U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

Fiscal Year 2011 Congressional Budget

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Energy Efficiency and Renewable Energy

Proposed Appropriation Language

For Department of Energy expenses including the purchase, construction, and acquisition of plant and capital equipment, and other expenses necessary for energy efficiency and renewable energy activities in carrying out the purposes of the Department of Energy Organization Act (42 U.S.C. 7101 et seq.), including the acquisition or condemnation of any real property or any facility or for plant or facility acquisition, construction, or expansion, **[**$2,242,500,000**]** *$2,355,473,000*, to remain available until expended **[**: *Provided*, That funds provided under this heading in this and prior appropriation Acts are available for on-site and off-site improvements for the Ingress/Egress and Traffic Capacity Upgrades project at the National Renewable Energy Laboratory: *Provided further*, That, of the $80,000,000 provided under the wind energy subaccount under Energy Efficiency and Renewable Energy, up to $8,000,000 may be competitively awarded to universities for turbine and equipment purchases for the purposes of studying turbine to turbine wake interaction, wind farm interaction, and wind energy efficiencies, provided that such equipment shall not be used for merchant power production: *Provided further*, That, of the amount appropriated in this paragraph, $292,135,000 shall be used for the projects specified in the table that appears under the heading "Congressionally Directed Energy Efficiency and Renewable Energy Projects" in the joint explanatory statement accompanying the conference report on this Act**]**. *(Energy and Water Development and Related Agencies Appropriations Act, 2010.)*

Explanation of Change

The three provisos are deleted because: 1) No funding is requested for the Ingress/Egress and Traffic Capacity Upgrades project; 2) Funding for this Congressionally Directed activity is not supported in the President’s Budget; and 3) Funding was received for Congressional Directed Projects within the Energy and Water Development and Related Agencies Appropriations Act, 2010.

Energy Efficiency and Renewable Energy

Office of Energy Efficiency and Renewable Energy

Overview

Appropriation Summary by Program

(dollars in thousands)

	FY 2009 Current Appropriation[a]	FY 2009 Current Recovery Act Appropriation	FY 2010 Current Appropriation	FY 2011 Request
Energy Efficiency and Renewable Energy				
Hydrogen and Fuel Cell Technologies	164,638	42,967	174,000	137,000
Biomass and Biorefinery Systems R&D	214,245	777,138[b]	220,000	220,000
Solar Energy	172,414	115,963	247,000	302,398
Wind Energy	54,370	106,932	80,000	122,500
Geothermal Technology	43,322	393,106	44,000	55,000
Water Power	39,082	31,667	50,000	40,488
Vehicle Technologies	267,143	109,249	311,365	325,302
Building Technologies	138,113	319,186	222,000	230,698
Industrial Technologies	88,196	212,854	96,000	100,000
Federal Energy Management Program	22,000	22,388	32,000	42,272
RE-ENERGYSE	0	0	0	50,000
Facilities and Infrastructure	76,000	258,920[b]	19,000	57,500
Weatherization and Intergovernmental Activities	516,000[c]	11,544,500	270,000	385,000
Program Direction	127,620	80,000[d]	140,000	200,008
Program Support	18,157	21,890	45,000	87,307
Congressionally Directed	228,803	0	292,135	0
Advanced Battery Manufacturing	0	1,990,000	0	0
Alternative Fueled Vehicles	0	298,500	0	0
Transportation Electrification	0	398,000	0	0
Information and Communication Efficiency	0	48,647	0	0
Subtotal, Energy Efficiency and Renewable Energy	2,170,103	16,771,907	2,242,500	2,355,473

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[a] SBIR/STTR funding transferred in FY 2009 was $19,327,840 for the SBIR program and $2,347,160 for the STTR program.

[b] Facilities and Infrastructure includes $13.5 million for the Integrated Biorefinery Research Facility.

[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.”

[d] Does not include $4.0 million transfer to Departmental Administration

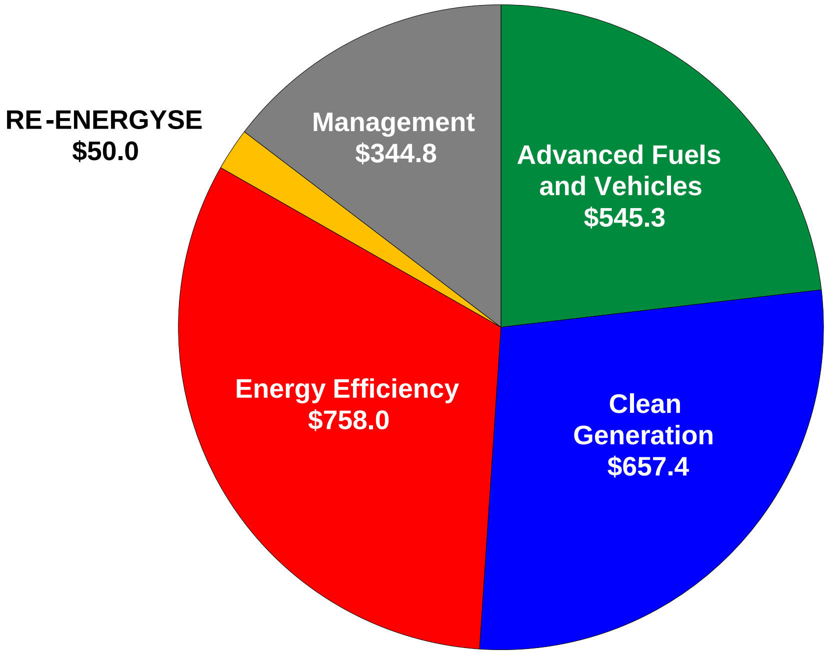
(dollars in thousands)

