changes or Shifts by Site

Chicago Operations Office (COO)
Research and Development

- The financial assistance agreements awarded through the solicitations "Cooperative Research and Development for Advanced Communication and Control" and "Cooperative Research and Development for Electric Transmission and Distribution" have been completed. No additional funding is required.

Idaho National Laboratory (INL)
Research and Development

- In FY2010, OE has increased its focus on Cyber Security research. As a result, INL will receive additional funding to support the office's efforts to accelerate the development and deployment of next generation network devices.

National Energy Technology Laboratory (NETL)
Research and Development

- NETL will be the principal contracting operations office for the Research and Development Program. Additional responsibilities include technical support, issuing Request for Proposals (RFPs) and conducting lab calls.

Sandia National Laboratory
Research & Development

- SNL's additional funds will support enhanced efforts in cyber security research.

Pacific Northwest National Laboratory (PNNL)
Research and Development

- PNNL's additional funds will be used to support OE's growth in cyber security research. It will also include work on smart grid development and implementation, as well as Clean Energy Transmission & Reliability.

Washington Headquarters
Research and Development

- Activities will consist of management and administration of the Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) programs, I-Manage, and communications. Additional activities include cyber security research and clean energy transmission and reliability.

Site Description

Argonne National Laboratory (ANL)

Research and Development

ANL performs research and development for the High Temperature Superconductivity R&D (HTS) activity. Argonne uses unique expertise in superconducting materials science and in developing characterization tools to help improve the understanding of current flow in HTS materials. Unique facilities such as the Intense Pulsed Neutron Source (IPNS) and the Advanced Photon Source are used for measurement and characterization in ANL's research. Argonne also provides support to cyber security activities.

Permitting, Siting, and Analysis

ANL provides analytical to support DOE in its EPACT Sec. 368 requirement to work with the Federal agencies of Defense, Commerce, Agriculture, Interior and in consultation with FERC, States, tribes, appropriate local units of governments, affected energy industries and other interested parties, to perform any environmental reviews so as 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.

Brookhaven National Laboratory (BNL)

Research and Development

BNL supports the High Temperature Superconductivity R&D activity by working with national laboratory/industry teams and universities to undertake research on fundamental wire properties and processing issues.

Chicago Operations Office (COO)

Research and Development
The Chicago Operations Office commissioned the solicitations for "Cooperative Research and Development for Advanced Communication and Control" and "Cooperative Research and Development for Electric Transmission and Distribution" and has been providing project management support to the financial assistance agreements awarded through the solicitations.

Idaho Operations Office (IDO)

Research and Development
IDO administered the University Cooperative Projects for the High Temperature Superconductivity R&D activity. The University projects were in cooperation with the National Laboratories and consisted of seven projects to transfer new technologies developed at the universities to individual National Laboratories that would benefit from these new technologies. All University projects have been completed.

Idaho National Laboratory (INL)

Research and Development
The Idaho Laboratory provides a Supervisory Control and Data Acquisition (SCADA) test bed to support the Visualization and Controls activity.

Lawrence Berkeley National Laboratory (LBNL)

Research and Development
LBNL has the lead for a national laboratory/industry/university consortium that was formed to support research in Visualization and Controls. This consortium is assisting in implementing the DOE Visualization and Controls activity.

Permitting, Siting, & Analysis
Funding to LBNL is used for analysis 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 works with industry to develop second generation HTS wires based on the ion beam assisted deposition (IBAD) process pioneered by LANL. LANL's expertise in film deposition processes and materials science is used to improve the performance of IBAD wires. Commercial versions are expected to carry 1,000 amperes of current through a centimeter wide metal strip coated with a film the thickness of only a few human hairs - a revolutionary change. LANL is also working with industry to develop superconducting transmission cables and superconducting fault current limiters. Finally, LANL provides support to energy assurance visualization activities.

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 solictations. 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 is the central project management center for the ISER program. Additionally, NETL acts as the coordinating lead laboratory for the visualization and modeling working group (VMWG), to integrate analysis from the VMWG laboratories. NETL also produces a 1-hour analysis of energy related situations showing major energy assets. In addition, 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.

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. NREL performs analysis addressing regulatory and institutional barriers to distributed power and provides technical assistance to State agencies and others on these issues. Activities will also include renewable energy grid integration to fully integrate transmission and distribution system level renewable energy technologies into the electric grid. NREL also supports the High Temperature Superconductivity R&D activity by working with national laboratory/industry teams and universities to research fundamental wire properties and processing issues.

Oak Ridge National Laboratory (ORNL)

Research and Development

ORNL is part of a national laboratory/industry/university consortium that was formed to support research in Visualization and Controls activities. ORNL operates the National Transmission Technology Research Center for testing transmission technologies. ORNL is one of the primary labs for renewable and distributed systems integration research including plug-in hybrid electric vehicles' effects on the grid and renewable energy grid integration. ORNL is developing second generation HTS wires based on the rolling-assisted, biaxially textured substrate process (RABiTS) patented by ORNL. ORNL is applying its expertise in cryogenic systems and power system technology in projects to develop superconducting fault current limiters, transformers and transmission cables. ORNL also has expertise in power electronics in support of the grid and energy storage.

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.

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 technologies for improved load/demand management while responding to market prices and electricity supply/demand conditions. PNNL is one of the lead 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 Visualization and Controls. 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.

Richland Operations Office (ROO)

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 the deployment schedules, and provides lesson 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. 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 Visualization and Controls. SNL also works to develop advanced superconductors based on the sol-gel chemical deposition process.

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
DOE Headquarters also issues 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, such as the Western Governors Association. DOE Headquarters staff constantly analyzes the regional and national effects of the loss of crude oil, natural gas, refined petroleum products, and electricity. In addition, during energy disruptions, Headquarters staff issues both periodic and special reports on the real-time status of the particular energy situation, timetables for restoration of energy supplies, and other factors, as well as responds to special information requests from senior officials throughout the Executive Branch.

Infrastructure Security and Energy Restoration
Washington Headquarters funding is used to support the Operations Response Directorate. Specifically, this support will encompass computer, technology, and visualization support to 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

(dollars in thousands)

	FY 2008 Current Appropriation	FY 2009 Original Appropriation	FY 2010 Request
Research and Development			
Clean Energy Transmission and Reliability	0	0	42,000
Smart Grid Research and Development	0	0	67,000
Energy Storage	0	0	15,000
Cyber Security for Energy Delivery Systems	0	0	50,000
High Temperature Superconductivity	27,930	23,796	0
Visualization and Controls	25,075	24,373	0
Energy Storage and Power Electronics	6,741	6,552	0
Renewable and Distributed Systems Integration	25,466	30,000	0
Total, Research and Development	85,212[1]	84,721	174,000

Public Law Authorizations:
P.L. 110-161, Consolidated Appropriations Act, 2008
P.L. 111-8, Omnibus Appropriations Act, 2009

Mission

The mission of the Research and Development subprogram is to advance technology, in partnership with industry, government, and the public, to meet America's need for a reliable, efficient, and resilient electric power grid.

Benefits

The Office's Research and Development subprogram will pursue technologies that reduce greenhouse gas emissions, contribute to energy independence, and enhance economic growth by improving the reliability, efficiency, flexibility, functionality, and security of the Nation's electricity delivery system. The activities will: (1) enhance the carbon-reducing contributions of clean energy systems such as wind, solar, advanced nuclear, coal with carbon capture and sequestration, energy efficient appliances and equipment, and electric transportation including plug-in vehicles by accelerating development and deployment of smart grid and other advanced technologies, tools, and techniques (2) further lower carbon emissions by increasing the energy efficiency of electricity delivery and reducing thermal losses on power lines and components with advanced cables and conductors such as those using high temperature superconducting materials; (3) strengthen the reliability of the electric grid by enhancing visualization tools and situational awareness strategies for identifing potential operational problems, reducing their frequency and duration, and preventing local disturbances from cascading into regional outages; (4) lower electricity costs by reducing 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

[1] Before a reduction of $2,385,936, of which $2,130,300 was transferred to the SBIR program and $255,636 was transferred to the STTR program.

due to cyber attacks by developing advanced cyber security protections and controls to better detect, prevent, mitigate, and recovery from external disruptions to the energy sector.

Contribution to the Secretary's Priorities and GPRA Unit Program Goals

OE's R&D subprogram contributes to DOE's GPRA Unit Program Goal 1.3.16, which refers to the Secretary's Priority of Economic Prosperity, the Strategic Goal of Energy Infrastructure, and the DOE Strategic Theme of Energy Security.

The four activities within R&D each contribute to the Secretary's Priority and the Strategic Goal by promoting the development of an efficient, "smart" electricity transmission and distribution network and creating a green workforce. This includes national leadership efforts to develop smart grid technologies, tools, and techniques; energy storage systems; advanced cables and conductors, and power electronics devices for grid modernization and integration of renewable and other clean energy systems while ensuring that the our nation's energy infrastructure is protected from cyber attacks.

The R&D subprogram partners with the Office of Energy Efficiency and Renewable Energy (EERE), Fossil Energy (FE), and Nuclear Energy (NE) to achieve the Secretary's Priorities of Lower Green House Gas Emissions and Clean, Secure Energy, as well as Economic Prosperity. The R&D subprogram also partners with the Office of Science.

An efficient, flexible, and reliable electric transmission and distribution (T&D) system is pivotal in reducing greenhouse gas (GHG) emissions and implementing carbon management strategies for the electricity sector because it provides two distinct benefits. First, it improves the energy efficiency of electric transmission and distribution, thereby reducing electrical power losses and the GHG emissions that would have been produced in generating the lost power. Second, it enables the integration of low-carbon energy options such as renewable and other clean power sources; energy-efficient buildings, appliances, and industrial equipment; and transportation alternatives such as electric vehicles.

Reducing losses from power lines and other power delivery components will produce GHG reductions. For example, using high temperature superconducting (HTS) power cables, transformers, motors, generators, and fault current limiters will greatly lower energy losses (near zero, in some applications) and thus reduce GHG emissions. Strategies to reduce peak loads will also reduce GHG emissions because energy losses are greatest during peak load periods when electric T&D equipment is often used at or near thermal limits. Advanced technologies, tools, and techniques can reduce peak loads and their associated thermal loadings on electric delivery equipment, thereby increasing the energy efficiency of electric T&D. Improved sensors, control systems, and communications strategies that provide real-time information to grid operators for "visualizing" power flows across the T&D system are also essential because they enable 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 will also make it easier and more cost-effective to install and operate renewable energy and energy efficiency technologies and to interconnect them with the electric grid in a reliable and safe manner. In addition, an electric distribution system that includes real-time controls, distributed generation and storage, and advanced metering infrastructure will greatly improve the adoption and use of energy efficient buildings, appliances, and equipment. Finally, the future potential of electric vehicles (including plug-in hybrids) will require an electric distribution system that is capable of providing cost-effective charging services to consumers without adding to peak demand or causing other harmful effects 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.

Contribution to GPRA Unit Program Goal 1.3.16, Electricity Delivery and Energy Reliability

The R&D subprogram contributes to Strategic Goal 1.3.16, Electricity Delivery and Energy Reliability by pursuing advancements in renewables integration, transmission, distribution, cyber security, and energy storage technologies.

Means and Strategies

To achieve its GPRA Unit Program goal, the Office employs a variety of means and strategies designed to maximize the probability of success in an environment that is affected by many externalities. Accordingly, collaboration with external stakeholders is an essential element of the Office's implementation strategy.

The Office's strategies to increase market penetration of electric transmission and distribution systems is achieved through 1) decreased cost and increased technological performance; and (2) the implementation of national industry consensus standards for interoperability of smart grid and various distributed energy systems and demand response, including cyber security protections, interconnection, communications, and controls. Technology advances include development of second-generation superconducting wire, development of real-time monitoring and control software tools, and development of system operating models to improve grid reliability and energy efficiency. Modernization and expansion of the electricity infrastructure is achieved by improving the reliability, energy efficiency, and cost-effectiveness of the system using the following methods: (1) improving the efficiency and production of high temperature superconducting wires and power equipment; (2) developing real-time information and control technologies and systems; (3) developing distributed intelligence sensing and control technologies; (4) reducing the cost and increasing the energy density of energy storage systems; and (5) providing technical assistance and analysis that supports State and regional wholesale electric market improvements and the development with the National Institutes of Standards and Technology and standards development organizations of interoperability standards.

In carrying out OE's mission, the following collaborative activities are performed:

- 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 other 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 (DOE's Strategic Theme 1) with a diverse supply of reliable, affordable, and environmentally responsible energy;
    - 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 Insitute, American Public Power Association, and the National Rural Electric Cooperative Asspociation as well as 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.

Validation and Verification

To validate and verify performance, OE conducts internal and external reviews and audits. The Office's programmatic activities are subject to continuing review by Congress, the Government Accountability Office, and the Department's Inspector General. Senior management invites external reviews of office-wide planning, design, management, and programmatic results in order to improve efficiencies. Each program activity manager conducts annual peer reviews by committees comprised of independent subject-area experts to review the management and technical achievements of both programs and projects. Program activity managers maintain long-term goals, annual targets, and milestones, which are tracked by the Department's program management reporting system. OE will build on previous budget and performance integration progress, and rigorously apply its integrated project reporting system, including the monitoring of milestones, performance, cost and schedule, and the implementation of corrective actions as needed.

In FY 2008, the world's first ever transmission level (138 kilovolt) HTS cable in a commercial power grid was energized in Long Island, New York - at nearly half a mile in length, it is also the longest HTS cable system in the world. Additionally, the Albany HTS cable was re-connected to the National Grid power system after replacing a 30 meter section of the 350-meter long cable system with an equal section fabricated from second generation (2G) HTS wire. This is the first in-grid demonstration in the world of a device that incorporates 2G HTS wire, which is expected to provide important performance and price benefits compared to copper wire. Testing of the first prototype saturable core HTS fault current limiter (FCL) was initiated for distribution voltages.

Annual Performance Results and Targets

FY 2005 Results	FY 2006 Results	FY 2007 Results	FY 2008 Targets	FY 2009 Targets	FY 2010 Targets
Strategic Goal 1.3, Energy Infrastructure					
Research and Development/Clean Energy Transmission and Reliability					
					Demonstrate prototype 70,000 A-m critical current-length for second generation wire.
					Demonstrate Electromechanical Grid Stability Prototype Alarm Tool.
Research and Development/Smart Grid Research and Development					
					Demonstrate 10% peak load reduction or improvement in asset utilization on two feeder systems.
					Complete development of open-source-based database architecture and Web applications for the Smart Grid Information Clearinghouse.
					Solicit Grid Materials, Devices and Systems Hub
Research and Development/Energy Storage					
					Demonstrate MW scale flow battery for renewable firming and load management
Research and Development/Cyber Security for Energy Delivery Systems					
					Complete development of security audit files for 3 control systems.
Research and Development/High Temperature Superconductivity					

FY 2005 Results	FY 2006 Results	FY 2007 Results	FY 2008 Targets	FY 2009 Targets	FY 2010 Targets
Completed the manufacture of a 200m superconducting power cable for American Electric Power (AEP). (MET GOAL)	Operated a first-of-a-kind superconducting power cable on the electric grid for 240 hours. (MET GOAL)	Completed six months operation of superconducting cable operating on the grid at greater than 10 kilovolts. (MET GOAL)	By 2020, develop prototype wire achieving 1,000,000 length-critical current (A-m) for second generation wire (MET GOAL)	Maintain progress in routinely manufacturing prototype superconducting wires to fabricate, test and produce two Tesla magnetic fields at 65 K coils for electric power applications. (2009 - 2.0 Tesla)	
Research and Development/Visualization and Controls					
Installed four additional data concentrators at four different data archiving and analysis locations, achieving a prototype wide area measurement system in the Nation's Eastern Interconnection consisting of six fully functioning data archiving and analysis locations installed at six different utilities. (MET GOAL)	Facilitated the installation and operation of 30 additional measurement units and 2 additional archiving and analysis locations in a real-time measurement network, for a cumulative total of 80 measuring units and 8 archiving and analysis locations. (MET GOAL)	Developed a plan for the transfer of leadership from DOE to the Electric Reliability Organization (ERO) for the deployment of a synchronized measurement network in North America, and released the Real Time Dynamic Monitoring System (RTDMS) prototype visualization tool to industry for comment and recommendations. (MET GOAL)	By 2014, develop tools and algorithms to enable an automatic, smart, real-time switchable network for transmission system operations that enables secure and reliable grid operations for major regions of the grid that is hardened against cyber attacks. Definitions for Target: PMUs - phasor measurement unit; dv - distribution voltage (MET GOAL)	Develop Prototype Angle Stability Monitoring Tool (2009 - Prototype Angle Stability Alarming Tool)	
Completed field hardware installation at a cumulative total of at least 100 commercial, industrial, and/or municipal customers participating in the demand response and load conservation network in Connecticut, and reduce peak demand (kilowatt hours) in real-time by 5-8% on average (as compared to non-curtailed kilowatt hour consumption) for all participating customers, thereby improving the energy efficiency of electricity usage. (MET GOAL)					
Research and Development/Energy Storage and Power Electronics					
Completed the manufacture of and factory testing of a 2MW/2MWh zinc-bromine battery system (consisting of four 500kW/500kWh units) for	Commissioned three pioneering energy storage systems in collaboration with the California Energy Commission and collect	Commissioned two major pioneering energy storage systems in collaboration with the CEC and NYSERDA, and complete data collection and	Test three ionic liquids for possible use as electrolytes in batteries or electrochemical capacitors with the potential for doubling the energy and	Finalize conceptual system design for a Flywheel Energy Storage System for Voltage Support and Distribution Upgrade Deferral in	

FY 2005 Results	FY 2006 Results	FY 2007 Results	FY 2008 Targets	FY 2009 Targets	FY 2010 Targets
supplying extra power during peak load conditions at a utility substation. (MET GOAL)	preliminary technical and economic data. (MET GOAL)	monitoring of three systems commissioned in FY 2006. (MET GOAL).	increasing the power by at least 50% for capacitors or doubling the lifetime and improving safety of rechargeable non-aqueous batteries. (MET GOAL t)	collaboration with NYSERDA.	
Research and Development/Renewable and Distributed Systems Integration					
Demonstrated emission levels of 0.25 lbs/MWh from a turbine combustion system. (MET GOAL) Completed a case study on a CHP installation that uses heat from microturbine to provide plate tank heating and sludge drying at an industrial facility, contributing to the PART long-term measure of developing a 70 percent efficient CHP integrated system. (MET GOAL) Completed and documented two DE/CHP demonstration projects within the high tech industry, contributing to the PART long-term measure of developing a 70 percent efficient CHP integrated system. (MET GOAL)	Developed one packaged CHP system which operates at 70+% efficiency. (MET GOAL)	Developed second packaged CHP system which operates at 70+% efficiency. (MET GOAL)	Demonstrate peak load reduction on distribution feeders with the implementation of Distributed Energy (DE) and Energy Management (EMS) at a cost competitive with a system/capacity upgrade (i.e. cost not to exceed $1,600 per kW in 2001 dollars). Measured in Percent (%) Reduction in Peak Load and Number of Feeders Analyzed/Demonstrated. (MET GOAL)	Demonstrate peak load reduction on distribution feeders with the implementation of Distributed Energy (DE) and Smart Grid technologies with 5% reduction in peak load and one feeder analyzed/ demonstrated. (2009 - 5%, 1)	

Clean Energy Transmission and Reliability

Funding Schedule by Activity

(dollars in thousands)

	FY 2008	FY 2009	FY 2010
Clean Energy Transmission and Reliability			
Clean Energy Transmission and Reliability	0	0	42,000
Total, Clean Energy Transmission and Reliability	0	0	42,000

Description

Transmission is the "linchpin" of the Nation's electric system, literally binding our country together with other critical infrastructures. It ties urban loads to affordable sources of generation, and it connects regions for enhanced reliability. Parts of the Nation's electric system are being operated closer to the edge than ever before; it is straining under the increasingly complex demands being placed upon it. There is a strong need for additional transmission capacity to maintain reliability. At the same time, we recognize that we must prepare for potentially dramatic changes in the way the system is planned and operated as the amount of renewables is increased and in light of greenhouse gas emissions.

President Obama's energy plan calls for a significant investment in alternative and renewable energy. Substantial expansion of renewable power 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. To address these needs, the Clean Energy Transmission and Reliability (CETR) program supports activities in next-generation cables and conductors to increase the delivery capacity of electricity systems, to improve the affordability of electric services by reducing the need for new rights-of-way, and to enhance efficiency by reducing energy losses. The program also supports activities that enhance our understanding of the power system, and enable response to changing system and market conditions, paramount for ensuring reliable and efficient grid operations under high penetration of variable generation.

This is a new program structure proposed for FY 2010. It combines activities funded in FY 2009 and before in the High Temperature Superconductivity program, and in the Visualization and Control program (i.e., synchrophasors and wide-area measurements). Accomplishments and activities in FY 2008 and FY 2009 are covered in those subprograms in subsequent sections in this Budget Justification.

Benefits

The CETR program supports grid modernization through the development of advanced transmission-driven technologies to improve grid reliability, efficiency, and security. It is developing advanced technologies, tools, 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;
- 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 thereby reduce the greenhouse gas (GHG) intensity associated with the electric grid;
- Enable efficient transmission capability in existing rights of way through advanced cables and conductors, reducing transmission congestion and promoting long distance electricity delivery.

The program is strengthening America's role as the world leader in science and technology, partnering globally to coordinate and exchange research and to spur further innovation. Superconducting power equipment, for example, has the potential to become a key 21st century technology for improving the capacity, efficiency, and reliability of electric power equipment. The higher capacity and low loss of superconductive power cables could provide a new approach to building transmission and distribution that will reduce the footprint and allow additional capacity to be put in place over existing rights of way. HTS investments in the United States will ensure a global supply of second generation wire needed for world-wide electric infrastructure developments.

An informed workforce is as critical to transmission reliability and to achieving our Nation's energy vision as advanced technologies and tools. Hence, university partnerships are a core element of the CETR program and are working to develop and nurture the needed scientific and engineering talent. Coupled with the strategic power engineering research that is being sponsored at the national laboratories and in partnership with the private sector, the program 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.

Detailed Justification

(dollars in thousands)

	FY 2008	FY 2009	FY 2010
Clean Energy Transmission and Reliability	**0**	**0**	**42,000**

President Obama has pledged that 10 percent of the nation's electricity should come from renewable energy by 2012 and 25 percent by 2025. A shift away from the legacy system paradigm is required to ensure our long-term global competitiveness and sustainability. In order to meet the President's goals, there will need to be expansion of the transmission system so that remote renewable energy (especially utility scale solar and wind) can reach demand centers such as large cities. It will also require better management and visualization of the grid infrastructure, especially as higher penetration of variable generation is integrated with traditional baseload electricity sources.

	FY 2008	FY 2009	FY 2010
▪ **Transmission Reliability and Renewables Integration**	**0**	**0**	**20,000**

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 more flexible generation and energy storage.

To meet these demands, the Transmission Reliability activity focuses on equipping system planners and operators with the real-time information they need for achieving the long-term goal of improved electric transmission (and distribution) 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. The Deparment 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 program.

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 WAMS activity 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 CETR program 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.

FY 2010 activities include:

- Develop 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 PMU-based network and develops 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;

	(dollars in thousands)	
FY 2008	FY 2009	FY 2010

- Conduct a risk-based approach to analyze possible contingencies to understand the need for more effective operator alerts;
- Examine potential deployment locations for PMUs to monitor the dynamics of renewable generation sources to better integrate renewables into the grid;
- Research new algorithms and computational methods for solving complex power system problems.

	FY 2008	FY 2009	FY 2010
▪ **Advanced Cables and Conductors**	**0**	**0**	**22,000**

Today's electricity system is being operated at power flow levels that approach the voltage, stability, and thermal limits of the cables and conductors. Greater demands on the electricity delivery system require greater power transfer capabilities, increased capacity, and greater flexibility. Other challenges include difficulties obtaining rights-of-way or expanding capacity in existing rights-of-way.

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. In FY 2010, efforts will be focused on mitigating the AC losses generated in existing second generation (2G) HTS wire architectures.

HTS wire research focuses on both rolling-assisted biaxial textured substrates (RABiTS) and ion-beam assisted deposition (IBAD) substrate texturing methods which are based on discoveries at DOE laboratories funded by the program. When used in laboratory-scale modeled power applications, AC losses generated in these materials have been higher than predicted, and may create challenges for the technology's commercial viability. If AC losses in HTS wires are not reduced, cables and coils of 2G HTS wires will generate more heat losses than can be reasonably managed by cryocoolers or force over sizing of the equipment – adding to the system cost. Innovative, cost effective and scalable processes to minimize AC losses will be developed. This could include processes to etch the HTS layer, novel wire-element packaging/filamentization and alternative techniques for depositing HTS precursor layers in desired patterns. Additionally - non-magnetic substrates that will allow HTS wires to have lower magnetically induced losses, while maintaining fault current limiting abilities will be investigated. Electromechanical characteristics and joining techniques will be developed to enhance the mechanical integrity of HTS cables. A scoping study and preliminary characterization of ultra-high current HTS DC cable configurations for reliable and secure long distance renewable power delivery will be completed. To maximize the wire performance, research efforts will continue to improve processing to nanoscale engineer the superconductor to behave like an infinitely long single crystal instead of the inferior granular structure. Methods to manipulate the microstructure at the nanoscale such as flux pinning strategies to increase performance (critical current density (J_c)) will continue to be pursued. In addition, inter-dependencies of individual processing parameters that are being developed in the program, which include process simplification, nanoscale defect engineering, superconductor thickness and processing speed, will be determined and optimized in order to achieve the goal of consistently and reliably produce high performance.

2G wire with uniform properties in long lengths. Work will be coordinated with Office of Science on the potential for "room-temperature" superconducting compounds.

	FY 2008	FY 2009	FY 2010
Total, Clean Energy Transmission and Reliability	**0**	**0**	**42,000**

Explanation of Funding Changes

	FY 2010 vs. FY 2009 ($000)
Transmission Reliability and Renewables Integration	
▪ **Transmission Reliability and Renewables Integration** Increase reflects new budget structure for the Research and Development program. Activities for Visualization and Controls, and transmission-level renewables integration efforts funded in Renewables and Distributed Systems Integration in FY 2009 will be funded in this new control point beginning in FY 2010.	+20,000
Total, Transmission and Reliability and Renewables Integration	+20,000
Advanced Cables and Conductors	
▪ **Advanced Cables and Conductors** Increase reflects new budget structure for the Research and Development program. These activities were funded in High Temperature Superconductivity in FY 2009.	+22,000
Total, Advanced Cables and Conductors	+22,000
Total Funding Change, Clean Energy Transmission and Reliability	**+42,000**

Smart Grid Research and Development

Funding Schedule by Activity

(dollars in thousands)

	FY 2008	FY 2009	FY 2010
Smart Grid Research and Development			
Smart Grid Research and Development	0	0	32,000
Grid Materials, Devices and Systems Hub	0	0	35,000
Total, Smart Grid Research and Development	0	0	67,000

Description

The "Smart Grid" is an electric grid with full integration of advanced information, communication, and control technologies into electric system operations. Smart grid utilizes open architecture, standards-compliant technologies, fast two-way communications, and digital controls to integrate all new developments and technologies in renewable and alternative clean energy generation, transmission and distribution, and customer load management. This smart grid system not only directly supports achievement of the goals for renewable energy and distributed systems, but also enables new operational configurations such as "microgrids," new services such as offering differentiated reliability levels with competitive market pricing, and new applications for electricity use such as plug-in hybrid electric vehicles to meet energy diversity and climate change challenges.

The goal of the Smart Grid Research and Development subprogram is to adapt and integrate use of advanced digital technology to modernize the nation's electric delivery network for enhanced operational intelligence and connectivity. The enhanced intelligence of a smart grid, through use of advanced digital (i.e., microprocessor-based measurement and control, communications, computing, and information) technology, is aimed at greatly improving reliability, security, and efficiency of the electric grid, and at minimizing its environmental impact. The enhanced connectivity will allow different applications, systems, and devices to be interoperable with one another, through a combined use of open system architecture, as an integration platform, and commonly-shared technical standards and protocols for communications and information systems.

The electric delivery network for smart grid modernization encompasses the electric transmission and distribution infrastructure that interconnects large generation at one end and consumers' electric loads at the other end, as well as all components and systems in between, including distributed energy resources and all forms of electric vehicles.

The Smart Grid subprogram also supports the establishment of an energy innovation hub, called the Grid Materials, Devices and Systems Hub, to address the basic science, technology, economic, and policy issues hindering our ability to become energy secure and economically strong. The hub focuses on development of advanced materials 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, new power electronics materials would enable faster reaction times for improved fault mitigation, and research in phase changing materials could lead to equipment with self diagnostics and in-situ response.

The Smart Grid Research and Development subprogram directly supports Section 1304, Smart Grid Technology Research, Development, and Demonstration, of Title XIII-Smart Grid in the Energy Independence and Security Act of 2007 (EISA 2007). Specifically, the subprogram supports achieving the following, key characteristics of a smart grid as defined in Title XIII:

- Increased use of digital information and controls technology to improve reliability, security, and efficiency of the electric grid
- Dynamic optimization of grid operations and resources with full cyber-security
- Deployment and integration of distributed resources and generation, including renewable resources
- Development and incorporation of demand response, demand-side resources, and energy efficiency resources
- Deployment of smart technologies for metering, communications concerning grid operations and status, and distribution automation
- Integration of "smart" devices and consumer devices
- Deployment and integration of advanced electricity storage and peak shaving technologies, including plug-in electric and hybrid vehicles and thermal air conditioning
- Provision to consumers of timely information and control options
- Development of standards for communication and interoperability of appliances and equipment connected to the electric grid, including the infrastructure serving the grid

This is a new program structure proposed for FY 2010. It combines activities funded in FY 2009 and before in the Renewable and Distributed Systems Integration subprogram, as well as in power electronics (as part of the Energy Storage and Power Electrics subprogram). These two activities and their accomplishments in FY 2008 and FY 2009 are covered in the respective subprograms in subsequent sections in this Budget Justification. In addition, the new program structure includes a new activity, i.e., Grid Materials,Devices and Systems Hub, to address the fundamental scientific challenges associated with advanced power electronics materials and "smart" materials for embedded sensor applications.

Benefits

The economic and environmental benefits of smart grid implementation are significant, as summarized in a recently published report by the Electricity Advisory Committee (EAC).[a] For example, in economic benefits, smart grid technologies could reduce power disturbance costs to the US economy by $49 billion per year; smart grid could also reduce the need for massive infrastructure investments between $46 billion and $117 billion over the next 20 years. Implementing smart grid technologies can reduce carbon emissions by helping to minimize peak generation, increasing energy efficiency by giving the consumer control over energy use, integrating large amounts of renewable energy, and "fueling" plug-in hybrid electric vehicles.

Further, the same EAC report described smart grid benefits to utilities including: improved reliability; deferred capital spending for generation, transmission, and distribution investments; reduced operations and maintenance costs; increased efficiency of power delivery; integration of renewable energy and

[a] Electricity Advisory Committee, *Smart Grid: Enabler of the New Energy Economy*, December 2008

distributed resources; and improved system security. In regard to smart grid benefits to consumers, the EAC report included the following: consumption management; cost savings from peak load reduction; convenience of distributed generation; cost savings through energy efficiency; convenience of advanced meters; reduced industrial consumer costs; and enhanced business consumer service.

Overall, these benefits will be fully realized when the modernized electric grid achieves the seven, principal functionalities of a smart grid, as defined by and advanced through the Smart Grid Research and Development subprogram:

1) Enabling informed participation by customers
2) Accommodating all generation and storage options
3) Enabling new products, services, and markets
4) Providing the power quality for the range of needs in the 21st century
5) Optimizing asset utilization and operating efficiently
6) Addressing disturbances – automated prevention, containment, and restoration
7) Operating resiliently against physical and cyber attacks and natural disasters

Advanced materials research, development, and applications (through the **Grid Materials, Devices and Systems Hub** activity) underlie many sensing and control needs of the smart grid principal functionalities above. The Hub's approaches and findings will strengthen our domestic capacity for energy technology research, and will ultimately position the United States to be the leader in international cooperation in energy innovation; they will provide economic opportunities for U.S. companies to access global energy technology markets worth billions of dollars each year.

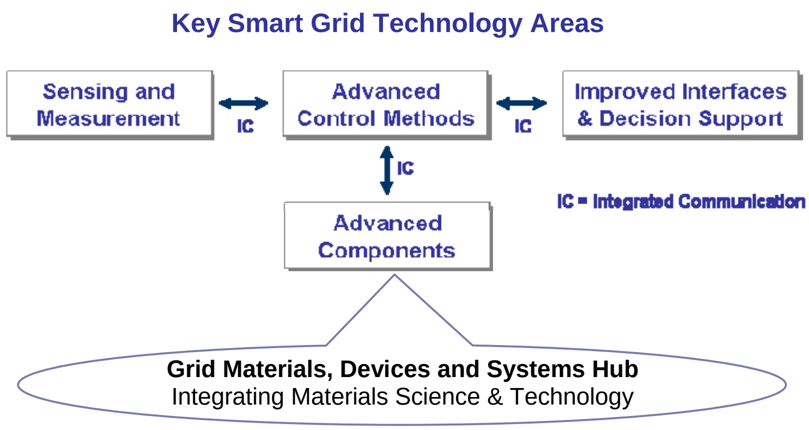
Detailed Justification

(dollars in thousands)

	FY 2008	FY 2009	FY 2010
Smart Grid Research and Development	**0**	**0**	**32,000**

The Smart Grid Research and Development activity focuses on adapting and integrating use of digital technology to meet the seven principal functionalities of a smart grid. A systems approach will be undertaken through all stages, from planning to development and implementation, and will encompass activities such as design and architecture, electric/communications/information technology infrastructure integration, integration of electric/market operations and policies, and advances in smart grid capabilities, functions, and services to evolve the electric grid into a 21st century smart grid.

The Smart Grid Research and Development activity in FY 2010 will focus on four of the five key technology areas: Advanced Control Methods, Improved Interfaces and Decision Support, Advanced Components, and Integrated Communications.[a] The fifth area, Sensing and Measurement, will not have any active effort in FY 2010. A smart grid roadmap will be developed, aiming toward achieving a coordinated nationwide cost-effective deployment of smart grid technologies. Based on the smart grid roadmap, activities will be initiated to support high-priority RD&D objectives. Furthermore, support will continue for the smart grid information clearinghouse development, management, and maintenance. The information clearinghouse activity, awarded through a FY 2009 solicitation, responds to a high-priority need of the NARUC/FERC Smart Grid Collaborative and to the EAC recommendation.



Advanced Control Methods
In FY 2010, this technology area will develop smart grid functionalities to provide integrated operating and control solutions for renewable systems, plug-in hybrid electric vehicles (PHEV), and other smart grid end-use applications.

A challenge to *distributed renewables integration* is that the electric grid was not designed to accommodate active generation and storage at the distribution level, particularly two-way distribution where a local residence or business, for example, is sending power back into the distribution system when it is producing more power than needed.

The renewable and distributed systems integration demonstration projects awarded competitively in FY 2008 will continue to be supported for their planned progression in FY 2010. Additional renewables integration efforts will be closely coordinated with EERE to fully integrate distribution system level renewable energy technologies into the electric grid. OE will undertake the integration of renewable generation, as well as end use technologies, with the electric distribution grid. Activities may include technology research and tool development for analyzing interactions of renewable energy technology with electric system operations, integration model validation and implementation, islanding impact studies, fault location and prediction, and interconnection standards development. Specific integration studies and near-term demonstrations will encourage and promote utility acceptance of increased renewables connected to the grid. These studies and demonstrations will develop tools and protocols for reliably operating a system with variable electricity sources.

In the *PHEV integration* area, research is needed to understand and address the integration issues with the electric grid, and to optimize the integrated system performance in order to maintain reliability, reduce costs and optimize energy use, and decrease emissions. In FY 2010, smart charge controllers will be further built and tested in pilot PHEVs through established field demonstration programs at major automaker(s). This will follow completion of testing a prototype embodying smart charging control strategies in FY 2009. The strategies focus on low-cost controls technology that enables grid-responsiveness in emergencies, grid-awareness to charge at off-peak periods at customer choice, and mobile billing capabilities. Engagement with standards-making bodies, such as the Society of Automotive Engineers (SAE) standards committees J1772 (EV conductive charger coupler) and J2836 (Communication between Plug-in Vehicles and the Utility Grid), will continue to be supported for standards development to achieve seamless plug & play for vehicle-to-infrastructure communications.

Improved Interfaces and Decision Support

The smart grid will require wide, seamless, often real-time use of applications and tools that enable utility operators and managers to make decisions quickly. Decision support and improved interfaces will enable more accurate and timely human decision making at all levels of the grid, including the consumer level, while also enabling more advanced operator training. These technologies and simulator training tools will transform complex power system data that is characteristic of a "Smart Grid" into information that can be understood "at a glance" by human operators, helping them to identify, analyze, and act on emerging problems..

In FY 2010, development of a detailed simulation tool for Smart Grid systems will continue, with built-in alternative technical, economic, and regulatory aspects of the electric energy delivery system for evaluation of the impacts of the potential outcomes. The simulation tool, being developed via a collaborative environment, is to help researchers, policymakers, and industry understand and shape the evolution of a smart grid as it becomes an information-rich network of devices that are increasingly making autonomous, value-based decisions in a changing regulatory and policy environment.

Advanced Components

Today's grid is characterized by materials and devices of the past. Power system components (e.g. transformers; breakers) are mostly the same as those employed over the past half century or more. This electromechanically controlled system needs to be transformed into an electronically controlled network. This promises significant improvements in reliability, efficiency, and cost effectiveness.

In FY 2010, the Advanced Components activity will pursue opportunities for cost-effective, high-voltage energy conversion and flow control. These will give the grid the ability to respond quickly to an emergent problem by using strategies like changing flow patterns and voltage conditions, as well as help ensure the stability and efficient integration of diverse generation sources. Development of solid-state devices with enhanced functionality and flexibility (e.g. transformers with fault-current limiting capability and/or reactive power compensation) will overcome the limitations of conventional technology platforms. While progress has been made under previous Departmental efforts such as solid-state fault current limiters and transformers, additional research is still needed to reach the desired state.

These application advancements will be further enabled by the development of advanced power electronics materials and novel material-based sensors, which are the focus of the new Grid Materials,Devices and Systems Hub.

Integrated Communications (standards and deployment monitoring)

(dollars in thousands)

This technology area focuses on developing and implementing an open architecture for a plug-and-play environment that makes the smart grid a dynamic, interactive infrastructure backbone for real-time information and power exchange. In FY 2010, architectural guidelines and communications standards will continue to be harmonized to advance interoperation for the growing automation components of the electric delivery system, through support provided to the Pacific Northwest National Laboratory/GridWise Architecture Council (GWAC). Also supported under this effort will be communications to various stakeholders on the importance and benefits of interoperability for a smart grid, as well as facilitation of their adoption of interoperability principles and concepts.

Additionally in FY 2010, new projects to support implementation of the smart grid interoperability framework, developed by the National Institute of Standards and Technology (NIST) as authorized in Section 1305 of EISA, which are expected in FY 2009, will be solicited and launched. These projects will aim toward achieving interoperability of a broad suite of smart grid devices and systems, as well as consistency throughout varying grid structure platforms.

Also in FY 2010, a rigorous Smart Grid Maturity Model (SGMM) will be developed to unite and define all components of the Smart Grid evolution—inclusive of all business, policy, social, and technical aspects—into a comprehensive framework for measurement and decision making. The developed SGMM will then be transferred to an industry body for implementation through a global open stewardship process, similar to what the Capability Maturity Model Integration (CMMI) has done for the software industry.

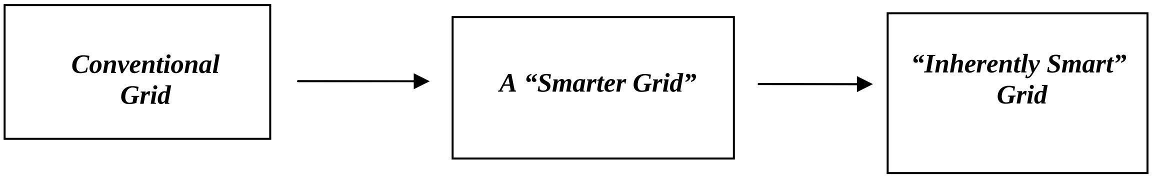
	FY 2008	FY 2009	FY 2010
Grid Materials, Devices and Systems Hub	**0**	**0**	**35,000**

If the future power grid is to fully expand its capabilities, to sense and dynamically reconfigure as necessary, to achieve resiliency under multiple contingencies, then the power system must advance to the next level beyond an information technology overlay. This advance will require transformation of the infrastructure's foundation from static, electromechanical technologies and devices to a topology with dynamic system characteristics, giving devices and equipment "Smart" attributes to adapt and respond.

This foundational transformation underlies the establishment of the new Grid Materials, Devices and Systems Hub activity in FY 2010. The Hub's objective is to explore conductors, insulators, power electronics, and other "smart" materials that change properties or shape based on response to external conditions and using this knowledge, to develop deployable solutions to meet our nation's future energy challenges, to minimize power outages of a heavily stressed system, and to facilitate the integration of clean energy sources into the grid. No funding is included for construction.