	FY 2009 Current Appropriation[a]	FY 2009 Current Recovery Act Appropriation	FY 2010 Current Appropriation	FY 2011 Request
Use Of Prior Year Balances	-13,238	0	0	0
Total, Energy Efficiency and Renewable Energy	2,156,865	16,771,907	2,242,500	2,355,473

Preface

The Office of Energy Efficiency and Renewable Energy (EERE) requests $2.4 billion in FY 2011. EERE's research, development, demonstration, and deployment (RDD&D) activities are critical to meeting the Nation's goals of sustaining strong economic growth and job creation while dramatically reducing greenhouse gas (GHG) emissions and energy imports. EERE programs provide a vital link between advances in basic research and the creation of commercially successful products and services. EERE does this by supporting strategic applied research and development projects, and identifying ways that national policies can create strong markets for innovations that can be deployed into widespread use by commercial enterprises, creating new businesses and jobs. Among other goals, the budget is designed to ensure that accelerated projects funded by the Recovery Act are sustained by private investment.

FY 2011 Request by Major Energy Categories
$2,355.5



The FY 2011 portfolio is aimed at accelerating revolutionary change in the Nation's energy economy through four distinct technical areas that will drive productivity advances in industry that can sharply increase profits while slashing demand for fuels and electricity. First, it will achieve rapid gains in the efficient use of energy. This means identifying cost-effective new building designs that can reduce commercial and residential energy use by at least a factor of two in the next five years (compared to existing structures and enabling a vigorous building energy retrofit industry capable of providing comprehensive energy retrofits for the Nation's buildings in the next 15 years. This will be achieved through major national programs in codes, standards, labeling, and innovative financing.

Second, it means shifting to a portfolio of new transportation technologies based on electricity, renewable fuels, and advanced technologies that can decouple the U.S. vehicle fleet from fossil fuels.

Third, EERE will achieve rapid growth in renewable energy supplies using biomass, wind, solar, geothermal, water power, fuel cells, and other energy resources to produce competitive sources of fuels and electricity through carefully targeted basic and applied research, demonstrations in partnership with industry, and investments that can lead to the installation of key infrastructure and facilitate permitting and acquisition of rights of way. Energy storage systems will be an important part of this investment.

In addition DOE's RE-ENERGYSE program will reinvigorate the investment in education at all levels to support the next generation of scientists and engineers that are needed to address the country's energy challenges.

EERE's budget will ensure robust, transparent, and accountable program management and support functions that will efficiently and effectively execute and inform this organization's critical mission.

EERE's organizational objectives will be achieved through a rigorous national program in: applied R&D; industry leading codes, standards and labeling; and innovative commercialization, financing and industry partnership models. EERE will work closely with DOE's Office of Science and the Advanced Research Projects Agency – Energy (ARPA-E) to ensure that cutting edge technology innovations are accelerated into the commercial marketplace.

Key FY 2011 investments include activities which:

- Demonstrate that renewable energy can be provided at a large scale and built quickly. This will include the following large scale demonstration programs:
    - Large Scale Biopower - Commercial use of biopower from cellulosic feedstocks at a scale that will validate the potential of biopower, cost sharing with private sector, and aligning with the DOE loan guarantee program;
    - Concentrating Solar Power (CSP) Initiative - More than one GW of CSP in a single cluster; and
    - Offshore Wind Initiative - Support at least one large-scale offshore wind project in the U.S., and build or expand on areas currently targeted for deployment by developers.
- Educate and train the workforce for the new energy economy. Building on infrastructure created by Recovery Act investments, EERE will continue to expand the scope and quality of training programs for green jobs in all efficiency and renewable program areas. It will also include initial investments in education programs that will ensure a continued flow of the skilled researchers, engineering teams, and field workers that will be needed to take the jobs created by rapidly growing investment in efficiency and renewable technologies.
- Ensure that all Federal buildings, transportation fleets, and other facilities operate with investments in energy efficiency and renewable energy that provide the greatest benefits to the taxpayer.
- Build upon Recovery Act investment to enable cost-effective retrofits for all homes, commercial, and government buildings. This will be achieved through a carefully crafted program of advanced building components and whole building designs, partnerships with major financial institutions to facilitate energy efficient mortgages, a clearly understood energy labeling system that will ensure efficient markets for energy efficiency, and innovative financial initiatives by cities. EERE will also help design model building energy codes that can drive rapid increases in the efficiency of new buildings.
- Transform the Nation's highway transportation system, including support for competing investments in renewable liquid fuels, hybrid electric and all-electric vehicles, and fuel cells as components of a strategy that will allow markets to shape the ultimate outcome.
- Drive continuous reductions in the price of wind and solar power, making them fully competitive with other energy sources on an aggressive schedule.
- Produce commercially viable biomass and bioproducts from diverse resources, and convert these materials into competitively priced fuels, electricity, and chemical feedstocks.

Within the Energy Efficiency and Renewable Energy Appropriation EERE has 15 programs in FY 2011: Hydrogen and Fuel Cell Technologies (6 subprograms), Biomass and Biorefinery Systems R&D (3 subprograms), Solar Energy (5 subprograms), Wind Energy (2 subprograms), Geothermal Energy (1 subprogram), Water Power (1 subprogram), Vehicle Technologies (6 subprograms), Building Technologies (5 subprograms), Industrial Technologies (2 subprograms), Federal Energy Management Program (5 subprograms), RE-ENERGYSE (2 subprograms), Facilities and Infrastructure (1 subprogram), Weatherization and Intergovernmental Activities (3 subprograms), Program Direction (4 subprograms), and Program Support (5 subprograms).