(dollars in thousands)

FY 2008	FY 2009	FY 2010



- Electromechanical controls
- "Elemental" materials (e.g., Cu; Al; steel; oil)
- Radial distribution architecture
- Passive consumers
- Central-generation, vertically-oriented (G-T-D) business models; monthly billing
- Conservative operating margins based on simplified power system representations
- Data delays with limited wide-area visibility

- Advanced materials (e.g., HTS; ACCR)
- Smart meters
- Demand response (e.g., smart appliances)
- Distributed generation (e.g., PV)
- Communications
- Substation automation
- "Real-time" data

- **Electronically controlled (solid-state devices) ***
- **Embedded property-changing materials and sensors ***
- Network distribution architecture
- Engaged (integrated) consumers
- "Inherently secure" control systems (cybersecurity)
- Energy storage
- Dynamic operating conditions based on informed decision making
- "Real-time" system information

* *Focus of Grid Materials, Devices and Systems Hub.*

The grand challenges for the Grid Materials,Devices and Systems Hub activity include:

- Development of advanced Power Electronics materials, devices and integrated systems for cost-effective, high-voltage energy conversion and flow control;
- Discovery and design of "smart" material-based sensors and devices for long distance energy transfer; fault mitigation, including condition monitoring and fault diagnostics; and system configuration.

In FY 2010, an Innovation Hub will be solicited through a competitive process. The hub will involve national laboratories, universities, material producers, device and equipment manufacturers, and other public and private sector stakeholders. It will focus on *power electronics materials* that leverage recent advances by DARPA in wide bandgap semiconductors, including Silicon Carbide (SiC) and Gallium Nitride (GaN). Major challenges facing these technologies will be addressed, including materials deficiencies that contribute to fundamental limitations of the device technology, and cost and performance issues that are directly related to materials and the control of materials processes.

Also, in FY 2010, research focusing on *smart material-based sensors and devices* will be established. The Hub will initiate efforts in embedded sensor applications for "smart" materials. These applications will lead to the development of self-diagnostics of operating conditions of various devices. Integrating this self-diagnostics capability with algorithms for asset managers through broader "smart grid" communications will help manage 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.

Total, Smart Grid Research and Development	**0**	**0**	**67,000**

Explanation of Funding Changes

	FY 2010 vs. FY 2009 ($000)
Smart Grid Research and Development	
▪ **Smart Grid Research and Development** The increased funding reflects the budget restructuring of the Research and Development program. In addition, the increase supports implementation of the NIST-developed interoperability framework, and implementation of the Smart Grid program plan by launching select high-priority smart grid technology projects identified in the smart grid roadmap.	+32,000
Total, Smart Grid Research and Development	+32,000
Grid Materials, Devices and Systems Hub	
▪ **Grid Materials, Devices and Systems Hub** Establishment of Grid Materials, Devices and Systems Hub is a new activity in FY 2010.	+35,000
Total, Grid Materials, Devices and Systems Hub	+35,000
Total Funding Change, Smart Grid Research and Development	**+67,000**

Energy Storage

Funding Schedule by Activity

(dollars in thousands)

	FY 2008	FY 2009	FY 2010
Energy Storage			
Energy Storage	0	0	15,000
Total, Energy Storage	0	0	15,000

Description
This program incorporates research and development efforts on energy storage technology, 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.

This is a new program structure proposed for FY 2010. These activities were previously funded in the Energy Storage and Power Electronics subprogram. Accomplishments and activities in FY 2008 and FY 2009 are covered in those subprograms in subsequent sections in this Budget Justification.

Benefits
With the increased awareness and support of energy storage as an emerging technology, crucial for the modernization of the U.S. electric grid, the Energy Storage program in FY 2010 will re-emphasize its focus on technology advancement. Work will be done in collaboration with the newly formed Energy Frontier Research Centers in the Office of Science, to develop innovative technologies that have the promise of significantly improving the energy storage industry. Improvements are needed in the basic materials forming battery, electrolytic capacitor and flywheel systems to reduce their cost and improve energy storage and cycling capabilities. The program will increase basic research and improve 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. The program 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.

Detailed Justification

(dollars in thousands)

	FY 2008	FY 2009	FY 2010
Energy Storage	**0**	**0**	**15,000**

Energy storage technology has gained importance in the energy field as a potential answer to many of the problems being experienced on the electric grid. Congestion of supply, increasing penetration of variable renewable generation, increased power quality demands and concern over greenhouse gas emissions mark the current electric infrastructure. One of the distinctive characteristics of the electricity sector is that supply is relatively fixed, at least in the short-term, while demand will fluctuate. Developing technology to store electrical energy so it can be available whenever needed, would represent an important breakthrough. Large scale, megawatt-level electricity storage systems, or multiple smaller distributed storage systems, could significantly reduce transmission system congestion, manage peak loads, make renewable electricity sources more dispatchable, and increase the reliability of the overall electric grid. Reducing the cost and size of energy storage systems is the key to more widespread use. Effort is needed to assess opportunities for new devices and new manufacturing processes to reduce the cost of existing battery storage devices. For all types of systems, effort is needed to explore the possibilities of substituting lower cost materials without sacrificing technical performance. Advances in the design of storage devices are needed for batteries, flywheels, and capacitors, as well as evaluation of trade-offs in features and performance to lower manufacturing costs.

The energy storage program builds on the previous years' successes, but represents a major acceleration of materials and device research, multiple field tests, and extensive modeling and analysis. The material research and development studies initiated in FY 2008/2009 will enter a second phase with a major, competitively placed, solicitation to develop components based on innovative material and nano technologies. In this phase, prototype electrodes, of reasonable scale, will be fabricated and tested at the laboratory bench top level to identify advantages and challenges to each new material system in batteries. Similar projects will focus on other distributed energy storage technologies such as flywheels and electrochemical capacitors. These technology innovative projects will be conducted collaboratively with DOE Basic Energy Sciences (BES) Energy Frontier Research Centers and Energy Innovation Hubs.

In FY 2010 storage research will be expanded to support successful integration of renewable energy resources (typically wind and solar) into the grid by mitigating their variability. As penetration levels of these systems increase, concern over the effect of their variability also increases. Large ramp rates due to rapid wind increases or decreases and due to passing clouds potentially can cause rapid changes in output which must be compensated for by the utilities. Peak generation from these systems does not always coincide with peak demand for the energy. Storing that energy will become an option to spilling that energy or to curtailing conventional generation in order to accept the renewable energy.

Current planning for wind farms focuses on large installations with multi-mega watt outputs. In order to store significant amounts of energy, large storage systems are necessary. Two potential technologies capable of this are reversed pumped hydro power and Compressed Air Energy Storage (CAES). Both technologies are capable of storing hundreds of megawatt hours of energy but require suitable geological sites. For CAES, underground reservoirs which are reasonably air tight must be found or constructed. This year studies will be initiated in improving prediction and assessment methods and in developing new methods to construct engineered geologic formations. Potential concerns over the effect of oxygen on underground strata and the potential for biological growth in under ground storage media will be addressed. Adiabatic CAES cycles will be investigated to improve the overall system efficiency. Partnerships will be formed to demonstrate CAES systems in utility installations.

In FY 2010, analytical work on energy storage systems and benefits will be conducted, with a

	(dollars in thousands)		
	FY 2008	FY 2009	FY 2010

major study on the value and benefits storage can provide for the integration of renewable systems such as wind and PV. A new competitive solicitation will be issued to perform an economic analysis of pumped hydro and CAES systems for bulk storage. Studies will also be preformed to examine adding energy storage modules to existing utility planning software so that storage may enter the normal utility planning cycle.

Total, Energy Storage	**0**	**0**	**15,000**

Explanation of Funding Changes

	FY 2010 vs. FY 2009 ($000)
Energy Storage	
▪ **Energy Storage**	
Increase reflects a budget restructuring of the Research and Development program. These activities were previously funded in the Energy Storage and Power Electronics subprogram. In addition, the FY 2010 request supports acceleration with new focus on materials research, enlarged field testing activities, and analytical studies in response to rapidly mounting utility interest in storage applications and the need for cost effective storage options.	+15,000
Total, Energy Storage	+15,000
Total Funding Change, Energy Storage	**+15,000**

Cyber Security for Energy Delivery Systems

Funding Schedule by Activity

(dollars in thousands)

	FY 2008	FY 2009	FY 2010
Cyber Security for Energy Delivery Systems			
Cyber Security for Energy Delivery Systems	0	0	50,000
Total, Cyber Security for Energy Delivery Systems	0	0	50,000

Description

The cyber security of energy control systems has emerged as one of the Nation's most serious infrastructure protection issues. Events such as the penetration of the Slammer worm into the Davis-Besse nuclear power plant, discovery of the Aurora vulnerability, and CIA reports of successful cyber-launched power disruptions in foreign countries, have increased concerns about cyber threats to U.S. energy infrastructures. Intelligence reports indicate that cyber attackers are becoming increasingly targeted, sophisticated, and better financed. Although important security improvements have been made, the threats are outpacing our ability to defend against new attacks. With so many vital services and critical infrastructures interconnected with energy systems, a large scale cyber attack could disrupt power and cause cascading failures throughout the economy and communities.

DOE is working closely with energy owners and operators, system vendors, and other federal agencies to secure energy control systems. OE's National SCADA Test Bed (NSTB) program is getting results through testing, training, and conducting next-generation R&D. So far, NSTB has conducted more than 20 test bed and on-site field assessments of control systems, resulting in the development of 11 hardened control systems and deployment of 31 systems in the marketplace. In addition, NSTB has trained more than 1,800 energy sector stakeholders on best practices for control systems security. Yet despite these achievements, the escalating threat environment and the implementation of Smart Grid technologies have dramatically increased the urgency and demand for inherently secure control systems and components.

As utilities implement Smart Grid technologies, it is imperative that they take full advantage of the most advanced and secure control systems technology. A Smart Grid will enable greater integration of renewable and distributed resources and will use information and communications technologies to improve grid reliability, availability, and efficiency. This will require the deployment of a new array of intelligent components and devices and will prompt a pardigm shift in how utilities control and optimize electricity distribution. However, these new designs will exponentially increase digital access points through smart meters and automated control equipment, which could be vulnerable to cyber attacks if not adequately protected.

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* sets forth a goal for 2015 to develop, implement, and maintain control systems that can survive an intentional cyber assault without loss of critical function. OE and the energy sector have made important progress toward this goal through the efforts of the National SCADA Test Bed (NSTB) and related industry programs. However, numerous challenges remain. There is currently limited expertise in cyber security of control systems throughout the energy sector, both in operations and in research. Even less expertise exists to address the dynamics of the cyber-physical interactions that threaten power systems. And despite the potentially large consequences of a widespread cyber incident, there is not a strong business case to ensure cyber security technologies are deployed. Finally, while incremental technology improvements are being made to harden control systems, only limited R&D is currently available for advanced, next-generation systems that are inherently secure and capable of protecting against future threats.

The OE Cyber Security for Energy Delivery Systems (CS-EDS) Program will pursue the development of resilient communications and control systems that automatically detect and prevent cyber infiltration and enable power systems to keep operating in the face of a disturbance. The program is designed around highly-focused multidisciplinary teams that will address the rapidly advancing capabilities of the threat. OE will implement a game changing research program that will provide the speed and agility to proactively manage and reduce the risk of energy disruptions due to cyber attacks in the energy sector.

This is a new program budget structure proposed for FY 2010. It encompasses activities funded in FY 2009 and before as part of the Visualization and Control program. Accomplishments and activities in FY 2008 and FY 2009 are covered in those subprograms in subsequent sections in this Budget Justification.

Benefits

The CS-EDS will use a multi-disciplinary approach to engage world-class experts in computer science and engineering, cyber security, energy systems engineering, and risk analysis to reduce the risk of energy disruptions due to cyber attacks on the nation's energy infrastructure. The traditional cyber security approach uses "defense-in-depth", which relies on critical cyber assets being protected by various perimeter defenses. However, the complexity of multiple layers requires more communications, networks, devices, and software and may introduce new vulnerabilities that were not anticipated. In addition, vulnerabilities and weaknesses in today's approach to cyber security are revealed almost daily. To address the new vulnerabilities, utilities often add on more technologies, practices, or policies. Implementing these changes in an environment that requires the delivery of energy on a constant 24/7/365 basis is difficult and often delays deployment of countermeasures, thus creating a "window of opportunity" for adversaries. This reactive posture puts the nation's energy sector at risk and requires a fundamentally new approach.

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 2008	FY 2009	FY 2010
Cyber Security for Energy Delivery Systems	**0**	**0**	**50,000**

OE's National SCADA Test Bed has become a trusted and indispensable resource for industry, government, and international organizations. OE's partnership with industry through the *Roadmap to Secure Control Systems in the Energy Sector* has become a national model for other critical infrastructures to secure their control systems. Yet despite significant progress, additional capabilities are required to keep pace with and anticipate the rapidly expanding cyber threat environment.

The CS-EDS activity will build on DOE's core expertise in energy systems, modeling and simulation, control systems, information assurance, and cyber security to enhance the cyber security of the Nation's energy infrastructure. To keep pace with rapidly emerging cyber threats, OE will develop a unique enterprise of multi-disciplinary teams and resources that includes computer science and engineering, energy systems engineering, and threat analysis. With a substantial emphasis on using advanced mathematics and high-performance computational modeling, OE will integrate these essential components with the primary goal of developing resilient control systems that can withstand a cyber assault without loss of critical services.

OE has developed a deep understanding of the cyber security needs to secure control systems in the energy sector by conducting on-site and test-bed vulnerability assessments, focused research and development, developing best practices, and training.

The CS-EDS program will also conduct innovative research in the design and development of trustworthy systems built from untrusted components as the energy sector increasingly relies on foreign and commercial-off-the-shelf sources and transitions to a smart grid. Test-bed capabilities will be expanded to develop cyber security for legacy and emerging energy delivery systems, including a new smart grid test-bed, advanced forensics methodologies, intrusion detection systems, and real-time visualization capabilities.

The CS-EDS program will include "world-class" talent and harness the capabilities of the entire research community, including government, industry, and academia to:

1. Take a fundamentally different approach to cyber security in the energy sector using mathematics and computational modeling to build trustworthy systems from untrusted components as a transition strategy to secure legacy systems.

2. Develop inherently secure (resilient) systems that can withstand a major cyber assault without loss of critical functions.

3. Achieve a better understanding of the threats, vulnerabilities, and consequences associated with cyber attacks on the energy infrastructure.

4. Develop advanced forensics methodologies, intrusion detection systems, and real-time visualization of cyber attacks on the energy infrastructure

5. Continue test bed assessments of SCADA/EMS systems used widely across the infrastructure to support the development of next generation "hardened" systems.

	(dollars in thousands)		
	FY 2008	FY 2009	FY 2010

6. Conduct research Smart Grid technologies (advanced metering infrastructure, distributed energy resources, integration of renewable technologies, and home area networks, and wireless technologies) to develop secure systems and networks that can survive cyber attacks with loss of critical services.

Total, Cyber Security for Energy Delivery Systems	**0**	**0**	**50,000**

Explanation of Funding Changes

	FY 2010 vs. FY 2009 ($000)
Cyber Security for Energy Delivery Systems	
▪ **Cyber Security for Energy Delivery Systems** Increase is the result of a budget restructuring of the research and development program. In addition, increase reflects development of a collaborative research effort with the primary goal of accelerating the development and deployment of resilient next-generation network devices, architectures, and smart grid systems.	+50,000
Total, Cyber Security for Energy Delivery Systems	+50,000
Total Funding Change, Cyber Security for Energy Delivery Systems	**+50,000**

High Temperature Superconductivity

Funding Schedule by Activity

	FY 2008	FY 2009	FY 2010
High Temperature Superconductivity			
High Temperature Superconductivity	27,148	23,130	0
SBIR/STTR	—	666	0
Total, High Temperature Superconductivity	27,148	23,796	0

Description

The High Temperature Superconductivity subprogram (HTS) focuses on applying high temperature superconductivity technology to the national effort to modernize and expand America's electricity delivery system. High-Temperature Superconducting power equipment has the potential to become a key twenty-first century technology for improving the capacity, efficiency, and reliability of the electric delivery system. For example, higher-capacity HTS power lines (both AC and DC) could provide a new approach to building transmission and distribution systems that will reduce the footprint and allow additional capacity to be placed in service within existing rights-of-way.

Core activities focus on researching and developing viable second generation (2G) coated conductor HTS wires that promise high performance at significantly lower cost than today's HTS wire. Additionally, development activities focus on use of the HTS wire in electric power equipment such as cable systems and fault current limiters and demonstration in utility systems.

The Department is proposing a budget restructuring for the Research and Development portfolio beginning in FY 2010. Activities in the High Temperature Superconductivity subprogram will be included in the new Clean Energy Transmission and Reliability program. HTS accomplishments and activities in FY 2008 and FY 2009 are included in this section, and FY 2010 activities are covered in the Clean Energy Transmission and Reliability section in this Budget Justification.

Benefits

The opportunity now exists to modernize and expand the Nation's electricity delivery system with equipment using HTS wires that have 100 times the capacity of conventional copper wires without energy loss due to electrical resistance. This breakthrough enables a new generation of reliable grid equipment with typically twice the capacity of same-sized conventional equipment with only half the energy losses. HTS technologies offer new attributes (high capacity, low impedance, ultra-compact footprint, and reduced environmental impacts) and entirely new functionalities (fault current limiting and overload protection). They will make the electricity delivery system more reliable, flexible, controllable, and self protecting. Superconducting cables, operating at extremely low temperatures, eliminate virtually all resistance to the flow of electric current. HTS cables can deliver up to five times more electricity than traditional conventional copper or aluminum cables and have the potential to address the challenge of providing sufficient electricity to densely populated areas.

Detailed Justification

	(dollars in thousands)		
	FY 2008	FY 2009	FY 2010
High Temperature Superconductivity (HTS)	**27,148**	**23,130**	**0**

Activities will continue to support core research in second-generation (2G) HTS wire development and manufacturing processes as well as research on dielectrics, cryogenics, and demonstration of HTS cable systems and fault current limiter technologies. HTS wire research focuses on both rolling-assisted biaxial textured substrates (RABiTS) and ion-beam assisted deposition (IBAD) substrate texturing methods which are based on discoveries at DOE laboratories funded by the program. These methods will continue to be developed by the national laboratories and their industrial partners.

In FY 2008 – key milestones were reached to develop and implement processes to domestically produce long lengths (500 m to 1 km) of HTS second generation (2G) wire. These milestones were reached in collaboration with the Department of Defense (DOD) through the Title III program. However, as manufacturing process steps were scaled up to produce long lengths – uniformity and reproducibility of long-length properties were not comparable to results in short lengths. A few localized flaws can greatly limit overall performance and uniformity over the entire long length (up to 1 km). The world's first ever transmission level (138 kilovolt) HTS cable in a commercial power grid was energized in Long Island, New York - at nearly half a mile in length, it is also the longest HTS cable system in the world. Additionally, the Albany HTS cable was re-connected to the National Grid power system after replacing a 30 meter section of the 350-meter long cable system with an equal section fabricated from second generation (2G) HTS wire. This is the first in-grid demonstration in the world of a device that incorporates 2G HTS wire, which is expected to provide important performance and price benefits compared to copper wire. Testing of the first prototype saturable core HTS fault current limiter (FCL) was initiated for distribution voltages.

In FY 2009 – R&D efforts are focused on improving the ability to consistently and reliably produce uniform properties over long lengths of high performance 2G wire. This includes activities to simplify the processing steps and even reduce steps by combining functionality of the layers, determine efficient and scalable ways to incorporate nanoscale defects into the superconductor so as to dramatically enhance the wire performance, and to increase the superconductor thickness for the wire to carry higher current. Activities also include the development of faster processes with higher rates, and the development of more tolerant precursor chemistries to widen process control window. Experiments and laboratory demonstrations are being conducted to investigate cable design and manufacturing issues related to the fundamental differences between 1G and 2G HTS wires such as cable joints, thermal compensation and cable configuration. Prototypes 2G cable phases will be manufactured and tested to provide relevant cable system design data. Thermal analysis and experiments will be performed to finalize cryogenic system specifications and design. Fabrication and testing of subsystem component modules for HTS fault current limiter (FCL) designs will be initiated. In addition, the program will cooperate with DHS to test and characterize the world's first inherently fault current limiting HTS power cable design – a 25 meters long laboratory scale prototype fault current limiting HTS cable will be tested at distribution voltage level.

SBIR/STTR	**—**	**666**	**0**

In FY 2008, $698,250 and 83,790 were transferred to the SBIR and STTR programs respectively. The FY 2009 amounts shown are the estimated requirements for the continuation of the SBIR and STTR programs

	(dollars in thousands)		
	FY 2008	FY 2009	FY 2010
Total, High Temperature Superconductivity	**27,148**	**23,796**	**0**

Explanation of Funding Changes

	FY 2010 vs. FY 2009 ($000)
High Temperature Superconductivity Decrease reflects budget restructuring for the R&D program. HTS activities will be refocused and funded in the Clean Energy Transmission and Reliability program beginning in FY2010.	-$23,796
Total Funding Change, High Temperature Superconductivity	-$23,796

Visualization and Controls

Funding Schedule by Activity

(dollars in thousands)

	FY 2008	FY 2009	FY 2010
Visualization and Controls			
Visualization and Controls	24,373	23,691	0
SBIR/STTR	—	682	0
Total, Visualization and Controls	24,373	24,373	0

Description

The Visualization and Controls (V&C) subprogram supports grid modernization through the development of advanced visualization and control technologies to improve grid reliability, efficiency, and security. These technologies will help create a resilient National power grid that automatically detects and responds to cyber and physical disturbances, prevents widespread outages, and supports the development and deployment of Smart Grid technologies.

The V&C subprogram will develop advanced technologies, tools, and techniques that will:

- Improve situational awareness for faster response to transmission disturbances to reduce the number and spread of outages;
- Improve sensing and response to deteriorating conditions to allow the transmission system to operate closer to its loading limits and reduce operating margins;
- Enhance the cyber security of the transmission system's digital control, communications, and computing systems to reduce the risk of energy disruptions; and
- Enhance the cyber security of Smart Grid technologies to enable robust integration with the power grid.

The long-term goal (by 2014) is to develop technologies, tools, and techniques that enable automatic, smart, real-time switchable networks for the transmission system, enhance the security and reliability of grid operations, improve controls over major regions of the grid, and harden the electric infrastructure against cyber attacks.

The Department is proposing a budget restructuring for the Research and Development portfolio beginning in FY 2010. Activities in the Visualization and Control subprogram will be included in the new Clean Energy Transmission and Reliability program and in the Cyber Security for Energy Delivery Systems. V&C accomplishments and activities in FY 2008 and FY 2009 are included in this section, and FY 2010 activities are covered in the Clean Energy Transmission and Reliability and Cyber Security for Energy Delivery Systems sections in this Budget Justification.

Benefits

Advances in visualization and control technologies, tools, and techniques will transform today's aging electric transmission infrastructure into a more reliable and efficient power grid that can better withstand cyber and physical disturbances without loss of critical services. To accomplish this, the V&C

subprogram is working with the North American Electric Reliability Corporation and the electricity industry to develop a North American wide-area monitoring system (WAMS) featuring geographically-dispersed, global positioning system (GPS) time-synchronized sensors to provide real-time situational awareness across the North American grid. The subprogram is also developing advanced technologies to enhance the cyber security of control systems including more secure supervisory control and data acquisition (SCADA) and energy management systems, secure data communications protocols, intrusion detection/prevention systems, and a virtual control systems environment to evaluate the risk and consequences of cyber attacks on the energy infrastructure. The expected benefits include:

- Enhanced situational awareness to detect system disturbances and prevent widespread outages;
- Better utilization of existing transmission lines by allowing the transmission system to operate closer to its design limits (thereby reducing the growing need for more lines); and
- Improved reliability through the development of advanced digital control, communications and computing systems that are more resilient to malicious cyber attack.

As part of the next-generation electricity transmission and distribution (T&D) system, additional improvements in sensors and controls could significantly increase the efficiency of electricity generation and delivery, thereby reducing greenhouse gas (GHG) emissions. Outfitting the T&D system with digital sensors, information technologies, and controls could further increase system efficiency and lower GHG emissions by facilitating the integration of end-use resources and other distributed technologies into the grid.

Detailed Justification

	(dollars in thousands)		
	FY 2008	FY 2009	FY2010
Visualization and Controls	**24,373**	**23,691**	**0**

Market restructuring, greenhouse gas reductions, and new end-use technologies such as plug-in hybrid vehicles have redefined the way we use electricity. As the demand for more and higher quality electricity continues to grow, as well as the need to better integrate distributed and renewable resources, more sophisticated and secure control technologies will be required to assure the reliability and security of the Nation's power grid.

To meet these demands, the V&C subprogram is developing advanced technologies and tools to help create a resilient electric transmission system that can better detect disturbances and automatically reconfigure to prevent widespread outage. Key activities include the development of a North American wide-area monitoring system (WAMS) to enhance situational awareness, tools to evaluate operational performance, and advanced technologies to enhance the cyber security of control systems including supervisory control and data acquisition (SCADA) systems and distributed control systems.

Sensors are an essential "building block" to equip system planners and operators with the real-time information they need for achieving the long-term goal of improved electric transmission and distribution planning and operations. DOE activities in this area involve working with electric utilities, vendors, regulators, and research organizations to expand the breadth of coverage of sensors in the transmission and distribution system. Advanced GPS time-synchronized sensors are intelligent electronic devices (IED) that are known as "synchrophasors" when used in a network, that are deployed in substations and include phasor measurement units (PMU), digital fault recorders, and circuit breaker monitors. Other sensors that monitor dynamic line conditions (sag monitors) are deployed directly on transmission lines.

The WAMS activity involves partnering with universities, national laboratories, vendors, and the electricity industry to develop the underlying theory and software for power system planning and operations applications under competitive markets. Market uncertainties under restructuring have been a threat to grid reliability and the efficient, economic operation of the power system. The V&C subprogram will also model, simulate, and experiment with new market designs and operating practices to understand and optimize the new markets for energy, ancillary services, and demand response prior to actual implementation on the power system. Customer demand reduction programs will enable energy-consuming products and processes to respond to market prices of electricity to balance supply and demand, help reduce transmission congestion, and ensure system reliability. 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.

In FY 2008, the leadership of the North American SynchroPhasor Initiative (NASPI) was transitioned from DOE to the North American Electric Reliability Corporation (NERC). NERC, working with the electricity industry, will lead NASPI in the deployment of phasor measurement units across the North American grid, and DOE will focus on the development of longer range research to develop applications and analysis tools that use the high-speed synchrophasor data. Area Interchange Error (AIE) visualization system was commissioned at NERC for monitoring compliance with NERC mandatory reliability standards that will improve the reliability of the Nation's electric grid.

In FY 2009, there are plans to develop enhancements to the Real Time Dynamic Monitoring System (RTDMS) visualization tool with the addition of a prototype angle stability monitoring and alarming tool that provides operators with alarms based on voltage angle thresholds. A communications architecture specification will be developed to provide secure, low-latency transmission of high-speed synchrophasor data from the North American SynchroPhasor network to enable sharing of real-time data among utilities and NERC to provide wide area visibility and situational awareness across the interconnected transmission grid.

The V&C subprogram also includes control systems/cyber security activities which will be moved to a separate subprogram, *Cyber Security for Energy Delivery Systems* in FY 2010. The control systems security activity seeks to reduce the risk of energy disruptions due to cyber attacks on control systems. Control systems, including supervisory control and data acquisition (SCADA) and distributed control systems (DCS), are used widely throughout the electric power grid to manage and monitor the delivery of energy to the Nation. Control systems are critical to the effective and reliable operation of the nation’s energy infrastructure. However, many of these systems were designed and deployed mainly to enhance productivity and efficiency with little concern for cyber security. In addition, according to the Office of the Director of National Intelligence, adversaries ranging from hackers to organized crime to nation-states are increasingly targeting these systems for exploitation.

The V&C control systems security activity also supports the development and deployment of secure

(dollars in thousands)

Smart Grid technologies that are resistant to cyber attacks. It is imperative that we address cyber security issues in the early development phase as we modernize the power grid to incorporate Smart Grid technologies such as ubiquitous sensing, two-way communications, advanced networking technologies (e.g., home area networks, wireless, high-speed broadband communications, and wide area networks), distributed and renewable generation sources, and plug-in hybrid vehicles,

Today's control systems are vulnerable to malicious cyber attacks due to the increased adoption of standardized technologies with known vulnerabilities, lack of cyber security tools suitable for use in a real-time, power grid environment, and the increased connectivity to other networks including the internet. Sophisticated cyber attack tools are now widely available on the internet for adversaries with little technical knowledge to launch an attack from almost anywhere using a laptop computer and an internet connection. A major concern is the limited ability of end-users (utilities) to identify and mitigate control system vulnerabilities in a timely manner, detect cyber intrusions, implement protective measures and response strategies, and sustain cyber security improvements over time.

In FY 2008, the V&C control systems security activity accomplished the following:

- Completed testing and a cyber security analysis of the Inter-Control Center Protocol (ICCP);
- Successfully demonstrated the capability of the virtual control systems environment (VCSE) to estimate the risk of supply chain vulnerabilities;
- Successfully developed and commercialized templates to evaluate the security configuration of control systems manufactured by 10 different vendors;
- Evaluated the functionality and cyber security of an advanced middleware software solution for inter-control center communications;
- Released a second report on common control system vulnerabilities;
- Completed control systems cyber security training for over 1,500 utility representatives including a Red/BlueTeam exercise;
- Completed cyber security assessments of three SCADA systems in a test bed environment; and
- Commercialized a software tool to passively map assets on a control system networks

In FY 2009, the V&C control systems security activity will complete cyber security assessments of three SCADA systems, launch development of a security state visualization tool and an advanced technology to secure data communications between enterprise data systems and the control system network, and complete the development of cyber security requirements for advanced metering infrastructure technologies to support the development and deployment of Smart Grid technologies. The subprogram will also complete enhancements to the Real Time Dynamic Monitoring System (RTDMS) visualization tool with the addition of a prototype angle stability monitoring and alarming tool that provides operators with alarms based on voltage angle thresholds.

	FY 2008	FY 2009	FY2010
SBIR/STTR	**—**	**682**	**0**

In FY 2008, $626,875 and $75,225 were transferred to the SBIR and STTR programs respectively. The FY 2009 amount is an estimated requirement for the continuaton of the SBIR and STTR program.

	FY 2008	FY 2009	FY2010
Total, Visualization and Controls	**24,373**	**24,373**	**0**

Explanation of Funding Changes

	FY 2010 vs. FY 2009 ($000)
Visualization and Controls	
Decrease reflects budget restructuring for the R&D program. In FY 2010, Transmission Reliability activities will be funded in the Clean Energy Transmission and Reliability programs; cybersecurity activities are in a separate subprogram	-25,305
Total Funding Change, Visualization and Controls	**-25,305**

Energy Storage and Power Electronics

Funding Schedule by Activity

	(dollars in thousands)		
	FY 2008	FY 2009	FY 2010
Energy Storage and Power Electronics			
Energy Storage	2,235	3,953	0
Power Electronics	4,317	2,416	0
SBIR/STTR	—	183	0
Total, Energy Storage and Power Electronics	6,552	6,552	0

Description

In partnership with industry, the Energy Storage and Power Electronics subprogram develops advanced electricity storage and power electronics technologies for modernizing and expanding the electric grid. This will improve the quality, reliability, flexibility, and cost effectiveness of the existing system.

The Department is proposing a budget restructuring for the Research and Development portfolio beginning in FY 2010. Energy Storage activities will be included in a separate Energy Storage program; power electronics activities will be incorporated into the Smart Grid Research and Development subprogram. Accomplishments and activities in FY 2008 and FY 2009 are included in this section, and FY 2010 activities are covered in the new subprogram sections in this Budget Justification.

Benefits

The Energy Storage Systems (ESS) Program provides a public domain repository of over 30 years of energy storage systems knowledge and experience. The ESS Program has developed components and systems, introduced economic benefit analysis and raised awareness of energy storage systems within the utility industry. Large utility companies and Independent System Operators (AEP, Duke, National Power, CAISO, PJM, NYISO, among others) are including energy storage in their portfolios as a result of the ESS Program's efforts. The ESS Program has helped the two largest state energy agencies (CEC and NYSERDA) form energy storage initiatives within their respective states by providing technical expertise in program planning, contract selection and oversight. The energy storage system benefits these organizations anticipate receiving include: peak shaving to minimize congestion in the T&D systems and to defer equipment upgrades caused by overloading during peaks; enhancing the value of variable renewable generation sources; providing fast response regulation services without generating green house gas emissions; and improving the power quality and reliability of the grid.

Detailed Justification

	(dollars in thousands)		
	FY 2008	FY 2009	FY 2010
Energy Storage	**2,235**	**3,953**	**0**

In partnership with industry, Energy Storage R&D develops advanced electricity storage to modernize and expand the electric grid to improve the quality, reliability, flexibility, and cost effectiveness of the existing system.

(dollars in thousands)

A long-term goal for energy storage is to increase energy density in a prototype battery or electrochemical capacitor systems by 50 percent. Another goal is to make storage technologies cost effective for a portfolio of utility applications.

The Energy Storage program works extensively through highly leveraged collaborations with State energy agencies such as California, New York, and Iowa, as well as with major utilities like AEP and National Grid. These collaborations have allowed the program to sponsor a wide spectrum of applications with a portfolio of storage technologies. DOE support has succeeded in bringing a number of applications closer to market. For example, DOE funding has been successful in bringing voltage and frequency regulation by fast storage into market ready position and triggering appropriate new tariff regulations by Independent System Operators.

In FY 2008, the Storage activity initiated investigations of novel materials including ionic liquids for possible use as electrolytes in batteries and supercapacitors. This investigation identified several electrolytes with extended operating ranges of up to 8V compared to conventional ranges of 2-3V. However these electrolytes also displayed high ionic transport resistances, limiting their ability to deliver high power. Efforts are continuing to resolve this issue. The Storage Program also initiated investigations into nano-engineering of electrode materials, extending successful SBIR projects. Devices combining these technologies will be developed with the long term potential of doubling the energy and increasing the power by at least 50 percent for capacitors, and doubling the lifetime and improving safety of rechargeable non-aqueous batteries. These studies are being performed in coordination with the Department's Office of Science. This activity also continued the development of energy storage devices including advanced batteries, electrochemical capacitors, flywheels, and other energy storage systems to meet the emerging needs of the electric system.

In collaboration with NYSERDA and NYPA, the Long Island Bus Terminal Energy Storage Project was commissioned. This 1 MW NAS battery stores energy at off-peak rates to drive 1800 hp natural gas compressors to allow refueling of busses during on-peak hours.

In FY 2009, the program continued the material research initiated in FY 2008 in the areas of new electrode and electrolyte material development. Testing of carbon enhanced lead acid batteries continued with the promise of significantly increasing the lifetime of this low cost technology. FY 2009 funding also allowed continued collaboration in highly leveraged prototype demonstration and deployment projects. State energy agency collaboration continued with the beginning of the Long Island Municipal Bus Terminal project data acquisition phase and the initiation a new CEC/SMUD trackside rail project. The Energy Storage activity has been instrumental in assisting emerging technologies reach this stage. System modeling, prototype development and field testing in realistic grid conditions are critical to that process.

	FY 2008	FY 2009	FY 2010
Power Electronics	**4,317**	**2,416**	**0**

High voltage power electronics allow precise and rapid switching of electric power to support improved long distance transmission and advanced distribution topologies. Power electronic devices will enable quick response to system disturbances improving grid reliability and allowing increased power flow reducing the need for additional infrastructure.

There has been, and continues to be, a substantial Federal R&D investment in power electronics that OE leverages. Much of this investment has been targeted at automotive and military applications. Utility applications are very different from these lower power applications. In automotive and military applications, size and weight are the key drivers whereas in utility applications, high power and voltage are the critical issues. This requires additional focus on thermal management, topology development and packaging concerns.

In FY 2008, the power electronics activity was initiated. The activity focused on investigation into the feasibility of developing new materials for grid applications:

- Devices that need to be able to withstand high voltages, current levels, and power densities;
- Advanced topologies that need to reach the high power levels of utility applications;
- Advanced control methodologies and technologies that need to better coordinate multiple systems; and
- Lower cost and more modular "building block" units that are programmable for multiple functions and have standardized interfaces.

In FY 2009, funding focused on material development for utility scale solid state fault current limiters. Next-generation materials also studied included silicon carbide (SiC) and gallium nitride (GaN). These are wide bandgap materials with superior voltage and temperature operating characteristics when compared with silicon.

	FY 2008	FY 2009	FY 2010
SBIR/STTR	**—**	**183**	**0**

In FY 2008, $168,525 and $20,223 were transferred to the SBIR and STTR programs respectively. The FY 2009 amount is the estimated requirement for the continuation of the SBIR and STTR program.

	FY 2008	FY 2009	FY 2010
Total, Energy Storage and Power Electronics	**6,552**	**6,552**	**0**

Explanation of Funding Changes

	FY 2010 vs. FY 2009 ($000)
Energy Storage and Power Electronics Decrease reflects the budget restructuring of the R&D budget for FY 2010. In FY 2010, Energy Storage will become a separate sub-program. Power electronics will be incorporated into two sub-programs: near-term solid-state equipment development will be integrated into the Smart Grid sub-program, while longer-range strategic power electronics materials research will be a focus of the Grid Research Institute.	-6,552
Total Funding Change, Energy Storage and Power Electronics	**-6,552**

Renewable and Distributed Systems Integration

Funding Schedule by Activity

	(dollars in thousands)		
	FY 2008	FY 2009	FY 2010
Renewable and Distributed Systems Integration			
Renewable and Distributed Systems Integration	24,753	29,160	0
SBIR/STTR	—	840	0
Total, Renewable and Distributed Systems Integration	24,753	30,000	0

Description

The main goal of the Renewable and Distributed Systems Integration (RDSI) activity involves developing technologies, tools, and techniques for integrating renewable energy, distributed generation, energy storage, thermally activated technologies, and demand management into electric system planning and operations to manage peak loads, improve customer services, and enhance asset utilization.

The integration uses a systems approach to address technical, economic, regulatory, and institutional barriers for using renewable and distributed systems, and establishes proven value propositions under varying use scenarios for broad implementation.

Improving the ability to integrate renewables and other technologies into the distribution and transmission system will facilitate and support achieving target goals in State portfolio standards for renewables and energy efficiency and reduce the overall carbon footprint of the electricity grid. In addition, the integrated system will enable "microgrid" operations, new value-added electric services such as premium power for critical loads, and new applications for electricity such as utilizing plug-in hybrid electric vehicles to meet energy diversity and reduce dependence on oil.

The Department is proposing a budget restructuring for the Research and Development portfolio beginning in FY 2010. Renewable and Distributed Systems Integration activities will be included in the Smart Grid Research and Development subprogram. Accomplishments and activities in FY 2008 and FY 2009 are included in this section, and FY 2010 activities are covered in the new Smart Grid Research and Development subprogram section in this Budget Justification.

Benefits

The RDSI activity accomplishes integrated demonstration projects with utilities, State agencies, equipment manufacturers, universities, national laboratories, and technology providers to reach the goal to demonstrate a 20 percent reduction in peak load demand at a distribution feeder by the year 2015. This reduction in peak demand will eliminate or defer the need for new transmission and distribution capacity, reduce congestion and decrease electricity prices and volatility. Successfully meeting this goal will require advancing system management tools that permit both utilities and consumers to benefit from distributed generation capacity and demand reduction practices.

Public policy initiatives, e.g., renewable portfolio standards and mandates to achieve a percentage of peak supply via demand response practices, are intended to increase efficiency, and minimize impacts that contribute to climate change. As a result, utilities are being asked to capture the potential value of distributed energy resources when considering investments in “firm” distribution capacity additions. To date, however, there are no standard models, tools, or techniques to evaluate and incorporate distributed generation resources into electric system planning and operations. One of the outcomes of the RDSI demonstrations will be to address the operational issues associated with renewable and distributed generation technologies, as well as the business models needed to incorporate these technologies into capacity planning and demand-side management. RDSI technologies benefits will be methods for achieving the needed reliability at the distribution level by incorporating many technologies into demonstrations, including distributed generation, energy storage, demand response, renewable energy, and power electronics devices.

Another benefit will be to verify the application of distributed energy systems for safe, secure, and cost-effective “islanding” operations, i.e., operating parts of the system while disconnected from the main grid, thereby mitigating the impacts of outages and ensuring a more resilient overall system. This benefit of RDSI is expected to make the overall electric system more flexible and secure.

In summary, the benefits of the Renewable and Distributed Systems Integration activity (RDSI) include:

1) reduced carbon emissions and emissions of other air pollutants through increased use of renewable energy,
2) increased asset utilization through integration of distributed energy systems and customer loads to reduce peak load and thus price volatility,
3) contribution to achieving goals in State portfolio standards for renewable energy and energy efficiency,
4) enhanced reliability, security, and resiliency from microgrid applications in critical infrastructure protection, digital equipment applications, and constrained areas of the electric grid,
5) improved system efficiency with on-site, distributed generation and improved economic efficiency through demand-side management, and
6) support of energy diversity by understanding and enabling plug-in hybrid electric vehicle (PHEV) operations with the grid.

Detailed Justification

	(dollars in thousands)		
	FY 2008	FY 2009	FY 2010
Renewable and Distributed Systems Integration	**24,753**	**29,160**	**0**

The Renewable and Distributed Systems Integration activity focuses on integrating renewable energy, clean distributed energy systems, and demand management of customer (industrial/commercial/residential) loads into the planning and operations of the electric transmission and distribution network. This integration supports demonstrating technical and economical feasibility of using renewable and distributed systems in utility-scale applications, and provides sound use cases with robust performance data for broad acceptance and implementation by industries and utilities.

To date, renewable and distributed systems are greatly under-utilized. The Energy Information Administration report, *Electric Power Annual*, cites data for 2005 indicating that renewable energy, other than hydroelectric, accounted for a mere 2.3 percent of net generation, and that demand-side management contributed to a total peak-load reduction of 3.4 percent.

(dollars in thousands)

To significantly increase penetrations of renewable energy and distributed energy systems, significant technical advances both in individual generation technologies and in system design, integration, and operations must be accomplished, requiring focused, accelerated, and well coordinated R&D. The OE program works closely with the Energy Efficiency and Renewable Energy (EERE) program to ensure that advances in generation technology development (solar, wind, biomass, geothermal, fuel cells) by EERE can be readily integrated into the electric system through OE's research and developed technologies.

	FY 2008	FY 2009	FY 2010
▪ **Peak Load Reduction**	**25,466**	**24,160**	**0**

This technology area focuses on integration of distributed energy resources (distributed generation, renewables, energy storage, thermally activated technologies, and demand response) to increase utilization of both utility- and customer-owned assets and to reach the goal of 20 percent peak load reduction by 2015.

Integrated Demonstrations.
In FY 2008 the RDSI program awarded nine integrated demonstration projects through an open solicitation.

In FY 2009, the integrated demonstration projects commenced. Each of these awarded projects involves significant use of distributed resources to provide a substantial amount of peak power, i.e., at least 15 percent of the capacity of distribution feeder(s) and/or substation, and other functions and services. These other functions and services that will be developed and demonstrated through the projects will include low-cost sensors for distribution cables, advanced monitoring for distribution automation, and information gateways to enable demand-side management by both utilities and consumers.

In the Microgrid area, activity will continue on advanced control strategies development to ensure automatic re-synchronization, fast switching, and coordinated control and protection operations. The integration of agent based control and grid management algorithms will continue; this has been jointly undertaken since FY 2007 with the European Union SmartGrid projects as part of international collaboration on microgrids R&D. In FY 2008 assessments of microgrids for military facilities was initiated. In FY 2009, completed several assessments which included detailed load and critical load assessments, benefits analysis, costs, potential suitable generation mixes, and basic system designs. These microgrids will aide the military in meeting their requirements for increasing energy efficiency, utilizing renewable energy sources, and increasing energy security for mission critical activities.

Interconnection Standards Development and Testing.
There were a series of planned interconnection standards developments in FY 2008, including completion of the 5-year reaffirmation and revision of ANSI IEEE 1547, *Standard for Interconnecting Distributed Resources with Electric Power Systems*.

In FY 2009, activities continued in developing and harmonizing national and international standards for interconnection of distributed resources and electric power systems, and in testing advanced interconnection technologies to support standards development. These standards are essential for connecting renewable and distributed resources to the grid. In FY 2009, IEEE P1547.5, *Draft Technical Guidelines for Interconnection of Electric Power Sources Greater than 10MVA to the Power Transmission Grid*, and IEEE P1547.6, *Draft Recommended Practice for Interconnecting Distributed Resources with Electric Power Systems Distribution Secondary Networks*, will be completed and published.

(dollars in thousands)

<u>Renewable Energy Grid Integration</u>.
The activity was closely coordinated with EERE to work on issues to fully integrate transmission and distribution system level renewable energy technologies into the electric grid. EERE is primarily responsible for characterizing renewable generation technology requirements. OE has undertaken the integration of renewable generation, as well as, end use technologies, with the electric transmission and distribution grid.

In FY 2008 and FY 2009, this activity supported the efforts of the system operators (including from the Western Interconnection and the State of Hawaii) to plan for and to effectively integrate large amounts of variable, renewable generation into the electric system. Work included technical assessments and studies, such as integration of high accuracy wind modeling techniques and traditional power system analysis tools. Efforts also included use of laboratory-based, simulated, electric system operation centers for human factor assessments.

	FY 2008	FY 2009	FY 2010
▪ **Smart Grid Development and Implementation**	**0**	**5,000**	**0**

The Smart Grid Development and Implementation technology area focuses on defining the characteristics and associated performance of, and developing technologies to meet the performance metrics of, an integrated, intelligent electric transmission and distribution network, also known as a "smart grid." A systems approach is undertaken for all activities, involving design and architecture, integration of electric/market operations and policies, and new capabilities to enable new functions and services in the 21st century.

In FY 2008, Smart Grid advancement projects involved implementation of smart grid concepts in utilities, with a further objective of implementation in individual States and multi-State regions. The implementation was guided by a roadmap, with defined performance metrics, that was developed through a workshop with open participation by all stakeholders. Also in FY08, the first forum was held that engaged industries in interoperability issues and their resolutions.

In FY 2008 in the PHEV area, smart charger controllers were installed in test vehicles and monitor test performance. Additionally, analysis of PHEV impacts on power wholesale pricing under varying PHEV penetration scenarios and charging load profiles, a joint project with the EERE FreedomCAR and Vehicle Technologies, was completed in FY 2008.

In FY 2009, development and implementation of a smart grid architecture framework to support technical principles of interoperability continued. A second interoperability forum was held in FY 2009 to share progress in industry implementation and related standards efforts. This activity will be transitioned to industry sponsorship in FY 2010.

	(dollars in thousands)		
	FY 2008	FY 2009	FY 2010

In FY 2009, PHEV field testing of smart charger controllers continued, with collection of a full year of performance data in PHEV fleet vehicles.

Additionally in FY 2009, system simulation and analysis was conducted to quantify the life-cycle system benefits from attaining smart grid performance metrics, building on the distribution system simulation and analysis tools developed in FY 2007 – FY 2008.

SBIR/STTR	**—**	**840**	**0**

In FY 2008, $636,650 and $76,398 were transferred to the SBIR and STTR programs respectively. The FY 2009 amount is an estimated requirement for the continuaton of the SBIR and STTR program.

Total, Renewable and Distributed Systems Integration	**24,753**	**30,000**	**0**

Explanation of Funding Changes

	FY 2010 vs. FY 2009 ($000)
Renewable and Distributed Systems Integration	
▪ **Renewable and Distributed Systems Integration** Decrease reflects a restructuring of the Research and Development budget. In FY 2010 these activities will be funded in a new subprogram, Smart Grid Research and Development.	-30,000
Total, Renewable and Distributed Systems Integration	-30,000
Total Funding Change, Renewable and Distributed Systems Integration	**-30,000**

Operations and Analysis

Funding Profile by Subprogram

	(dollars in thousands)		
	FY 2008 Current Appropriation	FY 2009 Original Appropriation	FY 2010 Request [(1)]
Operations and Analysis			
Permitting, Siting, and Analysis	5,644	5,271	0
Infrastructure Security and Energy Restoration	5,807	6,180	0
Total, Operations and Analysis	11,451	11,451	0
Permitting, Siting and Analysis			6,400
Infrastructure Security and Energy Restoration			6,188

Public Law Authorizations:
P.L. 110-161, Consolidated Appropriations Act, 2008
P.L. 111-8, Omnibus Appropriations Act, 2009
[(1)] PSA and ISER are proposed as separate budget programs in FY 2010, but are discussed together in this section.

Mission

The mission of the Operations and Analysis program is: (1) to contribute to the development and implementation of electricity policy at the Federal and State level; (2) to authorize electricity exports and Presidential permits for cross-border transmission lines; (3) to enhance the reliability, survivability and resiliency of the energy infrastructure; and (4) to facilitate recovery from disruptions to the energy supply. The Operations and Analysis program is composed of two independent subprograms: the Permitting, Siting, and Analysis (PSA) and the Infrastructure Security and Energy Restoration (ISER). These will become separate programs beginning in FY 2010.

Benefits

PSA implements the electricity grid modernization requirements of the Energy Policy Act of 2005. It also assists States, regions, and other Federal agencies to develop and improve policies, market mechanisms, State laws, and programs that facilitate the development of the electricity infrastructure required to access clean energy resources. It issues permits for cross-border transmission lines and authorizes electricity exports.

ISER leads the national effort to enhance the security of our Nation's critical infrastructure from all threats and hazards. When security efforts fail, the Department of Energy (DOE), through ISER, is responsible for maintaining continuous and reliable energy supplies for the United States through preventative measures and restoration and recovery actions in a coordinated effort with other Federal agencies, States, local governments and the private sector. ISER assists other agencies in the restoration of electricity after disasters. ISER also provides expert recommendations on the improvement of energy infrastructure security.

Contribution to the Secretary's Priorities

PSA supports modernization by facilitating the siting of new or the upgrade of existing transmission facilities and the development of State policies and programs that allow the electric grid to operate more reliably and efficiently. These activities serve to expand the geographic coverage of the electric grid, thus increasing the availability of the transmission required to connect clean energy technologies to the grid and deliver the resource to markets.

PSA contributes to OE's mission by facilitating the development of State programs and new transmission that will improve the reliability and efficiency of the electric power grid and provide access to new renewable resources. This results in the more efficient use of existing fossil fueled generation and increased use of renewable, carbon-neutral resources, with the effect of reducing greenhouse gas emissions. These same dynamics result in a net reduction in the use of higher-cost generating facilities, such as oil- and natural-gas fired, with an overall reduction in the cost of electricity to the country.

ISER's mission is to assure the reliability, survivability, and resiliency of the U.S. critical energy infrastructure in a threat scenario. The U.S. economy depends critically upon a secure supply of energy, and ISER provides the methods and tools to protect against physical and cyber disruptions, reducing the impact of disruptive events, and quickly restoring energy when disruptions occur. ISER's activities are backed by the DOE national laboratories' world-class science and technology. Further, ISER has established close relationships with the private industry owners and operators of the energy infrastructure, as well as State and local governments, to understand their perspectives on protection, mitigation, and response options and to quickly deploy the best available technology in a tailored, systems approach. ISER has a long, successful history of supporting U.S. energy infrastructure restoration efforts in times of disruptive events.

Contribution to GPRA Unit Program Goal 1.3.16 Electric Delivery and Energy Reliability

Strategic Theme	Strategic Goal Title	Secretary's Priorities	GPRA Unit Program Number	GPRA Unit Program Title
1. Energy Security	3. Energy Infrastructure	Economic Prosperity	16	Electric Delivery and Energy Reliability

Means and Strategies

PSA is implementing the electricity grid modernization requirements contained in EPAct. These include publication of a national transmission congestion study every three years (next is August 2009) that is coupled with possible designation of national interest electric transmission corridors; coordination of all Federal permits required for siting transmission projects; identification of energy transport corridors on Federal lands in the East, Alaska, Hawaii, and Texas done jointly with Federal resource agencies by August 2009; provision of technical assistance to State public utility commissions and regional electricity-related organizations on various electricity policy topics; and preparation of an annual report to Congress on electric industry economic dispatch practices.

Leading up to the August 2009 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, create a transparent process that includes interactions with interested persons and consultation with affected States, and perform technical analyses as required.

PSA will provide grants and technical assistance to States and regional entities to develop policies that facilitate development of the electricity infrastructure required to access clean energy resources. PSA will augment technical studies designed to identify the problems of integrating large-scale variable renewables, i.e., wind and solar, onto the electricity grid. The results of these studies will be used by electricity grid operators and grid planners. PSA will grant permits for international transmission lines and electricity exports after analyzing regional analyses provided by permit applicants on the impacts of the proposal on electric reliability and preparing the required environmental analyses through third-party, applicant funded environmental contractors.

ISER will use various means and strategies to achieve its GRPA Unit Program Goals. As such, 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 procedures. 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.

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 for application domestically and internationally.

ISER will continue to implement its international strategy to assist key energy producing allies in securing their critical energy infrastructure. ISER analyzes the potential impacts of disruptions on the global energy system, identifies critical nodes, and collaborates with stakeholders to develop optimized strategies to prevent or mitigate disruptions. In addition, OE will compliment 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.

This approach will assist in maintaining continuous and reliable energy supplies for the United States and assist in addressing the challenges of the increasing complexity and interdependency of our Nation's energy infrastructure in conjunction with the rising energy market globalization, the extreme fluctuation of energy prices, the global competition for energy resources, and catastrophic natural disasters or deliberate efforts are major energy challenges.

Validation and Verification

To validate and verify program performance, PSA collects industry plans for development of transmission projects and tracks the progress through to installation. This provides a means of determining the effectiveness of PSA's efforts to facilitate the development of needed transmission. PSA collects quarterly and annual data on international electricity trade to determine compliance with the regulatory requirements contained in cross-border permits and electricity export authorizations.

Grants awarded by PSA and ISER to State for policy development require reporting against identified goals and deliverables. Funded projects from both programmatic areas are monitored against budget, schedule, and deliverables to ensure that the objectives are met.

All studies and reports prepared pursuant to EPAct undergo extensive review by effected States and industry organizations.

The programmatic activities within PSA and ISER are subject to continuing review by Congress, the Government Accountability Office (GAO), and the Department's Inspector General. Additionally, budget planning, strategic planning, and milestone management are tracked by the Department's program management reporting system.

To validate and verify performance, ISER participates in numerous peer-evaluated performance exercises, drills, and reviews. ISER's products and efforts are, in large part, focused on external customers and interfaces, such as other federal agencies, other countries, the various states, and a multitude of private sector partners in the energy industry. ISER also participates in FEMA Regional Interagency Security Committee exercises in all ten FEMA-designated regions. Additionally, ISER participates in national level annual exercises, such as TOPOFF and Ardent Sentry. Direct feedback from industry during symposia and information exchanges provide valuable insight into shortfalls and areas for improvement.

Interagency collaboration with DHS, the National Guard, the Coast Guard, and FEMA provide opportunity for review and discussion of policies and plans, as well as corrective actions resulting from interagency exercises.

Emergency response efforts, such as deployments in response to hurricane damage to the energy infrastructure, are routinely critiqued by FEMA, and generally subject to other reviews by the IG, GAO, or special commissions. ISER efforts are tracked and recorded for later self-evaluation and outside review. After-action reports are generated for the major energy crises for which ISER has deployed its Emergency Support Function 12 resources, with documented lessons learned and actions tracked to completion. Additionally, the overall performance of the Emergency Support Functions under the National Response Framework are subject to post-disaster review and reporting to assess the total system effectiveness, and to identify strengths and weaknesses within the system.

Annual Performance Results and Targets

FY 2005 Results	FY 2006 Results	FY 2007 Results	FY 2008 Targets	FY 2009 Targets	FY 2010 Targets
Strategic Goal 1.3, Energy Infrastructure					
Permitting, Siting, and Analysis				Complete DOE's Second Study of National Electric Transmission Congestion.	Hold at least two events (workshops or technical conferences) to facilitate collaborative efforts among groups of States to address congestion problems identified in the Congestion Studies or other problems related to the modernization of electricity-related infrastructure.
Infrastructure Security and Energy Restoration				Formally request in writing access to electric transmission information from relevant regional stakeholders in order to have near real time visualization capability within the Energy Response Center of the entire U.S. electric transmission grid at 230 KV and above, thereby enabling improved situational awareness during emergencies.	In cooperation with the private sector, complete an analysis of an initial pilot study to expand OE's analysis of the Nation's energy system and its interdependencies in order to further enhance the reliability, survivability and resiliency of energy systems

Permitting, Siting, and Analysis
Funding Schedule by Activity

(dollars in thousands)

	FY 2008	FY 2009	FY 2010
Permitting, Siting, and Analysis			
Permitting, Siting, and Analysis	5,644	5,271	6,400
Total, Permitting, Siting, and Analysis	5,644	5,271	6,400

Description
The mission of the Permitting, Siting, and Analysis Division (PSA) is to modernize the electric grid and to enhance the reliability of the energy infrastructure. This is accomplished by (1) contributing to the development and implementation of electricity policy at the Federal and State levels, (2) implementing the mandatory transmission provisions of the Energy Policy Act of 2005 (EPAct), and (3) administering the mandatory international electricity regulatory program through the permitting of cross-border electric transmission lines and authorizing electricity exports.

Benefits
PSA helps 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. Under EPAct, PSA (1) identifies transmission congestion that may impede access to clean energy resources, (2) recommends National Interest Transmission Corridors (National Corridors) which could provide Federal backstop siting authority, (3) serves as the lead agency for coordinating all Federal authorizations required to site new transmission facilities, and (4) assists in the designation of energy corridors on Federal lands. These PSA activities facilitate and streamline the siting of new electric infrastructure.

Detailed Justification

(dollars in thousands)

	FY 2008	FY 2009	FY 2010
Permitting, Siting, and Analysis	**5,644**	**5,271**	**6,400**

PSA provides technical and financial assistance to States and regional entities to develop policies that facilitate development of the electricity infrastructure required to access clean energy resources. In granting permits for international transmission lines and electricity exports, 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's electricity-related responsibilities under EPAct include the following activities:

- Section 368 of EPAct requires that energy transport corridors be designated on Federal lands in the 11 western states and in the rest of the U.S. After completion of a Programmatic Environmental Impact Statement co-lead by PSA, approximately 6,000 miles of energy corridors in the 11 western states were designated by the Departments of Interior and

Agriculture in January 2009. A similar process began in FY 2008 for the rest of the U.S.

- Section 1221(a) 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 August 2006, DOE and eight other Federal agencies entered into a Memorandum of Understanding on Early Coordination of Federal Authorizations and Related Environmental Reviews Requires in Order to Site Electric Transmission Facilities. PSA has developed proposed regulations implementing its responsibilities under section 216(h) and has established a publically available website to track all critical elements in the Federal review process for transmission projects. Requested funds will also be used for work on environmental assessments and other analyses needed for requests by electric transmission developers for the Department, as mandated by EPAct, to coordinate all Federal permits for transmission projects that cross Federal lands.
- Section 1221(h) of EPAct added section 216(h) to the Federal Power Act requiring PSA to conduct a study of electric transmission congestion every 3 years. The first congestion study was published in August 2006, and on October 5, 2007, DOE designated two National Corridors. DOE is on target to complete its second congestion study by the required August 2009 deadline that will include the consideration of renewable resources to comply with provisions in the Recovery Act. Based in part on the results of the Congestion Study, DOE may designate National Corridors. Under certain circumstances, such designations could result in the Federal Energy Regulatory Commission (FERC) having jurisdiction to consider applications for the siting of electricity transmission facilities within the designated National Corridors. FERC has the authority to grant limited eminent domain in those circumstances. While cause and effect on such matters is difficult to prove, the Department notes that, since the 2007 designations, both designated regions have had successful state approvals of major new transmission.

PSA assists States and regions with their electricity policies by continuing to provide financial and 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: transmission siting; regional resource and transmission planning; energy efficiency; renewable energy policies and portfolio standards; demand- response (reducing electricity use at peak times); smart grid; and coal with carbon capture and sequestration. A portion of this effort will be continued support to implement States' and the utility industry's National Action Plan for Energy Efficiency. A new project under this Action Plan is supporting its sponsors' consideration of a national voluntary "evaluation measurement protocol" to better verify energy savings achieved by ratepayer-funded energy efficiency measures. 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. Some of these efforts include: continued analytical support to the Western Governors Association's (WGA) "Committee on Regional Electric Power Cooperation (CREPC)," from which sprung the DOE/WGA Western Renewable Energy Zones project funded in FY08-09. The DOE/WGA project may lead to major new transmission being built in the West to access remote renewables. Similarly, PSA analytical funding to the CREPC group has resulted in the Western Electricity Coordinating Council (WECC) conducting more

	(dollars in thousands)	
FY 2008	FY 2009	FY 2010

Interconnection-wide transmission analysis and planning functions.

PSA will augment technical studies designed to identify the problems of integrating large-scale variable renewables, i.e., wind and solar, onto the electricity grid. The results of these studies will be used by electricity grid operators and grid planners.

To reduce the demand and use of electricity, DOE has continued its support of regional groups of state utility commissioners seeking to better coordinate and enact regulations on energy efficiency, distributed generation, demand response, and smart grid. These regional efforts are in the Mid-Atlantic, MidWest, and the Pacific Northwest.

Funds will also support the Department's International Electricity Regulatory program, which helps achieve OE's program goal of modernizing the electric grid and enhancing the reliability of the energy infrastructure." In FY 2008, International Electricity Regulatory Program processed 20 electricity export authorizations and processed Presidential permit applications for 7 new transmission facilities at the U.S. international borders. Before rendering any regulatory decisions, the environmental impacts of the proposed action are assessed pursuant to the requirements of the National Environmental Policy Act. PSA also must 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 would not adversely affect the reliability of the U.S. electrical grid.

FY 2010 activities include:

- Continue providing technical and financial assistance to States 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.

- Continue the mandatory regulatory responsibilities of the International Electricity Regulatory Program by permitting international electric transmission lines and electricity exports.

- Continue the mandatory electricity-related responsibilities under EPAct.

	FY 2008	FY 2009	FY 2010
Total, Permitting, Siting, and Analysis	**5,644**	**5,271**	**6,400**

Explanation of Funding Changes

	FY BY vs. FY CY ($000)
Permitting, Siting, and Analysis	
▪ **Permitting, Siting, and Analysis** Additional funding supports an increase in technical assistance to State electricity regulatory agencies and to electric utilities as they implement their National Action Plan for Energy Efficiency. This will support the additional analyses required for new projects, such as a national voluntary evaluation measurement and verification of energy savings from efficiency. Increased funds will be used for additional support to States on smart grid policies. DOE also expects to coordinate dozens of transmission projects requiring multiple Federal authorizations.	+1,129
Total, Permitting, Siting, and Analysis	+1,129
Total Funding Change, Permitting, Siting, and Analysis	**+1,129**

Infrastructure Security and Energy Restoration

Funding Schedule by Activity

	FY 2008	FY 2009	FY 2010
	(dollars in thousands)		
Infrastructure Security and Energy Restoration			
Infrastructure Security and Energy Restoration	5,807	6,180	6,188
Total, Infrastructure Security and Energy Restoration	5,807	6,180	6,188

Description

The ISER program leads national efforts to enhance the security of our Nation's critical energy infrastructure from all threats and hazards. The Department of Energy (DOE), through ISER, is responsible for maintaining continuous and reliable energy supplies for the United States through preventative measures, restoration and recovery actions in a coordinated effort with other Federal agencies, States, local governments and the private sector.

Benefits

ISER's mission is to assure the reliability, survivability, and resiliency of the U.S. critical energy infrastructure. The U.S. economy depends critically upon a secure supply of energy. ISER's role is to provide the methods and tools to protect against physical and cyber disruptions, reduce the impact of disruptive events, and quickly restore energy when disruptions occur. It is becoming increasingly important in view of the all-hazards threat scenario, so activities are supported by OE's R&D and PSA efforts and DOE national laboratories' world-class science and technology. For instance, in the area of visualization, where tools such as "VERDE" were developed by OE's R&D Division and later deployed to ISER. Further, ISER has established close relationships with the private industry owners and operators of the energy infrastructure, as well as State and local governments, to understand their perspectives on protection, mitigation, and response options and to quickly deploy the best available technology in a tailored, systems approach. In addition, ISER has a long, successful history of supporting U.S. energy infrastructure restoration efforts in times of disruptive events.

The U.S. energy infrastructure, both physical and cyber, comprises a diverse set of energy sources and distribution systems that are global in nature. Therefore, facilitating the reliability, survivability, and resiliency of the energy infrastructures of key, strategic, international partners is essential to securing the U.S. energy supply. ISER analyzes the potential impacts of disruptions on the global energy system, identifies critical nodes, and collaborates with stakeholders to develop optimized strategies to prevent or mitigate disruptions. Moreover, ISER supports restoration activities by sharing its years of disaster response and restoration experience to improve the partner's contingency planning, training, and response capabilities. ISER provides direct and indirect assistance to strategic partners (national and international) in conducting comprehensive risk assessments of critical energy sites, developing conceptual designs for improving security, and training indigenous staff in security methodologies and system operation.

Detailed Justification

	(dollars in thousands)		
	FY 2008	FY 2009	FY 2010
Infrastructure Security and Energy Restoration	5,807	6,180	6,188

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 the private sector on preparedness, response, recovery and mitigation.

The increasing complexity and interdependency of our Nation's energy infrastructure in conjunction with the rising energy market globalization, the global competition for energy resources, and catastrophic natural disasters or deliberate efforts are major energy challenges. ISER's infrastructure security and reliability efforts include the development and implementation of a system-wide analytical process designed to provide insightful analysis of the global energy infrastructure network while also improving the reliability, survivability, and resiliency of this same energy infrastructure. ISER's classified vulnerability assessments provide detailed information on critical energy facilities, supporting National Special Security Events, such as the 2009 Presidential Inauguration.

ISER also has a role in cybersecurity, focusing on situational awareness, information sharing, and emergency response between the Federal government and industry. ISER also leads 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, as well as with the Energy Government Coordinating Council (GCC), composed of members within DOE and across the Federal community, concerned with maintaining energy security and reliability. As a result, the Assistant Secretary for the Office of Electricity Delivery and Energy Reliability is the Co-Chair of the Energy Sector Coordinating Council.

In its role as the Energy Sector-Specific Agency, ISER on behalf of DOE serves to implement the risk management framework set up by the National Infrastructure Protection Plan (NIPP). The broad scope of the NIPP risk management framework includes protecting physical property and cyber systems. Implementation of the framework involves close coordination with other government agencies and the private sector.

When the security of the energy infrastructure fails, ISER is responsible for maintaining continuous and reliable energy supplies for the United States through preventative measures and restoration and recovery actions in a coordinated effort with other Federal agencies, States, local governments and the private sector. ISER accomplishes this mission by coordinating the vast technical expertise from across the Department to plan for, protect against, and minimize the effects of energy disruptions both in the US and internationally. 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.

In carrying out emergency support responsibilities, ISER undertakes preparedness, response, recovery, and mitigation activities with other Federal agencies, the States and local governments. Preparedness activities include planning, training and organizing in advance of potential incidents to build operational capabilities, while response, recovery and mitigation activities involve deploying individuals to address emergency situations. ISER rapidly deploys under national emergency declarations to areas where the energy infrastructure has been severely damaged. Its responders apply 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. Situational awareness during emergency response efforts is provided by ISER's staff of energy infrastructure analysts. ISER has also assigned dedicated personnel to the ten regional offices of the Federal Emergency Management Agency (FEMA) to organize and coordinate these activities.

In addition, 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 to States 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.

In an effort to improve communications during an energy emergency, ISER has 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. The limits of ISER's response capabilities were severely tested in 2008 due to the number and extent of disruptions to the U.S. electricity infrastructure caused by natural disasters – hurricanes, floods, ice storms.

Significant accomplishments in FY 2008 and FY 2009:

- Coordinated with White House and electric power utility to analyze alternate solutions and provide several recommended options designed to improve system reliability and resiliency as the result of Washington D.C.'s blackout that impacted the White House in 2008.
- Provided analytical products and subject matter expertise in support to U.S. Secret Service to secure energy systems supporting the 2009 Presidential Inauguration and the 2008 Republican and Democratic National Conventions.
- Deployed energy experts to support energy disruptions in nine of ten FEMA regions covering a wide spectrum of natural disasters to including several hurricanes, winter storms, wild fires,

floods and tornados. Supported four FEMA regions simultaneously during hurricane season with 61 responders.

- Executed the Secretary of Energy's authority under the Federal Power Act (section 202c) to connect utilities from ERCOT to utilities in the Eastern interconnection to restore power to critical water treatment facilities supporting Houston and avoiding loss of critical resource to a hurricane damaged area.
- Established the DOE Energy Response Center (ERC) which serves as the focal point for situational awareness on energy systems, and coordination with other government entities and the private sector. Real-time updates were provided to the President of the United States, several cabinet members, state governors, and members of Congress through the ERC.
- In May 2008, the U.S. and the Kingdom of Saudi Arabia signed a five year Technical Cooperation Agreement (TCA) for cooperation in the area of critical infrastructure. ISER, as the DOE lead, tasked Sandia to develop a Design Basis Threat model for the Kingdom and utilized this model to conduct a comprehensive System Effectiveness Analysis (SEA) of the Abqaiq Processing Facility – the most significant oil production facility in the world.
- Prepared the DOE Energy Critical Infrastructure Protection Annual Report which included contributions from all major energy sector partners with a focus on the some 115 activities currently underway in the sector to meet Energy Specific Plan Goals and Milestones. This partnership has increased industry sharing of best practices and has enhanced voluntary cooperation, significantly increasing ISER's ability to reach out to sector partners for critical information during emergencies.
- ISER produces analytic products and conducts conferences, workshops, and exercises that greatly enhance the energy emergency response and situational awareness capabilities for State and local governments, industry officials, and policy and decision makers, e.g., the "Comparing the Impacts of the 2005 and 2008 Hurricanes on the Energy Infrastructure Report," and the Southeast Petroleum Disruption and After-Action Workshop in Atlanta, GA.

Activities in FY 2010:

- 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 will include:
  - Continuing efforts to examine the reliability of discrete domestic energy assets in partnership with the private sector resulting in the development of reliability, survivability, and resiliency plans that examine critical dependencies and potential mitigation strategies.
  - Applying scientific analysis applications as a viable alternative to more expensive and resource intensive methods, potentially saving the Federal Government hundreds of thousands of dollars.
  - Continuing efforts to examine energy flow at a systems level (within the petroleum, natural gas, and electricity systems) with the intention of understanding vulnerabilities and potential consequences due to supply disruptions. This will guide both domestic and international risk mitigation activities.

(dollars in thousands)		
FY 2008	FY 2009	FY 2010

- o Conducting a regional energy assurance exercise and three local government resiliency projects.

This process incorporates scientific applications to improve current methodologies and enhance analytical techniques to:

- o provide a better understanding of what infrastructure is deemed critical in the U.S. during catastrophic events,
- o provide local and State governments with tools and analysis for emergency response planning and disruption preparation and to develop partnerships with Federal agencies and energy private sector.

- Improve situational awareness and response capabilities through advancements in power outage and restoration visualization and modeling. This activity includes completing the development of and maintaining an electric grid monitoring capability cooperatively deployed with the private sector that applies advanced sensing and data visualization tools. The system provides OE with an early warning and analysis capability with respect to examining disruptions in electricity delivery. It will also permit ISER to assess system stress on a real-time basis, conduct outage propagation and impact analyses, when needed, and communicate emergency conditions, as appropriate, to stakeholders.
- Identifying, monitoring and responding to newly discovered threats to SCADA/other process control systems that may affect the reliable delivery of energy to the nation, and partner with industry to identify and implement mitigation solutions.
- Continue ongoing engagements and pursue new engagements with energy producing allies to improve the security of their energy system components. These comprehensive energy system security assessments addresses electric power, oil, and natural gas infrastructures, and includes all aspects of the energy systems from supply to distribution. These engagements are conducted in partnership with DOE PI and the relevant Combatant Command. The final outcome is an Energy Infrastructure Security Plan, jointly developed with the host nation subject matter experts and tailored to the nation's circumstances.

	FY 2008	FY 2009	FY 2010
Total, Infrastructure Security and Energy Restoration	**5,807**	**6,180**	**6,188**

Explanation of Funding Changes

	FY 2010 vs. FY 2009 ($000)
Infrastructure Security and Energy Restoration	
▪ **Infrastructure Security and Energy Restoration**	
No significant change.	+8
Total, Infrastructure Security and Energy Restoration	+8
Total Funding Change, Infrastructure Security and Energy Restoration	**+8**

Program Direction

Funding Profile by Category

	FY 2008	FY 2009	FY 2010
Chicago Field Office			
Salaries and Benefits	173	180	184
Travel	8	11	11
Support Services	116	142	142
Other Related Expenses	21	28	28
Total, Chicago Field Office	318	361	363
Full Time Equivalents	1	1	1
National Energy Technology Laboratory			
Salaries and Benefits	4,009	4,791	4,887
Travel	194	180	163
Support Services	75	35	32
Other Related Expenses	370	179	162
Total, National Energy Technology Laboratory	4,647	5,185	5,244
Full Time Equivalents (non-add)*	7 (13)	(19)	(19)
Headquarters			
Salaries and Benefits	7,728	9,998	10,199
Travel	836	943	939
Support Services	2,465	2,800	2,788
Other Related Expenses	1,609	1,893	1,885
Total, Headquarters	12,639	15,634	15,812
Full Time Equivalents	49	60	62
Total Program Direction			
Salaries and Benefits	11,910	14,969	15,269
Travel	1,038	1,134	1,113
Support Services	2,655	2,977	2,962
Other Related Expenses	2,000	2,100	2,075
Total, Program Direction	17,603	21,180	21,420
Total, Full Time Equivalents (non-add)*	57 (13)	61 (19)	63 (19)

* As Fossil Energy employees at NETL funded by OE, FTEs are reported and coutned in Fossil Energy Budget.

Mission

Program Direction covers the cost of sustaining Federal staff required to provide overall direction, management, and support for the Office of Electricity Delivery and Energy Reliability's efforts to achieve its mission. Program Direction includes Federal payroll, travel, support service, and other related services.

Detailed Justification

	(dollars in thousands)		
	FY 2008	FY 2009	FY 2010
Salaries and Benefits	**11,910**	**14,969**	**15,269**

Funds a total of 82 FTEs that will provide the executive management, program oversight, analysis, and information required for the effective implementation of the Office's program. Of these, 62 FTEs are planned for Headquarters employees in Washington, D.C., 1 FTE for the Chicago Field Office, and 19 FTEs at NETL. The 19 FTEs at NETL are funded in OE's budget but are counted in the Fossil Energy Budget. Therefore, the 19 FTEs are non-add in the OE budget.

Staff oversees finances and performance of over 100 R&D electric transmission projects; contribute to the development and implementation of electricity policy at the Federal and State levels; issue authorization for electricity exports and Presidential permits for cross-border transmission lines; enhance security and reliability of the grid infrastructure; and facilitate recovery from disruptions to the energy supply.

Headquarters personnel work in one of three subprograms (Research and Development; Permitting, Siting, and Analysis; and Infrastructure Security and Energy Restoration) or in the support element called 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 education and outreach strategies. They also monitor and make decisions on funding, evaluate progress toward milestones, and hold research performers and others who receive funds accountable for their performance.

The personnel in the Permitting, Siting, and Analysis subprogram lead the formulation and implementation of the Department's policies and programs with regard to: (1) implementation of electricity policy-related provisions of EPAct assigned to the Department; (2) assistance to States and regional organizations on best practices for various electricity-related policies and programs; and (3) issuance of 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 2008	FY 2009	FY 2010

governments, and with private industry, to coordinate the Federal government's efforts to ensure a secure and reliable flow of energy to 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 and develop scientific and technological solutions to correct or minimize system vulnerabilities. Finally, they 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	**1,038**	**1,134**	**1,113**

Travel allows 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 energy infrastructure security program; and assist the Department of Homeland Security, State and local governments, and the private sector to help protect against and recover from disruptions in the energy infrastructure. 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 OE projects at geographically dispersed locations, and attend project and program reviews.

Support Services	**2,655**	**2,977**	**2,962**

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 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	**2,000**	**2,100**	**2,075**

Other Related Expenses includes corporate IT support (DOECOE) and working capital expense, such as rent, supplies, copying, graphics, mail services, 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 to sustain Federal staff not identified in the above categories.

Total, Program Direction	**17,603**	**21,180**	**21,420**

Explanation of Funding Changes

	FY 2010 vs. FY 2009 ($000)
Salaries and Benefits Reflects a 2.0% increase in the cost of salary and benefits and two (2) new FTEs at Headquarters	+300
Travel No significant change.	-21
Support Services No significant change.	-15
Other Related Expenses No significant change.	-25
Total Funding Change, Program Direction	+240

Support Services by Category

(dollars in thousands)

	FY 2008	FY 2009	FY 2010
Technical Support			
Feasibility of Design Considerations	63	71	70
Development of Specifications	66	73	73
System Definition	26	29	29
System Review and Reliability Analyses	157	176	175
Trade-off Analyses	212	238	237
Test and Evaluation	131	147	146
Surveys Or Reviews of Technical Operations	157	176	175
Total, Technical Support	813	911	906
Management Support			
Analyses of Workload and Work Flow	170	191	190
Directives Management Studies	157	176	175
Automated Data Processing	105	118	117
Manpower Systems Analyses	157	176	175

	(dollars in thousands)		
	FY 2008	FY 2009	FY 2010
Preparation of Program Plans	558	626	623
Training and Education	197	220	219
Analyses of DOE Management Processes	210	235	234
Reports and Analyses Management and General Administrative Services	288	323	322
Total, Management Support	1,843	2,066	2,056
Total, Support Services	2,655	2,977	2,962

Other Related Expenses by Category

	(dollars in thousands)		
	FY 2008	FY 2009	FY 2010
Other Related Expenses			
Rental Payments to GSA, 23.1			
Rental Payments to Others, 23.2			
Communications, Utilities, and Miscellaneous Charges, 23.3	4	4	4
Printing and Reproduction, 24.0			
Other Services, 25.2	673	678	678
Purchase of Goods and Services from Government Accoutns, 25.3			
Operation and Maintenance of Facilities, 25.4			
Research and Development, 25.5			
Medical Care, 25.6			
Operations and Maintenance of Equipment, 25.7			
Supplies and Materials, 26.0	55	57	57
Equipment, 31.0			
Working Capital Fund	1,268	1,361	1,336
Total, Other Related Expenses	2,000	2,100	2,075

Congressional Directed Projects

Funding Profile by Subprogram

	(dollars in thousands)		
	FY 2008	FY 2009	FY 2010
Congressionally Directed Projects	**24,290**	**19,648**	**0**

Detailed Justification

	(dollars in thousands)		
	FY 2008	FY 2009	FY 2010

Congressionally Directed Projects

- **AK Chenga Bay Generator Replacement** — **379** | **0** | **0**

  Funds the purchase and installation of three new generators in Chenega Bay, Alaska.

- **AL Alabama Power Project, Integrated Distribution Management System** — **1,968** | **2,855** | **0**

  Southern Company Services, along with Alabama Power and Miner & Miner, are developing an Integrated Distribution Management System (IDM). The project seeks to implement an integrated and common user interface with all of the functions and activities associated with operating a modern distribution system. This includes items such as an Electronic Map Board, Outage Notification, switching operations and power flow calculations. It will also incorporate all of the user requirements and interface associated with the Supervisory Control and Data Acquisition system.

- **AZ Dine Power Authority (DPA)** — **492** | **0** | **0**

  The DPA project will finalize permitting details on the Navajo Transmission Project (NTP) and will study the strategy to implement, or enhance the transmission line to accept renewable energy sources and to begin developing a strategic plan on future transmission line development on, or across the Navajo Nation. The DPA project will also look at developing renewable energy generation projects, such as wind and solar energy, that will complement the NTP and further develop renewable energy development on the Navajo Nation
- **AK National Center for Reliable Electric Power Transmission** — **492** | **476**

  The fault current limiter (FCL) is an enabling technology that facilitates the transmission system to grow its capacity with increased reliability and power quality. Researchers at the University of Arkansas at Fayetteville (UAF) will evaluate solid-state power semiconductor devices based on wide-band-gap Silicon Carbide that promise fast response, high voltage levels, and smaller systems that can be implemented into compact substations.

- **AZ Navajo Tribal Utility Authority, Fort Defiance** — **1,968** | **1,903** | **0**

  The Navajo Electrification Demonstration Project will provide line extensions to 340 preselected Navajo homes which currently do not have basic electricity service. The project will include system design, acquisition of required right-of-way easement, procurement of materials, construction of line extension and project management.

	(dollars in thousands)		
	FY 2008	FY 2009	FY 2010
▪ **CA Utility Integration of Distribution Generation**	**590**	**0**	**0**

Underground cables are an increasing portion of San Diego Gas and Electric's (SDG&E's) electric service delivery and transmission infrastructure. Application of distributed generation on SDG&E's system in a microgrid application, for example, is increasingly likely to be connected to the grid via solid dielectric, polymeric cables. While industry expectations are that polymeric cables should have a thirty to forty year life, experience has shown that certain vintages of cable are performing better than others. Development of predictive analytics in support of the Modern Grid will help to ensure that equipment required to integrate distributed generation into the grid will operate in an optimal manner with minimal maintenance.

▪ **CT Connecticut Energy Savings Technology Project**	**738**	**0**	**0**

Nxegen is a technology-based energy service company that provides real-time energy and load management services to the commercial, industrial, and municipal markets throughout Connecticut. As a result of previous research and development (R&D) efforts, Nxegen has developed a wireless real-time communications system, along with associated firmware and software for monitoring and controlling energy usage within a customer facility. During this project, Nxegen proposes to enhance the functionality and capabilities of its energy management system so as to provide customers optimal control of energy use at their respective facilities and allow them to participate in various energy markets.