Mission

The mission of EERE is to undertake RDD&D activities that advance technologies and related practices to help meet the growing global demand for clean, reliable, sustainable, and affordable energy services, and to reduce energy consumption. EERE achieves this mission by developing cost competitive clean energy technologies and practices, and facilitating commercialization and deployment in the marketplace to strengthen U.S. energy security, environmental quality, and economic vitality.

Benefits

In recent years, EERE programs have played essential roles in encouraging private investments in technologies and enabling legislation that will continue to have major impacts on U.S. energy usage

EERE continues to work to amplify these trends moving forward, and estimates that with the continued leveraging of EERE technologies: U.S. net oil imports can decline by 57 percent; consumers can spend 24 percent less on energy; the Nation can emit 19 percent less CO_2; and primary energy consumption can decline by 16 percent, all relative to 2050 baseline projections (see graphs below). Cumulatively, between 2011 and 2050, technology leveraged by EERE programs will help the U.S. reduce oil imports by approximately 30 billion barrels (approaching 10 years' worth of current passenger vehicle use)[a], save consumers and businesses more than $6 trillion in energy costs, and displace nearly 30 billion metric tons of CO_2 emissions and over 350 quadrillion Btu of primary energy (see Tables 1 and 2 for more portfolio data).

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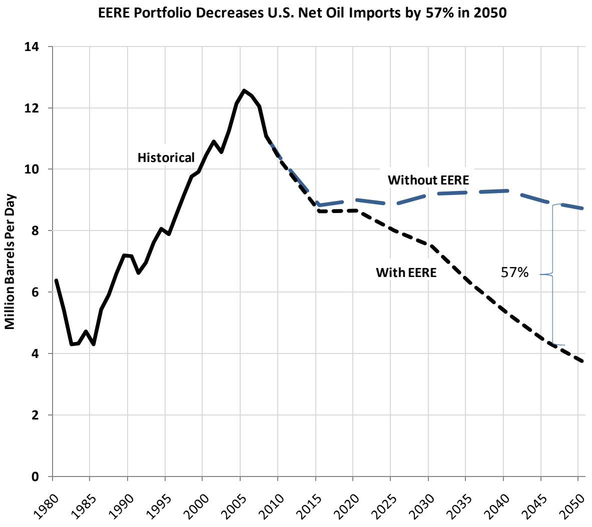
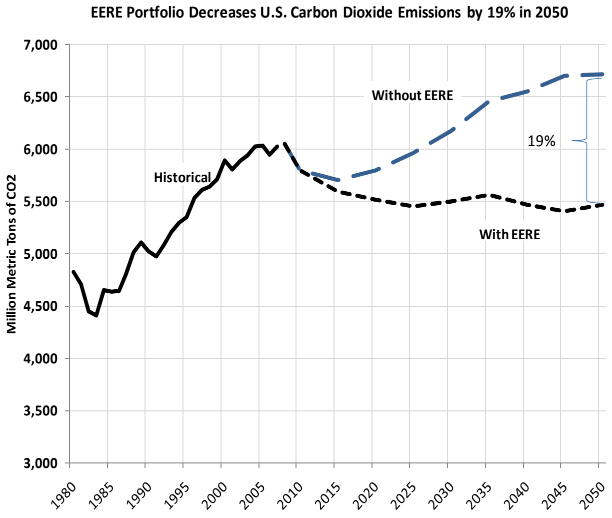
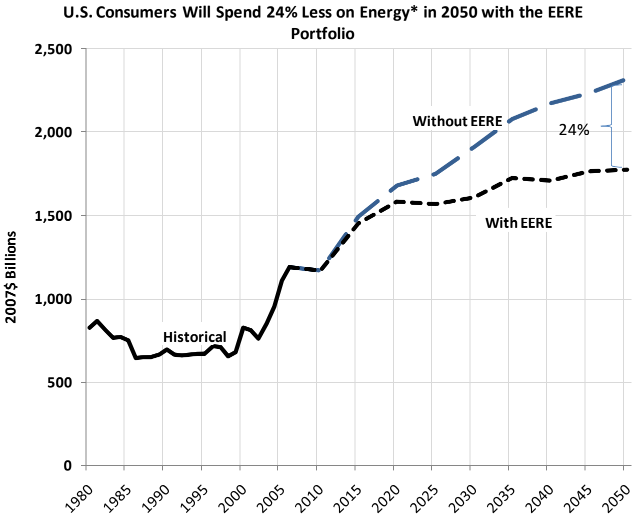
[a] Annual Energy Review. Energy Information Administration, Office of Energy Markets and End Use. Washington: June 2009, page xxiii. http://www.eia.doe.gov/aer/pdf/aer.pdf

Estimated Portfolio Benefits in Oil, Energy Cost, Carbon Dioxide and Energy Consumption


EERE Portfolio Decreases U.S. Net Oil Imports by 57% in 2050


EERE Portfolio Decreases U.S. Carbon Dioxide Emissions by 19% in 2050


U.S. Consumers Will Spend 24% Less on Energy* in 2050 with the EERE Portfolio

* This includes expenditures on fuels and electricity by all sectors. This does not include expenditures on capital investments in new energy equipment and infrastructure.

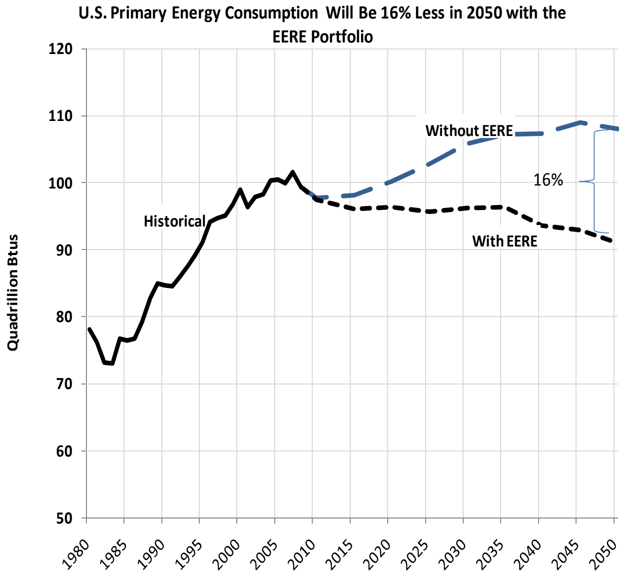

U.S. Primary Energy Consumption Will Be 16% Less in 2050 with the EERE Portfolio

Table 1. Cumulative Impacts of Technology Leveraged by EERE Programs[a]

	Metric	Model	Year			
			2015	2020	2030	2050
Energy Security	Oil Imports Reduction, cumulative (Bil bbl)	NEMS	0.10	0.63	4.6	N/A
		MARKAL	0.22	0.70	4.1	31
	Natural Gas Imports Reduction, cumulative (Tcf)	NEMS	0.19	1.5	6.1	N/A
		MARKAL	ns	1.9	10.2	41
Environmental Impacts	CO_2 Emissions Reduction, cumulative (Mil mtCO_2)	NEMS	251	1226	5717	N/A
		MARKAL	316	1290	6242	27367
	SO_2 Allowance Price Reduction ($/ton)	NEMS	ns	ns	ns	N/A
		MARKAL	N/A	N/A	N/A	N/A
	NO_x Allowance Price Reduction ($/ton)	NEMS	269	504	767	N/A
		MARKAL	N/A	N/A	N/A	N/A
Economic Impacts	Primary Energy Savings, cumulative (quads)	NEMS	4.4	19	80	N/A
		MARKAL	6.1	21	89	358
	Oil Savings, cumulative (Bil bbl)	NEMS	0.11	0.72	5.9	N/A
		MARKAL	0.23	0.88	5.5	34.4
	Consumer Savings, cumulative (Bil $)	NEMS	41	206	1055	N/A
		MARKAL	53	276	1473	5543
	Electric Power Industry Savings, cumulative (Bil $)	NEMS	42	119	378	N/A
		MARKAL	29	89	291	784
	Household Energy Expenditures Reduction ($/household/yr)	NEMS	50	190	640	N/A
		MARKAL	114	297	817	2316
	Jobs, cumulative (net added jobs)	NEMS/ IMSET	NA	NA	NA	NA

- "Reductions" and "savings" are calculated as the difference between results from the baseline case (i.e. no future DOE funding for this technology) and the program case (i.e. requested DOE funding for this technology is received and is successful).
- Oil impacts are shown as two metrics. "Oil Imports Reduction" refers only to reductions in oil imports; "Oil Savings" refers to savings (reduction) in total oil consumption.
- All cumulative metrics are based on results beginning in 2011.
- All monetary metrics are in 2007$.
- Cumulative monetary metrics are in 2007$ that are discounted to 2011 using a 3% discount rate.

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

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[a] Additional information on EERE's impact analysis methodology and assumptions, as well as the final FY 2011 budget impact estimates, can be found at http://www1.eere.energy.gov/ba/pba/program_benefits.html

Table 2. Annual Impacts of Technology Leveraged by EERE Programs

	Metric	Model	Year			
			2015	2020	2030	2050
Energy Security	Oil Imports Reduction, annual (Mbpd)	NEMS	0.1	0.5	1.6	N/A
		MARKAL	0.2	0.3	1.7	5.0
	Natural Gas Imports Reduction, annual (Tcf)	NEMS	0.1	0.4	0.5	N/A
		MARKAL	ns	0.8	0.9	1.8
	MPG Improvement (%)	NEMS	0.0	0.0	0.2	N/A
		MARKAL	0.0	0.0	0.1	2.5
Environmental Impacts	CO2 Emissions Reduction, annual (Mil mtCO_2/yr)	NEMS	95.1	256.5	613.6	N/A
		MARKAL	112.9	276.6	677.9	1247.3
	CO_2 Intensity Reduction of US Economy (g CO2/$GDP)	NEMS	7.0	16.7	30.5	N/A
		MARKAL	9.1	19.5	37.8	44.7
	CO_2 Intensity Reduction of US Power Sector[3] (g CO2/kWh)	NEMS	ns	ns	ns	N/A
		MARKAL	ns	ns	ns	ns
	CO_2 Intensity Reduction of US Transportation Sector (g CO2/mile)	NEMS	ns	16.5	59.8	N/A
		MARKAL	ns	12.3	61.5	164.9
Economic Impacts	Primary Energy Savings, annual (quads/yr)	NEMS	1.5	3.7	8.0	N/A
		MARKAL	2.0	3.8	9.6	17.1
	Oil Savings, annual (Mbpd)	NEMS	0.1	0.5	2.1	N/A
		MARKAL	0.2	0.5	2.3	5.4
	Consumer Savings, annual (Bil $)	NEMS	18.3	61.0	188.4	N/A
		MARKAL	19.2	79.5	289.7	687.4
	Electric Power Industry Savings, annual (Bil $)	NEMS	13.9	24.7	55.0	N/A
		MARKAL	11.0	17.3	39.0	59.3
	Reduction in Energy Intensity of US Economy (BTUs of energy/$GDP)	NEMS	148.3	272.0	425.4	N/A
		MARKAL	163.8	265.7	532.6	612.3
	Net Energy System Cost Reduction, cumulative (Bil $)	NEMS	N/A	N/A	N/A	N/A
		MARKAL	90.1	324.8	1270.3	5480.7

- "Reductions" and "savings" are calculated as the difference between results from the baseline case (i.e. no future DOE funding for this technology) and the program case (i.e. requested DOE funding for this technology is received and is successful).
- Oil impacts are shown as two metrics. "Oil Imports Reduction" refers only to reductions in oil imports; "Oil Savings" refers to savings (reduction) in total oil consumption.
- All cumulative metrics are based on results beginning in 2011.
- All monetary metrics are in 2007$.
- Cumulative monetary metrics are in 2007$ that are discounted to 2011 using a 3% discount rate.