▪ **DE Vehicle to Grid (V2G) Demonstration Project**	**738**	**0**	**0**

The V2G Demonstration Project will pilot-test, collect, and analyze data from five V2G-enabled electric vehicles operating in a 'real world' setting. The vehicles will be used daily in an existing fleet and data from them will be recorded and analyzed. This data will allow assessment of the viability of V2G technology. In order to demonstrate the technology, the project will conduct research to better understand the existing market for V2G-enabled electric vehicles; analyze a large data base of driving patterns and develop the required software to predict driver use patterns and dispatch power from the vehicles; and facilitate small but commercial-scale production of V2G-capable vehicles. The majority of the work will be undertaken by the University of Delaware. The Delaware Economic Development Office will provide consultation services and marketing support.

▪ **FL Florida State University Electric Grid System Study**	**984**	**0**	**0**

The Center for Advanced Power Systems (CAPS) at Florida State University (FSU) is continuing selected research thrusts initiated in 2005 aimed at reliable and secure power delivery systems and modernization of the U.S. power grid. This current initiative comprises effort on distributed energy resource integration, understanding AC losses in high-temperature superconducting materials, understanding performance of dielectric materials under cryogenic conditions, and a study and workshop related to power industry research and development challenges and business models.

▪ **FL Wauchula Municipal Electric Substation Rehab**	**984**	**0**	**0**

(dollars in thousands)

The objective of this project is to rehabilitate and upgrade the City of Wauchula (City) Municipal Electric Substation. The substation is part of an electrical distribution system (owned and operated by the City) which serves the entire City as well as portions of Hardee County, Florida; a total area of approximately 10 square miles. Electrical demand has exceeded the substation capacity in recent years, and anticipated commercial, residential, and industrial developments in the area will exacerbate this situation. In addition, reliability is questionable due to the age and condition of the substation's major equipment and relaying. Respectively, these modifications would enhance the reliability of the distribution system, and harden the system against storm damage (such as occurred during the 2004 and 2005 hurricane seasons).

	FY 2008	FY 2009	FY 2010
▪ **IA Iowa Stored Energy Park**	**1,476**	**1,427**	**0**

Supports development of a Compressed Air Energy Storage (CAES) facility at the Iowa Stored Energy Park (ISEP).

	FY 2008	FY 2009	FY 2010
▪ **WV, PA, & IN Pilot Energy Cost Control Evaluation**	**1,476**	**0**	**0**

Evaluate the cost savings and reduced energy consumption associated with using existing commercial off-the-shelf technology. PECCE is an energy management technology project that can support several NETL buildings. This will be accomplished through installation of a system including hardware, software, training and documentation that is adaptable to existing energy monitoring and control eqipment/facilites.

	FY 2008	FY 2009	FY 2010
▪ **MN Willimar Municipal Utilities Power Generation Study**	**295**	**0**	**0**

There is much information for large and very small scale utilities but little available regarding renewable energy options for midscale municipal utilities. The Willmar Municipal Utilities Power Generation Study will investigate opportunities for small to midscale municipal utilities to "go green". The study will create understanding of the current renewable energy research and energy efficiency projects that are or have been implemented at both larger and smaller scale. The study will determine the applicability to midscale municipal utilities.

	FY 2008	FY 2009	FY 2010
▪ **MO University of Missouri-Rolla Distributed Energy Research Center**	**492**	**0**	**0**

This work will demonstrate the benefits of incorporating energy storage into a FACTS device to achieve 4-quarter control. This provides improved response to voltage excursions and uncontrolled oscillations on the grid.

	FY 2008	FY 2009	FY 2010
▪ **MS New Albany Electrical Substation**	**886**	**0**	**0**

Funding is used for improvements on existing technologies and an electrical substation.

	FY 2008	FY 2009	FY 2010
▪ **ND Bismark State College, Center of Excellence**	**5,116**	**2,188**	**0**

The objective of this project is to complete construction of the National Energy Center of Excellence (NECE), and conduct training in the technology areas related to electric power generation, transmission, and distribution.

	FY 2008	FY 2009	FY 2010
▪ **NM Energy Surety Research Center at New Mexico Tech University**	**1,968**	**0**	**0**

The objective of this project is to create both a theoretical and experimental test bed through which components of the modern grid can be characterized. The broad goal is to develop modeling tools and experience that will enable the accelerated progress toward implementation of the modern grid components. Specific attributes of interest are the components' abilities to provide increased security, reliability, power quality, efficiency, and safety.

	(dollars in thousands)		
	FY 2008	FY 2009	FY 2010
▪ **NY Electric Transmission Line Improvements**	**1,476**	**0**	**0**
The objective of this project is to provide for improvements to the Luther Forest Technology Campus electric transmission line. Existing 115 KV circuits will be looped into the Campus with a new 115 KV substation at Luther Forest.			
▪ **OH Rolls-Royce Fuel Cell Systems (US), Inc., Stark State College of Tech., Fuel Cell Prototyping Center, Canton, OH, Sol**	**492**	**0**	**0**
The objectives of this project will show the benefits of pre-conditioning the natural gas fuel to a reciprocating engine with the injection of a small amount of synthesis gas--namely extension of lean combustion limits to significantly reduce emissions. Success will allow Rolls-Royce Fuel Cell Systems (US) Inc (RRFCS) to engage an engine manufacturer as a partner in 2009 for a commercial demonstration.			
▪ **TN High Voltage Transmission Lines Phase II**	**492**	**476**	**0**
Research activities support the development of a GPS-sag monitor.			
▪ **WA Electric Utility Transmission Program**	**787**	**0**	**0**
The funding is used for an engineering program which offers a multidiciplined transmission and distribution certificate program for working professionals in engineering. The program utilizes faculty in the areas of civil, mechanical, and electrical engineering, as well as industry experts. The federal funding component is used for curriculum design, renovation of laboratory space, and the purchase of equipment.			
▪ **AL - Alternate Fuel for Cement Processing**	**0**	**1,427**	**0**
▪ **CA - San Mateo County Solar Genesis Project**	**0**	**1,427**	**0**
▪ **CO - Smartgrid Integration Lab**	**0**	**476**	**0**
▪ **ND - Energy Development and Reliability**	**0**	**285**	**0**
▪ **ND - North Dakota Energy Workforce Development**	**0**	**1,808**	**0**
▪ **ND - Red River Valley Research Corridor Technology Development**	**0**	**381**	**0**
▪ **NM - Energy Technologies Research and Education Initiative**	**0**	**952**	**0**
▪ **NY - Development of Toroidal Core Transformers**	**0**	**952**	**0**
▪ **NY - Long Island Smart Metering Pilot Project**	**0**	**714**	**0**
▪ **TX - Microgrids for Colonias**	**0**	**476**	**0**
▪ **VI - Feasibility Study of Connection the St. Thomas - St. John & St. Croix Electricity Grids**	**0**	**476**	**0**
▪ **WA - Power Grid Reliability & Security**	**0**	**952**	**0**
Total, Congressionally Directed Projects	**24,290**	**19,648**	**0**

Explanation of Funding Changes

	FY 2010 vs. FY 2009 ($000)
Congressionally Directed Projects	
No funding requested	-19,648
Total, Congressionally Directed Projects	**-19,648**

Energy Transformation Acceleration Fund

Energy Transformation Acceleration Fund

Advanced Research Projects Agency – Energy

Proposed Appropriation Language

Energy Transformation Acceleration Fund

For necessary expenses in carrying out the activities authorized by section 5012 of the America COMPETES Act (Pub. L. No. 110-69), $10,000,000, to remain available until expended.

Energy Transformation Acceleration Fund
Advanced Research Projects Agency – Energy (ARPA-E)

Overview

Appropriation Summary by Program

(dollars in thousands)

	FY 2008 Current Appropriation	FY 2009 Original Appropriation[1]	FY 2009 Additional Appropriations[2]	FY 2010 Request
Energy Transformation Acceleration Fund				
Advanced Research Projects Agency – Energy	—	—	+400,000	10,000
Total, Energy Transformation Acceleration Fund	—	—	+400,000	10,000

[1] The Omnibus Appropriations Act of 2009 provided $15,000,000 for the Advanced Research Projects Agency – Energy in the Science appropriation.
[2] The Additional Appropriations column reflects funding from the American Recovery and Reinvestment Act of 2009, P.L. 111–5. See the Department of Energy Recover website at http://www.energy.gov/recovery for up-to-date information regarding Recovery Act Funding.

Preface

The America COMPETES Act of 2007 (H.R. 2272, P.L. 110-69, 42 U.S.C. 16538) established the Advanced Research Projects Agency – Energy (ARPA-E) within the Department of Energy (DOE) to overcome the long-term and high-risk technological barriers in the development of energy technologies.

ARPA-E will achieve this by identifying and promoting revolutionary advances in fundamental sciences, translating scientific discoveries and cutting-edge inventions into technological innovations, and accelerating transformational technological advances in areas that industry by itself is not likely to undertake because of technical and financial uncertainty.

To this end, ARPA-E will help fill the gaps in the energy innovation pipeline through the targeted acceleration of:

- Novel, early-stage energy research with possible technology applications;
- Development of techniques, processes, and technologies, and related testing and evaluation;
- Research and development of manufacturing processes for novel energy technologies, and;
- Coordination with nongovernmental entities for demonstration of technologies and research applications to facilitate technology transfer.

ARPA-E creates a new organization within the DOE. The Director of ARPA-E will report directly to the Secretary of Energy, and will be appointed by the President, by and with the advice and consent of the United States Senate. The Director will be responsible for approving all new programs within ARPA-E, developing funding criteria, and assessing program success through the establishment of technical milestones.

To the extent appropriate, the Director may coordinate technology transfer efforts with the Technology Transfer Coordinator appointed under Section 1001 of the Energy Policy Act of 2005 (42 U.S.C. 16391).

To the maximum extent practicable, the Director will ensure that the activities of ARPA-E are coordinated with, and do not duplicate the efforts of, programs and laboratories within the DOE and other relevant research agencies.

The Omnibus Appropriations Act of 2009 included $15,000,000 in the Science appropriation to establish ARPA-E within the DOE. The FY 2010 funding request for ARPA-E is through the Energy Transformation Acceleration Fund at the U.S. Treasury, and by statute, appropriations to this Fund are to be separate and distinct from the rest of the budget for the DOE.

The Director will administer the Fund through awards to:

- Institutions of higher education;
- Companies;
- Research foundations;
- Trade and industry research collaborations; or
- Consortia of such entities, which may include federally-funded research and development centers

Mission

This 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 that result in:

- Reduced energy imports,
- Improved energy efficiency, and
- Reduced energy-related emissions, including greenhouse gases.

A second goal of ARPA-E is to ensure that the United States maintains a technological lead in developing and deploying advanced energy technologies.

Benefits

The ARPA-E program supports the DOE mission in advancing the economic and energy security of the United States by promoting scientific and technological innovation.

The technologies ARPA-E will identify and promote can potentially produce transformative results and complement other ongoing research focusing on driving known technological solutions toward their fundamental limits. ARPA-E will work with our Departmental applied agencies where their expertise is relevant, to be able to move technology advances to the proof of concept and prototyping phase, and, in the case of smaller-scale projects, into the demonstration phase.

ARPA-E will focus on:

- Disruptive applied technologies;
- High-risk, high-potential programs;
- Projects in need of rapid and flexible experimentation and/or engineering;
- Marrying technological opportunities with mission gaps, and;
- Breakthrough science that can transform a field.

ARPA-E will seek to fund the radical or breakthrough advances necessary to transform the energy marketplace by creating platform technologies; to identify and support the science and technology critical to our nation's energy infrastructure; act as the bridge between the basic research and the more applied areas; and find energy supplies that will also not degrade our environment.

Strategic Themes, Goals, and the Secretary's Initiatives

A new strategic plan has not yet been established and approved by the Secretary of Energy. The Secretary has established major priorities and initiatives which informed the development of this budget.

Funding by Strategic Goal

The FY 2010 request of $10 million provides for ARPA-E contributes generally to all of these Strategic Goals by providing overall federal direction and administrative support for the ARPA-E program, to administer the $400 million provided by the American Recovery and Reinvestment Act of 2009.

Means and Strategies

The ARPA-E program will pursue the following means and strategies to achieve its program goals:

- Identifying and promoting revolutionary advances in fundamental sciences;
- Translating scientific discoveries and cutting-edge inventions into technological innovations; and
- Accelerating transformational technological advances in areas that industry by itself is not likely to undertake because of technical and financial uncertainty.

Validation and Verification

The validation and verification of the program's activities are subject to continuing review by Congress, the Government Accountability Office, and the DOE Inspector General. The Program will conduct an annual internal controls review under the Federal Managers' Financial Integrity Act. The Program's performance measures and associated quarterly milestones will be reviewed and approved by the ARPA-E Director. Performance measures on quality improvements are being established and monitored.

Funding by Site by Program

(dollars in thousands)

	FY 2008 Current Appropriation	FY 2009 Original Appropriation[3]	FY 2009 Additional Appropriations[4]	FY 2010 Request
Washington Headquarters				
Program Direction	—	—	2,000	10,000
Total, Washington Headquarters	—	—	—	10,000
Total, Energy Transformation Acceleration Fund	—	—	—	10,000

Site Description

Washington Headquarters

In support of the Energy Transformation Acceleration Fund and the Advanced Research Projects Agency – Energy (ARPA-E) Program Direction budget element, the Washington Headquarters site provides management and leadership of ARPA-E, oversight of the Fund, and also administers contracts/agreements with the award recipients, support services contracts and all other financial/contract agreements associated directly with ARPA-E.

[3] The Omnibus Appropriations Act of 2009 provided $15,000,000 for the Advanced Research Projects Agency – Energy in the Science appropriation.
[4] The Additional Appropriations column reflects funding from the American Recovery and Reinvestment Act of 2009, P.L. 111–5. See the Department of Energy Recover website at http://www.energy.gov/recovery for up-to-date information regarding Recovery Act Funding.

Advanced Research Projects Agency – Energy (ARPA-E)

Funding Profile by Subprogram

(dollars in thousands)

	FY 2008 Current Appropriation	FY 2009 Original Appropriation	FY 2009 Additional Appropriations[1]	FY 2010 Request
Advanced Research Projects Agency – Energy				
Program Direction	—	—	2,000	10,000
Total, Advanced Research Projects Agency – Energy	—	—	2,000	10,000

Public Law Authorizations:
Public Law 110-69, "America COMPETES Act of 2007"

[1] The Additional Appropriations column reflects funding from the American Recovery and Reinvestment Act of 2009, P.L. 111–5. See the Department of Energy Recover website at http://www.energy.gov/recovery for up-to-date information regarding Recovery Act Funding.

Program Direction

Funding Profile by Category

	(dollars in thousands/whole FTEs)		
	FY 2008 Current Appropriation	FY 2009 Original Appropriation	FY 2010 Request
Program Direction			
Salaries and Benefits	—	—	3,000
Travel	—	—	100
Support Services	—	—	5,125
Other Related Expenses	—	—	1,000
Working Capital Fund	—	—	525
Technology Transfer and Outreach	—	—	250
Total, Program Direction	—	—	10,000
Full Time Equivalents	—	—	*40*

Description

As described in the preface, ARPA-E will identify and promote revolutionary advances in fundamental sciences, translating scientific discoveries and cutting-edge inventions into technological innovations, and accelerating transformational technological advances in areas that industry by itself is not likely to undertake because of technical and financial uncertainty.

The Director will designate employees to serve as program managers for each of the programs established pursuant to the responsibilities outlined in the preface. By statute, ARPA-E hiring and management will be unrestricted by civil services laws. ARPA-E will have very broad authority in this regard and will be a lean and flat organization.

The Director will make use of existing DOE authorities that are provided to the Secretary to hire administrative, financial, and clerical staff as necessary, and will use Other Transactions Authority (OTA) for contracting and procurement to enable ARPA-E to maintain a fast-moving and flexible culture.

Program Direction provides overall federal direction and administrative support. This budget provides for salaries and benefits of federal staff, including awards, federal staff and contractor travel, and the support services contracts required for advisory and assistance services. This budget further provides funding for other related expenses, including leased office space, and for the DOE Working Capital Fund. Also included in this budget is funding for technology transfer and outreach, specified by statute to be 2.5 percent of the amounts appropriated.

Detailed Justification

(dollars in thousands)

	FY 2008 Appropriation	FY 2009 Appropriation	FY 2010 Request
Salaries and Benefits	**0**	**0**	**3,000**

ARPA-E federal staff will provide leadership and management for ARPA-E in both administrative program management functions. Administrative functions include the Director's office, contract management, general counsel, financial management, and human capital management. Program managers will establish research and development goals, solicit applications for specific areas of particular promise, build research collaborations, and select projects to be supported under the program.

Travel	**0**	**0**	**100**

The request funds travel by ARPA-E staff to carry out the activities supported under the program. 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.

Support Services	**0**	**0**	**5,125**

The ARPA-E Support Services budget element 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 the Support Services element for FY 2010 are information technology and computer system operations support, and administrative and clerical support.

Other Related Expenses	**0**	**0**	**1,000**

The Other Related Expenses budget element includes costs for building leases and other related expenses (communications, utilities, compute and video support, training, printing and graphics, photocopying, postage, supplies, and common administrative services).

Working Capital Fund	**0**	**0**	**525**

The Working Capital Fund budget element funds legal support services and other Working Capital Fund expenses (i.e. funding for headquarters building maintenance, rents, communications, utilities, computer and video support, printing and graphics, photocopying, postage, supplies and common administrative services).

Technology Transfer and Outreach	**0**	**0**	**250**

By statute, at least 2.5 percent of the amount appropriated for a fiscal year shall be used for technology transfer and outreach activities.

Total, Program Direction	**0**	**0**	**10,000**

Explanation of Funding Changes

	FY 2009 vs. FY 2010 ($000)
Salaries and Benefits Increase reflects that FY 2010 is the first budget request for the Advanced Research Projects Agency – Energy.	+3,000
Travel Increase reflects that FY 2010 is the first budget request for the Advanced Research Projects Agency – Energy.	+100
Support Services Increase reflects that FY 2010 is the first budget request for the Advanced Research Projects Agency – Energy.	+5,125
Other Related Expenses Increase reflects that FY 2010 is the first budget request for the Advanced Research Projects Agency – Energy.	+1,000
Working Capital Fund Increase reflects that FY 2010 is the first budget request for the Advanced Research Projects Agency – Energy.	+525
Technology Transfer and Outreach Increase reflects that FY 2010 is the first budget request for the Advanced Research Projects Agency – Energy.	250
Total Funding Changes, Program Direction	+10,000

Support Services by Category

(dollars in thousands/whole FTEs)

	FY 2008 Current Appropriation	FY 2009 Original Appropriation	FY 2010 Request
Technical Management			
Program Direction			
Management and Technical Services	—	—	4,925
Total, Program Direction	—	—	4,925
Total, Technical Management	—	—	4,925
Management Support			
Program Direction			
Administrative Services	—	—	200
Total, Program Direction	—	—	200
Total, Management Support	—	—	200
Total, Support Services	—	—	5,000

Other Related Expenses and Working Capital Fund by Category

(dollars in thousands/whole FTEs)

	FY 2008 Current Appropriation	FY 2009 Original Appropriation	FY 2010 Request
Other Related Expenses			
Headquarters Program Direction			
Communication, Other Rent, and Utilities	—	—	900
Other Services	—	—	25
Human Resources and Administration	—	—	50
Supplies and Materials	—	—	25
Working Capital Fund	—	—	525
Total, Headquarters Program Direction	—	—	1,525
Total, Other Related Expenses	—	—	1,525

Nuclear Energy

Nuclear Energy

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Nuclear Energy

(including transfer of funds)

Proposed Appropriation Language

For Department of Energy expenses including the purchase, construction, and acquisition of plant and capital equipment, and other expenses necessary for nuclear energy activities in carrying out the purposes of the Department of Energy Organization Act (42 U.S.C. 7101 et seq.), including the acquisition or condemnation of any real property or any facility or for plant or facility acquisition, construction, or expansion, and the purchase of not to exceed 36 passenger motor vehicles, including 1 ambulance, all for replacement only, $761,274,000, to remain available until expended**.**

Nuclear Energy
Office of Nuclear Energy

Overview

Appropriation Summary by Program

(dollars in thousands)

	FY 2008 Current Appropriation	FY 2009 Original Appropriation	FY 2009 Additional Appropriation	FY 2010 Request
Nuclear Energy Appropriation				
University Research	0	5,000	0	0
Nuclear Power 2010	133,771	177,500	0	20,000
Generation IV Nuclear Energy Systems	113,732	180,000	0	191,000
Nuclear Hydrogen Initiative	9,668	7,500	0	0
Fuel Cycle Research and Development	0	145,000	0	192,000
Fuel Cycle Research and Facilities	456,806	0	0	0
Radiological Facilities Management	48,119	66,146	0	77,000
Idaho Facilities Management	115,935	140,000	0	203,402
Idaho Sitewide Safeguards and Security	75,261	78,811	0	0
Program Direction	80,872	73,000	0	77,872
Congressionally Directed Projects	0	2,854	0	0
Subtotal, Nuclear Energy Appropriation	1,034,164	875,811	0	761,274
Transfer from State Department	2,000	0	0	0
Use of Prior Year Balance	0	-5,000	0	0
Funding from Other Defense Activities	-75,261	-78,811	0	0
Total, Nuclear Energy Appropriation	960,903	792,000	0	761,274
Other Defense Activities (NE) Appropriation[a]				
Mixed Oxide Fuel Fabrication Facility	0	487,008	0	0
Idaho Sitewide Safeguards and Security	75,261	78,811	0	83,358
Subtotal, Other Defense Activities Appropriation	75,261	565,819	0	83,358
Less Security Charge for Reimbursable Work	-3,003	0	0	0

[a] Includes only the NE portion of the Other Defense Activities appropriation.

	FY 2008 Current Appropriation	FY 2009 Original Appropriation	FY 2009 Additional Appropriation	FY 2010 Request
	(dollars in thousands)			
Total Other, Defense Activities Appropriation	72,258	565,819	0	83,358
Total Nuclear Energy and Other Defense Activities (NE) Appropriations	1,033,161	1,357,819	0	844,632

Preface

The Office of Nuclear Energy (NE) supports the diverse nuclear energy programs of the U.S. NE leads the U.S. Government's efforts to research and develop nuclear energy technologies, including generation, safety, waste storage and management, and security technologies, to help meet energy and climate goals. NE uses modeling and simulation capability in addition to work with physical materials to enhance its research capabilities.

An important NE priority is to support use of nuclear energy in the U.S. through its research and development (R&D) programs. NE is actively engaged in long-term R&D activities, including the development of technologies for advanced reactor designs through the Generation IV Nuclear Energy Systems (Gen IV) program. Through its Fuel Cycle R&D program, NE is researching the development of technical options to the Nation's current fuel cycle management strategy.

In FY 2010, NE has six programs requested within the Nuclear Energy appropriation: Nuclear Power 2010 (NP 2010), Gen IV Nuclear Energy Systems (Gen IV), Fuel Cycle R&D, Radiological Facilities Management (RFM), Idaho Facilities Management (IFM), and Program Direction. The Nuclear Hydrogen initiative is being terminated at the end of FY 2009. The NP 2010 program will be brought to closure by the end of FY 2010. Funds are requested for one additional program managed by NE, Idaho Sitewide Safeguards, under the Other Defense Activities appropriation.

The FY 2008 Consolidated Appropriations Act (P.L. 110-161) moved funding for the Mixed Oxide Fuel Fabrication Facility (MOX Facility) from the Defense Nuclear Nonproliferation appropriation to the Nuclear Energy appropriation. In addition, the report accompanying the Consolidated Appropriations Act, 2008 transferred management responsibility for this project to NE. The Department's General Counsel has determined that the Secretary's authority to remove program responsibility from National Nuclear Security Administration (NNSA) entities is limited by the NNSA Act. Therefore, the funding for the MOX Facility project in FY 2010 is being requested in the Defense Nuclear Nonproliferation appropriation, as it has been in the past.

Funding for the MOX Facility in FY 2009 was appropriated under Other Defense Activities. The management responsibility of the project remains with the Defense Nuclear Nonproliferation Fissile Materials Disposition program within the NNSA.

Mission

NE conducts R&D on nuclear energy generation, security, materials, systems, safety, and waste management technologies and tools, and operates and maintains nuclear infrastructure in a safe and compliant manner to support achievement of national energy, climate, and non-proliferation goals.

Benefits

NE supports the Department's mission by researching and developing new technologies for the nuclear industry, and by helping to ensure national security through safe deployment of nuclear power and development of proliferation-resistant nuclear technologies. NE will complete its contribution to work started over the last four years to license new nuclear plants in the U.S. by early in the next decade, and will continue long-term R&D of advanced, next generation nuclear technologies.

NE's R&D programs, through science discovery and innovation, support technology development activities that could help to enhance long-term U.S. energy independence. The Gen IV program supports the scientific development of innovative technologies for next-generation reactors, including safety, materials and security systems. Fuel Cycle R&D's focus is on long-term, science-based R&D of technologies with the potential to produce beneficial changes to the manner in which the nuclear fuel cycle and nuclear waste is managed.

NE's Infrastructure programs, including the IFM and RFM programs, ensure that the Department's nuclear facilities, used for advanced nuclear energy technology R&D, are maintained and operated such that they are able to support national priorities. Key activities conducted under this program include ensuring NE facilities meet essential safety and environmental requirements and are maintained at user-ready levels. Other key activities include managing all special nuclear materials contained in these facilities and the disposition of Department of Energy (DOE) materials under NE ownership. Beginning in FY 2010, the Department is requesting funds to begin reestablishing a domestic capability to produce Pu-238 for use in radioisotope power systems (RPSs) required by certain National Aeronautics and Space Administration space missions and national security applications.

Contractor Defined-Benefit Pension Plans

The FY 2010 President's Request for NE includes $45.0M to directly support defined-benefit contractor pension contributions. This funding is distributed in existing budget categories and is not carried forward in FY 2011-FY 2014.

The requested funding will be used in part to reimburse the costs of DOE contractor contributions to defined-benefit (DB) pension plans as required by the Employee Retirement Income Security Act (ERISA), as amended by the Pension Protection Act of 2006 (PPA), and consistent with Departmental direction. The PPA amended ERISA to require accelerated funding of DB pension plans so that the plans become 100% funded in 2011. Most contractors that manage and operate DOE's laboratories, weapons plants, and execute environmental clean-up projects at various government owned sites and facilities are contractually required to assume sponsorship of any existing contractor DB pension plans for incumbent employees who work and retire from these sites and facilities. Increased contributions began to be required for some of these DB pension plans as a result of the downturn in investment values in FY 2009. Whether additional funding will be needed in future years will depend on the funded status of the plans based on plan investment portfolios managed by the contractors as sponsors of the DB pension plans.

American Recovery and Reinvestment Act (ARRA)

NE received no ARRA funding. Refer to http://www.energy.gov/recovery/index.htm, the Department's recovery website, for up to date recovery information.

Strategic Themes, Goals and the Secretary's Initiatives

A new strategic plan has not yet been established and approved by the Secretary of Energy. The Secretary has established major priorities and initiatives.

Energy Innovation Hubs

NE takes part in the Department's multi-disciplinary Energy Innovation Hubs, which focus on critical science and technology for high-risk, high-reward research to revolutionize how the U.S. produces, distributes, and uses energy. The Hubs will promote energy security and reduce greenhouse gas emissions. They will also strengthen the Nation's economy by coordinating teams of experts from multiple fields to blend technology development, engineering design, and energy policy. Finally, they will develop the critical areas of expertise needed for the green economy. NE will support two Hubs that specifically focus on Modeling and Simulation and Extreme Materials.

Regaining ENERGY Science and Engineering Edge (RE-ENERGYSE)

The Department is undertaking a broad educational effort that cuts across program offices to inspire students and workers to pursue careers in science, engineering, and entrepreneurship related to clean energy. The Regaining ENERGY Science and Engineering Edge (RE-ENERGYSE) is a new initiative to focus on a number of critical areas that will build the foundation of a vibrant American workforce to participate in the green economy. The Office of Nuclear Energy will be supporting the initiative through competitive awards at universities and educational research institutions focused on advancing nuclear energy technologies.

Basic and Applied R&D Coordination

In FY 2008 and FY 2009, NE worked with other DOE offices on research in advanced mathematics for optimization of complex systems, control theory, and risk assessment. This R&D integration focus area was the subject of workshops sponsored by the Office of Science in August 2006 and December 2006.

In FY 2010, NE is requesting $35.0 M within the Gen IV program to support a Modeling and Simulation Energy Innovation Hub, which will promote the coordination of basic and applied research. This Hub focuses on providing validated advanced modeling and simulation tools necessary to enable fundamental change in how the U.S. designs and licenses nuclear power and fuel cycle technologies. This has the potential to improve the performance and reduce the costs of new nuclear facilities.

In addition, in FY 2008 and FY 2009 NE supported applied research focused on transmutation fuels, separations science and engineering and related systems within Fuel Cycle R&D. Some of this work was the subject of workshops sponsored by the Office of Science in September 2005, July 2006 and August 2006. In FY 2010 DOE's Fuel Cycle R&D program will broaden efforts to address critical unanswered scientific questions surrounding the stabilization, storage, treatment, and ultimate disposal of radioactive waste. Offices within DOE that will benefit from this research integration effort include the Offices of Environmental Management, Civilian Radioactive Waste Management, Legacy Management, and Science.

As part of NE's coordination with basic R&D activities conducted by the Office of Science, the Fuel Cycle R&D program will also include integrated experimental R&D and simulation efforts focused on developing the key capabilities and products related to fuel cycle and waste management options.

	(dollars in thousands)		
	FY 2008	FY 2009	FY 2010
Advanced mathematics for optimization of complex systems, control theory, and risk assessment[a]			
Office of Nuclear Energy	13,329	25,672	35,000
Fuel Cycle R&D[b]			
Office of Nuclear Energy	45,059	142,652	153,825

Indirect Costs and Other Items of Interest

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.

Indirect-Funded Maintenance and Repair

	(dollars in thousands)		
	FY 2008	FY 2009	FY 2010
Idaho National Laboratory	16,358	16,417	17,078
Total, Indirect-Funded Maintenance and Repair	16,358	16,417	17,078

[a] In FY 2008-09, includes activities within the Systems Analysis and Integration/Advanced Computing and Simulation funding activity within Fuel Cycle R&D.
[b] In FY 2008, includes activities within the Separations R&D and Transmutation R&D funding activities within the Advanced Fuel Cycle Initiative component of the Fuel Cycle Initiative program.

Direct-Funded Maintenance and Repair

	(dollars in thousands)		
	FY 2008	FY 2009	FY 2010
Idaho National Laboratory	23,947	22,429	27,961
Oak Ridge National Laboratory	481	500	520
Total, Direct-Funded Maintenance and Repair	24,428	22,929	28,481

Nuclear Energy
Office of Nuclear Energy

Funding by Site by Program

	(dollars in thousands)		
	FY 2008	FY 2009	FY 2010
Argonne National Laboratory			
Fuel Cycle Research and Development	20,046	18,930	15,000
Generation IV Nuclear Energy Systems	2,632	1,300	1,700
Nuclear Hydrogen Initiative	625	213	0
Total, Argonne National Laboratory	23,303	20,443	16,700
Brookhaven National Laboratory			
Fuel Cycle Research and Development	1,485	900	0
Generation IV Nuclear Energy Systems	276	75	100
Nuclear Hydrogen Initiative	7	0	0
Nuclear Power 2010	67	0	0
Radiological Facilities Management	3,200	0	0
Total, Brookhaven National Laboratory	5,035	975	100
Chicago Operations Office			
Generation IV Nuclear Energy Systems	40	15	44
Nuclear Hydrogen Initiative	5	20	0
Total, Chicago Operations Office	45	35	44
Idaho National Laboratory			
Fuel Cycle Research and Development	39,942	39,130	69,000
Generation IV Nuclear Energy Systems	80,684	107,814	74,236
Idaho Facilities Management	113,485	137,550	202,016
Nuclear Hydrogen Initiative	3,555	3,098	0
Radiological Facilities Management	13,300	15,100	14,810
Total, Idaho National Laboratory	250,966	302,692	360,062
Idaho Operations Office			
Fuel Cycle Research and Development	13,765	38,871	34,000
Congressionally Directed Projects	0	2,854	0
Generation IV Nuclear Energy Systems	10,766	56,189	62,447

	(dollars in thousands)		
	FY 2008	FY 2009	FY 2010
Idaho Facilities Management	0	0	1,386
Nuclear Hydrogen Initiative	939	1,714	0
Nuclear Power 2010	132,771	177,000	20,000
Program Direction	32,676	32,676	34,514
Radiological Facilities Management	2,920	6,146	0
University Research	0	5,000	0
Total, Idaho Operations Office	193,837	320,450	152,347
Lawrence Berkeley National Laboratory			
Fuel Cycle Research and Development	788	825	0
Lawrence Livermore National Laboratory			
Fuel Cycle Research and Development	3,040	2,940	0
Generation IV Nuclear Energy Systems	110	0	0
Total, Lawrence Berkeley National Laboratory	3.150	2,940	0
Los Alamos National Laboratory			
Fuel Cycle Research and Development	30,120	13,431	12,825
Generation IV Nuclear Energy Systems	556	345	1,225
Mixed Oxide Fuel Fabrication Facility	200	0	0
Radiological Facilities Management	15,971	27,500	27,030
Total, Los Alamos National Laboratory	46,847	41,276	41,080
National Renewable Energy Laboratory			
Nuclear Hydrogen Initiative	246	0	0
NNSA Service Center			
Generation IV Nuclear Energy Systems	8,396	1,944	0
Mixed Oxide Fuel Fabrication Facility	1,500	0	0
Total, NNSA Service Center	9,896	1,944	0
Oak Ridge National Laboratory			
Fuel Cycle Research and Development	26,721	11,025	15,000
Generation IV Nuclear Energy Systems	4,253	6,278	3,875

	(dollars in thousands)		
	FY 2008	FY 2009	FY 2010
Nuclear Hydrogen Initiative	92	0	0
Mixed Oxide Fuel Fabrication Facility	400	0	0
Radiological Facilities Management	12,178	17,400	5,160
Total, Oak Ridge National Laboratory	43,644	34,703	24,035
Oak Ridge Operations Office			
Program Direction	2,189	1,290	1,353
Total, Oak Ridge Operations Office	2,189	1,290	1,353
Pacific Northwest National Laboratory			
Fuel Cycle Research and Development	3,748	4,350	6,000
Total, Pacific Northwest National Laboratory	3,748	4,350	6,000
Radiological and Environmental Sciences Laboratory			
Idaho Facilities Management	2,450	2,450	0
Program Direction	2,774	2,899	5,487
Total, Radiological and Environmental Sciences Laboratory	5,224	5,349	5,487
Sandia National Laboratories			
Fuel Cycle Research and Development	4,778	4,510	0
Generation IV Nuclear Energy Systems	1,275	925	1,175
Nuclear Hydrogen Initiative	3,129	890	0
Total, Sandia National Laboratories	9,182	6,325	1,175
Savannah River National Laboratory			
Fuel Cycle Research and Development	2,053	2,100	0
Mixed Oxide Fuel Fabrication Facility	11,160	0	0
Nuclear Hydrogen Initiative	1,070	1,338	0
Total, Savannah River National Laboratory	14,283	3,438	0
Savannah River Operations Office			
Fuel Cycle Research and Development	3,250	0	0
Mixed Oxide Fuel Fabrication Facility	265,529	0	0
Total, Savannah River Operations Office	268,779	0	0

	FY 2008	FY 2009	FY 2010
	(dollars in thousands)		
Washington Headquarters			
Fuel Cycle Research and Development	28,281	7,988	40,175
Generation IV Nuclear Energy Systems	4,744	5,115	46,198
Nuclear Hydrogen Initiative	0	227	0
Nuclear Power 2010	933	500	0
Program Direction	43,233	36,135	36,518
Radiological Facilities Management	550	0	30,000
Total, Washington Headquarters	77,741	49,965	152,891
Total, Nuclear Energy	958,903	797,000	761,274

Site Description

Argonne National Laboratory

Introduction

Argonne National Laboratory (ANL) is one of the Department of Energy's (DOE) scientific research laboratories and is the Nation's first national laboratory, chartered in 1946. ANL is located approximately 25 miles southwest of the Chicago Loop, occupies 1,500 acres, and is surrounded by a forest preserve.

Fuel Cycle Research and Development

ANL supports electrochemical separations and waste form development activities. ANL has the lead for key systems analysis activities, including certain transmutation analysis and data development activities.

Generation IV Nuclear Energy Systems

ANL continues to play an important role in conducting key R&D in support of the Generation IV Nuclear Energy Systems (Gen IV) program. ANL participates in system design and evaluation activities for the Gen IV systems, makes important contributions to Gen IV fuels and materials efforts, and leads or participates in joint projects with France, Korea, Canada, Euratom, and Japan. ANL is responsible for staffing the position of Generation IV National Technical Director for Design and Evaluation Methods, who coordinates the U.S. efforts on method development and validation. ANL provides one of two U.S. experts for the international experts group.

Nuclear Hydrogen Initiative

ANL had supported the program by conducting laboratory analyses of thermochemical hydrogen production methods, specifically alternative cycles other than sulfur-based cycles.

Brookhaven National Laboratory

Introduction

The Brookhaven National Laboratory (BNL) is a multiprogram laboratory located in Upton, New York. DOE's BNL conducts research in the physical, biomedical, and environmental sciences, as well as in energy technologies. Brookhaven builds and operates major facilities available to university, industrial, and government scientists. BNL also performs a prospective benefits analysis of DOE's nuclear energy research and development (R&D) portfolio.

Fuel Cycle Research and Development
BNL provides support to the Systems Analysis work due to its unique capability in reactor analysis and nuclear data evaluations.

Nuclear Power 2010
BNL supported benefits assessments related to NP 2010 activities.

Radiological Facilities Management
The Brookhaven Linear Isotope Producer (BLIP) at BNL uses a linear accelerator that injects 200 million-electron-volt protons into the 33 giga-electron-volt Alternating Gradient Synchrotron. Isotopes such as strontium-82, germanium-68, copper-67, and others that are used in medical diagnostic applications are produced at BLIP. The Medical Isotope Program was transferred from the Office of Nuclear Energy (NE) to the Office of Science (SC) in FY 2009.

Chicago Operations Office
Introduction
The Chicago Operations Office provides procurement, contract, cooperative agreement, and grant support.

Generation IV Nuclear Energy Systems
The Chicago Operations Office supports distribution of certain Gen IV funding.

Nuclear Hydrogen Initiative
The Chicago Operations Office supported distribution of certain Nuclear Hydrogen funding.

Idaho National Laboratory
Introduction
The Idaho National Laboratory (INL) is an extensive research and engineering complex that has been the center of nuclear energy research since 1949. It occupies 890 square miles in southeastern Idaho along the western edge of the Snake River Plain, 42 miles northwest of Idaho Falls, Idaho. The INL consists of three main engineering and research campuses: (1) the Reactor Technology Complex (RTC) at the site, (2) the Materials and Fuels Complex (MFC) at the site, and (3) the Research and Education Campus in Idaho Falls. As INL Landlord, NE also operates the Central Facilities Area (CFA) at the site that provides support to all the compounds and campuses at the site. The NE has Lead Program Secretarial Office (LPSO) responsibility for the Idaho Operations Office (ID). INL is the center for NE's strategic nuclear energy R&D enterprise. INL has a central role in Gen IV nuclear energy systems development and fuel cycle R&D, and space nuclear power and propulsion applications. While focused on its role as the center for nuclear R&D, as a multi-program national laboratory, INL also continues to pursue national security, and homeland security activities.

Fuel Cycle Research and Development
INL is leading the Fuel Cycle R&D Technical Integration Office. INL has assembled a unique set of expertise across all technical areas important to fuel cycle programs. This expertise enables INL to fully integrate the range of information necessary to set requirements for all elements of the program. INL

will be a key contributor in the development of a detailed program plan for the Department's fuel cycle R&D effort. INL has developed the VISION code and coordinated development of related databases used to analyze various fuel cycle scenarios, supports R&D on transmutation fuel and electrochemical separations techniques, and can perform the irradiations of transmutation fuels. Related facilities are concentrated at the Materials and Fuels Complex and at the Advanced Test Reactor, and include a complete suite of gloveboxes, hot cells, and dedicated equipment.

Generation IV Nuclear Energy Systems
INL is the lead laboratory for the Gen IV program and conducts the program's technical integration activities. INL, together with Oak Ridge National Laboratory (ORNL), is the principal laboratory responsible for the development of advanced gas reactor fuel and materials R&D in support of all Gen IV reactor concepts. INL serves as the technical integrator of research for Light Water Reactors.

Idaho Facilities Management
INL is a multi-program national laboratory that employs R&D assets to pursue a wide range of nuclear power R&D and other national energy security activities. The purpose of the Idaho Facilities Management (IFM) program is to operate and maintain the INL infrastructure required to support mission needs and priorities in a manner that is in compliance with environment, safety and health rules and regulations.

NE is responsible for 890 square miles of land west of Idaho Falls (the site) and numerous laboratory and administrative facilities located in the town of Idaho Falls. NE operates and maintains buildings, nuclear and radiological facilities and associated support structures; a full complement of site wide utilities, including power, communications and data transmission systems; 800 miles of paved and unpaved roads; 61 miles of high voltage electrical transmission lines; and 14 miles of railroad track.

Nuclear Hydrogen Initiative
Through FY 2009, INL provided leadership in executing the NHI.