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

Strategic Themes, Goals and the Secretary's Initiatives

EERE's programs contribute directly to the Secretary's Energy and Innovation goals. The achievement of RDD&D goals by EERE's programs will yield significant short- and long-term results in areas critical to the Secretary's strategic goals: reducing GHG emissions, deploying clean, secure energy, and enhancing economic prosperity.

Basic and Applied R&D Coordination

Coordination between the Department's basic research and applied technology programs is a high priority for the Secretary of Energy. The Department has a responsibility to coordinate its basic and applied research programs to effectively integrate R&D by the science and technology communities (e.g., national laboratories, universities, and private companies) that support the DOE mission. Efforts have focused on improving communication and collaboration between federal program managers and increasing opportunities for collaborative efforts targeted at the interface of scientific research and technology development to ultimately accelerate DOE mission and national goals. Coordination between the basic and applied programs is also enhanced through joint programs, jointly-funded scientific facilities, and the program management activities of the DOE Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) programs. Additionally, co-funding research activities and facilities at the DOE laboratories and funding mechanisms that encourage broad partnerships (e.g., Funding Opportunity Announcements) are also means by which the Department facilitates greater communication and research integration within the basic and applied research communities.

Key Accomplishments

Hydrogen and Fuel Cell Technologies diversified its portfolio and competitively selected 13 projects under the Recovery Act to deploy hundreds of fuel cells and create jobs in manufacturing, installation, maintenance, and support service sectors. The program developed and demonstrated residential combined heat and power (CHP) fuel cell systems operating for more than 3,000 hours and demonstrating up to 85 percent overall efficiency.

Biomass and Biorefinery Systems R&D accelerated deployment of Recovery Act funding by issuing solicitations for: new integrated biorefineries; the development of an algal biofuels consortium; the development of an advanced biofuels consortium; accelerated alternative vehicle fuels testing; and biofuels infrastructure. Critical analytical studies have been completed and put to use for program investment and portfolio decision making. Fifteen sustainability-focused projects were initiated with domestic and international partners.

Solar Energy attained several significant R&D milestones. PV R&D demonstrated manufacturable 23.4 percent efficient cells and manufactured the first 100KW of U.S.-produced T-5 product for commercial rooftops. Targets of $0.17-$0.20/kWh for residential and $0.12-$0.16/kWh for commercial PV systems have been exceeded. CSP R&D developed next generation polymeric reflective coatings for troughs and towers that critically enable reduced solar field cost and enhanced performance necessary to achieve targets.

Wind Energy completed dynamometer testing and calibration of a wind turbine gearbox that will provide invaluable operational data for the Gearbox Reliability Collaborative effort. The program selected 81 new wind energy project awards for up to $22.3 million, more than half of which will simultaneously address market and deployment challenges. The program also issued the 2008 Wind Technologies Market Report, which is the most comprehensive, publicly-available source on the state of the wind market.[a]

Geothermal Technologies developed a National Geothermal Action Plan and Road-Map[b] and sponsored the first Annual National Science Foundation Geothermal Research opportunity for undergraduate students.

Water Power awarded EERE's first-ever grants for wave, tidal, and ocean current energy. These grants support the development and testing of devices; fund resource assessments; address environmental impacts and siting concerns; and establish two university-led National Marine Renewable Energy Centers to serve the emerging marine and hydrokinetic (MHK) industry as integrated facilities for research and in-water testing. The program established the primary source of information for the water power industry with an updated, searchable database of all wave, tidal, and ocean current technologies and projects, as well as a catalogue for MHK technology developers.[c]

Vehicle Technologies determined that its commercial vehicle engine efficiency work has resulted in fuel economy gains of 10 to 12 percent over the past four to five years. These gains are estimated to have saved 2.4 billion gallons of fuel worth more than $7.6 billion since 2002.[d] The program garnered three *R&D 100* awards program during the year and signed two separate license agreements to commercialize their patented composite cathode materials for advanced lithium-ion batteries. The program developed performance for significantly higher specific battery capacities, a 50 percent increase over conventional materials.

Building Technologies established seven new energy conservation standards; and updated six and completed seven test procedure final rules. The program engaged more than 20 commercial building stakeholders to design a new building prototype that uses 50 percent less energy, and retrofit an existing building for at least 30 percent energy savings. The program also demonstrated Solid State Lighting (SSL) prototypes including: a cool white LED that delivers 117 lm/W and a record-breaking white OLED with a power efficacy of 102 lumens/Watt (lm/W) at 1,000 candela/square meter (cd/m^2); commercialized dynamic insulation; new Energy Star Hybrid Electric Water Heaters; and a low-cost solar water heating system. DOE also established the ENERGY STAR criteria for water heaters and SSL, and completed 30 to 40 percent whole house energy savings builder technology packages for five U.S. climate regions.