Radiological Facilities Management
INL is responsible for maintaining facilities and equipment for the assembly, testing, and delivery of radioisotope power systems. This capability focuses on the assembly of the encapsulated Plutonium 238 (Pu-238) into heat sources, insertion of heat sources into generators, testing of the assembled generators, and delivery of the generators to customers. Activities also include the transfer of neptunium-237 (Np-237) inventory from the Savannah River Site (SRS) to the INL for use in the future for Pu-238 production. In FY 2008, INL began providing fuel for university research reactors including fuel for conversions from highly enriched uranium to low enriched uranium, and shipped spent fuel from university reactors to DOE's SRS. In FY 2010 this effort is funded under IFM.

Idaho Operations Office
Introduction
The Idaho Operations Office provides procurement, contract, cooperative agreement, and grant support. This office also provides support for contractor security investigations conducted by the Federal Bureau of Investigation and the Office of Personnel Management for DOE Federal employees and contractors.

Lawrence Berkeley National Laboratory
Introduction
Lawrence Berkeley National Laboratory (LBNL) has been a leader in science and engineering research for more then 70 years. Located on a 200 acre site in the hills above the University of California's Berkeley campus, adjacent to the San Francisco Bay, Berkeley Lab holds the distinction of being the oldest of the U.S. DOE's National Laboratories.

Fuel Cycle Research and Development
LBNL provides key support for generic repository performance due to the unique qualification of the laboratory's staff.

Lawrence Livermore National Laboratory
Introduction
Lawrence Livermore National Laboratory (LLNL) is a multi-disciplinary R&D laboratory focused on national defense, which has two noncontiguous geographic locations in northern California. LLNL is approximately one square mile and is located 40 miles east of San Francisco. LLNL conducts research in advanced defense technologies, energy, environment, biosciences, and basic science.

Fuel Cycle Research and Development
LLNL provides expertise on the impact of separation technologies on the geologic repository, advanced computer simulations and modeling efforts, and coordination with the Office of Science and Civilian Radioactive Waste Management experts from other laboratories.

Generation IV Nuclear Energy Systems
LLNL supports the development of Gen IV reactor concepts

Los Alamos National Laboratory
Introduction
Los Alamos National Laboratory (LANL) is a multi-disciplinary research facility located on approximately 28,000 acres near the town of Los Alamos in northern New Mexico. LANL is engaged in a variety of programs for DOE and other government agencies. LANL's primary mission is to engage in research and technical activities supporting the Nation's defense. LANL also supports DOE missions related to arms control, non-proliferation, nuclear material disposition, energy research, science and technology, and environmental management. R&D in the basic sciences, mathematics, and computing have a broad range of applications, including: national security, non-nuclear defense, nuclear and non-nuclear energy, atmospheric and space research, geoscience, bioscience, biotechnology, and the environment.

Fuel Cycle Research and Development
LANL is leading safeguards activities, and provides major support as the lead organization for oxide fuel research. LANL has unique facilities to measure and evaluate the nuclear data that are critical for the analyses of nuclear systems. LANL also provides expertise in the areas of advanced fuels, materials and accelerator-driven systems.

Generation IV Nuclear Energy Systems
LANL provides technical support in the evaluation of materials compatibility for candidate materials of

construction for advanced reactor designs. This work is coordinated with the SNL and the Massachusetts Institute of Technology.

Mixed Oxide Fuel Fabrication Facility
LANL provides technical services, independent design review, independent assessment of the safety basis for the MOX Fuel Fabrication Facility, and support for technical aspects associated with monitoring and inspection activities.

Radiological Facilities Management
At LANL, the facilities at Technical Areas (TA) -3, -35, -48 and -55 provide unique national actinide capabilities in the areas of analytical chemistry, materials characterization, chemical diagnostics, radiochemistry, and applied spectroscopy. A portion of the Plutonium Facility-4 at the TA-55 is dedicated to Pu-238 activities and is used to purify and encapsulate Pu-238 used in radioisotope power sources for the National Aeronautics and Space Administration (NASA) space exploration missions and national security applications. LANL capabilities were expanded to include establishing a Pu-238 scrap recovery capability to recycle Pu-238 scrap for use in future missions.

National Renewable Energy Laboratory
Introduction
The National Renewable Energy Laboratory (NREL) is located in Golden, Colorado.

Nuclear Hydrogen Initiative
NREL coordinated the research in the thermochemical area through FY 2008. This responsibility was discontinued in FY 2009.

NNSA Service Center
Introduction
The National Nuclear Security Administration (NNSA) Service Center provides procurement, contract, cooperative agreement, and grant support for the Gen IV, and Mixed Oxide (MOX) Fuel Fabrication Facility Program.

Generation IV Nuclear Energy Systems
Through contracts administered by the NNSA Service Center with General Atomics and Russian contractor, OKB Mechanical Engineering, engineering services and technical support are funded to continue ongoing R&D for the Gas Turbine Modular Helium Reactor development program in Russia.

Mixed Oxide Fuel Fabrication Facility
Through contracts administered by the NNSA Service Center with Mele, technical support is provided for oversight of the MOX Fuel Fabrication Facility Project.

Oak Ridge National Laboratory
Introduction
The Oak Ridge National Laboratory (ORNL) is a DOE scientific research laboratory located in Oak Ridge, Tennessee. ORNL also maintains the DOE computer code system, software, and documentation at the Radiation Safety Information Computational Center (RSICC) and serves as a repository for DOE computational research activities, including computer software that is developed by the Nuclear

Engineering Education Research (NEER) projects. The RSICC computer software is made available to nuclear engineering departments, Nuclear Energy Research Initiative (NERI) and NEER awardees.

Fuel Cycle Research and Development

ORNL provides key support for fuels, separations and waste form R&D. ORNL also conducts safeguards and nuclear data research. ORNL provides materials expertise.

Generation IV Nuclear Energy Systems

ORNL and INL are the principal laboratories responsible for the R&D of advanced gas reactor fuel suitable for Very High Temperature Reactors. ORNL also staffs the Generation IV National Technical Director for Materials, leads the development of the Generation IV Materials handbook efforts, and conducts much of the materials testing in support of the Generation IV.

Nuclear Hydrogen Initiative

In FY 2008, ORNL performed studies to evaluate nuclear hydrogen for synergistic applications, and supported development of separation membranes to improve the efficiency of nuclear hydrogen production technologies.

Mixed Oxide Fuel Fabrication Facility

ORNL provides technical support to NNSA in reviewing regulatory/licensing topics and documents.

Radiological Facilities Management

The Radiochemical Engineering Development Center at the ORNL is the Department's production, storage, and distribution center for the heavy-element research activities. ORNL provides the unique capabilities for fabricating carbon insulator and iridium heat source components for radioisotope power sources used for NASA space exploration missions. These sophisticated heat source components are necessary for the safe operation of these power systems during normal operation and during launch, reentry or other deployment accidents.

Enriched stable isotopes are processed at two laboratories. The material laboratory performs a wide variety of metallurgical, ceramic, and high vacuum processing techniques; the chemical laboratory performs scraping, leaching, dissolving, oxidizing processes to remove unwanted materials and place the isotope into a "chemically stable" form. Radioactive isotopes are chemically processed and packaged in hot cells in Buildings 4501 and 7920. The Medical Isotope Program was transferred from NE to SC in FY 2009.

Pacific Northwest Laboratory
Introduction

Pacific Northwest Laboratory (PNL) is a multi-program laboratory located on approximately 640 acres of the Department's Hanford site. PNL also monitors a marine science lab in Sequim, Washington.

Fuel Cycle Research and Development

PNL has a key role in waste form activities by leveraging, its history and expertise. PNL provides technical support in the areas of advanced separations, fuels, materials, safeguards and nonproliferation analysis, and systems analysis.

Radiological and Environmental Sciences Laboratory (RESL)
Idaho Facilities Management
RESL is a DOE-owned and operated Federal reference laboratory with core mission capabilities in radiation measurement and calibrations, and analytical chemistry. The laboratory conducts measurement quality assurance programs to assure that key DOE missions are completed in a safe and environmentally responsible manner.

Sandia National Laboratories
Introduction
Sandia National Laboratories (SNL) is a research development facility located on approximately 18,000 acres on the Kirtland Air Force Base reservation near Albuquerque, New Mexico and has smaller facilities in Livermore, California and Tonopah, Nevada. The mission of SNL is to meet national needs in the nuclear weapons and related defense systems, energy security, and environmental integrity.

Fuel Cycle Research and Development
SNL provides systems analysis support, particularly in the area of transportation analysis. SNL also has the lead for certain nuclear safeguards and security activities.

The laboratory has also developed widely used computer codes and models to analyze reactor safety. These codes have been validated and verified, and have been integrated into the nuclear industry's regulatory infrastructure. In this context, extensive databases have been developed to support probabilistic risk assessment modeling and analyses.

The laboratory also has extensive experience in waste form development. This experience assists with definition of alternatives for managing wastes.

Generation IV Nuclear Energy Systems
SNL R&D is focused on advanced gas turbo-machinery with helium or supercritical carbon dioxide as the working fluids.

Nuclear Hydrogen Initiative
SNL had served as the technical integrator for NHI, responsible for coordinating the participation of all laboratories in the development and conduct of the NHI R&D program. In FY 2008, SNL conducted R&D on the sulfur-iodine thermochemical process to operate an integrated demonstration.

Savannah River National Laboratory
Introduction
The Savannah River National Laboratory (SRNL) is an extensive material production and engineering complex that has been a nuclear site since 1951 when construction began supporting the U.S. strategic weapons program. SRS is now a multiprogram operational site covering 310 square mile site near Aiken, South Carolina. Because of its Cold War nuclear legacy, there is a significant level of environmental management cleanup work being performed at the site. In addition to supporting NE programs, the SRS workforce continues to support NNSA's weapons disposition program. SRNL is a multiprogram laboratory located on approximately 34 acres within the SRS.

Fuel Cycle Research and Development
SRNL conducts research on advanced aqueous separations, systems analysis, advanced safeguards, and waste form development. SRS provides engineering analyses in support as well.

Mixed Oxide Fuel Fabrication Facility
SRNL will continue to support design, licensing, procurement, construction and start-up/ operations planning activities for the MOX Facility.

Nuclear Hydrogen Initiative
SRNL coordinated hybrid sulfur thermochemical cycle R&D activities.

Savannah River Operations
Introduction
The Savannah River Operations Office (SRS) is an extensive material production and engineering complex that has been a nuclear site since 1951 when construction began supporting the U.S. strategic weapons program. SRS is now a multiprogram operational site covering 310 square mile site near Aiken, South Carolina. Because of its Cold War nuclear legacy, there is a significant level of environmental management cleanup work being performed at the site.

Fuel Cycle Research and Development
SRS performs engineering studies on various process alternatives.

Mixed Oxide Fuel Cycle Fabrication Facility
SRS provides oversight of the MOX Facility project.

Washington Headquarters
FY 2008, FY 2009, and FY 2010 include funding for SBIR and other small business initiatives.

Fuel Cycle Research and Development
Headquarters (HQ) provides management of certain research activities and competitive solicitations. In FY 2010 HQ will work on the development of a competitively-awarded materials Hub which will support R&D on advanced materials for nuclear reactors and systems.

Generation IV Nuclear Energy Systems
HQ will work on the development of a competitively-awarded modeling and simulation Hub that will support validated advanced modeling and simulation tools.

Nuclear Power 2010
Includes funding for closing out activities on the NuStart combined Construction and Operating License demonstration project.

Radiological Facilities Management
Includes funding for certification of isotope shipping casks, independent financial audits of the revolving fund, and other related expenses. The Medical Isotope Program was transferred from NE to SC in FY 2009.

In FY 2010 the Department plans to initiate a project to restart the production of Pu-238 for the Space and Defense program. Activities will include: National Environmental Policy Act (NEPA) documentation and other safety and design actions necessary to meet the DOE O 413.3A requirements to obtain CD-1 in early FY 2011.

University Research

Funding Profile by Subprogram

(dollars in thousands)

	FY 2008 Current Appropriation	FY 2009 Original Appropriation	FY 2010 Request
University Research	0	5,000	0

Public Law Authorizations:
P.L. 111-8, Omnibus Appropriations Act, 2009

Mission

The University Research program provided grants and fellowships to support nuclear science and engineering research in 2009. No funding is being requested for this program in FY 2010 because the department is undertaking a broad educational effort that cuts across program offices to inspire students and workers to pursue careers in science, engineering, and entrepreneurship related to energy.

Benefits

The University Research program will provide 9 three-year investigator-initiated research contracts, and up to 4 three-year fellowship grants.

Contribution to GPRA Unit Program Goal 1.2.14.00 (Develop New Nuclear Generation Technologies)

The University Research program provided fellowships and grants to support science and engineering R&D conducted at universities

Means and Strategies

The University Research program used various means and strategies to achieve its GPRA Unit Program goal.

The Department implemented the following means:

- Provided fellowships and research grants funding support nuclear science and engineering university programs.

The Department implemented the following strategies:

- Coordinated with the Nuclear Regulatory Commission (NRC) and Defense Nuclear Nonproliferation (DNN) through the Integrated University Program to support investigator-initiated nuclear science research that focused on cutting edge nuclear technologies.

Validation and Verification

NE conducts various internal and external reviews and audits to validate and verify program performance. Periodic program reviews evaluate progress against established plans. NE holds monthly, quarterly, semi-annual, and annual reviews, consistent with program management plans and project baselines, to ensure technical progress, cost, and schedule adherence, and responsiveness to program requirements.

Annual Performance Results and Targets

FY 2005 Results	FY 2006 Results	FY 2007 Results	FY 2008 Results	FY 2009 Targets	FY 2010 Targets
GPRA Unit Program Goal 1.2.14.00 (Develop New Nuclear Generation Technologies)					
University Research					
				Provide 10 three-year research grants and 3 three-year fellowships to U.S. universities in support of nuclear science and engineering research.	

Funding Schedule by Activity

	(dollars in thousands)		
	FY 2008	FY 2009	FY 2010
University Research			
Integrated University Program	0	5,000	0
Total, University Research	0	5,000	0

Description

The program provided fellowships and grants to universities for nuclear energy R&D in 2009. No funding is being requested for this program in FY 2010 because the department is undertaking a broad educational effort that cuts across program offices to inspire students and workers to pursue careers in science, engineering, and entrepreneurship related to energy.

Benefits

The University Research program will provide 9 three-year investigator-initiated research contracts, and up to 4 three-year fellowship grants.

Detailed Justification

	(dollars in thousands)		
	FY 2008	FY 2009	FY 2010
University Research	**0**	**5,000**	**0**
▪ **Integrated University Program**	**0**	**5,000**	**0**

In FY 2009, the Integrated University Program supported investigator-initiated nuclear science research. This research program was planned in collaboration with the Nuclear Regulatory Commission (NRC) and the Defense Nuclear Nonproliferation (DNN) program. In FY 2010 will undertake a broad educational effort that cuts across program offices to inspire students and workers to pursue careers in science, engineering, and entrepreneurship related to energy.

Total, University Research	**0**	**5,000**	**0**

Nuclear Power 2010

Funding Profile by Subprogram

(dollars in thousands)

	FY 2008 Current Appropriation	FY 2009 Original Appropriation	FY 2010 Request
Nuclear Power 2010	133,771	177,500	20,000

Public Law Authorizations:
P.L. 110-161, The Consolidated Appropriations Act, 2008
P.L. 111-8, Omnibus Appropriations Act, 2009

Mission

The Nuclear Power 2010 (NP 2010) program is a joint government/industry cost-shared effort established in 2002 to help industry overcome regulatory uncertainties by demonstrating untested Nuclear Regulatory Commission regulatory and licensing processes. The program will accomplish its intended purpose in FY 2010 and will be brought to conclusion.

Benefits

The NP 2010 program has provided funding to industry to achieve notable milestones including the issuance of three NRC-approved Early Site Permits, which establish that a site is suitable for possible future construction and operation of a nuclear power plant, and the submission to the NRC of two construction and operating license (COL) applications for two reactor designs. The program has promoted industry interest in the deployment of the first new nuclear plants in 30 years[a] and will enable industry to make decisions to build plants in 2010. The NP 2010 program will achieve a prioritized set of its performance goals on one licensing project in FY 2010.

Climate Change Technology Benefits

The NP 2010 program focused on enabling industry decisions to build new nuclear plants in 2010, with anticipated operation of new plants by 2015. Deployment of new nuclear generating capacity directly contributes to the benefits described in the Department's climate change portfolio. Through the activities noted above, the NP 2010 program will help reduce regulatory uncertainty, thereby increasing the likelihood that new plants will be deployed.

Contribution to GPRA Unit Program Goals 1.2.14.00 (Develop New Nuclear Generation Technologies)

The NP 2010 program has supported this program goal through its cost-shared partnerships by identifying sites for new nuclear power plants, developing advanced standardized (Generation III+) nuclear plant designs, evaluating the business case for building new nuclear power plants, and demonstrating untested regulatory processes to enable industry decisions to build new advanced light water reactor (LWR).

[a] To date industry has submitted a total of 17 COL applications to NRC covering 26 new nuclear reactors: http://www.nrc.gov/reactors/new-reactors/new-licensing-files/expected-new-rx-applications.pdf

Means and Strategies

As the program is closed out in FY 2010, it will use various means and strategies to continue to achieve its GPRA Unit Program goal. 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:

- Continue the joint government/industry cost-shared effort to support one combined construction and operating license for the NuStart Consortium.

The Department will implement the following strategies:

- Continue relevant partnerships with the private sector, national laboratories, universities, and international partners to support advanced light water reactor technologies.

- Lead the international community in pursuit of advanced light water reactor technologies (Generation III+) that will benefit the U.S. with enhanced safety and improved economics.

These strategies and other efforts will result in the efficient and effective management of the program - thus putting the taxpayer's dollars to more productive use.

The following external factors could affect the program's ability to achieve its strategic goal:

- Ultimately, the decision to build new nuclear power plants rests with industry alone. This decision depends in part on power demand and economic and environmental factors beyond the scope of the Department's research and development (R&D) programs. In the near term, it depends on complex economic decisions made by industrial partners.

In carrying out the program's mission, the Office of Nuclear Energy (NE) performs the following collaborative activities:

- The Department is working with industry on a cost-shared basis to conduct demonstrations of untested Federal regulatory and licensing processes governing the siting, construction, and operation of nuclear power plants.

Validation and Verification

NE conducts various internal and external reviews and audits to validate and verify program performance. Periodic program reviews evaluate progress against established plans. NE holds monthly, quarterly, semi-annual, and annual reviews, consistent with program management plans and project baselines, to ensure technical progress, cost, and schedule adherence, and responsiveness to program requirements.

NE also considers stakeholder input when planning and evaluating program activities. In July 2008, the Battelle Corporation released its report, *Nuclear Energy for the Future: Executive Recommendations for R&D Capabilities*, which identifies the capabilities and facilities required to support the achievement of the nuclear energy industry's goals. This report reflects input from the domestic nuclear energy industry and the academic community.

NE's programmatic activities are also subject to periodic external reviews by Congress, GAO, the Department's IG, NRC, the U.S. Environmental Protection Agency, state environmental and health agencies, and the Department's Office of Engineering and Construction Management. In addition, NE solicits the advice and counsel of external agencies such as Nuclear Energy Advisory Committee and National Academy of Sciences.

Annual Performance Results and Targets

FY 2005 Results	FY 2006 Results	FY 2007 Results	FY 2008 Results	FY 2009 Targets	FY 2010 Targets
GPRA Unit Program Goal 1.2.14.00 (Develop New Nuclear Generation Technologies)					
Efficiency Measure (Common Measure for NP 2010, Nuclear Hydrogen Initiative, Generation IV, and Fuel Cycle R&D)					
Achieve cumulative variance of less than 10 percent from each of the cost and schedule baselines for the Advanced Fuel Cycle, Generation IV Nuclear Energy Systems and Nuclear Hydrogen Initiatives. (MET)	*Maintain total administrative overhead costs in relation to total R&D program costs of less than 8 percent. (Baseline for administrative overhead rate is currently being validated). (MET)*	*Maintain total administrative overhead costs in relation to total program costs less than 8%. (MET)*	*Maintain total administrative overhead costs in relation to total program costs of less than eight percent. (MET)*	*Maintain total administrative overhead costs in relation to total program costs of less than eight percent.*	*Maintain total administrative overhead costs in relation to total program costs of less than eight percent.*
Nuclear Power 2010					
Issue project implementation plans for two COL Demonstration Projects. (MET TARGET)	Complete engineering and licensing demonstration activities necessary to implement the NP 2010 program in accordance with the principles of project management, to help ensure that program performance goals are achieved on schedule and within budget. (MET TARGET)	Complete NP 2010 engineering and licensing activities, focusing on the resolution of reactor certification and design issues and the preparation and review of COL applications, to enable an industry decision in 2010 to build a new nuclear power plant. (MET TARGET)	Enable industry to make a decision to build a new nuclear power plant by 2010 by supporting New Nuclear Plant Licensing Demonstration Projects and by administering the Department's standby support program. . (MET TARGET)	Enable industry to make a decision to build a new nuclear power plant by 2010 by supporting New Nuclear Plant Licensing Demonstration Projects and by administering the Department's standby support program.	Enable industry to make decisions to build a new nuclear power plant by 2010 by concluding Federal efforts on one COL demonstration Project.

Funding Schedule by Activity

	(dollars in thousands)		
	FY 2008	FY 2009	FY 2010
Nuclear Power 2010			
Cost-shared Program with Industry	132,771	177,000	20,000
Standby Support Program	1,000	500	0[b]
Total, Nuclear Power 2010	133,771	177,500	20,000

Description

NP 2010 is a joint government/industry cost-shared effort to enable industry decisions to build new plants by demonstrating untested Federal regulatory and licensing processes governing the siting, construction, and operation of nuclear power plants. A second separate component of the program has been the Standby Support program, funding for which is provided through the NE Program Direction subprogram in FY 2010.

Benefits

The NP 2010 program has provided funding to industry to achieve notable milestones including the issuance of three NRC-approved Early Site Permits, which establish that a site is suitable for possible future construction and operation of a nuclear power plant, and the submission to the NRC of two COL applications for two reactor designs. The program has promoted industry interest in the deployment of the first new nuclear plants in 30 years[c] and has enabled industry to make decisions to build plants in 2010. The NP 2010 program will achieve a prioritized set of its performance goals on one licensing project in FY 2010.

The program has promoted industry interest in the deployment of new nuclear reactors. As of the end of CY 2008, 14 power companies applied to the NRC for 17 COLs, and another six companies announced their intention to apply for six COLs over the next two years. These applicants have benefited from the NP 2010 design certification and COL activities. The majority of the submitted COL applications (8 of the 17) reference the two NP 2010-sponsored reactor technologies – AP 1000 and Economic Simplified Boiling Water Reactor (ESBWR), which are augmented with applicant-specific information.

Detailed Justification

	(dollars in thousands)		
	FY 2008	FY 2009	FY 2010
Cost-shared Program with Industry	**132,771**	**177,000**	**20,000**

As part of the program's cost-shared efforts, NP 2010 has supported technology engineering and design for Generation III+ advanced light water reactors. These new designs offer advancements in safety and

[b] Standby Support Program funding moves to the program direction account in FY 2010.
[c] To date industry has submitted a total of 17 COL applications to NRC covering 26 new nuclear reactors: http://www.nrc.gov/reactors/new-reactors/new-licensing-files/expected-new-rx-applications.pdf

economics over the Generation III designs licensed or certified previously by the NRC. To reduce the regulatory uncertainties and thereby enable the deployment of new standardized Generation III+ nuclear power plants in the U.S., the program helped demonstrate the untested Federal regulatory processes for the new plant siting (called Early Site Permits (ESP)), and for construction and operation of new nuclear plants (called combined COL), and design certification.

To demonstrate the untested regulatory process for obtaining NRC approval for constructing and operating new nuclear power plants in FY 2005, the Department established competitively selected, cost-shared cooperative agreements with industry teams. Additionally, the agreements originally included the completion of design certification and detailed standardized plant designs for Westinghouse's AP1000 and General Electric Hitachi's (GEH) ESBWR. By the end of FY 2009, sufficient momentum will have been created by the shared-cost programs such that the vendors will have adequate incentive to complete any additional work through private funding; and overall, the program has achieved its intended purpose of helping industry overcome regulatory uncertainties, thereby enabling industry to make build decisions. Funding will be provided in FY 2010 to support close out activities on the NuStart COL project.

In FY 2008, the project teams (NuStart, Dominion, GEH, and Westinghouse) submitted COL applications to the NRC and began working to resolve questions arising from the NRC staff review. The Department provided funding to industry to support:

- Issuance of the Dominion Early Site Permit by NRC, the third of three ESPs sponsored by NP 2010.
- Submission of the Dominion and NuStart COL applications to NRC in the first quarter of FY 2008 for the construction and operation of the GEH ESBWR and Westinghouse AP1000, respectively.
- Industry interactions with NRC to address questions on the COL applications including development of responses to NRC Requests for Additional Information (RAIs).
- Continuation of vendor resolution of open items related to the AP1000 amended and ESBWR design certifications to allow NRC to issue completed chapters of the safety evaluation reports.
- Continuation of first-of-a-kind design finalization activities for the standardized AP1000 and ESBWR designs and preparation of the engineering analyses and calculations, design criteria documents, design technical information, and total cost and schedule necessary for an industry purchase of a new nuclear plant.

In FY 2009, the project teams (NuStart, Dominion, GEH, and Westinghouse) will continue activities with NRC to resolve COL application questions. Resolution will result in issuance of Safety Evaluation Reports and Environmental Impact Statements by the NRC. Reactor vendor activities continue to focus on design certification for the AP1000 and ESBWR standard plant design and first-of-a-kind engineering (FOAKE) or design finalization for the AP1000. In FY 2009, NP 2010 funding will support:

- Continuing industry interactions with NRC on the ESBWR and the AP 1000 reference COL applications including responses to NRC RAIs, meetings with the Advisory Committee on

(dollars in thousands)

Reactor Safety (ACRS), and issuance of Safety Evaluation Reports (SER) and Draft Environmental Impact Statements.

- Resolving open AP1000 amended and ESBWR certification items to allow the NRC to issue SERs for design certification.
- Continuing FOAKE design finalization activities for the standardized AP1000 and design and preparation of the engineering analyses and calculations, design criteria documents, and design technical information.
- Accelerating standard AP1000 design finalization activities necessary to complete vendor component/equipment procurement specifications and allow the utilities to issue contracts to initiate fabrication of modular plant components and other long lead equipment.

In FY 2010, NP 2010 will provide final funding for the NuStart COL reference application to:

- Complete support of industry interactions with NRC on the NuStart COL application including meetings with the ACRS, issuance of the Final Safety Evaluation Report and the Final Environmental Impact Statement, and initiation of hearings by the Atomic Safety Licensing Board.

Supporting one application project in FY 2010 will provide sufficient support for industry decisions to deploy new nuclear plants. By FY 2010 sufficient momentum will have been created by the cost-shared programs that the vendors (GEH and Westinghouse) and other partners will have adequate incentive to complete any additional work through private funding. The Department will not provide funding for the GEH and Westinghouse activities or the Dominion COL project.

	FY 2008	FY 2009	FY 2010
Standby Support Program	**1,000**	**500**	**0**

NP 2010 has also pursued non-cost-shared activities in the Standby Support program. Standby Support is a form of insurance protection from certain delays in nuclear plant operation beyond the control of the power company owner.

In FY 2008, the Department:

- Issued guidance for Conditional Agreement requests.
- Received one Request for Conditional Agreement for standby support coverage and two Advanced Notices of Intent to Request Conditional Agreement from three sponsors.

In FY 2009, the Department will:

- Review requests for conditional agreements from sponsors of new nuclear power plants
- Update cost models and underlying analyses by working with financial and technical subject matter experts to support the development of estimated costs for individual requests.

In FY 2010, the Department will continue staff activities to administer the program.

	FY 2008	FY 2009	FY 2010
Total, Nuclear Power 2010	**133,771**	**177,500**	**20,000**

Explanation of Funding Changes

	FY 2010 vs. FY 2009 ($000)
Cost-shared Program with Industry The decrease from $177,000 to $20,000 results from ending cost-shared activities with the reactor vendors, Westinghouse, GEH, and the Dominion COL application in FY 2010. These partners have developed satisfactory equity and momentum in the design and certification and licensing of the Gen III+ reactors such that they are well positioned to complete these activities as a fully private venture. In addition, uncertainty pertaining to the direction of the Dominion project has lead to cessation of funding under the NP 2010 program for the Dominion COL application. FY 2010 support for the NuStart project will provide sufficient information for an industry decision to deploy a new nuclear plant.	-157,000
Standby Support Program The decrease from $500,000 to $0 is the result of funding for these activities being managed by the federal staff. Funding for federal staff is contained in the Program Direction subprogram.	-500
Total Funding Change, Nuclear Power 2010	-157,500

Generation IV Nuclear Energy Systems

Funding Profile by Subprogram

	(dollars in thousands)		
	FY 2008 Current Appropriation	FY 2009 Original Appropriation	FY 2010 Request
Generation IV Nuclear Energy Systems	113,732	180,000	191,000

Public Law Authorizations:
P.L. 110-161, The Consolidated Appropriations Act, 2008
P.L. 111-8, Omnibus Appropriation Act, 2009

Mission

The mission of the Generation IV Nuclear Energy Systems program (Gen IV) is to address critical unanswered questions about advanced nuclear reactor technologies through research and development (R&D) to potentially help meet tomorrow's needs for reliable electricity production. The R&D focuses on technologies that are necessary to establish the viability of next-generation nuclear energy systems as well as those that could be useful in extending the operating life of existing light water reactors (LWRs).

Benefits

Through scientific R&D and international collaboration, Gen IV supports the R&D of next-generation nuclear reactor technologies that could have improved performance in sustainability, safety, economics, security, and proliferation resistance.

Climate Change Technology Program Benefits

Gen IV is developing advanced nuclear technologies that could contribute climate change benefits. Nuclear energy is presently responsible for over 70% of all avoided CO2 emissions in the electrical energy sector. Like existing LWRs, Gen IV reactors emit no CO2 during operation. If Gen IV reactor technologies were used to replace conventional sources of process heat, such as burning fossil fuels, Gen IV technology holds the potential to match or exceed the reduction in green-house-gas emissions credited to current generation nuclear power plants.

Contribution to GPRA Unit Program Goal 1.2.14.00 (Develop New Nuclear Generation Technologies)

Gen IV supports this program goal through the R&D of innovative, next-generation technologies for nuclear energy, including nuclear energy generation, security, materials, systems, safety, and waste management technologies and tools. The Gen IV program supports R&D that will help achieve enhanced safety, reduced cost, and proliferation resistance and could enable used fuel management alternative to direct geologic disposal.

The Gen IV program will also conduct research and development activities on component and material aging and degradation that could directly benefit existing nuclear plants by extending their current operating licensing period and future plants by enabling designs with a longer operating life.

Means and Strategies

The Gen IV program will use traditional R&D experimental methods combined with advanced testing and computation methods to achieve its goals. The program also performs collaborative activities to help meet its goals and to remain cognitive of international reactor technologies including collaborations with the international R&D community.

The Department will implement the following means:

- Advance R&D on next-generation reactor systems to gain improvements in the areas of sustainability, cost, reliability, and proliferation-resistance. The Gen IV program includes participation by the national laboratories, industry, and university research communities as well as the international research community represented by the Generation IV International Forum (GIF). International cost sharing is in place for the R&D on these intermediate- and long-term reactor technologies and industry cost-sharing will be employed where appropriate,.

- Develop advanced testing, inspection, and analytical tools to provide a scientific basis to potentially extend the safe and economical operation of existing nuclear plants to at least 80 years through joint government/industry-cost-shared R&D. Universities, industry, and national laboratories will conduct the R&D to test, and support the licensing of high-performance LWR reactor fuel and clad materials by the Nuclear Regulatory Commission needed for extended operating cycles and enhanced safety and productivity.

The Department will implement the following strategies:

- Work with national laboratories, universities, and private sector researchers to R&D advanced nuclear reactor technologies.

- Lead the international community in the cooperative pursuit of advanced nuclear technologies that will benefit the U.S. with enhanced safety, improved economics, and reduced production of wastes.

- Establish an Energy Innovation Hub for Modeling and Simulation to transform the way in which the U.S. develops, implements, and licenses nuclear energy technologies through the application of state-of-the-art computer modeling and simulation of all processes from the sub-atomic to the system-integration level.

These strategies will address the most technical and limiting factors related to advanced reactor technologies and will also benefit operating reactors.

The following external factors could affect the program's ability to achieve its strategic goal:

- Industry is inclined to focus on near-term deployment using proven technologies. Industry may not support or be supportive of longer-term development of better technologies.

- Nuclear R&D requires complimentary irradiation capabilities and high-level, post-irradiation examination facilities that are scarce, costly, and have long-lead times to construct.

- Fast neutron capabilities are in high demand globally with few supply sources.
- There are no operating international facilities to test relevant-scale fuels and material assemblies under accident conditions.

- Gen IV nuclear energy research relies on data produced through collaborations with foreign nations. Should vital data from foreign partners prove unavailable, the effectiveness of the U.S. R&D efforts could be diminished. International cooperation is essential and the U.S. needs to be viewed as a contributing partner.

In carrying out the program's mission, NE performs the following collaborative activities:

- The Department and the Nuclear Regulatory Commission (NRC) coordinate program planning to ensure that their R&D activities are complimentary, cost-effective, and not duplicative.

- The Gen IV program is receiving broad international cooperation and support consistent with the objectives of the program.

Validation and Verification

NE conducts various internal and external reviews and audits to validate and verify program performance. Periodic program reviews evaluate progress against established plans. NE holds monthly, quarterly, semi-annual, and annual reviews consistent with program management plans and project baselines to ensure technical progress, cost, and schedule adherence, and responsiveness to program requirements. Internally, NE provides continual management and oversight of its R&D and vital infrastructure programs.

NE has engaged its stakeholders when planning and evaluating NE's potential and current program activities to support nuclear energy's role in meeting the Nation's energy security and environmental goals. For example, in August 2008, the Directors of the Department's National Laboratories released *A Sustainable Energy Future: The Essential Role of Nuclear Energy*, which describes the role of nuclear energy in our Nation's energy portfolio. In addition, NE solicits the advice and counsel of the Nuclear Energy Advisory Committee (NEAC) and the National Academy of Sciences. In November 2008, NEAC released *Nuclear Energy: Policies and Technologies for the 21st Century*, which calls attention to the role of nuclear power and its impact on energy security, the environment, and nonproliferation.

NE's programmatic activities are also subject to periodic external reviews by Congress, GAO, the Department's IG, NRC, the U.S. Environmental Protection Agency, state environmental and health agencies, and the Department's Office of Engineering and Construction Management.

Annual Performance Results and Target

FY 2005 Results	FY 2006 Results	FY 2007 Results	FY 2008 Targets	FY 2009 Targets	FY 2010 Targets
GPRA Unit Program Goal 1.2.14.00 (Develop New Nuclear Generation Technologies)					
Efficiency Measure (Common Measure for NP 2010, Nuclear Hydrogen Initiative, Generation IV, and Fuel Cycle R&D)					
Achieve cumulative variance of less than 10 percent from each of the cost and schedule baselines for the Advanced Fuel Cycle, Generation IV Nuclear Energy Systems and Nuclear Hydrogen Initiatives. (MET)	*Maintain total administrative overhead costs in relation to total R&D program costs of less than 8 percent. (Baseline for administrative overhead rate is currently being validated). (MET)*	*Maintain total administrative overhead costs in relation to total program costs less than 8%. (MET)*	*Maintain total administrative overhead costs in relation to total program costs of less than eight percent. (MET)*	*Maintain total administrative overhead costs in relation to total program costs of less than eight percent.*	*Maintain total administrative overhead costs in relation to total program costs of less than eight percent.*
Generation IV Nuclear Energy Systems					
Issue the final design documents for the fuel capsule, test train, fission product monitoring system, and control system for the fuel irradiation shakedown test (AGR-1). (MET TARGET)	Complete Generation IV research and development activities to inform a design selection for the next generation nuclear power plant by FY 2011. (MET TARGET)	Complete Generation IV research and development activities, focusing on fuels and materials testing and plant system optimization, to inform the functional and operational design requirements of a next generation of nuclear power plant by FY 2011. (MET TARGET)	Determine a path forward for the design and construction of a next Generation nuclear power plant by 2011 by submitting an NGNP licensing strategy to Congress and completing NGNP conceptual design technology selection studies. (MET TARGET)	Continue the research, analysis and conceptual design activities needed to identify preferred alternative technologies for reactor systems, including examination of fuel and moderator materials.	Support the Nuclear Energy Advisory Committee's evaluation of ongoing R&D and identification of future R&D and other activities needed. Additional performance measures and targets are under development.

Generation IV Nuclear Energy Systems

Funding Schedule by Activity

(dollars in thousands)

	FY 2008	FY 2009	FY 2010
Generation IV Nuclear Energy Systems			
Generation IV R&D	113,732	178,649	154,627
Energy Innovation Hub for Modeling and Simulation	0	0	35,000
SBIR/STTR	0	1,351	1,373
Total, Generation IV Nuclear Energy Systems	113,732	180,000	191,000

Description

The Gen IV program aims at long-term technology advances through scientific R&D to improve further the safety performance, security, proliferation-resistance, and lower costs of advanced reactor concepts that could be available in the 2030 timeframe. The Gen IV R&D program will utilize collaborations with the international community. By coordinating U.S. efforts with those of partner nations, our funding leverage is multiplied while strengthening our scientific base and R&D capabilities. The Gen IV R&D program will also focus on solving the underlying technology challenges (fuels, materials, and neutronic and thermofluids modeling) of the reactor concepts identified in the "Technology Roadmap for Generation IV Nuclear Energy Systems". These reactor concepts include the Sodium-cooled Fast Reactor (SFR), Molten Salt Reactor (MSR), Supercritical-Water-Cooled Reactor (SCWR), Lead-cooled Fast Reactor (LFR), Very High Temperature Reactor (VHTR), and the Gas-cooled Fast Reactor (GFR).

The Gen IV program supports R&D activities at university and educational research institutions through competitive awards focused on advancing nuclear energy technologies. Through its university initiative, NE will designate funds appropriated to its R&D programs for work to be performed at university and research institutions. These funds will support mission-specific, applied R&D activities, investigator-initiated basic research, human capital development activities such as fellowships and young faculty awards, and infrastructure and equipment upgrades for university-based research reactors and laboratories.

Benefits

Gen IV activities provide technical benefits across the NE R&D portfolio. These technical advancements and anticipated benefits include pioneering the use of advanced modeling and simulation. Modeling and simulation can provide a scientific basis for risk-informed, reactor safety analyses used in licensing; development of advanced systems to accurately measure system operating parameters for use in multiple reactor types.

Detailed Justification

	(dollars in thousands)		
	FY 2008	FY 2009	FY 2010
Generation IV R&D	**113,732**	**178,649**	**154,627**

Gen IV R&D will focus on the development of advanced materials for structures, components and fuel claddings for use with various coolants and that face high-radiation, high-temperature environments with a particular focus on thermal reactor technologies. To develop an approach that combines advanced simulation with theory and experiments, this materials R&D will be coordinated with the Office of Science and the newly established Extreme Materials Energy Innovation Hub funded under the Fuel Cycle Research and Development (R&D) program. Further, the science and technology developed under Gen IV R&D supports modular reactor concepts as well as existing light water reactors in areas as such as material degradation and fuel performance. Gen IV R&D also includes an examination of supercritical carbon dioxide as a working fluid for a more efficient method of producing electricity and the use of liquid salt as a circulating fluid in primary and intermediate cooling loops due its higher heat removal capabilities. From a broader perspective, Gen IV R&D support includes secretariat support for the international policy and experts groups and a number of crosscutting research activities focused on the establishment of common evaluation methodologies of economics, safety, and proliferation resistance and physical protection of Gen IV reactors. R&D activities associated with reactor fuels are coordinated with Fuel Cycle R&D. R&D activities associated with computational analysis are coordinated with the newly established Energy Innovation Hub for Modeling and Simulation.

In FY 2009, a detailed program plan will be developed that will define the goals and specific activities for this revitalized Generation IV program.

In FY 2009, the Department is:

- Developing the fundamental scientific basis to understand, predict, and measure changes in materials, systems, structures, and components as they age.
- Applying this fundamental knowledge in collaborative public-private partnerships to develop and demonstrate methods and technologies that support safe and economical long-term operation of existing LWRs.
- Researching new technologies to address enhanced plant performance, economics, and safety.
- Continuing advanced modeling techniques utilizing the Department's high-speed, massively parallel computers for the development of close-coupled neutronic and thermofluid codes.
- Continuing, in collaboration with international partners, the development of crosscutting benchmarking methodologies (economics, proliferation resistance and physical protection, and reactor safety).
- Maintaining the *Generation IV Materials Handbook*.
- Continuing collaboration with France on nano-structured ferritic alloys and initiated collaborative projects with France and the Republic of Korea on mechanical and corrosion testing of nickel-based alloys for VHTR applications and thermal-hydraulic analyses and experiments for VHTR safety. Continuing collaboration with Japan on zirconium-carbide fuel particle coatings.
- Completing environmental experiments and mechanical property tests for potential Intermediate Heat Exchanger alloys.

	(dollars in thousands)	
FY 2008	FY 2009	FY 2010

- Completing test plan for water-cooled Reactor Cavity Cooling System (RCCS) experiments in Natural Convection Shutdown Heat Removal Test Facility (NSTF) at ANL.

Possible FY 2010 activities include:

- Continue development of advanced materials, such as oxide dispersion strengthened (ODS), nano-structured ferritic materials, and nano-cluster dispersion materials for use in structural system, fuel claddings and other high temperature applications.
- Conduct initial mechanical behavior testing on advanced steel alloy compositions.
- Perform post-irradiation examinations on unique material samples obtained from the Fast Flux Test Facility and the Phenix Fast Reactor in France to obtain mechanical and physical properties of these materials for use in materials model development.
- Continuing advanced modeling techniques utilizing the Department's high-speed, parallel computers for the development of close-coupled neutronic and thermofluid codes.
- Maintain the *Generation IV Materials Handbook* and arrange for other international partner organizations to share existing data and new materials data developed in the Gen IV Program.
- Demonstrate the technical and economic viability of an advanced Brayton-cycle energy-conversion system using supercritical carbon dioxide as the working fluid.
- Commence irradiation in the INL Advanced Test Reactor of the first VHTR fuel produced in commercial scale production equipment (AGR-2).
- Perform post-irradiation examination of the AGR-1 fuel removed from ATR.
- Initiate irradiation of the first Advanced Graphite Creep (AGC-1) test experiment to provide data for nuclear graphite qualification.
- Participate in the work of the Proliferation Resistance and Physical Protection (PRPP) Working Group.
- Participate in the work of the Economics Modeling Working Group (EMWG).
- Participate in the work of the Reliability and Safety Working Group (RSWG).
- Provide critical Secretariat and meeting facilitation support for two international policy group and two international expert group meetings.
- Continue the development of advanced VHTR system simulation software that makes use of recent advances in high-speed parallel processing hardware and uses a novel framework of computational modules.

Energy Innovation Hub for Modeling and Simulation	**0**	**0**	**35,000**

The design and licensing of the current fleet of reactors was based on conventional engineering processes that relied on a series of evolutionary steps that moved from prototypes to demonstrations to commercial power plants. Without significant experimentation, validation, and verification, the engineering development processes for the current fleet of reactors had to ensure that the designs were sufficiently conservative to cover the lack of precise models to simulate system behaviors under steady-state and transient conditions.

	(dollars in thousands)	
FY 2008	FY 2009	FY 2010

The newest generation of plant designs (Generation III+) makes use of improved methods where available, but there has been no systematic industry-wide effort to upgrade mechanistic models to reflect a fundamental understanding of the underlying physical phenomena. The result is that the designs still rely on substantial conservative engineering judgment. This is both understandable and appropriate because the new designs, although incorporating many advances, are not fundamentally different from the well-understood plants now operating.

The Modeling and Simulation Hub will focus on providing validated advanced modeling and simulation tools necessary to enable fundamental change in how the U.S. designs and licenses nuclear power and waste management technologies. This has the potential to improve the performance and reduce the costs of new nuclear facilities.

The Modeling and Simulation Hub will be competitively awarded. This Hub will work to accelerate the predictive modeling and simulation capability that could be used in many technology areas but will initially focus on the highly complex capabilities needed in the nuclear energy arena.

In FY 2010, the Department will:

- Competitively establish the Energy Innovation Hub for Modeling and Simulation.
- Establish partnerships with industry, academia, national labs, and foreign entities to develop revolutionary improvements in nuclear technology simulations.
- Produce coupled thermal-hydraulic and neutronic models with extremely accurate 3D models that can be used to benchmark other tools.
- Plan future R&D testing campaigns, including reactor tests, safety analyses, and for thermal transient testing required to validate enhanced computational methods.

	FY 2008	FY 2009	FY 2010
SBIR/STTR	**0**	**1,351**	**1,373**

The FY 2009 and FY 2010 amounts shown are estimated requirements for the continuation of the SBIR and STTR program.

	FY 2008	FY 2009	FY 2010
Total, Generation IV Nuclear Energy Systems	**113,732**	**180,000**	**191,000**

Explanation of Funding Changes

	FY 2010 vs. FY 2009 ($000)
Generation IV R&D The decrease from $178,649,000 to $154,627,000 reflects the emphasis shifting from near-term R&D activities to those R&D activities aimed at long-term technology advances. Gen IV R&D includes international collaboration activities on the development of crosscutting benchmarking methodologies (economics, proliferation resistance and physical protection, and reactor safety) and the underlying technology challenges (fuels, materials, and neutronic and thermofluids modeling) that benefit the majority of reactor concepts.	-24,022

	FY 2010 vs. FY 2009 ($000)
Energy Innovation Hub for Modeling and Simulation The increase from $0 and $35,000,000 focuses on providing validated advanced modeling and simulation tools necessary to enable fundamental change in how the U.S. develops, implements, and manages nuclear power and waste management technologies.	+35,000
SBIR/STTR The increase from $1,351,000 to $1,373,000 reflects an increase in R&D expenditures subject to SBIR and STTR.	+22
Total Funding Change, Generation IV Nuclear Energy Systems	**+11,000**

Nuclear Hydrogen Initiative

Funding Profile by Subprogram

(dollars in thousands)

	FY 2008 Current Appropriation	FY 2009 Original Appropriation	FY 2010 Request
Nuclear Hydrogen Initiative	9,668	7,500	0

Public Law Authorizations:
P.L. 110-161, The Consolidated Appropriations, 2008
P.L. 111-8, Omnibus Appropriation Act, 2009

Mission

The budget proposes to eliminate funding for the Nuclear Hydrogen Initiative (NHI) and related work on the production of hydrogen in the Office of Nuclear Energy (NE). This long-term research effort was designed to develop economical commercial-scale hydrogen production technologies that would utilize high temperature process heat and/or electricity and could be used to tandem advanced nuclear energy generation systems. The FY 2010 budget places an increased emphasis on higher priority nearer-term transportation technology research and has refocused hydrogen and fuel cell research and development (R&D) within the Office of Energy Efficiency and Renewable Energy. FY 2010 NE research funding will be focused on higher priority activities more directly related to nuclear energy such as waste management and storage, materials, and simulation.

Benefits

Hydrogen offers promise as a direct energy carrier for the transportation sector. The direct use of hydrogen in transportation would also reduce U.S. dependence on petroleum, while enhancing our national security. By completing experiments and testing on long-term cell operability, thermal cycling, process stability, and other important questions, the program developed insights into high-temperature thermochemical cycles, high-temperature electrolysis, and reactor/process interface issues.

Contribution to GPRA Unit Program Goal 1.2.14.00 (Develop New Nuclear Generation Technologies)

NHI has contributed to this program goal by researching, developing, and demonstrating hydrogen production technologies at small scales.

Means and Strategies

The Department has implemented the following means:

- Researched hydrogen production technologies compatible with nuclear energy systems with the participation of the national laboratories, industry, and university research communities as well as international research partners.

The Department has implemented the following strategies:

- Partnered with the private sector, national laboratories, universities, and international partners.

Validation and Verification

NE conducts various internal and external reviews and audits to validate and verify program performance. Periodic program reviews evaluate progress against established plans. NE holds monthly, quarterly, semi-annual, and annual reviews, consistent with program management plans and project baselines, to ensure technical progress, cost, and schedule adherence, and responsiveness to program requirements. Internally, NE provides continual management and oversight of its R&D and vital infrastructure programs.

NE also considers stakeholder input when planning and evaluating its programs and activities. NE's programmatic activities are also subject to periodic external reviews by Congress, GAO, the Department's IG, NRC, the U.S. Environmental Protection Agency, state environmental and health agencies, and the Department's Office of Engineering and Construction Management. In addition, NE solicits the advice and counsel of external agencies such as Nuclear Energy Advisory Committee and National Academy of Sciences.

Annual Performance Results and Target

FY 2005 Results	FY 2006 Results	FY 2007 Results	FY 2008 Results	FY 2009 Targets	FY 2010 Targets
GPRA Unit Program Goal 1.2.14.00 (Develop New Nuclear Generation Technologies)					
Efficiency Measure (Common Measure for NP 2010, Nuclear Hydrogen Initiative, Generation IV, and Fuel Cycle R&D)					
Achieve cumulative variance of less than 10 percent from each of the cost and schedule baselines for the Advanced Fuel Cycle, Generation IV Nuclear Energy Systems and Nuclear Hydrogen Initiatives. (MET)	*Maintain total administrative overhead costs in relation to total R&D program costs of less than 8 percent. (Baseline for administrative overhead rate is currently being validated). (MET)*	*Maintain total administrative overhead costs in relation to total program costs less than 8%. (MET)*	*Maintain total administrative overhead costs in relation to total program costs of less than eight percent. (MET)*	*Maintain total administrative overhead costs in relation to total program costs of less than eight percent.*	No targets will be established. Program is proposed for termination.
Nuclear Hydrogen Initiative					
Issue conceptual design documents for the thermochemical and high temperature electrolysis pilot scale experiments. (MET TARGET)	Complete development of key technologies and infrastructure requirements in preparation for the thermochemical and high temperature electrolysis integrated laboratory-scale experiments. (MET TARGET)	Complete NHI research and development activities focused on thermochemical and high temperature electrolysis (HTE) processes to support the Department's selection of a hydrogen production technology in 2011. (MET TARGET)	Select a hydrogen production technology by 2011 that will be demonstrated in a pilot-scale experiment by conducting integrated laboratory-scale experiments on sulfur-iodine thermochemical and HTE processes. (MET TARGET)	Select a hydrogen production technology by 2011 that will be demonstrated in a pilot-scale experiment by conducting integrated laboratory-scale experiments on sulfur-iodine thermochemical and HTE processes.	No targets will be established. Program is proposed for termination.

Funding Schedule by Activity

	(dollars in thousands)		
	FY 2008	FY 2009	FY 2010
Nuclear Hydrogen Initiative			
Nuclear Hydrogen Initiative	9,668	7,343	0
SBIR/STTR	0	157	0
Total, Nuclear Hydrogen Initiative	9,668	7,500	0

Description

This program is proposed for termination. The FY 2010 budget places an increased emphasis on development of transportation technologies that can have a near-term impact on our energy and climate change goals. More specifically, the NE research funding will focus on higher priority activities that are more directly related to the NE mission, such as waste management and storage, materials, and simulation. Through FY 2009, NHI supported the potential future production of hydrogen for commercial applications by conducting R&D of enabling technologies, demonstrating hydrogen production technologies at small scales, and studying potential hydrogen production strategies all within the context of coupling the technologies with next generation nuclear facilities. The hydrogen production technologies that were being evaluated by the program require higher temperatures than are available from current nuclear reactors. Those production technologies have the potential to be coupled with other energy sources, and therefore are not specific to nuclear technology.

Benefits

By completing experiments and testing on long-term cell operability, thermal cycling, process stability, and other important questions, the program developed useful insights into high-temperature thermochemical cycles, high-temperature electrolysis, and reactor/process interface issues.

Detailed Justification

	(dollars in thousands)		
	FY 2008	FY 2009	FY 2010
Nuclear Hydrogen Initiative	**9,668**	**7,343**	**0**

Through FY 2009 this program focused on long-term R&D activities associated with thermochemical and High Temperature Electrolysis (HTE) processes designed to demonstrate the viability of using heat and/or electricity from various advanced reactors researched by the Gen IV program (mainly NGNP), with the goal of demonstrating the economic, commercial-scale production of hydrogen. The objective of NHI has been to demonstrate the technologies at increasingly larger scales, culminating in a demonstration of an industrial-scale hydrogen production process that would be technically and economically suited for commercial deployment. In FY 2008, integrated laboratory-scale experiments were initiated to validate closed-cycle operations and evaluate long-term performance of components and materials. These experiments will be concluded in FY 2009. By the end of FY 2009, the program will report on the findings of their research and identify which production technology may be the most viable to the long-term. As part of this process, an independent national laboratory review team will review technical maturity, technology risk, and economic aspects of the baseline processes and provide the Department with their recommendation.

(dollars in thousands)

NHI R&D activities have been conducted through several vehicles including international collaborations via the GIF and bilateral agreements pioneered under the International Nuclear Energy Research Initiative and domestically via the national laboratories.

In FY 2008, the Department began testing of integrated laboratory-scale experiments and performed the following:

- Conducted HTE integrated laboratory-scale experiment operation consisting of three 240-cell modules at 5 kWe power level each and 15 kWe total which proved the viability of scaling up this technology in a modular fashion from previous 25-cell experiments. These tests were conducted at temperatures of 750 – 900 C to simulate proposed high temperature reactor operating conditions and identified the need to perform additional development on cell designs and fabrication techniques.
- Conducted integrated laboratory-scale experiments on S-I thermochemical system. Tests revealed operating and materials issues that require additional technology development needed to perform extended duration tests to obtain chemical performance data.
- Successfully demonstrated multi-cell electrolyzers for the Hybrid Sulfur thermochemical cycle which proved the viability of scaling up this technology. These tests identified the need to address sulfur build-up in the elctrolyzer membrane.

In FY 2009, NE designated at least 20 percent of funds appropriated to its R&D programs for work to be performed at university and research institutions. These funds support investigator-initiated basic research and mission-specific applied R&D activities, human capital development activities such as fellowships and young faculty awards, and infrastructure and equipment upgrades for university-based research reactors and laboratories.

In FY 2009, the Department is:

- Completing HTE experiments begun in FY 2008 to investigate long-term cell operability and thermal cycling issues.
- Completing operation and testing on the SI integrated laboratory-scale thermochemical experiment to assess process stability and component durability.
- Finalizing investigation of improved membranes for the Hybrid Sulfur electrolyzer.
- Summarizing research finding and identifying the hydrogen production technology with the most promise.
- Completing the final year of university research projects awarded in FY 2007.

	FY 2008	FY 2009	FY 2010
SBIR/STTR	**0**	**157**	**0**

The FY 2009 amount shown reflects the estimated requirements for the SBIR and STTR program.

	FY 2008	FY 2009	FY 2010
Total, Nuclear Hydrogen Initiative	**9,668**	**7,500**	**0**

Explanation of Funding Changes

	FY 2010 vs. FY 2009 ($000)
Nuclear Hydrogen Initiative The decrease from $7,343,000 to $0 is a result of completing ongoing experiments and ending the program in FY 2009.	-7,343
SBIR/STTR The decrease from $157,000 to $0 is a result of completing ongoing research efforts and ending the program in FY 2009.	-157
Total Funding Change, Nuclear Hydrogen Initiative	**-7,500**

Fuel Cycle Research and Development

[formerly Advanced Fuel Cycle Initiative]

Funding Profile by Subprogram

(dollars in thousands)

	FY 2008 Current Appropriation	FY 2009 Original Appropriation	FY 2010 Request
Fuel Cycle Research and Development	0	145,000	192,000

Public Law Authorizations:
P.L. 110-161, The Consolidated Appropriations Act, 2008
P.L. 111-8, Omnibus Appropriation Act, 2009

Mission

The mission of Fuel Cycle Research and Development (R&D) Program is to develop nuclear fuel and waste management technologies that will enable a safe, secure, and economic fuel cycle and research option for the storage and disposal of nuclear waste. The Fuel Cycle R&D Program is focused on long-term, science-based R&D of technologies with the potential to produce beneficial changes to the way in which the nuclear fuel cycle, and particularly nuclear waste, is managed.

Benefits

The Fuel Cycle R&D program supports research to enable technology development needed to reduce high level waste and safely manage and dispose of long-lived, highly radiotoxic elements.

Technologies reached by the Fuel Cycle R&D program could:

- improve waste storage and disposal options;
- promote the safe and secure management of nuclear fuel and waste products;
- minimize proliferation risk of the civilian nuclear fuel cycle; and
- reduce the time-scale for managing waste from a timeframe of many hundreds of thousands of years to centuries (engineering time-scales).

Climate Change Technology Program Benefits

Through the activities described above, the program will seek to create a safe and sustainable path forward for nuclear power and thereby promote the greenhouse gas abatement benefits of nuclear power.

Contribution to GPRA Unit Program Goal 1.2.14.00 (Develop New Nuclear Technologies)

The Fuel Cycle R&D program supports achievement of GPRA goals and priorities by conducting long-term, science-based research, development activities needed to reduce high level waste and safely manage long-lived, highly radiotoxic elements.

Means and Strategies

The Fuel Cycle R&D program will use various means and strategies to achieve its goals. However, various external factors may impact the ability to achieve these goals. The program also performs collaborative activities to help meet its goals.

The Department will implement the following means:

- Conduct long-term, science-based R&D through small-scale experiments, theory development, modeling and simulation, validation experiments, and development of transformational technologies which has the potential to produce beneficial changes to the way the nuclear fuel cycle, and particularly nuclear waste, is managed.

The Department will implement the following strategies:

- Partnering with the private sector, national laboratories, universities, and international partners to develop advanced nuclear technologies.

- Leading the international community in pursuit of advanced nuclear technology that will benefit the U.S. with enhanced safety, improved economics, and reduced production of wastes.

These strategies will result in the efficient and effective management of the program - thus putting the taxpayer's dollars to more productive use.

The following external factors could affect the program's ability to achieve its strategic goal:

- Deployment of advanced fuel cycle technologies will depend upon policy decisions that will determine the implementation of advanced spent fuel and waste management technologies.

- All nuclear energy research programs rely heavily on data produced through collaborations with foreign nations. Should vital data from foreign partners prove unavailable, the effectiveness of U.S. R&D efforts may be diminished.

In carrying out the program's mission, the Office of Nuclear Energy (NE) performs the following collaborative activities:

- The Department and the Nuclear Regulatory Commission (NRC) coordinate program planning to assure that their R&D activities are complimentary, cost effective, and not duplicative.

- Participation in international experiments related to the development of advanced fuel cycle technologies is being performed in support of Fuel Cycle R&D objectives.

- NE collaborates with other programs within the Department, such as the Office of Science, the Office of Civilian Radioactive Waste Management, the Office of Environmental Management and the National Nuclear Security Administration, on Fuel Cycle R&D -related activities.

Validation and Verification

NE conducts various internal and external reviews and audits to validate and verify program performance. Periodic program reviews evaluate progress against established plans. NE holds monthly, quarterly, semi-annual, and annual reviews, consistent with program management plans and project baselines, to ensure technical progress, cost, and schedule adherence, and responsiveness to program requirements. Internally, NE provides continual management and oversight of its R&D and vital infrastructure programs.

NE also considers stakeholder input when planning and evaluating program activities. In addition, NE solicits the advice and counsel of external entities such as Nuclear Energy Advisory Committee and National Academy of Sciences.

NE's programmatic activities are also subject to periodic external reviews by Congress, GAO, the Department's IG, NRC, the U.S. Environmental Protection Agency, state environmental and health agencies, and the Department's Office of Engineering and Construction Management.

Annual Performance Results and Target

FY 2005 Results	FY 2006 Results	FY 2007 Results	FY 2008 Targets	FY 2009 Targets	FY 2010 Targets
GPRA Unit Program Goal 1.2.14.00 (Develop New Nuclear Generation Technologies)					
Efficiency Measure (Common Measure for NP 2010, Nuclear Hydrogen Initiative, Generation IV, and Fuel Cycle R&D)					
Achieve cumulative variance of less than 10 percent from each of the cost and schedule baselines for the Advanced Fuel Cycle, Generation IV Nuclear Energy Systems and Nuclear Hydrogen Initiatives. (MET)	*Maintain total administrative overhead costs in relation to total R&D program costs of less than 8 percent. (Baseline for administrative overhead rate is currently being validated). (MET)*	*Maintain total administrative overhead costs in relation to total program costs less than 8 percent. (MET)*		*Maintain total administrative overhead costs in relation to total program costs of less than 8 percent.*	*Maintain total administrative overhead costs in relation to total program costs of less than 8 percent.*
Fuel Cycle Research and Development [formerly Advanced Fuel Cycle Initiative]					
Issue preliminary report on the post-irradiation examination (PIE) of actinide-bearing metal and nitride transmutation fuels in the Advanced Test Reactor (ATR). (MET TARGET)	Complete research and development activities that allow the program to support the Secretary of Energy's determination of the need for a second geologic repository for spent nuclear fuel by FY 2008. (MET TARGET)	Complete research and development activities, focused on advanced fuel separations technology development and demonstration, to support the Secretary of Energy's determination of the need for a second geologic repository for spent nuclear fuel by FY 2008. (MET TARGET)	See Fuel Cycle Initiative section.	Commence a top to bottom program review with input from a broad variety of stakeholders. Continue research and development activities, focused on advanced separations technologies, advanced transmutation fuels and targets, and waste forms needed for long-term fuel cycle management. *Replacement performance measures and targets are under development.*	Performance measures and targets are under development.
Conduct laboratory-scale test of group actinide separation process (plutonium, neptunium, americium and curium extracted together) with actual LWR spent fuel and report preliminary results. (MET TARGET)					

Funding Schedule by Activity

	(dollars in thousands)		
	FY 2008	FY 2009	FY 2010
Fuel Cycle Research and Development			
Fuel Cycle Research and Development	0	142,652	153,825
Energy Innovation Hub for Extreme Materials	0	0	35,000
SBIR/STTR	0	2,348	3,175
Total, Fuel Cycle Research and Development	0[a]	145,000	192,000

Description

The program focus is being re-directed from a near-term technology deployment program to a long-term, science-based research and development program which has the potential to produce beneficial changes to the way the fuel cycle, and particularly spent fuel, is managed.

The Fuel Cycle R&D program is an integrated program to research, develop, and improve waste management options and transformational technologies. It involves small-scale experiments, coupled with theory development and advanced modeling and simulation with validation experiments. This new, long-term, science-based R&D program will provide a more complete understanding of the underlying science supporting the development of advanced fuel cycle technologies and waste management options and therefore help provide a sound basis for future decision-making.

In FY 2009, a program plan will be developed for this refocused and expanded waste-management-focused program that will reflect priorities and include program goals and specific activities. R&D on separations processes, transmutation, waste forms, and fuels, including the safety, cost effectiveness and security of these materials and processes, will continue. However, the program will be broadened in scope to support R&D on storage technologies, security systems, alternative disposal pathways (e.g. salt formation and deep borehole, etc.) and will begin revisiting the scientific considerations of long-term geologic storage in conjunction with the Office of Civilian Radioactive Waste Management (OCRWM). The program plan will also reflect consideration of the findings from the planned nuclear waste strategy panel.

Small-Scale Experiments. As opposed to large-scale, integrated experiments typical of demonstration-based programs, the focus on the experiments for a science-based approach shifts to smaller-scale, phenomenological and separate or coupled effects testing that provides a fundamental understanding of targeted phenomena. Innovative experimental design and novel measurement techniques will be incorporated into the experimental programs.

Theory Development. An essential element of the science-based approach is to build upon existing theories and develop new theories that explain the various phenomena of interest. In the long-term, the

[a] In FY 2008, the Advanced Fuel Cycle Initiative is included in the Fuel Cycle Research and Facilities program.

theory must span from quantum mechanics to continuum mechanics in explaining the behavior of physical systems. A well-integrated approach between experiments and theory development is required for success of the science-based approach.

Modeling and Simulation. The knowledge gained under the experimental and theoretical elements of the science-based approach will be incorporated into an advanced modeling and simulation program to take advantage of existing state-of-the-art computing capabilities. Due to the very complex nature of the licensing process for nuclear technologies, a formal science-based approach will be developed and implemented to demonstrate the validity of the newly developed simulation tools for addressing the behavior of technologies in realistic situations and for developing requirements and priorities for the science-based program.

The Fuel Cycle R&D program will also support a competitively established Energy Innovation Hub. The Extreme Materials Innovation Hub will further the fundamental knowledge of the behavior of materials under extreme conditions, including high radiation fields, high temperatures, and corrosive environments over long periods of time, relevant to nuclear energy applications. This work will directly support the development of novel fuels, waste forms, and structural materials.

The Fuel Cycle R&D program supports R&D activities at universities and educational research institutions through competitive awards focused on advancing nuclear energy technologies. Through its university initiative, NE will designate funds appropriated to its R&D programs for work to be performed at university and research institutions.

Benefits

The Fuel Cycle R&D program supports long-term technology development activities needed to reduce high level waste volume and safely manage long-lived, highly radiotoxic elements.

Technologies researched in the Fuel Cycle R&D program could:

- improve waste storage and disposal options;
- promote the safe and secure management of nuclear fuel and waste products;
- minimize the proliferation risk of the civilian nuclear fuel cycle;
- reduce the time-scale for managing waste from a timeframe of many hundreds of thousands of years to centuries (engineering time-scales).

Detailed Justification

	(dollars in thousands)		
	FY 2008	FY 2009	FY 2010
Fuel Cycle R&D	**0**	**142,652**	**153,825**

The Fuel Cycle R&D program will undertake long-term, science-based research and development of technologies that can help address waste management concerns, reduce high level waste, and safely manage and dispose of long-lived, highly radiotoxic elements. The program will utilize small-scale experiments, coupled with theory development and advanced modeling and simulation with validation experiments to accomplish its tasks. A detailed program plan is under development; however, in FY 2010, it is anticipated that the program will continue to conduct R&D on separations processes, transmutation, waste forms, and fuels and will also support R&D on storage technologies, security systems, alternative disposal pathways (e.g. salt formation and deep borehole, etc.). In addition, the program will work in conjunction with the OCRWM to begin revisiting the scientific considerations of long-term geologic storage. Highlights of ongoing activities and potential future actions associated with those areas are outlined below.

The program will also issue competitive solicitation to award mission-specific R&D projects to universities.

S*eparations Research and Development.* Includes research on separations technologies and systems with improved proliferation resistance, with very low "near-zero" process losses and minimal undesirable waste streams; and waste forms with predictable, long-term behavior and enhanced resistance to long-term degradation suitable for a variety of potential geologic repository environments. Advanced separations technologies must meet integrated system specifications in terms of purity and losses for separating and reusing valuable products from wastes, in a way that supports U.S. nonproliferation objectives. Novel processes will be pursued to minimize wastes and process losses resulting in durable waste forms for safe and effective disposal.

FY 2009 activities include:

- Continuing to research advanced aqueous separations processes with an increasing emphasis on simplification of the process steps including investigating alternate extraction processes to minimize the number of different solvents needed.
- Continuing research on electrochemical processing technologies with a focus on improving process throughput and process control and monitoring technologies.
- Investigating safeguards issues related to special material accountability.

Possible FY 2010 activities include:

- Continue developing and implementing the scientific instrumentation needed to better understand the behavior of actinides and fission products in a broad range of chemical environments.
- Initiate a series of fundamental measurements to serve as a basis for expanding the understanding of actinide separations science. This activity will be closely coordinated with the Office of Science.
- Conduct studies on fundamental understanding and manipulation of solvent properties.
- Continue creating multidisciplinary teams that will identify and solve specific separations challenges.
- Continue solvent radiolysis and degradation testing, using a cobalt-60 radiation source.
- Initiate the search for novel molecules that will allow for extraction of specific elements (using modern molecular design simulation tools).

(dollars in thousands)		
FY 2008	FY 2009	FY 2010

- Coordinate advanced safeguards instrumentation development for materials accountability measurements with increased accuracy and reliability for future separations facilities with the related Office of National Nuclear Security Administration (NNSA) programs.

Waste Forms Research and Development. Separation of used nuclear fuel and transmutation fuels requires the development of waste forms suitable for disposal in a future geologic repository and research on ways to meet U.S. environmental requirements for future systems. Certain long-lived fission products can be significant contributors to the long-term environmental effects of used fuel in specific geological environments, and separation of these elements for incorporation into new waste forms for safe disposal is needed. In order to decrease the volume of high level wastes, while maintaining durability, research is also needed in advanced glasses and metal waste form compositions and waste loadings.

In FY 2009, the Department is transitioning the program to a long-term science-based approach by implementing the scientific methods needed to further understand the behavior of waste forms in various realistic conditions, build multi-disciplinary teams, and define a set of prioritized scientific challenges.

In FY 2009, The Department is:

- Continuing R&D to optimize the stability of waste forms and the efficiency of waste form production through laboratory-scale demonstration of solidification processes for both glass and metal waste forms.
- Characterizing waste forms resulting from separations processes and investigating their potential performance in a variety of geological settings.
- Evaluating metal waste forms to understand and define waste loading performance.
- Preparing the first metal waste form using surrogate undissolved solids.

Possible FY 2010 activities include:

- In collaboration with other Department of Energy offices, continue developing the basis for a science-based waste form program that will provide for a broader set of options with significantly improved performance in a large variety of geologic environments.
- Create multi-disciplinary teams that will identify and solve specific waste form challenges, including developing self-healing corrosion and radiation tolerant waste forms via micro-structural design and strategically placed additives in order to provide the capability to isolate specific waste species for extended periods in a variety of geological media and settings.

Advanced Fuels. Includes research on the phenomenology of fuel behavior, modeling, and development of advanced experimental and simulation tools to achieve better characterization of potential advanced transmutation fuels. The program will explore novel fuel forms that could significantly improve transmutation performance and the development of advanced cladding materials to support longer fuel burnup and higher reactor operating temperatures.

Research will also be conducted to develop advanced fuel and target fabrication techniques that minimize process losses and wastes. Under the science-based program, the fabrication research will be conducted using bench-scale and laboratory-scale techniques and rely heavily on advanced modeling of the fundamental mechanisms for fuel fabrication.

FY 2009 activities include:

- Initiating post-irradiation examination of Advanced Test Reactor (ATR) test fuel pins removed from the test reactor in FY 2008.
- Continuing irradiation and testing of metal and oxide transmutation fuels in the ATR.
- Researching fuel fabrication processes evaluating advanced cladding materials.
- Completing irradiation of U.S. origin transmutation fuels in the French Phénix fast reactor. This reactor will permanently shutdown in FY 2009.
- Continuing to prepare transmutation-related feedstock material needed for national and international fuels irradiation testing.
- Continuing international collaborations on innovative fuel development.
- Continuing development of instrumentation and controls for safeguarding nuclear materials during the fuel cycle and waste management process.
- Initiating development of safeguards related tools and methods for advanced integration and control to enable knowledge extraction of facility operation.
- Investigating safeguard issues related to special material accountability in metal fuel fabrication systems.

Possible FY 2010 activities include:

- Continue R&D on fuel fabrication processes and advanced alloy and composite cladding technologies.
- Fabricate and irradiate test items needed for verification and validation.
- Broaden research on metal and oxide fuels and innovative transmutation fuels and targets with high potential but low technical maturity.
- Continue with strategic international partnerships for innovative fuel development.
- Coordinate advanced safeguards instrumentation development for materials accountability measurements with increased accuracy and reliability for future fuel fabrication facilities with the related NNSA programs.
- Continue irradiation and test of metal and oxide transmutation fuels in the ATR.
- Continue creating multidisciplinary teams that will identify and solve specific fuel and cladding challenges including development of self-healing, radiation-tolerant fuels and cladding materials using micro-structural design with strategically placed additives to achieve very high burnup fuels that require less recycling (less wasteful) and improve fuel cycle economics.

- Continue developing advanced experimental techniques to further the fundamental understanding of fuel behavior during fabrication and irradiation. This activity could include the development of new fuel characterization techniques, gathering validation data for the fuels models at the micro-structural level, or obtaining continuous data about fuel performance during actual irradiation conditions (a first-of-a-kind capability).

Transmutation. Transmutation converts long-lived radioactive isotopes into shorter-lived elements. As a result, transmutation can lower the long-term radiotoxicity of used nuclear fuel to below that of mined uranium ore by reducing the time for decay from hundreds of millennia to as little as centuries. Research to date indicates that fast neutron technology will be needed to optimize transmutation and reduce radiotoxicity of high level waste, providing a flexible actinide management capability.

This research develops advanced instruments and measures, analyzes and publishes highly accurate nuclear data such as neutron fission and captures cross-sections for elements of interest to the Fuel Cycle R&D program. Improved accuracy of nuclear data is important to a variety of activities including transmutation performance analysis, safeguards instrumentation design, high-burnup fuel development, waste package performance, and development of advanced models and simulation codes. Nuclear data research will be performed in collaboration with the Office of Science.

In FY 2009, the Department is:

- Continuing R&D activities on high precision measurements of nuclear data, sensitivity analyses to reduce uncertainty, and developing advanced measurement techniques.
- Continuing the development of advanced materials that will significantly improve the performance of nuclear systems.
- Continuing to work collaboratively with the international community to efficiently leverage existing infrastructure.

FY 2010 activities may include:

- Continue R&D activities on high precision measurements of nuclear data, sensitivity analyses to reduce uncertainty, and development of advanced measurement techniques.
- Update nuclear data libraries to include reduced uncertainties based on new data in the fast neutron region of the spectrum.

Systems Analysis and Integration. Supports conduct of systems-wide analyses of advanced nuclear energy systems and fuel cycles to inform strategic planning and support key program decisions; and a technical integration function for integrating Fuel Cycle R&D efforts.

This work is focused on developing and maintaining a set of analytical tools and associated data to provide an objective and defensible basis for analysis of nuclear energy systems and fuel cycles. Analytical tools and datasets are developed, reviewed, maintained, and enhanced, including computer codes and models for dynamic systems analysis, reactor fuel transmutation data, and economic data to support accurate advanced fuel cycle assessments. Technical evaluations and reports are produced to provide input into strategic and program planning activities in order to facilitate near-term execution of Fuel Cycle R&D activities and guide long-term strategic planning.

The technical integration function provides support in the areas of technical integration, project controls, quality assurance, document management, knowledge management and communications. This function ensures the technical consistency of the program, integrated product development, and planning and monitoring of work activities.

In FY 2009, the Department is:

- Conducting a study of nuclear fuel cycle management options that is focused on identifying a very broad range of possible options for used fuel storage, recycling, and waste disposal (including pathways for options that would require significant scientific breakthroughs) and specifying criteria for each key technical and scientific challenge.
- Designing and assessing specific technical options and trade studies for future fuel cycle systems, such as assessment of approaches for minor actinide and heat management.
- Revising quality assurance program to better reflect National Quality Assurance -1 guidance and increased collaborations with industry and universities.

Possible FY 2010 activities include:

- Complete integrated systems definitions and preliminary assessments of advanced technical options.
- Initiate development of the Fuel Cycle R&D Knowledge Management architecture that is capable of capturing and managing all types of nuclear energy knowledge.
- Conduct detailed fuel cycle system studies for a range of possible fuel cycles (including thorium-based fuel cycles) and geologic repository environments in order to specify technical requirements (such as purity, loss fraction per specific isotope) for each key step of the fuel cycle.

Modeling and Simulation. Prior to FY 2010, this activity focused on creating and deploying “science-based” (first principle), verified and validated modeling and simulation capabilities essential for the design, implementation, and operation of future nuclear energy systems. For FY 2010 and beyond, modeling and simulation activities are accomplished under the broader Energy Innovation Hub for Modeling and Simulation which is funded within the Generation IV Nuclear Energy Systems Program.

	(dollars in thousands)	
FY 2008	FY 2009	FY 2010

In FY 2009, the Department is:

- Improving the fidelity of thermo-mechanical codes used for fuel modeling and improving the models of multi-component materials used in reactor fuels.
- Developing code architectures and methods to model the performance of advanced waste forms in adverse geological environments for very long-term storage and disposition.
- Developing a Unified Markup Language specification for a modeling and simulation interoperability framework that will facilitate the transfer of capabilities from the research environment to the engineers who will design, build and operation the new nuclear energy systems.
- Delivering Fundamental Models and Methods that will allow the understanding of performance of materials on the lower length scales needed to simulate the performance of integrated systems.
- Providing a centrally planned, but distributed set of computational resources that leverages other Department of Energy high performance computing programs and is needed to support the application development and use.
- Developing a set of experimental data needs and requirements over the entire spectrum of time- and length-scale for the models.
- Developing the set of validation techniques necessary for demonstrating the quality of the modeling tools and for defining requirements for further development of these tools.

	FY 2008	FY 2009	FY 2010
Energy Innovation Hub for Extreme Materials	**0**	**0**	**35,000**

A new activity introduced in FY 2010, the Extreme Materials Innovation Hub supports research into advanced materials for nuclear technologies, such as reactors, waste storage and disposal technologies, components, fuels, cladding and waste forms. Recent experiments and experience indicate that dramatically improved materials for use in various applications that face extreme environments including high-radiation and high-temperature are possible. To achieve these transformational advances in materials performance a science-based approach is needed. The science-based approach combines fundamental understanding of materials behavior at micro-structural level combined with phase-field and atomistic theories, advanced experimental and characterization techniques to guide the development of data-bases at the micro-structural level and lower length-scales, and advanced modeling and simulation tools.

The Extreme Materials Innovation Hub will be a competitively awarded. This Hub will focus and integrate the national effort to develop and test advanced materials needed to transform the performance of nuclear energy systems.

Advanced materials have the potential to dramatically improve reactor performance, fuel cycle economics and the behavior of waste forms. The use of advanced materials for component replacement in the existing light water reactor fleet may improve safety margins and reduce the frequency of component replacements. For advanced reactors, development of better materials could improve efficiency of electricity generation as well as improved waste management strategies.

	(dollars in thousands)		
	FY 2008	FY 2009	FY 2010

Furthermore, fundamental understanding of materials and being able to tailor materials design to specific performance requirements will reduce the uncertainties associated with waste form performance in various environments.

The Extreme Materials Innovation Hub complements the Integrated Performance and Safety Codes effort of the Modeling and Simulation Hub. It will also make extensive use of the capabilities developed by the Office of Science through its Advanced Computing program. It will require, however, a different approach and the development of different tools.

In FY 2010, activities may include:

- Competitively establish the Energy Innovation Hub for Extreme Materials.
- Survey current understanding of relevant material behaviors to identify gaps in material theory.
- Survey the current inventory of material test facilities and capabilities and identify any gaps in testing capabilities.
- Survey existing material modeling tools and identify gaps in modeling capabilities needed to develop advanced materials that will operate in temperature, radiation, mechanical, chemical and geological environments relevant to nuclear energy.
- Start the development of new modeling and simulation tools needed to understand the performance of classes of material of interest to nuclear energy and tools focused on the synthesis, manufacturing and joining of advanced materials.
- Coordinate these activities with the Office of Science to ensure synergy and avoid redundancies.

	FY 2008	FY 2009	FY 2010
SBIR/STTR	**0**	**2,348**	**3,175**

The FY 2009 and FY 2010 amounts shown are an estimate of the requirement for the continuation of the SBIR and STTR program.

	FY 2008	FY 2009	FY 2010
Total, Fuel Cycle Research and Development	**0**	**145,000**	**192,000**

Explanation of Funding Changes

	FY 2010 vs. FY 2009 ($000)
Fuel Cycle R&D The increase of from $142,652,000 to $156,173,000 reflects the shift in focus toward answering a broad range of fundamental technology questions and expanding the scope of the program to encompass broader work on storage technologies, security systems, alternative disposal pathways (e.g. salt formation and deep borehole, etc.) and work with OCRWM to begin revisiting the scientific considerations of long-term geologic storage.	+11,173
Energy Innovation Hub for Extreme Materials The increase $35,000,000 reflects the initiation of a new activity.	+35,000
SBIR/STTR The increase from $2,348,000 to $3,175,000 reflects an increase in R&D expenditures subject to SBIR and STTR.	+827
Total Funding Change, Fuel Cycle Research and Development	**+47,000**

Fuel Cycle Research and Facilities

Funding Profile by Subprogram

	(dollars in thousands)		
	FY 2008 Current Appropriation	FY 2009 Original Appropriation	FY 2010 Request
Fuel Cycle Research and Facility			
Advanced Fuel Cycle Initiative	178,017	0	0
MOX Fuel Fabrication Facility	278,789	0	0
Total, Fuel Cycle Research and Facility	456,806	0[a]	0[b]

Public Law Authorizations:
P.L. 110-161, The Consolidated Appropriations Act, 2008

Significant Program Shifts

In FY 2008, the Advanced Fuel Cycle Initiative (AFCI) was included in the Fuel Cycle Research and Facilities under the Nuclear Energy appropriation. In FY 2009, the AFCI program is not included in the Fuel Cycle Research and Facilities budget but as a separate program under Office of Nuclear Energy (NE), similar to years prior to FY 2008. Beginning in FY 2010, AFCI has been refocused and renamed Fuel Cycle Research and Development (R&D).

The Mixed Oxide Fuel Fabrication Facility (MOX Facility) was appropriated within the NE account in FY 2009 under Fuel Cycle Research and Facilities. In FY 2009, the MOX Facility costs were appropriated within the Other Defense Activities account, budget execution was overseen by NE, and management responsibility for the project remained with the National Nuclear Security Administration (NNSA). In FY 2010, funding for the MOX Facility is being requested within the NNSA Defense Nuclear Nonproliferation account.

Benefits, Climate Change Technology Program Benefits, Contribution to the Secretary's Priorities, Contribution to GPRA Unit Program Goal 1.2.14.00 (Develop New Nuclear Generation Technologies), Contribution to GPRA Unit Program Goal 2.2.43.00 (Fissile Materials Disposition), Means and Strategies, and Validation and Verification

These sections of the budget are discussed under the Fuel Cycle R&D of the Nuclear Energy appropriation and the Fissile Materials Disposition program within the Defense Nuclear Nonproliferation appropriation.

[a] In FY 2009, funding for the AFCI is appropriated within the Nuclear Energy appropriation and the MOX Facility is appropriated within the Other Defense Activities appropriation.
[b] In FY 2010 and outyears, funding for the MOX Facility will be included within NNSA.