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[a] 2008 Wind Technologies Market Report. EERE. Washington: July 2009. Available at: http://www1.eere.energy.gov/windandhydro/pdfs/46026.pdf

[b] Draft National Geothermal Action Plan. EERE. Washington. Available at: http://www1.eere.energy.gov/geothermal/ngap.html

[c] Additional information on the Marine and Hydrokinetic Technology Database is available at: http://www1.eere.energy.gov/windandhydro/hydrokinetic/default.aspx

[d] Company data provided individually to EERE Vehicle Technologies Program by Caterpillar, Cummins, and Detroit Diesel in November 2008.

Industrial Technologies (ITP) R&D activities won three *R&D 100* awards in 2009. ITP has completed 2,264 Save Energy Now assessments, resulting in the identification of over 171 trillion Btus of natural gas savings and $1.3 billion dollars per year energy savings.

The Federal Energy Management Program awarded an unprecedented $594 million in Energy Savings Performance Contract (ESPC) projects, including DOE's largest-ever ESPC to construct one of the largest biomass facilities in the country at the Savannah River Site. Our training efforts have reached over 1,500 people in Utility Energy Service Contracts and ESPCs. The program also selected 104 agency energy and efficiency projects funded by the Recovery Act.

For EERE's **Facilities and Infrastructure**, Phase I of the Research Support Facility at the National Renewable Energy Laboratory (NREL) was successfully completed on time and within budget, providing workspace for approximately 750 Golden Field Office and NREL employees. Savings relative to the prior lease arrangement will net $122 million (in 2007 dollars) over a 30-year lifecycle.

The Weatherization and Intergovernmental Activities Program increased utilization of ESPCs by States and local governments, sustainable energy efficiency finance mechanisms, renewable energy certificate trading programs, and energy efficiency based utility incentives. The program awarded $16.5 million for 93 tribal energy projects and expanded the green workforce skilled in building energy retrofits. To date, approximately 7,300 homes were weatherized using Recovery Act funds. In FY 2009 approximately 95,000 homes were weatherized with Omnibus and emergency appropriations.

Indirect Costs and Other Items of Interest

Institutional General Plant Projects (IGPPs)

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

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

(dollars in thousands)

	FY 2009	FY 2010	FY 2011
Institutional General Plant Projects (IGPP)			
National Renewable Energy Laboratory	7,000	14,000	10,000
Total, IGPP	7,000	14,000	10,000

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 2009	FY 2010	FY 2011
National Renewable Energy Laboratory	2,219	2,504	2,884
Total, Indirect-Funded Maintenance and Repair	2,219	2,504	2,884

Outyear Indirect-Funded Maintenance and Repair

(dollars in thousands)

	FY 2012	FY 2013	FY 2014	FY 2015
National Renewable Energy Laboratory	4,261	5,519	11,979	15,723
Total, Indirect-Funded Maintenance and Repair	4,261	5,519	11,979	15,723

Direct-Funded Maintenance and Repair

(dollars in thousands)

	FY 2009	FY 2010	FY 2011
National Renewable Energy Laboratory	0	0	3,000
Total, Direct-Funded Maintenance and Repair	0	0	3,000

Outyear Direct-Funded Maintenance and Repair

(dollars in thousands)

	FY 2012	FY 2013	FY 2014	FY 2015
National Renewable Energy Laboratory	3,300	4,000	5,200	5,500
Total, Direct-Funded Maintenance and Repair	3,300	4,000	5,200	5,500

Information Technology Investments

DOE's IT investments are tied to its programmatic missions, goals, and objectives. IT investments funded by this budget are displayed below.

Indirect-Funded IT Projects

(dollars in thousands)