Annual Performance Results and Target

FY 2005 Results	FY 2006 Results	FY 2007 Results	FY 2008 Targets	FY 2009 Targets	FY 2010 Targets
GPRA Unit Program Goal 1.2.14.00 (Develop New Nuclear Generation Technologies)					
Advanced Fuel Cycle Initiative					
			Create a technology development document on recycling technology options, including their readiness and risks, the state of technology development achieved to date, future research and development, and economic evaluations needed to achieve the GNEP vision. (MET) Complete trade-off studies of new versus existing facilities for an Advanced Fuel Cycle Facility, including economic evaluations. (MET) Complete initial industry design studies for the Advanced Burner Reactor, including an evaluation of the development costs for the various prototype options. (MET) Complete technical and economic evaluations of four industry-led conceptual design studies for a nuclear fuel recycling center. (MET)		
GPRA Unit Program Goal 2.2.43 (Fissile Materials Disposition)					
Mixed Oxide Fuel Fabrication Facility					
			Cumulative percentage of the design, construction, and cold start-up activities completed for the MOX Fuel Fabrication Facility (Long-term Output) T: 30% (MET)		

Advanced Fuel Cycle Initiative

Funding Schedule by Activity

	(dollars in thousands)		
	FY 2008	FY 2009	FY 2010
Advanced Fuel Cycle Initiative			
Separations Research and Development	28,701	0	0
Advanced Fuels Research, Development and Testing	18,796	0	0
Transmutation Research and Development	16,358	0	0
Systems Analysis/Advanced Computing and Simulation	31,889	0	0
Transmutation Education	9,305	0	0
Advanced Fuel Cycle Facility	2,800	0	0
Consolidated Fuel Treatment Center	17,123	0	0
Advanced Burner Reactor	15,040	0	0
GNEP Technology Development	38,005	0	0
Total, Advanced Fuel Cycle Initiative	178,017	0[a]	0

Description

In FY 2008, the Advanced Fuel Cycle Initiative (AFCI) program was included in the Fuel Cycle Research and Facilities as appropriated. In FY 2009, the AFCI program is not included in the Fuel Cycle Research and Facilities budget but a stand-alone program under the Nuclear Energy appropriation. Beginning in FY 2010, AFCI has been renamed Fuel Cycle Research and Development (R&D).

Detailed Justification

	(dollars in thousands)		
	FY 2008	FY 2009	FY 2010
Separations Research and Development	**28,701**	**0**	**0**

In FY 2008 the program was focused on activities which would:

- Significantly reduce the volume and hazard of spent nuclear fuel that must be stored in a repository.
- Allow actinides in spent nuclear fuel to be used as a future fuel for either or both Light Water Reactor and Advanced Burner Reactor (ABR) in a safe and proliferation resistant manner.
- Provide a way that long lived actinides can be consumed so the ultimate waste products are less radiotoxic.
- Support national energy requirements in producing an energy source that has a very low emission of greenhouse gases.
- Develop and test advanced monitoring and accountability technologies that will strengthen

[a] In FY 2009, the AFCI program is appropriated within the Nuclear Energy appropriation.

	(dollars in thousands)		
	FY 2008	FY 2009	FY 2010

nuclear nonproliferation.

- Improve simulation technologies that will reduce separations costs and improve reliability.
- Develop advanced waste forms.

Advanced Proliferation-Resistant Aqueous Fuel Treatment	**17,301**	**0**	**0**

In FY 2008, the Department:

- Continued the end-to-end demonstrations of recycling technologies. The demonstrations are producing separated transuranics for use in the transmutation fuel development program and waste products for waste form fabrication.
- Continued advancing the state of the art for separations and waste forms through integrated laboratory-scale tests of the separations process selected for the recycling demonstration prototype; process demonstrations of various advanced separations technologies capable of isolating transuranics (collectively or individually); the collection and recovery of various volatile fractions from the shearing of spent fuel, the oxidation of spent uranium dioxide fuel and its subsequent dissolution, including alternate storage methods for rare fission gases such as krypton-85 separated from inert xenon, for tritium and for carbon-14; and the development of advanced waste forms for iodine and technetium and other long-lived radionuclides.
- Tested advanced safeguard instrumentation under simulated conditions to identify candidates for later testing in a recycling demonstration prototype.
- Conducted research in collaboration with the Department's Office of Science, to understand the basic chemistry of aqueous separations, including the structure and stability of various organic complexes.

Other Separations Processes (Including Electrochemical processing)	**11,400**	**0**	**0**

In FY 2008, the Department:

- Continued R&D on advanced recycle processes for fast reactor spent fuel. Such processes must be capable of separating uranium and transuranics from fission products in fuel with very high radioactivity, thus requiring remote handling.
- Conducted advanced recycle process activities required including: treatment of fast reactor metal fuels, laboratory-scale liquid cadmium cathode (LCC) testing of group actinide recovery, high throughput electrorefining, the investigation of crucible materials for LCC applications; advanced sampling methods for electrochemical processing technologies; reductive extraction of actinides and electrolytic drawdown from salt waste; and advanced processing methods for spent oxide reactor fuel, using high burnup fast reactor spent oxide fuel from the Fast Flux Test Facility (FFTF); cold testing; irradiated fuel testing and integrated electrochemical modeling as part of an ongoing International Nuclear Energy Research Initiative (I-NERI) project with the Korea Atomic Energy Research Institute.

	(dollars in thousands)	
FY 2008	FY 2009	FY 2010

- Developed engineering-scale oxide reduction equipment, also in collaboration with South Korean researchers.
- In collaboration with the Department's Office of Science, research was conducted to better understand the basic chemistry of electrochemical processing.

	FY 2008	FY 2009	FY 2010
Advanced Fuels Research, Development, and Testing	**18,796**	**0**	**0**

In FY 2008 the Department:

- Pursued advanced cladding development through recovery of unique material samples irradiated in the FFTF in the 1980s.
- Completed high burn-up nitride and metal fuel irradiations in the Advanced Test Reactor (ATR) that will be used for data comparison with the results of the French Phenix irradiations.
- Completed a medium burn-up metal fuel irradiation in the ATR that will be used to investigate fast reactor recycle fuel compositions.
- Fabricated and initiated an oxide fuel irradiation test in the ATR that will provide fuel performance results on representative fast reactor recycle fuel compositions.
- Obtained neptunium oxide feedstock material from the Savanna River Site laboratory and shipped to Idaho National Laboratory. This material is needed to supply future foreign and domestic transmutation fuel experiments and is a major input of the U.S. to the joint U.S.-Japan-France Global Actinide Cycle International Demonstration project, which will test advanced transmutation oxide fuels in the JOYO and Monju fast reactors.
- Tested advanced safeguards instrumentation under simulated conditions to identify candidates for future testing in fuel cycle facilities.

	FY 2008	FY 2009	FY 2010
Transmutation Research and Development	**16,358**	**0**	**0**

In FY 2008, the Department:

- Continued concept studies to assess the impact of cost reduction technologies.
- Developed an advanced system for measuring nuclear reactions called a time-projection chamber that will significantly improve the accuracy of certain nuclear data measurements. Conducted additional evaluation and refinement of physics cross sections for actinide isotopes to support an advanced transmutation fuel cycle.
- Completed mechanical testing and analysis of structural materials irradiated in the FFTF to support the development and qualification of advanced structural materials for use in fast spectrum transmutation systems.
- Completed analysis of previous experiments of potential structural materials and chose four promising candidates for future study, evaluation and testing.
- Evaluated existing fast reactor design methods and performed validation testing for selected safety methods using existing data.
- Initiated additional activities to reconstitute domestic sodium technology infrastructure by developing a specification for conceptual design of a sodium component testing facility.
- Continued coordination of international activities dealing with transmutation systems.
- Integrated advanced modeling and simulation activities with results of materials and physics experiments.

	(dollars in thousands)		
	FY 2008	FY 2009	FY 2010
Systems Analysis/Advanced Computing and Simulation	**31,889**	**0**	**0**
▪ **Systems Analysis and Integration**	**18,560**	**0**	**0**

In FY 2008, the Department:

- Developed an initial Global Nuclear Energy Partnership (GNEP) Integrated Waste Management Strategy and GNEP Technology Roadmap.
- Conducted a dynamic systems analysis and economic assessment of nuclear fuel recycle architectures, and updated the fuel cycle cost information.
- Conducted various analyses of open and closed fuel cycle deployment scenarios and potential environmental impacts as input to the draft GNEP Programmatic Environmental Impact Statement.
- Initiated new project management tools and procedures.
- Prepared reports to Congress and other groups on the AFCI/GNEP program activities and studies.

▪ **Advanced Computing and Simulation**	**13,329**	**0**	**0**

In FY 2008, the Department:

- Focused on the high priority of beginning development of advanced simulation codes for fast reactor design and fuel performance.

Transmutation Education	**9,305**	**0**	**0**

In FY 2008, the Department:

- Continued the AFCI Fellowship program with nine masters degree fellowships awarded.
- Performed additional university research activities within the various AFCI/GNEP R&D activities through the use of a competitive Funding Opportunity Announcement.
- Continued university-led NERI projects previously awarded in FY 2006 and FY 2007.

Advanced Fuel Cycle Facility	**2,800**	**0**	**0**

In FY 2008, the Department:

- Completed 50 percent of the Advanced Fuel Cycle Facility (AFCF) conceptual design work with focus on the transmutation fuel/target fabrication area of AFCF, completed key strategic trade studies, and developed cost and schedule range estimates in support of a future Secretarial Record of Decision on the path forward for GNEP.
- Conducted detailed environmental impact analysis for numerous potential sites for an AFCF as input to the GNEP Programmatic Environmental Impact Statement.

In FY 2009 the AFCF project was terminated.

Consolidated Fuel Treatment Center	**17,123**	**0**	**0**

In FY 2008, the Department:

- Accepted deliverables resulting from cooperative agreements that were awarded to four industry teams in FY 2007. These documents (initial conceptual designs, business models, technology roadmaps, and communications plans) will provide data to support future nuclear fuel cycle options and identify areas that would benefit from specific R&D activities. Follow on work may be awarded to selected industry teams.

In FY 2009 the Consolidated Fuel Treatment Center project was terminated.

Advanced Burner Reactor	**15,040**	**0**	**0**

In FY 2008, the Department:

- Completed the initial design studies needed to inform the GNEP path forward. As one of the deliverables under the cooperative agreement, the industry teams provided input to an overall GNEP technology roadmap which will determine the technology development required (both near-term and longer-term) to support ABR deployment. The roadmap defines what needs to be done, who will do it (industry or government), when it is required and appropriate contingency plans or off-ramps. In addition to the technology roadmap, industry will provide input to the business model for GNEP, which will assure that the ABR project is part of an overall sound plan to commercialize a closed fuel cycle. The business model will consider the risks, incentives, revenues, and market considerations needed to establish the appropriate framework for an effective industry and government partnership. The establishment of an appropriate regulatory framework and a compliance strategy for licensing commercial ABRs will be coordinated between DOE, NRC, and industry.
- Pursued international collaboration activities, as well as supported the NEPA process.

In FY 2009 the ABR project was terminated.

GNEP Technology Development	**38,005**	**0**	**0**

In FY 2008, the Department:

- Conducted activities to support the used nuclear fuel recycling center including technetium extraction, conversion and waste form process development. Engineering studies and /or technology development activities in response to feedback from industry identifying design and technology risks.
- Supported ABR by establishing the functional and operating requirements for the prototype; beginning to restore the domestic infrastructure required to design, fabricate and test sodium components; and validating the analytical tools used for reactor design. Engineering analysis and trade studies will be used to identify the biggest cost drivers and most promising technologies to reduce the costs to design, construct and operate future commercial ABRs, as well as improve plant performance. Examples include: reactor fuel handling machines, intermediate heat exchangers, advanced liquid metal pumps, reactor control technologies, and balance of plant technologies unique to fast reactor applications.
- Supported AFCF technology development activities including design of advanced fuel cycle systems to be installed in AFCF.
- Established an agreement with the Tennessee Valley Authority to develop advanced fuel cycle demonstration options, incorporating nuclear utility perspectives and experience.

	(dollars in thousands)		
	FY 2008	FY 2009	FY 2010
In FY 2009 GNEP Technology Development was terminated.			
Total, Advanced Fuel Cycle Initiative	**178,017**	**0**	**0**

Mixed Oxide Fuel Fabrication Facility

Funding Schedule by Activity

	(dollars in thousands)		
	FY 2008	FY 2009	FY 2010
Mixed Oxide (MOX) Fuel Fabrication Facility			
MOX Construction	231,721	0	0
MOX Other Project Cost Activities	47,068	0	0
Total, MOX Fuel Fabrication Facility	278,789	0	0

Description

The program goal is to eliminate U.S. weapons-grade plutonium declared surplus to national security needs. This project is considered central to meeting the U.S. nonproliferation objectives as described in Defense Nuclear Nonproliferation.

U.S. Plutonium Disposition

In September 2000, the U.S. and Russia signed a Plutonium Management and Disposition Agreement, which commits each country to dispose of 34 metric tons of surplus weapon-grade plutonium (68 metric tons total – enough material for approximately 17,000 nuclear weapons). In 2007, both the U.S. and Russian Governments reaffirmed their commitment to implement the 2000 Agreement for disposing their plutonium as MOX fuel in nuclear reactors.

Detailed Justification

	(dollars in thousands)		
	FY 2008	FY 2009	FY 2010
MOX Construction	**231,721**	**0**	**0**

The MOX Fuel Fabrication Facility (MOX Facility) will provide the U.S. with the capability to dispose of surplus weapon-grade plutonium by fabricating it into MOX fuel elements suitable for use in commercial nuclear reactors.

In FY 2008, funding supported:

- Continued construction activities such as installing additional floors to the MOX Facility.
- Continued installation of procured equipment.
- Continued installing of mechanical and electrical utilities.
- Continuing procurement of processing equipment.

	(dollars in thousands)		
	FY 2008	FY 2009	FY 2010
MOX Other Project Costs	**47,068**	**0**	**0**

MOX Other Project Cost Activities support project activities, such as, management oversight, design reviews, and facility start-up testing.

In FY 2008, funding supported:

- Continued management oversight and licensing for construction activities, planning for start-up and operation of the MOX Facility, supporting design and testing of the Aqueous Polishing process contained within the MOX project supporting environmental permitting and monitoring and supporting the NRC review of the operating licensing application for the MOX Facility.

	FY 2008	FY 2009	FY 2010
Total, MOX Fuel Fabrication Facility	**278,789**	**0**	**0**

Capital Operating Expenses and Construction Summary
Construction Projects[a]

(dollars in thousands)

	Total Estimated Cost (TEC)	Prior-Year Appro-priations	FY 2008	FY 2009	FY 2010	Unappro-priated Balance
99-D-143, Mixed Oxide Fuel Fabrication Facility, Savannah River Site	3,975,828	1,315,060	231,721	0	0	
Total, Construction Project			231,721	0	0	

[a] In FY 2009, the MOX Facility is requested within the Other Defense Activities appropriation and in FY 2010 and outyears, funding for the MOX Facility will be requested within the National Nuclear Security Administration program.

Radiological Facilities Management

Funding Profile by Subprogram

(dollars in thousands)

	FY 2008 Current Appropriation	FY 2009 Original Appropriation	FY 2010 Request
Radiological Facilities Management			
Space and Defense Infrastructure	30,371	35,000	47,000
Medical Isotopes Infrastructure	14,828	0	0
Research Reactor Infrastructure	2,920	6,146	0
Oak Ridge Nuclear Infrastructure	0	12,500	0
Los Alamos Nuclear Infrastructure	0	12,500	0
Pu-238 Production Restart Project	0	0	30,000
Total, Radiological Facilities Management	48,119	66,146	77,000

Public Law Authorizations:
P.L. 110-161, The Consolidated Appropriations Act, 2008
P.L. 111-8, Omnibus Appropriations Act, 2009

Mission

The Radiological Facilities Management (RFM) program maintains Office of Nuclear Energy (NE)-managed nuclear facilities at Idaho National Laboratory (INL), Oak Ridge National Laboratory (ORNL), and Los Alamos National Laboratory (LANL), primarily those housing large gloveboxes, hot cells, and their associated support facilities in a safe, environmentally-compliant and cost-effective manner to support national priorities. In FY 2009, Congress specifically directed NE allocate $12.5M to LANL and to ORNL for RFM-related equipment and facility upgrades, maintenance, and management practices. These are not ongoing upgrade programs. Beginning in FY 2009, the Medical Isotopes program transfers to the Office of Science. Beginning in FY 2010, the Research Reactor Infrastructure program will be funded under the Idaho Facilities Management (IFM) program. Also in FY 2010, RFM will include a project to re-establish the domestic capability to produce Plutonium (Pu)-238 for space missions and national security user applications.

Benefits

The RFM program ensures that the Department's nuclear capabilities supporting radioisotope power systems production are maintained and operated in a safe, environmentally-compliant and cost-effective manner to support those priorities and in FY 2009 supports fuels management for university reactors. Key activities include managing all special nuclear materials contained in the DOE facilities, the disposition of DOE materials under NE ownership, and the new Pu-238 Production Restart project.

Contribution to the Secretary's Priorities

PRIORITY 1: Science and Discovery:
Invest in science to achieve transformational discoveries

1. Organize and focus on breakthrough science

- Re-energize the national labs as centers of great science and innovation

Contribution to GPRA Unit Program Goal 1.2.15.00 (Maintain and Enhance National Nuclear Infrastructure)

The RFM program contributes to this goal by ensuring that the Department's unique facilities, required for the production of radioisotope power systems used in certain space missions and national security applications are maintained and operated such that they are available to support national priorities.

Means and Strategies

The RFM program will use various means and strategies to achieve its GPRA Unit Program goal. 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:

- Maintain the infrastructure and capability to deliver advanced radioisotope power systems for space missions and national security applications**.**

- Aggressively implement contracting reforms, including fixed price competitive bidding, earned value management, capital planning processes in accord with DOE Order 413.3A, and independent external evaluations, etc., to ensure that the infrastructure program is operating effectively and efficiently to meet the Department's highest priority program needs.

The Department will implement the following strategies:

- Partnering with the private sector, national laboratories, universities, and international partners as appropriate to maintain capability to deliver advanced radioisotope power systems for space missions and national security applications.

- Re-establishing domestic Pu-238 production capability to address potential future supply shortages.

These strategies will result in the efficient and effective management of the program - thus putting the taxpayer's dollars to more productive use.

The following external factors could affect the program's ability to achieve its strategic goal:

- Program infrastructure activities are interrelated with customer-defined (i.e., NASA and national security agencies) requirements for the development of radioisotope power systems. Any change in demand for RPSs could impact NE's provision of infrastructure and development support, including activities associated with restarting domestic Pu-238 production.

In carrying out the program's mission, NE performs the following collaborative activities:

- Coordinates with national security agencies and NASA in developing radioisotope power systems to ensure proposed systems and technologies satisfy the necessary technical requirements identified by customers for identified mission scenarios.

Validations and Verification

NE conducts various internal and external reviews and audits to validate and verify program performance. Periodic program reviews evaluate progress against established plans. NE holds monthly, quarterly, semi-annual, and annual reviews, consistent with program management plans and project baselines, to ensure technical progress, cost, and schedule adherence, and responsiveness to program requirements. Internally, NE provides continual management and oversight of its R&D and vital infrastructure programs.

Annual Performance Results and Targets

FY 2005 Results	FY 2006 Results	FY 2007 Results	FY 2008 Results	FY 2009 Targets	FY 2010 Targets
GPRA Unit Program Goal 1.2.15.00 (Maintain and Enhance National Nuclear Infrastructure)					
Radiological Facilities Management					
Keep cost and schedule milestones for upgrades and construction of key nuclear facilities within 10 percent of approved baselines, using the cost-weighted mean percent variance (+/-10 percent) approach. (MET TARGET)	Keep cost and schedule milestones for upgrades and construction of key nuclear facilities within 10 percent of approved baselines, using the cost-weighted mean percent variance (+/-10 percent) approach. (MET TARGET)	Maintain operability of key Radiological Facilities Management and Idaho Facilities Management-funded facilities to enable accomplishment of Nuclear Energy, other DOE and Work-for-Others milestones by achieving a Facility Operability Index of 0.9 or greater. (MET TARGET)	To ensure unique nuclear facilities are available to support critical Departmental missions, maintain a facility operability index of 0.9 for key Idaho Facilities Management and Radiological Facilities Management program facilities.	To ensure unique nuclear facilities are available to support critical Departmental missions, maintain a facility operability index of 0.9 for key Idaho Facilities Management and Radiological Facilities Management program facilities.	To ensure unique nuclear facilities are available to support critical Departmental missions, maintain a facility operability index of 0.9 for key Idaho Facilities Management and Radiological Facilities Management program facilities
					Performance measures for Pu-238 restart project are under development.
Consistent with safe operations, maintain and operate key nuclear facilities so the unscheduled operational downtime will be kept to less than 10 percent, on average, of total scheduled operating time. (MET TARGET)					
Maintain and operate radioisotope power systems facilities with less than 10 percent unscheduled downtime from approved baseline. (MET TARGET)					

Space and Defense Infrastructure

Funding Schedule by Activity

	(dollars in thousands)		
	FY 2008	FY 2009	FY 2010
Space and Defense Infrastructure			
Idaho National Laboratory (INL)	9,000	9,500	9,840
Los Alamos National Laboratory (LANL)	12,321	15,000	27,030
Oak Ridge National Laboratory (ORNL)	4,750	4,900	5,160
Other Activities	4,300	5,600	4,970
Total, Space and Defense Infrastructure	30,371	35,000	47,000

Description

The Space and Defense Infrastructure program produces plutonium 238 (Pu-238)-based radioisotope power systems (RPS) for National Aeronautics and Space Administration (NASA) mission and national security applications. The Department maintains capabilities at the Idaho, Oak Ridge, and Los Alamos National Laboratories needed to produce these systems.

Benefits

The Pu-238-based RPS's are needed for certain NASA and national security applications where other power sources, such as batteries, fuel cells, and solar technologies, are not economical or technologically viable. They enable NASA deep space missions that could lead to scientific discoveries, possibilities, and opportunities, as well as, support national security applications.

Detailed Justification

	(dollars in thousands)		
	FY 2008	FY 2009	FY 2010
Idaho National Laboratory (INL)	**9,000**	**9,500**	**9,840**
▪ **Radioisotope Power Systems Assembly Operations**	**8,500**	**9,000**	**9,340**

Funding supports the facility manager, alternate facility manager, trained operators and maintenance staff, materials control, quality control, quality inspection, documentation, radiation health physicist support, radiation engineering, nuclear safety support, facility Documented Safety Analysis, mechanical and electrical engineering support, crane operations and maintenance, tooling and engineer development technical and equipment support, and overall program management including: training, transportation coordination, project management, shipping container hardware fabrication and repair, and drawing support. INL will store and maintain the flight quality status of the radioisotope power system for the National Aeronautics and Space Administration's Mars Science Laboratory mission. INL will also establish the production of light-weight radioisotope heater unit hardware in 2010.

	(dollars in thousands)		
	FY 2008	FY 2009	FY 2010
▪ **Capital Equipment for Radioisotope Power System Assembly Operations**	**500**	**500**	**500**

Funding supports capital equipment used in radioisotope power system assembly activities.

Los Alamos National Laboratory (LANL)	**12,321**	**15,000**	**27,030**
▪ **Pu-238 Encapsulation and Scrap Recovery Facilities**	**12,000**	**12,000**	**25,030**

Funding supports maintenance and operation of dedicated Pu-238 processing, encapsulation and scrap recovery facilities. The facilities include equipment and support capabilities to manufacture the fuel forms and weld them into fuel clads; the capability to chemically remove impurities from the fuel; and support the required materials control, quality control, quality inspection and documentation; and overall program management including: training, transportation coordination, project management, and facility safety. LANL will begin to press Pu-238 pellets and encapsulate them for the Advanced Stirling Radioisotope Generator.

▪ **Capital Equipment for the Pu-238 Facilities**	**321**	**3,000**	**2,000**

These funds support capital equipment related to the maintenance and operation of dedicated Pu-238 processing, encapsulation and scrap recovery facilities.

Oak Ridge National Laboratory (ORNL)	**4,750**	**4,900**	**5,160**
▪ **Iridium Fabrication Facilities for Radioisotope Power Systems**	**4,250**	**4,400**	**4,410**

Funding for this element maintains infrastructure and capabilities to fabricate iridium cladding and carbon insulators used to encapsulate and contain the fuel pellets necessary for the safe operation of radioisotope power systems; equipment and capabilities for the production of iridium clad vent sets used to encapsulate the fuel; equipment and capability for the production of thermal insulation sleeves used in the reentry protection system; materials control, quality control, quality inspection, and documentation; and overall program management including: training, iridium inventory management, project management, and facility safety. In addition, in FY 2010 ORNL will support hardware and material requirements for the production of light-weight radioisotope heater units and hardware requirements for the encapsulation of Pu-238 pellets for the Advanced Stirling Generator Program.

▪ **Capital Equipment for Iridium Fabrication Facilities**	**500**	**500**	**750**

These funds support capital equipment associated with the capabilities to fabricate iridium cladding and carbon insulators.

Other Activities	**4,300**	**5,600**	**4,970**
▪ **Safety/Program Analysis and Testing Infrastructure**	**4,300**	**4,610**	**4,670**

Funding supports the maintenance of the required analytical and testing capability which enables the Department to analyze radioisotope power system performance and safety for various applications.

▪ **Certification of Type "B" Shipping Containers**	**0**	**990**	**300**

Funding supports DOE certification of fuel and power system shipping containers.

Total, Space and Defense Infrastructure	**30,371**	**35,000**	**47,000**

Explanation of Funding Changes

	FY 2010 vs. FY 2009 ($000)
Idaho National Laboratory (INL)	
▪ **Radioisotope Power Systems Assembly Operations** The increase from $9,000,000 to $9,340,000 is due to increased personnel costs for personnel required to operate the Space and Security Power Systems Facility.	+$340
Total, Idaho National Laboratory	+$340
Los Alamos National Laboratory (LANL)	
▪ **Pu-238 Encapsulation and Scrap Recovery Facilities** The increase from $12,000,000 to $25,030,000 includes a new $12,000,000 full-cost recovery charge (space charge) from the National Nuclear Security Administration and increased personnel costs that reflects two previous years of flat funding for personnel required to operate the facility.	+$13,030
▪ **Capital Equipment for the Pu-238 Facilities** The decrease from $3,000,000 to $2,000,000 is due to the completed equipment replacement used in fuel pellet production and associated operations.	-$1,000
Total, Los Alamos National Laboratory	+$12,030
Oak Ridge National Laboratory (ORNL)	
▪ **Iridium Fabrication Facilities for Radioisotope Power Systems** The increase from $4,400,000 to $4,410,000 is a minor increase in the cost of personnel required to maintain capability at the iridium fabrication facilities.	+$10
▪ **Capital Equipment for Iridium Fabrication Facilities** The increase from $500,000 to $750,000 is due to replacing aged equipment required for the production of iridium hardware.	+$250
Total, Oak Ridge National Laboratory	+$260
Other Activities	
▪ **Safety/Program Analysis and Testing Infrastructure** The increase from $4,610,000 to $4,670,000 is a modest increase in the cost of personnel required to maintain the analytical and testing capability.	+$60
▪ **Certification of Type "B" Shipping Containers** The decrease from $990,000 to $300,000 is due to the certification of one of several shipping containers required by the program.	-$690
Total, Other Activities	-$630
Total, Space and Defense Infrastructure	**+$12,000**

Capital Operating Expenses and Construction Summary
Capital Operating Expenses

(dollars in thousands)

	FY 2008	FY 2009	FY 2010
Capital Equipment	1,321	4,000	3,250
Total, Capital Operating Expenses	1,321	4,000	3,250

Medical Isotopes Infrastructure
Funding Schedule by Activity

	(dollars in thousands)		
	FY 2008	FY 2009	FY 2010
Medical Isotopes Infrastructure			
Oak Ridge National Laboratory (ORNL)	7,428	0	0
Los Alamos National Laboratory (LANL)	3,650	0	0
Brookhaven National Laboratory (BNL)	3,200	0	0
Other Activities	550	0	0
Total, Medical Isotopes Infrastructure	14,828	0[a]	0

Description

The Department maintains one-of-a-kind facilities at the Idaho, Oak Ridge, Brookhaven, and Los Alamos National Laboratories for isotope production and processing. Actual operations, production, research or other activities are funded either by other Department of Energy programs, the private sector, or other Federal agency users.

Benefits

These isotopes are used to improve the accuracy, effectiveness, and continuation of medical diagnoses and therapy, enhance homeland security, improve the efficiency of industrial processes, and provide precise measurement and investigative tools for materials, biomedical, environmental, archeological, and other research.

Detailed Justification

	(dollars in thousands)		
	FY 2008	FY 2009	FY 2010
Oak Ridge National Laboratory (ORNL)	**7,428**	**0**	**0**
▪ **Buildings 4501 and 7920 Hot Cells**	**3,664**	**0**	**0**

All isotope processing activities have been transferred from Building 3047 to Buildings 4501 and 7920. Activities include facility and shipping container maintenance, radiological monitoring, facility inspections, isotope inventory and shipment scheduling and delivery tracking.

▪ **Buildings 9204-3 and 5500 – Chemical and Materials Laboratories**	**3,764**	**0**	**0**

Activities include facility maintenance and inspections and customer order and account tracking system maintenance (E-Government). Over the next several years, the Department will continue to phase out the calutrons in Building 9204-3 at Y-12. Beginning in FY 2009, these activities transfer to the Office of Science.

[a] In FY 2009, the Medical Isotope Infrastructure activities transfer to the Office of Science.

	(dollars in thousands)		
	FY 2008	FY 2009	FY 2010
Los Alamos National Laboratory (LANL)	**3,650**	**0**	**0**
▪ **Isotope Production Facility/TA-48 Hot Cell, Building RC-1**	**3,650**	**0**	**0**

Activities include maintenance, radiological monitoring, and facility inspections. Isotope customers will pay the full cost of isotope processing in these facilities. Beginning in FY 2009, these activities transfer to the Office of Science.

Brookhaven National Laboratory (BNL)	**3,200**	**0**	**0**
▪ **Brookhaven Linear Isotope Producer (BLIP) Building 931 and Hot Cell Building 801**	**3,200**	**0**	**0**

Activities include maintenance, radiological monitoring, and facility inspections. Isotope customers will pay the full cost of isotope processing in this facility. Beginning in FY 2009, these activities transfer to the Office of Science.

Other Activities	**550**	**0**	**0**
▪ **Associated Nuclear Support**	**550**	**0**	**0**

This funding provides for requirements applicable to isotope producing sites. Such items include certification of isotope shipping casks, independent financial audits of the revolving fund, and other related expenses. Beginning in FY 2009, these activities transfer to the Office of Science.

Total, Medical Isotopes Infrastructure	**14,828**	**0**	**0**

Explanation of Funding Changes

	FY 2010 vs. FY 2009 ($000)
Medical Isotopes Infrastructure program transferred to the Office of Science in FY 2009.	0
Total, Medical Isotopes Infrastructure	**0**

Research Reactor Infrastructure
Funding Schedule by Activity

	(dollars in thousands)		
	FY 2008	FY 2009	FY 2010
Research Reactor Infrastructure			
Idaho National Laboratory	2,920	6,146	0
Total, Research Reactor Infrastructure	2,920	6,146	0

Description

This program provides fresh reactor fuel to and removes spent fuel from 26 operating university reactors. It supports the continued operation of university research reactors by providing universities with a test reactor capability with research, development, and educational opportunities in support of U.S. nuclear energy initiatives. Beginning in FY 2010, the Research Reactor Infrastructure program is included in the Idaho Facilities Management program.

Benefits

This program supports the continued operation of university research reactors which provide unique capabilities for research and development and educational opportunities supporting U.S. energy initiatives. Spent fuel shipments support U.S. and DOE non-proliferation and national security objectives.

Detailed Justification

	(dollars in thousands)		
	FY 2008	FY 2009	FY 2010
Idaho National Laboratory	**2,920**	**6,146**	**0**

This program provides Universities with fresh fuel as needed to support continued operation of their research reactors, and improved reactor instrumentation and equipment upgrades. This program is being funded under Idaho Facilities Management beginning in FY 2010.

Total, Research Reactor Infrastructure	**2,920**	**6,146**	**0**

Explanation of Funding Changes

	FY 2010 vs. FY 2009 ($000)
Idaho National Laboratory	
▪ **Research Reactor Infrastructure** The decrease of $6,146,000 is due to this program being funded under Idaho Facilities Management beginning in FY 2010.	-6,146
Total Funding Change, Radiological Facilities Management	**-6,146**

Oak Ridge Nuclear Infrastructure

Funding Schedule by Activity

	(dollars in thousands)		
	FY 2008	FY 2009	FY 2010
Oak Ridge Nuclear Infrastructure			
Oak Ridge National Laboratory	0	12,500	0
Total, Oak Ridge Nuclear Infrastructure	0	12,500	0

Description

This Congressionally directed funding was used for equipment and facility upgrades, maintenance, and management practices at the Radiochemical Engineering Development Center (REDC) at the Oak Ridge National Laboratory (ORNL), which is the Department's production, storage, and distribution center for heavy-element research activities.

Benefits

Constructed in the mid-1960's, REDC contains hot cells in Buildings 7920 and 7930 that support laboratory scale testing to support aqueous separation research and development and irradiated target processing activities for the High Flux Isotope Reactor along with supporting facilities.

Detailed Justification

	(dollars in thousands)		
	FY 2008	FY 2009	FY 2010
Oak Ridge National Laboratory	**0**	**12,500**	**0**

Based on FY 2009 Congressional direction, funding in the amount of $12,500,000 is provided for the following activities:

- Perform maintenance and end-of-life replacement of critical REDC complex equipment and infrastructure to assure the facilities continue to meet Departmental safety standards;
- Update REDC facility management practices to meet current Departmental requirements, including preparing safety documentation and supporting technical safety analyses, managing nuclear material inventories, enhancing worker protection programs, and training staff; and
- Conduct corrective and routine preventive maintenance on nuclear safety and facility support components and equipment within REDC building systems.

Explanation of Funding Changes

	FY 2010 vs. FY 2009 ($000)
Oak Ridge National Laboratory	
The decrease from $12,500,000 to $0 reflects elimination of the Congressionally directed funding. No funding is requested in FY 2010 for these activities.	-12,500
Total, Oak Ridge National Laboratory	-12,500

Los Alamos Nuclear Infrastructure

Funding Schedule by Activity

	(dollars in thousands)		
	FY 2008	FY 2009	FY 2010
Los Alamos Nuclear Infrastructure			
Los Alamos National Laboratory	0	12,500	0
Total, Los Alamos Nuclear Infrastructure	0	12,500	0

Description

This Congressionally directed funding was used for equipment and facility upgrades, maintenance, and management practices at Los Alamos National Laboratory, which plays a key role in the Department's missions by supporting a wide range of scientific research and development initiatives for national and energy security programs.

Benefits

The facilities at Technical Areas (TA) -3, -35, -48 and -55 provide unique national actinide capabilities in the areas of analytical chemistry, materials characterization, chemical diagnostics, radiochemistry, and applied spectroscopy.

Detailed Justification

	(dollars in thousands)		
	FY 2008	FY 2009	FY 2010
Los Alamos National Laboratory	**0**	**12,500**	**0**

Based on FY 2009 Congressional direction, funding in the amount of $12,500,000 is applied to the following priority activities at TA-3, -35, -48 and -55:

- Address critical deficiencies in building structures, systems and components that are credited to the facilities' operations and safety bases;
- Perform maintenance and end-of-life replacement of critical equipment and infrastructure to assure that the facilities continue to meet Departmental safety standards and required operational reliability;
- Maintain facility management practices to meet current Departmental requirements, including preparing safety documentation and supporting technical safety analyses, managing nuclear material inventories, enhancing worker protection programs, and training staff;
- Conduct corrective and routine preventive maintenance on nuclear safety and facility support components and equipment within building systems; and
- Complete equipment removal/relocation and associated decontamination and disposal.

Explanation of Funding Changes

	FY 2010 vs. FY 2009 ($000)
Los Alamos National Laboratory	
The decrease from $12,500,000 to $0 reflects the elimination of the Congressionally directed funding. No funding is requested in FY 2010 for these activities.	-12,500
Total, Los Alamos National Laboratory	-12,500

Pu-238 Production Project

Funding Schedule by Activity

	(dollars in thousands)		
	FY 2008	FY 2009	FY 2010
Pu-238 Production Project			
Pu-238 Production Project	0	0	30,000
Total, Pu-238 Production Project	0	0	30,000

Description

The Department has an ongoing program to produce radioisotope power systems that rely on Plutonium (Pu)-238 as an energy source. The capabilities necessary for developing these systems are funded within the Office of Nuclear Energy's Space and Defense Infrastructure Program. This Pu-238 Production Project will re-establish a domestic capability to produce Pu-238 for use in radioisotope power systems (RPSs) required by certain National Aeronautics and Space Administration (NASA) space missions and national security applications. The project will be conducted in accordance with DOE Order 413.3A and will re-establish the capability to fabricate neptunium-237 targets, to irradiate the targets in existing DOE nuclear reactors, and to recover Pu-238 from the irradiated targets through chemical extraction.

Existing supplies of Pu-238 are limited. Additional Pu-238 will be needed within the next decade to meet NASA and national security users' longer-term demand. It is expected that it will take up to 7 years to re-establish full domestic production. To ensure adequate Pu-238 is available to meet user agencies requirement, the project is being initiated in FY 2010.

Benefits

Pu-238-based RPS's are needed for certain NASA and national security applications where other power sources, such as batteries, fuel cells, and solar technologies, are not economical or technologically viable. Ensuring adequate supply will enable NASA to continue deep space missions, resulting in scientific discoveries, possibilities, and opportunities to investigate rare solar system events such as comet-planetary interactions. It would also maintain the availability of RPS's for national security user activities.

Detailed Justification

	(dollars in thousands)		
	FY 2008	FY 2009	FY 2010
Pu-238 Production Project	**0**	**0**	**30,000**
▪ **Pu-238 Production Project**	**0**	**0**	**30,000**

There is an urgent need to begin production of Pu-238 to minimize the impact on NASA's planning activities for space exploration. The restart project is anticipated to take 7 years to complete, resulting in the national capability to produce 5kg of Pu-238 on an annual basis.

The majority of FY 2010 funding will be used to complete Definition Phase activities including preparing National Environmental Policy Act (NEPA) documentation and developing alternatives analyses, conceptual designs, and other DOE O 413.3A requirements needed to obtain CD-1 decision (at least $25 million).

Given that DOE has produced Pu-238 in small quantities in the past at existing facilities, minimal funding will be used to update these processes including: initiating target fabrication using existing laboratory facilities and equipment; initiating initial target irradiations in the Advanced Test Reactor and High Flux Reactor; and using existing laboratory facilities and equipment to finalize separations flowsheets (no more than $5 million). Engineering design requirements for process equipment that are independent of the alternative selected at CD-1 will be developed and long-lead procurements identified. No equipment or facilities will be upgraded (other than what may be necessary for security purposes) until after CD-1 has been achieved.

The completion of these activities will support the approval of CD-1 in FY 2011 and position the project to quickly move forward and obtain CD-2.

Total, Pu-238 Production Project	**0**	**0**	**30,000**

Explanation of Funding Changes

	FY 2010 vs. FY 2009 ($000)
Pu-238 Production Project	
▪ **Pu-238 Production** The increase from $0 to $30,000,000 is for the acquisition of a Pu-238 production capability. The project is anticipated to be conducted over a period of 7 years resulting in the domestic capability to produce 5kg of Pu-238 on an annual basis.	+30,000
Total, Pu-238 Production Project	**+30,000**

Idaho Facilities Management

Funding Profile by Subprogram

(dollars in thousands)

	FY 2008 Current Appropriation	FY 2009 Original Appropriation	FY 2010 Request
Idaho Facilities Management	115,935	140,000	203,402

Public Law Authorizations:
P.L. 110-161, The Consolidated Appropriations Act, 2008
P.L. 111-8, Omnibus Appropriations Act, 2009

Mission

The mission of the Idaho Facilities Management (IFM) program is to manage the planning, acquisition, operation, maintenance, and disposition of nuclear facilities and resources at the Idaho National Laboratory (INL). The IFM program maintains Department of Energy (DOE) mission-supporting facilities and resources at INL in a safe, compliant status to support the Department's nuclear energy research, the Space and Defense Power Systems program, testing of naval reactor fuels and reactor core components, and range of national security technology programs that support the National Nuclear Security Administration (NNSA) and other Federal agencies such as the Department of Homeland Security in the areas of critical infrastructure protection and nuclear nonproliferation.

Benefits

The IFM program ensures that the Department's nuclear facilities and equipment are properly maintained and operated such that they are safe, compliant, and able to support mission needs and other priorities. Key activities include operation of the Advanced Test Reactor (ATR), management of all special nuclear materials contained in these facilities and the disposition of Nuclear Energy (NE) owned materials and support for university research reactors.

Climate Change Technology Program Benefits

Nuclear energy is a low-carbon energy source. IFM maintains infrastructure needed to support research on nuclear technologies.

Contribution to the Secretary's Priorities

PRIORITY 1: Science and Discovery:
Invest in science to achieve transformational discoveries.

1. Organize and focus on breakthrough science

    - Re-energize the national labs as centers of great science and innovation

Contribution to GPRA Unit Program Goal 1.2.15.00 (Maintain and Enhance National Nuclear Infrastructure)

The Idaho Facilities Management program contributes to this goal by ensuring that the INL facilities are maintained and operated such that they are safe, compliant, and able to support mission needs and other priorities. Key activities include managing all special nuclear materials contained in these facilities and the disposition of DOE materials under NE ownership, and providing support for university research reactors through fuel management and upgrading control system.

Means and Strategies

The IFM program will use various means and strategies to achieve its GPRA Unit Program goal. 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:

- Ensure that mission essential systems, resources, and services are identified, maintained, and operated in compliance with DOE, Federal, and State safety and environmental requirements in a secure and cost-effective manner.

- Implement contracting reforms, including fixed price competitive bidding, earned value management, capital planning processes in accord with DOE Order 413.3A, independent external evaluations, etc., to ensure that the infrastructure program is operating effectively and efficiently to meet the Department's highest priority program needs.

The Department will implement the following strategies:

- Partnering with the private sector, national laboratories, universities, and international partners to research and develop advanced nuclear power systems and waste management and storage technologies.

- Working with the international community in pursuit of technological advancements that will benefit the U.S. with enhanced safety, improved economics, and reduced production of wastes.

- Meet periodically throughout the year with INL, Nuclear Regulatory Commission (NRC), NNSA and the Test, Research, and Training Reactor Management Group to review university research reactor activities; discuss program issues; and solicit input, advice and guidance.

These strategies will result in the efficient and effective management of the program - thus putting the taxpayer's dollars to more productive use.

The following external factors could affect the program's ability to achieve its strategic goal:

- Changes in nuclear energy research and development (R&D) progress could possibly impact priorities within the IFM program, but not necessarily impact its overall costs and long-term liabilities.

In carrying out the program's mission, NE performs the following collaborative activities:

- Coordinates with the NNSA to convert university research reactors using highly enriched uranium fuel to low enriched uranium fuel.

Validation and Verification

NE conducts various internal and external reviews and audits to validate and verify program performance. Periodic program reviews evaluate progress against established plans. NE holds monthly, quarterly, semi-annual, and annual reviews, consistent with program management plans and project baselines, to ensure technical progress, cost, schedule adherence, and responsiveness to program requirements.

NE's programmatic activities are also subject to periodic external reviews by Congress, GAO, the Department's Inspector General, NRC, the U.S. Environmental Protection Agency, state environmental and health agencies, and the Department's Office of Engineering and Construction Management. In addition, NE solicits the advice and counsel of external agencies such as Nuclear Energy Advisory Committee and National Academy of Sciences.

Annual Performance Results and Targets

FY 2005 Results	FY 2006 Results	FY 2007 Results	FY 2008 Targets	FY 2009 Targets	FY 2010 Targets

GPRA Unit Program Goal 1.2.15.00 (Maintain and Enhance National Nuclear Infrastructure)

Idaho Facilities Management

Consistent with safe operations, achieve cumulative variance of less than 10 percent from each of the cost and schedule baselines for the Idaho Facilities Management programs. (MET TARGET)	*Consistent with safe operations, achieve cumulative variance of less than 10 percent from each of the cost and schedule baselines for the Idaho Facilities Management programs. (MET TARGET)*	*Consistent with safe operations, achieve cumulative variance of less than 10 percent from each of the cost and schedule baselines for the Idaho Facilities Management programs. (MET TARGET)*	*To ensure unique nuclear facilities are available to support critical Departmental missions, achieve cumulative variance of less than 10 percent from cost and schedule baselines at Idaho National Laboratory for Idaho Facilities Management program facilities and activities consistent with safe operations. (MET TARGET)*	*To ensure unique nuclear facilities are available to support critical Departmental missions, achieve cumulative variance of less than 10 percent from cost and schedule baselines at Idaho National Laboratory for Idaho Facilities Management program facilities and activities consistent with safe operations.*	*To ensure unique nuclear facilities are available to support critical Departmental missions, achieve cumulative variance of less than 10 percent from cost and schedule baselines at Idaho National Laboratory for Idaho Facilities Management program facilities and activities consistent with safe operations.*
Keep cost and schedule milestones for upgrades and construction of key nuclear facilities within 10 percent of approved baselines, using the cost-weighted mean percent variance (+/-10 percent) approach.. (MET TARGET)	Keep cost and schedule milestones for upgrades and construction of key nuclear facilities within 10 percent of approved baselines, using the cost-weighted mean percent variance (+/-10 percent) approach. (MET TARGET)	Maintain operability of key Idaho Facilities Management-funded facilities to enable accomplishment of Nuclear Energy, other DOE and Work-for-Others milestones by achieving a Facility Operability Index of 0.9 or greater. (MET TARGET)	To ensure unique nuclear facilities are available to support critical Departmental missions, maintain a facility operability index of 0.9 for key Idaho Facilities Management program facilities. *(MET TARGET)*	To ensure unique nuclear facilities are available to support critical Departmental missions, maintain a facility operability index of 0.9 for key Idaho Facilities Management and program facilities.	To ensure unique nuclear facilities are available to support critical Departmental missions, maintain a facility operability index of 0.9 for key Idaho Facilities Management and program facilities.

Idaho Facilities Management

Funding Schedule by Activity

	FY 2008	FY 2009	FY 2010
	(dollars in thousands)		
Idaho Facilities Management			
INL Nuclear Research Reactor Operations and Maintenance	38,887	50,717	58,537
INL Non-Reactor Nuclear Research Facility Operations and Maintenance	52,935	41,238	44,246
INL Engineering and Support Facility Operations and Maintenance	0	14,369	15,914
National Scientific User Facility	0	3,559	3,637
INL Regulatory Compliance	6,800	10,467	6,672
INL Facility Infrastructure Revitalization Program (IFIRP)	14,863	17,200	24,696
Radiological and Environmental Sciences Laboratory	2,450	2,450	0
Research Reactor Infrastructure	0	0	4,700
Contractor Defined-Benefit Pension Plans	0	0	45,000
Total, Idaho Facilities Management	115,935	140,000	203,402

Description

The IFM program operates and maintains the following three main engineering and research campuses at INL that are direct funded by NE: (1) the ATR Complex that includes the ATR and its supporting infrastructure, (2) the Materials and Fuels Complex (MFC), and (3) the Research and Education Campus.

Beginning in FY 2010, the Research Reactor Infrastructure program will be implemented through the INL. The program provides fresh reactor fuel to and removes spent fuel from university reactors and supports the continued operation of university research reactors providing universities with test reactor capability for research and development and educational opportunities in support of U.S. nuclear energy initiatives. Also beginning in FY 2010, the Radiological and Environmental Sciences Laboratory (RESL) will be funded through NE's Program Direction subprogram.

Benefits

The IFM program ensures that the Department's nuclear facilities and equipment are maintained and operated in a safe and compliant manner such that they are able to support mission needs and other priorities. Other key activities include operating the ATR, managing all special nuclear materials contained in these facilities and the disposition of NE-owned materials, and supporting university research reactors.

Detailed Justification

	(dollars in thousands)		
	FY 2008	FY 2009	FY 2010
Idaho Facilities Management	**115,935**	**140,000**	**203,402**

The INL Ten Year Site Plan (TYSP) outlines a strategy for the IFM Program based upon program research needs and priorities for Department nuclear energy programs, Naval Reactors, and a range of national security technology programs that support critical infrastructure protection and nuclear non-proliferation. The INL TYSP meets the requirement of DOE Order 430.1B, *Real Property Asset Management*. Every six months the plan is reviewed and revised if needed.

In FY 2010, priorities include ensuring facilities are available to conduct post-irradiation examination of ATR experiments and fuel and materials development. In addition, the program continues to fund routine maintenance to assure the programmatic facilities and equipment can be operated safely and reliably. The IFM program maintains and operates essential ATR support activities to be available and ready to support ATR operations. As part of the ATR Life Extension Program (LEP), the IFM program conducts Material Condition Assessments to determine remaining functional service life of mission essential plant components and systems and to identify critical spare parts that need to be procured.

▪ **INL Nuclear Research Reactor Operations and Maintenance**	**38,887**	**50,717**	**58,537**

This category supports nuclear research reactor operations and maintenance at the INL site for the ATR and supporting infrastructure, ATR Critical Facility (ATRC), and Neutron Radiography Reactor (NRAD).

The primary reactor at INL is the ATR. ATR supports the majority of NE R&D programs as well as NNSA programs, including Naval Reactors Program work in support of the U.S. Navy nuclear fleet and Global Threat Reduction Initiatives to support conversion of research and test reactors to low-enriched uranium fuel. The ATR also supports universities and industry users. Programmatic work is funded by the sponsoring programs. The cost to users depends upon the demands on the reactor and the nature of the user in accordance with DOE regulations. In FY 2009, key planned accomplishments include: completed the design of maintenance upgrades to the ATR control and console display systems to correct degrading reliability in these essential systems; completed the refurbishment of a ATR back-up diesel generator; completed the irradiation of experiments for the NNSA's Offices of Naval Reactors and Defense Nuclear Nonproliferation and production of Cobalt-60 (Co-60) for commercial use in industrial radiography sources.

In FY 2010, $58,537,000 is requested for the following reactor activities:

- ATR operations and maintenance includes funding for five reactor crews; operations management; consumable materials and supplies; critical facility operations; test sponsor engineering and safety; reactor systems engineering; project management; safety basis; training; document control; quality assurance; new fuel purchases and core component change out purchases; new nuclear material inspection and storage; radiological controls planning; safety oversight; environment, safety and health; and personnel, materials and services required to maintain all of the 54 buildings and structures, utilities, and grounds within the perimeter fence at the ATR site. Funding also provides support for ATR Resin Disposition to address short-term waste management needs for the disposition of remote-handled low-level waste (RH-LLW) resins for the ATR at the Nevada Test Site (NTS) until a long-term disposal solution for RH-LLW is developed.

(dollars in thousands)

- Maintenance and Repair of ATR and the surrounding complex includes the cost of personnel, materials and services required to maintain the buildings, equipment, structures, utilities, and grounds. ATR has extensive system surveillance and maintenance requirements that are dictated by component manufacturers, Technical Specifications and Requirements and local procedures. In FY 2010, the ATR operations program will complete scheduled maintenance activities for the ATR Complex, consistent with established requirements.
- ATR Life Extension program restores outdated systems and documentation essential to maintaining performance and reliability to extend operation at a small fraction of the reactor's replacement cost. Although over forty years old, the ATR has the potential for an extremely long operating life due to its unique design that allows extensive replacement of neutron-damaged components on an approximately seven year cycle. In FY 2010, the ATR digital control and console display systems and the 30-ton crane which are obsolete, deteriorating and no longer supportable will be replaced.
- ATR Safety Margin Improvement program supports specific improvements to reactor systems that will provide increased safe and reliable responses to potential accidents and establish selected system capabilities at ATR, similar to those at commercial nuclear plants. In FY 2010, funding provides for conceptual design and mission need statements for pre conceptual design phase on improvements such as (1) improved emergency core cooling system capability; (2) improved containment and ventilation systems; (3) control room habitability during postulated accidents; and (4) improved overall response during loss of coolant accidents and loss of flow accidents.
- NRAD and ATRC reactors operations and maintenance activities including preventative and corrective maintenance on reactor systems, maintaining safety basis documentation, and training and qualification activities for reactor operators.

	FY 2008	FY 2009	FY 2010
▪ **INL Non-Reactor Nuclear Research Facility Operations and Maintenance**	**52,935**	**41,238**	**44,246**

This category funds operations, maintenance, and support for non-reactor nuclear research facilities, radiological facilities, and documented safety analysis upgrade implementation for non-reactor nuclear and radiological facilities at INL, primarily at the MFC. The non-reactor nuclear research facilities support programmatic activities such as nuclear fuel development, separations development, pre- and post-irradiation fuel examinations, radiological chemical analysis. In FY 2009, key planned accomplishments include: completion of documented safety analyses (DSA) upgrades for Hot Fuels Examination Facility (HFEF) and Fuel Conditioning Facility (FCF)

	(dollars in thousands)	
FY 2008	FY 2009	FY 2010

consistent with DSA, including the installation of new seismically qualified racks for storage of special nuclear material; completion of upgrades at Radioactive Scrap and Waste Facility (RSWF) to support improved retrieval of remote-handled waste for disposal; and offsite shipments of 300 kg of surplus special nuclear material.

In FY2010, $44,246,000 is provided for the following activities:

- Non-reactor nuclear facilities operations and support include manning the control rooms and facilities; providing qualified Criticality Safety Officers and Material Balance Custodians, where needed; prioritizing and supporting maintenance and modification activities; analyzing and authorizing adjustments to operating parameters and facility operations, when needed; coordinating programmatic work activities; conducting and participating in audits, assessments, and reviews; developing and coordinating action plans; developing and providing nuclear training, quality assurance, document management; systems and safety engineering; environment, safety and health; nuclear materials management and stewardship; and program integration to support effective execution of NE and Environmental Management (EM) activities at the FCF, HFEF, Analytical Laboratory, Space and Security Power Systems Facility, Fuel Manufacturing Facility, Zero Power Physics Reactor, RSWF, and five Resource Conservation and Recovery Act facilities awaiting decontamination and decommissioning.
- Nuclear maintenance and repair includes the cost of personnel, materials and services required to maintain the buildings, equipment, structures, utilities, and grounds within the perimeter fence at the MFC site and other radiological facilities. In FY 2010, activities will focus on specific facility safety system and procedural upgrades to the FCF and HFEF as identified through documented safety analysis upgrades conducted in FY 2009. Examples of these upgrades may include, but not limited to, control system upgrades, heating, ventilating, and air conditioning modifications, seismic structural improvements, and operations and maintenance procedure improvements.

	FY 2008	FY 2009	FY 2010
▪ **INL Engineering and Support Facility Operations and Maintenance**	**0**	**14,369**	**15,914**

This category funds all activities that support non-nuclear work at INL and institutional facility and infrastructure planning activities, consistent with Departmental orders and regulations. In FY 2010, $6,928,000 is provided for IFM Program Planning and Management activities ensure IFM facilities, systems, and management processes are in place to accommodate initiatives in nuclear energy, national security, and basic scientific research in support of key DOE missions.

Key activities include:

- Real property life-cycle asset management;
- Recapitalization activities structured to keep existing facilities modern and relevant in an environment of changing standards and missions, consistent with DOE Order 430.1B requirements;

(dollars in thousands)

- Life-cycle planning to identify essential capital alterations and additions; improvements to land, buildings, and utility systems necessary to maintain INL general purpose infrastructure; common/domestic services infrastructure; and multi-program infrastructure;
- Alternative analyses for accomplishing NE-sponsored activities; and
- Implementation of a systematic real property asset building inspection program and operation and maintenance of the Department's Facility Information Management System and Condition Assessment Information System.

Additionally, $8,986,000 is provided for Idaho Operations Office community regulatory support to meet obligations defined in the following crosscutting agreements and contracts: S.M. Stoller, Payment in Lieu of Taxes, Shoshone-Bannock Tribes, and the National Oceanic and Atmospheric Administration. Beginning in FY 2010, the Office of Health, Safety, and Security will no longer fund background investigation at Idaho. The additional funding will support background investigations conducted by the Federal Bureau of Investigation and the Office of Personnel Management.

	FY 2008	FY 2009	FY 2010
▪ **National Scientific User Facility**	**0**	**3,559**	**3,637**

This category facilitates the optimal use of INL facilities for science-based experiments by non-INL users**.** Key nuclear energy research facilities at the INL were formally designated as a national scientific user facility in April 2007 and include ATR and MFC. This designation allows NE to better engage universities in mission related and educational development experiments as well as other laboratories and industrial users. National Scientific User Facility (NSUF) provides an effective means to optimize ATR activities through maximizing the number of experiments during reactor operating cycles. As a functional structure, NSUF makes available the capability to conduct materials and fuels research needed to extend the life of existing commercial reactors and to move forward with new reactor technology. In FY 2009 the funding was used to conduct three university experiments in the ATR and to support outreach activities to expand the number of partner universities, including the annual NSUF workshop.

The following are the FY 2010 activities associated that are funded in this category:

- Management, administration, and operations to annually solicit, peer-review, award, and support research projects/experiments. These efforts include coordination of research activities, such as irradiation in ATR, post irradiation examination in the HFEF, and related measurements in other laboratories at the INL.
- User community development through workshops and educational programs to attract researchers to INL, and enhance understanding of how to best use the research capabilities available through the NSUF process.
- Implementation of strategic partnerships to make more effective use of multiple research facilities, including non-INL facilities for nuclear research experiments under the NSUF process, and to allow for more focused research experience on complex experiments.

	(dollars in thousands)		
	FY 2008	FY 2009	FY 2010
▪ **INL Regulatory Compliance**	**6,800**	**10,467**	**6,672**

This category supports compliance activities driven by State and Federal environmental and other regulations that are under the purview of NE owner responsibilities. In FY 2009, key accomplishments include: removal of underground waste disposal lines located under Material Test Reactor building as outlined in agreements with the State or Idaho and transitioned key surplus facilities for immediate disposition to EM, including the ATR Hit Cells and Experimental Breeder Reactor-II (EBR-II) reactor containment building.

The FY 2010 funding will support the following activities:

- ATR Voluntary Consent Order to characterize and remediate contaminated tanks and conduct appropriate documentation and training;
- RH-LLW Disposal Project provides operating funds for pre-conceptual design and planning activities to replace the existing on-site disposal capability targeted for closure after 2015;
- RH-Transuranic (TRU) Waste Early Retrieval supports accelerated inventory, packaging and disposition of non-sodium contaminated low-level, mixed low-level, and TRU waste;
- Site Treatment Plan support and EBR-II Resource Conservation and Recovery Act cleanup;
- Low-Level and Mixed Low-Level waste disposal at the NTS; and
- INL Regulatory Compliance management.

▪ **INL Facility Infrastructure Revitalization Program (IFIRP)**	**14,863**	**17,200**	**24,696**

This category restores, rebuilds, and revitalizes the physical INL infrastructure. These projects enhance program execution, satisfy a critical need for improvement to INL infrastructure and make a significant contribution to the overall reduction of complex-wide deferred maintenance and to meeting the Department goal of an Asset Condition Index of at least 0.95. These activities provide critical element that support meeting modern standards for facility operations, as well as providing capabilities that meet current and future program research needs. IFIRP consists of two sub-elements: General Plan Project (GPP) and General Purpose Capital Equipment (GPCE). GPP funding of $21 million in FY 2010 supports projects that integrate construction and equipment upgrades to improve operational capabilities. In FY 2010 planned GPPs are: NRAD and ATRC reactors operations and maintenance activities including preventative and corrective maintenance on reactor systems, maintaining safety basis documentation, and training and qualification activities for reactor operators.

- MFC Technical Support Building to provide necessary office space for NSUF employees by consolidating personnel into a replacement building, reducing deferred maintenance backlogs;
- ATR Dial Room Replacement required to replace antiquated equipment;
- ATR Complex Revitalization activities to conduct multiple deferred maintenance projects across the ATR campus;

(dollars in thousands)

- Building IF-608 Power system upgrade and Installation of Uninterrupted Power Supply to enhance the reliability of antiquated equipment needed to support the Information Operations and Resource Center;
- ATR Complex Evaporation Liner Replacement Project to address deferred maintenance; and
- MFC Nuclear Facility Revitalization to conduct multiple deferred maintenance projects across the MFC campus.

GPCE is being performed in accordance with the approved INL GPCE Five Year Acquisition Plan. FY 2010 funding of approximately $3.4 million supports the purchase of priority equipment including an analytical laboratory remote manipulator, a 25 ton lift truck at MFC, and heat exchanger replacement equipment at ATR.

	FY 2008	FY 2009	FY 2010
▪ **Radiological and Environmental Sciences Laboratory**	**2,450**	**2,450**	**0**

Funding for RESL, a government-owned, government-operated laboratory, is moved to the Program Direction Account starting in FY 2010 to be consistent with funding practices for federally staffed facilities.

	FY 2008	FY 2009	FY 2010
▪ **Research Reactor Infrastructure**	**0**	**0**	**4,700**

Information on FY 2008 and FY 2009 accomplishments for this program can be found under Radiological Facilities Management program. In FY 2010, the Research Reactor Infrastructure program is included in the IFM program. The Department provides fresh reactor fuel to and removes spent fuel from university reactors. Currently, there are 26 operating university research reactors at 26 institutions in the U.S. Many of these facilities have permanent fuel cores and, therefore, do not require regular fuel shipments. However, DOE supplies approximately a dozen universities with fresh fuel and shipments of spent fuel as needed. This program, implemented through the INL, supports the continued operation of university research reactors providing a test reactor capability for research, development, and educational opportunities in support of U.S. nuclear energy initiatives.

FY 2010 funding will purchase fresh fuel for two to four university reactors (as needed) and subsequently support the operation of the last remaining university reactor fuel fabrication suppliers, including maintaining and/or replacing equipment used in support of university fuel fabrication activities that are at or near the end of service life.

This funding also supports the shipment of spent fuel to DOE facilities for storage. DOE seeks to remove all Highly Enriched Uranium (HEU) fuel from universities as soon as possible and to minimize the accumulation of Low Enriched Uranium (LEU) replacement fuel at universities. At this level of funding, one HEU spent fuel shipment from the remaining converted university research reactor will occur, and three to five HEU/LEU spent fuel shipments from other non-conversion reactors will occur in support of continued operations or facility needs consistent with the GAO, NRC, and DOE security and material control and accountability objectives.

Finally, the funding will support the procurement and implementation of a new spent fuel shipping container that complies with updated NRC and Department of Transportation regulations.

	FY 2008	FY 2009	FY 2010
▪ **Contractor Defined-Benefit Pension Plans**	**0**	**0**	**45,000**
Total, Idaho Facilities Management	**115,935**	**140,000**	**203,402**

Explanation of Funding Changes

	FY 2010 vs. FY 2009 ($000)
INL Operations and Infrastructure	
▪ **INL Nuclear Research Reactor Operations and Maintenance** The increase from $50,717,000 to $58,537,000 reflects: (1) an increase of $5,120,000 for ATR Safety Margin Improvement Projects for pre-conceptual and conceptual design work for the ATR primary coolant system and other operational funded related activities; (2) an increase of $2,700,000 for ATR experiments and research capabilities to initiate planning for an ATR core and plant computer modeling capability as well as review of existing National Environmental Policy Act documentation against proposed future capabilities at ATR..	+7,820
▪ **INL Non-Reactor Nuclear Research Facility Operations and Maintenance** The increase from $41,238,000 to $44,246,000 reflects an increase of $3,008,000 supports installation and testing of the Irradiated assisted Stress Corrosion Cracking Test Rig and improved Conduct of Operations efforts at MFC, targeted on staffing and improved training and surveillance programs consistent with documented safety analysis requirements, as well as escalation.	+3,008
▪ **INL Engineering and Support Facility Operations and Maintenance** The increase from $14,369,000 to $15,914,000 is based on (1) an increase due to escalation; (2) In FY 2010, the Office of Health, Safety, and Security will no longer fund background investigations at Idaho and additional funds are needed to this activity.	+1,545
▪ **National Scientific User Facility** The increase from $3,559,000 to $3,637,000 reflects an increase due to escalation.	+78
▪ **INL Regulatory Compliance** The decrease from $10,467,000 to $6,672,000 reflects a reduction based on completion of TRU early action work, offset by increases to support pre-conceptual design and planning activities for the RH-LLW Disposal Project.	-3,795

	FY 2010 vs. FY 2009 ($000)
▪ **Idaho Facility Infrastructure Revitalization Program/General Purpose Capital Equipment** The increase from $17,200,000 to $24,696,000 reflects a net increase based on (1) the start of MFC Technical Support Building to address deferred maintenance backlogs through consolidating personnel from existing facilities into a new replacement facility; (2) the start of ATR Complex Revitalization activities to conduct multiple deferred maintenance projects across the ATR campus; (3) ATR Complex Evaporation Liner Replacement Project to address deferred maintenance.	+7,496
▪ **Radiological and Environmental Sciences Laboratory (RESL)** The decrease from $2,450,000 to $0 reflects the transfer of RESL funding to Program Direction starting in FY 2010.	-2,450
▪ **Research Reactor Infrastructure** The increase of $4,700,000 in FY 2010 reflects the transfer of the Research Reactor Infrastructure program from Radiological Management Program to the IFM program in FY 2010.	+4,700
▪ **Contractor Defined-Benefit Pension Plans**	+45,000
Total Funding Change, Idaho Facilities Management	**+63,402**

Capital Operating Expenses and Construction Summary

Capital Operating Expenses

(dollars in thousands)

	FY 2008	FY 2009	FY 2010
General Plant Projects (Revitalization) & Deferred Maintenance Reduction (IFIRP)	14,863	17,200	24,696
Total, Capital Operating Expenses	14,863	17,200	24,696

Program Direction

Funding Profile by Category

(dollars in thousands/whole FTEs)

	FY 2008	FY 2009	FY 2010
Idaho Operations Office			
Salaries and Benefits	25,400	25,565	27,099
Travel	1,150	996	996
Support Services	1,050	1,004	1,015
Other Related Expenses	5,076	5,111	5,404
Total, Idaho Operations Office	32,676	32,676	34,514
Full Time Equivalents	197	197	197
Radiological and Environmental Sciences Laboratory			
Salaries and Benefits	2,325	2,440	2,585
Travel	65	65	65
Support Services	0	0	258
Other Related Expenses	384	394	2,579
Total, Radiological and Environmental Sciences Laboratory	2,774[a]	2,899	5,487
Full Time Equivalents	19	19	19
Oak Ridge Operations Office			
Salaries and Benefits	1,850	955	1,000
Travel	25	20	20
Support Services	46	50	51
Other Related Expenses	268	265	282
Total, Oak Ridge Operations Office	2,189	1,290[b]	1,353
Full Time Equivalents	14	8	8
Headquarters			
Salaries and Benefits	28,432	24,314	25,492
Travel	1,560	1,200	1,200

[a] FY 2008 and beyond includes funding for program direction expenses and 19 FTEs previously funded by the former Office of Environment, Safety and Health.

[b] Beginning in FY 2009, 6 FTEs and funding will be transferred to the Office of Science to support the High Flux Isotope Reactor.

	(dollars in thousands/whole FTEs)		
	FY 2008	FY 2009	FY 2010
Support Services	7,365	3,971	3,052
Other Related Expenses	5,876	6,650	6,774
Total, Headquarters	43,233[a]	36,135[b]	36,518
Full Time Equivalents	189	171	160
Total Program Direction			
Salaries and Benefits	58,007	53,274	56,176
Travel	2,800	2,281	2,281
Support Services	8,461	5,025	4,376
Other Related Expenses	11,604	12,420	15,039
Total, Program Direction	80,872	73,000	77,872
Total, Full Time Equivalents	419	395	384

Mission

Program Direction provides the federal staffing resources and associated costs required to provide overall direction and execution of the Office of Nuclear Energy (NE).

In addition to appropriated funds, NE also manages over $118 million dollars annually in work for others and reimbursable funding. This includes over $40 million annually from the National Aeronautics and Space Administration and the Department of Defense for the development of advanced radioisotope power systems for space exploration and national security missions.

Detailed Justification

	(dollars in thousands)		
	FY 2008	FY 2009	FY 2010
Salaries and Benefits	**58,007**	**53,274**	**56,176**

This account provides funding to support the salaries and benefits of the personnel associated with NE programs. Currently 25 percent of the workforce is eligible to retire and an additional 5 percent will be eligible by the end of FY 2010. Over the past several years, NE has been trying to address the issue of an aging workforce through the recruitment of entry-level engineering, scientific, and administrative positions. In addition to the Headquarters staff, NE funds field employees at the Idaho Operation Office (197), the Radiological and Environmental Sciences Laboratory (RESL) in Idaho (19), the Oak Ridge Operations Office (8), and three employees who support the U.S. Mission to the Organization for Economic Cooperation and Development (1); U.S. Mission to International Organization in Vienna (1); and the Department of Energy Tokyo Office (1). In FY 2009, 16 FTEs and funds for the Mixed Oxide

[a] Includes funding for 16 FTEs for the MOX Facility /Fissile Materials Disposition program.
[b] Beginning in FY 2009, 2 FTEs and funding will be transferred to the Office of Science to support the Medical Isotope program.

	(dollars in thousands)		
	FY 2008	FY 2009	FY 2010

Fuel Fabrication Facility/Fissile Materials Disposition program were transferred back to the National Nuclear Security Administration (NNSA). In addition, in FY 2009 the Office of Science will fund 6 FTEs at the Oak Ridge Operations Office associated with the management of the High Flux Isotope Reactor and 2 FTEs associated with the Medical Isotope Program.

	FY 2008	FY 2009	FY 2010
Travel	**2,800**	**2,281**	**2,281**

Travel includes funding for transportation of Headquarters and Operations Office personnel associated with NE programs, their per diem allowances while in authorized travel status, and other expenses incidental to travel.

	FY 2008	FY 2009	FY 2010
Support Services	**8,461**	**5,025**	**4,376**

Support Services includes funding for technical and management support services provided to NE Headquarters and the Operations Offices. The use of support services allows the Department to hire the best available industry experts to assist federal staff in managing the nuclear programs and complex activities. In addition to rapidly acquiring this expertise, using support services provides unlimited flexibility in team composition as the needs of NE evolve.

	FY 2008	FY 2009	FY 2010
Other Related Expenses	**11,604**	**12,420**	**15,039**

The major expenditure in the Other Related Expenses category in FY 2010 is $4,439,000 for the Headquarters Working Capital Fund (WFC). The WCF provides funding for mandatory administrative costs, such as: building occupancy and telephone services; copying, printing and graphics; networking, desktop support; procurement management; payroll and personnel; corporate training services; and the project management career development program. The Other Related Expense category also includes support for NE's federal advisory committee, training, as well as the housing, office communications, supplies, miscellaneous expenses and International Cooperative Administrative Support Services (ICASS) expenses associated with the three employees assigned overseas. Beginning in FY 2010 this account includes funds associated with the operation of Radiological and Environmental Sciences Laboratory (RESL) which was previously funded under Idaho Facilities Management. Funding these expenses in Program Direction allows NE to be consistent with funding practices for federally staffed facilities. The increase in FY 2010 is primarily associated with the increase the WCF and the inclusion of support activities for RESL.

	FY 2008	FY 2009	FY 2010
Total, Program Direction	**80,872**	**73,000**	**77,872**

Explanation of Funding Changes

	FY 2010 vs. FY 2009 ($000)
Salaries and Benefits	
The increase from $53,274,000 to $56,176,000 reflects additional funds for promotions, awards, and within-grade salary increases; (+$2,902,000).	+2,902

	FY 2010 vs. FY 2009 ($000)
Support Services The decrease from $5,025,000 to $4,376,000 is primarily due to the decrease in support required at HQ for NE programs ($-907,000) offset by the inclusion of support activities for RESL (+258,000)	-649
Other Related Expenses The increase from $12,420,000 to $15,039,000 is due to an increase in WCF costs (+$365,000); inclusion of expenses associated with RESL (+$2,185,000), increase in cost of services at Idaho and Oak Ridge (+310,000), offset by a reduction in HQ expenses of ($241,000)	+2,619
Total Funding Change, Program Direction	**+4,872**

Support Services by Category

(dollars in thousands)

	FY 2008	FY 2009	FY 2010
Technical Support			
Feasibility of Design Considerations	1,200	932	500
Development of Specifications	900	390	300
Economic and Environmental Analyses	430	300	280
Surveys Or Reviews of Technical Operations	1,415	528	500
Total, Technical Support	3,945	2,150	1,580
Management Support			
Automated Data Processing	1,775	1,400	1,596
Manpower Systems Analyses	400	200	100
Preparation of Program Plans	400	150	100
Training and Education	350	125	100
Reports and Analyses Management and General Administrative Services	1,591	1,000	900
Total, Management Support	4,516	2,875	2,796
Total, Support Services	8,461	5,025	4,376

Other Related Expenses by Category

	(dollars in thousands)		
	FY 2008	FY 2009	FY 2010
Other Related Expenses			
Working Capital Fund	3,488	4,074	4,439
Advisory and Assistance Services	200	100	150
Operations and Maintenance of Equipment	2,567	2,212	2,683
Printing and Reproduction	52	53	55
Training	424	374	387
Rent and Utilities	9	10	64
Communications, Utilities, Misc.	1,281	1,261	1,305
Supplies and Materials	448	636	1,054
Other Services	3,135	3,700	4,902
Total, Other Related Expenses	11,604	12,420	15,039

Congressionally Directed Projects

Funding Profile by Subprogram

	(dollars in thousands)		
	FY 2008	FY 2009	FY 2010
Congressionally Directed Projects	0	2,855	0

Description

The FY 2009 Omnibus Act included one Congressionally directed project within the Office of Nuclear Energy. This unrequested funding was appropriated as a separate funding line although specific activities may relate to nuclear energy technologies.

Detailed Justification

	(dollars in thousands)		
	FY 2008 *(non-add)*	FY 2009	FY 2010
Congressionally Directed Projects			
▪ Technologies Ventures Corporation (NM)	**(3,000)**	**2,855**	**0**

Funding was earmarked for Technologies Ventures Corporation (TVC) to assist a group of nuclear energy technology entrepreneurs with the development of their business case and funding proposal to facilitate equity investment in those ventures.

Explanation of Funding Changes

	FY 2010 vs. FY 2009 ($000)
Congressionally Directed Projects	
No funding requested	-2,855
Total, Congressionally Directed Projects	**-2,855**

GENERAL PROVISIONS

Sec. 301. Contract Competition.
(a) None of the funds in this or any other appropriations Act for fiscal year [2009] *2010* or any previous fiscal year may be used to make payments for a noncompetitive management and operating contract, or a contract for environmental remediation or waste management in excess of $100,000,000 in annual funding at a current or former management and operating contract site or facility, or to award a significant extension or expansion to an existing management and operating contract, or other contract covered by this section, unless such contract is awarded using competitive procedures or the Secretary of Energy grants, on a case-by-case basis, a waiver to allow for such a deviation. The Secretary may not delegate the authority to grant such a waiver.
(b) Within 30 days of formally notifying an incumbent contractor that the Secretary intends to grant such a waiver, the Secretary shall submit to the Subcommittees on Energy and Water Development of the Committees on Appropriations of the House of Representatives and the Senate a report notifying the Subcommittees of the waiver and setting forth, in specificity, the substantive reasons why the Secretary believes the requirement for competition should be waived for this particular award.
(c) In this section the term ``competitive procedures'' has the meaning provided in section 4 of the Office of Federal Procurement Policy Act (41 U.S.C. 403) and includes procedures described in section 303 of the Federal Property and Administrative Services Act of 1949 (41 U.S.C. 253) other than a procedure that solicits a proposal from only one source.
Sec. 302. Unfunded Requests for Proposals. None of the funds appropriated by this Act may be used to prepare or initiate Requests For Proposals (RFPs) for a program if the program has not been funded by Congress.
Sec. 303. Department of Energy Defense Nuclear Facilities Workforce Restructuring. None of the funds appropriated by this Act may be used--
(1) to augment the funds made available for obligation by this Act for severance payments and other benefits and community assistance grants under section 4604 of the Atomic Energy Defense Act (50 U.S.C. 2704) unless the Department of Energy submits a reprogramming [request]*notice* to the appropriate congressional committees; or
(2) to provide enhanced severance payments or other benefits for employees of the Department of Energy under such section; or
(3) develop or implement a workforce restructuring plan that covers employees of the Department of Energy.
Sec. 304. Unexpended Balances. 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. 305. Bonneville Power Authority Service Territory. 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. 306. User Facilities. 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. 307. Intelligence Activities. 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 [2009] *2010* until the enactment of the Intelligence Authorization Act for fiscal year [2009] *2010*.

Sec. 308. Laboratory Directed Research and Development. Of the funds made available by the Department of Energy for activities at government-owned, contractor-operated laboratories funded in this Act or subsequent Energy and Water Development Appropriations Acts, the Secretary may authorize a specific amount, not to exceed 8 percent of such funds, to be used by such laboratories for laboratory directed research and development: *Provided*, That the Secretary may also authorize a specific amount not to exceed 4 percent of such funds, to be used by the plant manager of a covered nuclear weapons production plant or the manager of the Nevada Site Office for plant or site directed research and development[: *Provided further*, That notwithstanding Department of Energy order 413.2A, dated January 8, 2001, beginning in fiscal year 2006 and thereafter, all DOE laboratories may be eligible for laboratory directed research and development funding].

[Sec. 309. Reliable Replacement Warhead. None of the funds provided in this Act shall be available for the Reliable Replacement Warhead (RRW).]

Sec. [310]309. General Plant Projects. Plant or construction projects for which amounts are made available under this and subsequent appropriation Acts with a current estimated cost of less than $10,000,000 are considered for purposes of section 4703 of Public Law 107-314 as a plant project for which the approved total estimated cost does not exceed the minor construction threshold and for purposes of section 4704 of Public Law 107--314 as a construction project with a current estimated cost of less than a minor construction threshold.

[Sec. 311. Energy Production. The Secretary of Energy shall provide funding to the National Academy of Sciences to conduct an inventory of the energy development potential on all lands currently managed by the Department of Energy together with a report, to be submitted not later than July 1, 2009, which includes (1) a detailed analysis of all such resources including oil, gas, coal, solar, wind, geothermal and other renewable resources on such lands, (2) a delineation of the resources presently available for development as well as those potentially available in the future, and (3) an analysis of the environmental impacts associated with any future development including actions

necessary to mitigate negative impacts.]
[Sec. 312.
(a) Reno Hydrogen Fuel Project. The non-Federal share of project costs shall be 20 percent.
(b) The cost of project vehicles, related facilities, and other activities funded from the Federal Transit Administration sections 5307, 5308, 5309, and 5314 program, including the non-Federal share for the FTA funds, is an eligible component of the non-Federal share for this project.
(c) Contribution of the non-Federal share of project costs for all grants made for this project may be deferred until the entire project is completed.
(d) All operations and maintenance costs associated with vehicles, equipment, and facilities utilized for this project are eligible project costs.
(e) This section applies to project appropriations beginning in fiscal year 2004.]
[Sec. 313.
(a) Integrated University Program. The Secretary of Energy, along with the Administrator of the National Nuclear Security Administration and the Chairman of the Nuclear Regulatory Commission, shall establish an Integrated University Program.
(b) For the purposes of carrying out this section, $45,000,000 is authorized to be appropriated in each of fiscal years 2009 to 2019 as follows:
(1) $15,000,000 for the Department of Energy;
(2) $15,000,000 for the Nuclear Regulatory Commission; and
(3) $15,000,000 for the National Nuclear Security Administration.
(c) Of the amounts authorized to carry out this section, $10,000,000 shall be used by each organization to support university research and development in areas relevant to their respective organization's mission, and $5,000,000 shall be used by each organization to support a jointly implemented Nuclear Science and Engineering Grant Program that will support multiyear research projects that do not align with programmatic missions but are critical to maintaining the discipline of nuclear science and engineering.]
Sec. *310. None of the funds made in this or subsequent Acts may be used for the testing of nuclear explosives in the recovery of oil and gas.*
Sec. *311. (a) Section 1801 of the Atomic Energy Act of 1954 (42 U.S.C. 2297g) is amended in subsection (b)(2) by striking "amounts contained within the Fund" and inserting "assessments collected pursuant to section 1802 of the Atomic Energy Act of 1954 (42 U.S.C. 2297g-1) as amended".*
(b) Section 1802 of the Atomic Energy Act of 1954 (42 U.S.C. 2297g-1) is amended:

(1) in subsection (a):

(A) by striking "$518,233,333" and inserting "$663,000,000"; and

(B) by striking "on October 24, 1992" and inserting "with fiscal year 2011".

(2) in subsection (c):

(A) by inserting "(1)" before "The Secretary";

(B) by inserting after "utilities": ", only to the extent provided in advance in appropriation Acts";

(C) by striking "$150,000,000" and inserting "$200,000,000";

(D) by inserting "beginning in fiscal year 2011" after "adjusted for inflation";

(E) by striking "(1)" and inserting "(A)";

(F) by striking "(2)" and inserting "(B)";

(G) by adding a new paragraph 2, ",(2) Amounts authorized to be collected pursuant to this section shall be deposited in the Fund and credited as offsetting receipts."

(3) in subsection (d), by striking "for the period encompassing 15 years after the date of the enactment of this title" and inserting "through fiscal year 2025"; and

(4) in subsection (e):

(A) in paragarph (1), by striking "15 years after the date of the enactment of this title" and inserting "September 30, 2025";

(B) in paragraph (2), by striking "$2,250,000,000" and inserting "$3,000,000,000"; and

(C) in paragraph (2) by inserting "beginning in fiscal year 2011" after "adjusted for inflation".
Sec. 312. 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 Appropriations Acts may hereafter be transferred between such appropriations, but no such appropriation, except as otherwise provided, shall be increased or decreased by more than 5 per centum by any such transfers, and notification of such transfers shall be submitted promptly to the Committees on Appropriations of the House and Senate.(Energy and Water Development and Related Agencies Appropriations Act, 2009.)