	FY 2009	FY 2010	FY 2011	Description
UPI/OMB Identifier 019-60-02-00-01-5000-04, IM System/Project Name NREL Application & Data Hosting/Housing	3,511	3,630	3,729	IT hardware and software used for multiple, related, computing services. This includes design, development, help and other support, operations and maintenance. Service Level Agreement in place-NO. Costs Allocated based on Usage-NO. MS.
UPI/OMB Identifier 019-20-01-12-02-3004-00, IM System/Project Name NREL Computational Science Simulation & Modeling	704	1,205	2,505	Hardware, software and labor for numerical simulation and modeling capabilities for NREL's scientists as a fundamental tool for the Lab's scientific research.
UPI/OMB Identifier 019-20-01-12-02-3006-00, IM System/Project Name NREL Computational Science Visualization	504	1,005	1,505	Hardware, software and labor for data analysis and visualization for NREL's scientific and engineering staff to gain insight into the results of simulations necessary for the scientific discovery process.
UPI/OMB Identifier 019-60-02-00-01-5000-04, IM System/Project Name NREL Cyber Security	1,432	1,482	1,522	Provides shared security services. Service Level Agreement in place-NO. Costs Allocated based on Usage-NO. CS.
UPI/OMB Identifier 019-60-02-00-01-5000-04, IM System/Project Name NREL Enterprise Collaboration Services	1,505	1,557	1,599	Supports video distribution and conferencing services - includes hardware, software and support services (No LAN/WAN). Provides email, instant messaging, and collaborative tools. Service Level Agreement in place-NO. Costs Allocated based on Usage-NO. MS.
UPI/OMB Identifier 019-20-01-12-02-8777-00, IM System/Project Name NREL Enterprise Software Management	1,519	1,570	1,612	Management and maintenance of enterprise software licenses required for the legal use of various software products. Centralized procurement of software licenses to avoid duplication.
UPI/OMB Identifier 019-20-01-12-02-8780-00, IM System/Project Name NREL ESIF HPC System	0	12,000	1,200	Will support numerical simulation and modeling for energy system integration challenges associated with integrating renewable energy resources into the utility grid.
UPI/OMB Identifier 019-20-01-12-02-4005-00, IM System/Project Name NREL High Speed Scientific Computing Data Infrastructure Modernization	100	200	0	Upgrade high speed data infrastructure to provide access to all DOE laboratory supercomputing network capabilities in order to accelerate mission related data modeling activities.
UPI/OMB Identifier 019-20-03-00-02-3110-00, IM System/Project Name NREL IT Management and Planning	1,866	1,931	1,983	High-level management of the IS organization, including budgeting, planning and architecture design, performance assessment, development and tracking of performance metrics, and DOE reporting.
UPI/OMB Identifier 019-60-02-00-01-5000-04, IM System/Project Name NREL Office Automation	3,612	3,736	3,837	Provides desktop computing services to users to include all general purpose, desktop computing hardware and software, components and services. Service Level Agreement in place-NO. Costs Allocated based on Usage-NO. ES.
UPI/OMB Identifier 019-20-01-12-02-8779-00, IM System/Project Name NREL Scientific Data Management & Mining	200	200	500	Includes hardware, software and labor supporting NREL's scientists, engineers, and analysts engaged in research resulting in the creation of large data scientific and technical data sets.
UPI/OMB Identifier 019-60-02-00-01-5000-04, IM System/Project Name NREL Telecommunications Networks	2,772	2,867	2,945	Provides networking services within complex, including hardware, software, and services. Local Area Network support. Service Level Agreement in place-NO. Costs Allocated based on Usage-NO. TS.
UPI/OMB Identifier 019-60-02-00-01-5000-04, IM System/Project Name NREL Telephony Services	1,146	1,186	1,218	Provides voice services to users including hardware, software, services and communications not provided by WANs. Service Level Agreement in place-NO. Costs Allocated based on Usage-NO. TS.
UPI/OMB Identifier 019-20-01-12-02-8778-00, IM System/Project Name NREL UNIX Systems Administration	946	979	1,005	Unix server maintenance, implementation, and maintenance of security tools. Includes administration and management of scientific NREL data through user accounts, appropriate permissions, backup and restore, and appropriate security.
UPI/OMB Identifier 019-20-01-12-01-8781-00, IM System/Project Name NREL/SNL High Performance Computing System	9,475	1,418	1,350	High Performance Computing System.
Total, Indirect Funded IT Projects	29,292	34,966	26,510	

Outyear Indirect-Funded IT Projects

(dollars in thousands)

	FY 2012	FY 2013	FY 2014	FY 2015	Description
UPI/OMB Identifier 019-60-02-00-01-5000-04, IM System/Project Name NREL Application & Data Hosting/Housing	3,915	4,111	4,317	4,532	
UPI/OMB Identifier 019-20-01-12-02-3004-00, IM System/Project Name NREL Computational Science Simulation & Modeling	2,630	2,762	2,900	3,045	
UPI/OMB Identifier 019-20-01-12-02-3006-00, IM System/Project Name NREL Computational Science Visualization	1,580	1,659	1,742	1,829	
UPI/OMB Identifier 019-60-02-00-01-5000-04, IM System/Project Name NREL Cyber Security	1,598	1,678	1,762	1,850	
UPI/OMB Identifier 019-60-02-00-01-5000-04, IM System/Project Name NREL Enterprise Collaboration Services	1,679	1,763	1,851	1,943	
UPI/OMB Identifier 019-20-01-12-02-8777-00, IM System/Project Name NREL Enterprise Software Management	1,693	1,778	1,867	1,960	
UPI/OMB Identifier 019-20-01-12-02-8780-00, IM System/Project Name NREL ESIF HPC System	1,260	1,323	1,389	1,459	
UPI/OMB Identifier 019-20-01-12-02-4005-00, IM System/Project Name NREL High Speed Scientific Computing Data Infrastructure Modernization	0	0	0	0	
UPI/OMB Identifier 019-20-03-00-02-3110-00, IM System/Project Name NREL IT Management and Planning	2,082	2,186	2,295	2,410	
UPI/OMB Identifier 019-60-02-00-01-5000-04, IM System/Project Name NREL Office Automation	4,029	4,230	4,442	4,664	
UPI/OMB Identifier 019-20-01-12-02-8779-00, IM System/Project Name NREL Scientific Data Management & Mining	525	551	579	608	
UPI/OMB Identifier 019-60-02-00-01-5000-04, IM System/Project Name NREL Telecommunications Networks	3,092	3,247	3,409	3,579	
UPI/OMB Identifier 019-60-02-00-01-5000-04, IM System/Project Name NREL Telephony Services	1,279	1,343	1,410	1,480	
UPI/OMB Identifier 019-20-01-12-02-8778-00, IM System/Project Name NREL UNIX Systems Administration	1,055	1,108	1,163	1,221	
UPI/OMB Identifier 019-20-01-12-01-8781-00, IM System/Project Name NREL/SNL High Performance Computing System	1,418	1,488	1,563	1,641	
Total, Indirect-Funded IT Projects	27,835	29,227	30,689	32,221	

Direct-Funded IT Projects

(dollars in thousands)

	FY 2009	FY 2010	FY 2011	Description
Program Direction				
UPI/OMB Identifier 019-60-02-00-01-5000-04, IM System/Project Name EE Application & Data Hosting/Housing HQ	2,687	4,521	4,810	IT hardware and software used for multiple, related, computing services. This includes design, development, help and other support, operations and maintenance. Service Level Agreement in place-NO. Costs Allocated based on Usage-NO. MS.
UPI/OMB Identifier 019-20-01-12-02-1011-00, IM System/Project Name EE Corporate Management and Planning System	1,110	1,882	1,751	The CPS is a comprehensive planning and management system created in response to EERE's need to aggregate program and project data across all of its offices with an overarching, fully integrated system, encompassing both internal and external data sets.
UPI/OMB Identifier 019-60-02-00-01-5000-04, IM System/Project Name EE Cyber Security HQ	1,163	1,794	1,967	Provides shared security services. Service Level Agreement in place-NO. Costs Allocated based on Usage-NO. CS.
UPI/OMB Identifier 019-60-02-00-01-5000-04, IM System/Project Name EE Enterprise Collaboration Services HQ	853	3,045	3,342	Supports video distribution and conferencing services - includes hardware, software and support services (No LAN/WAN). Provides email, instant messaging, and collaborative tools. Service Level Agreement in place-NO. Costs Allocated based on Usage-NO. MS.
UPI/OMB Identifier 019-60-02-00-01-5000-04, IM System/Project Name EE Office Automation HQ	1,278	1,748	1,916	Provides desktop computing services to users to include all general purpose, desktop computing hardware and software, components and services. Service Level Agreement in place-NO. Costs Allocated based on Usage-NO. ES.
UPI/OMB Identifier 019-60-02-00-01-5000-04, IM System/Project Name EE Telecommunications Networks HQ	448	1,333	1,459	Provides networking services within complex, including hardware, software, and services. Local Area Network support. Service Level Agreement in place-NO. Costs Allocated based on Usage-NO. TS.
UPI/OMB Identifier 019-60-02-00-01-5000-04, IM System/Project Name EE Telephony Services HQ	424	445	467	Provides voice services to users including hardware, software, services and communications not provided by WANs. Service Level Agreement in place-NO. Costs Allocated based on Usage-NO. TS.
Total, Program Direction	7,963	14,768	15,712	
Technology Advancement and Outreach				
UPI/OMB Identifier 019-60-02-00-01-5000-04, IM System/Project Name EE Application & Data Hosting/Housing Internet Websites	2,727	2,543	2,682	IT hardware and software used for multiple, related, computing services. This includes design, development, help and other support, operations and maintenance. Service Level Agreement in place-NO. Costs Allocated based on Usage-NO. MS.
Total, Technology Advancement and Outreach	2,727	2,543	2,682	
Biomass Program				
UPI/OMB Identifier 019-60-02-00-01-5000-04, IM System/Project Name EE Application & Data Hosting/Housing Internet Websites	221	223	226	IT hardware and software used for multiple, related, computing services. This includes design, development, help and other support, operations and maintenance. Service Level Agreement in place-NO. Costs Allocated based on Usage-NO. MS.
Total, Biomass Program	221	223	226	
Buildings Technologies Program				
UPI/OMB Identifier 019-60-02-00-01-5000-04, IM System/Project Name EE Application & Data Hosting/Housing Internet Websites	1,046	848	851	IT hardware and software used for multiple, related, computing services. This includes design, development, help and other support, operations and maintenance. Service Level Agreement in place-NO. Costs Allocated based on Usage-NO. MS.
Total, Buildings Technologies Program	1,046	848	851	
Federal Energy Management Program				

(dollars in thousands)

	FY 2009	FY 2010	FY 2011	Description
UPI/OMB Identifier 019-60-02-00-01-5000-04, IM System/Project Name EE Application & Data Hosting/Housing Internet Websites	376	1,873	2,111	IT hardware and software used for multiple, related, computing services. This includes design, development, help and other support, operations and maintenance. Service Level Agreement in place-NO. Costs Allocated based on Usage-NO. MS.
UPI/OMB Identifier 019-20-01-12-02-1040-00, IM System/Project Name EE FEMP Utility Data Management System	543	632	833	Establish a centralized utility data management system that will take advantage of meters installed by DOE sites.
Total, Federal Energy Management Program	919	2,505	2,944	
Geothermal Technologies Program				
UPI/OMB Identifier 019-60-02-00-01-5000-04, IM System/Project Name EE Application & Data Hosting/Housing Internet Websites	125	140	155	IT hardware and software used for multiple, related, computing services. This includes design, development, help and other support, operations and maintenance. Service Level Agreement in place-NO. Costs Allocated based on Usage-NO. MS.
Total, Geothermal Technologies Program Total	125	140	155	
Hydrogen and Fuel Cell Technologies Program				
UPI/OMB Identifier 019-60-02-00-01-5000-04, IM System/Project Name EE Application & Data Hosting/Housing Internet Websites	331	285	288	IT hardware and software used for multiple, related, computing services. This includes design, development, help and other support, operations and maintenance. Service Level Agreement in place-NO. Costs Allocated based on Usage-NO. MS.
Total, Hydrogen and Fuel Cell Technologies Program	331	285	288	
Industrial Technologies Program				
UPI/OMB Identifier 019-60-02-00-01-5000-04, IM System/Project Name EE Application & Data Hosting/Housing Internet Websites	424	439	483	IT hardware and software used for multiple, related, computing services. This includes design, development, help and other support, operations and maintenance. Service Level Agreement in place-NO. Costs Allocated based on Usage-NO. MS.
Total, Industrial Technologies Program	424	439	483	
Solar Energy Technology Program				
UPI/OMB Identifier 019-60-02-00-01-5000-04, IM System/Project Name EE Application & Data Hosting/Housing Internet Websites	601	608	576	IT hardware and software used for multiple, related, computing services. This includes design, development, help and other support, operations and maintenance. Service Level Agreement in place-NO. Costs Allocated based on Usage-NO. MS.
Total, Solar Energy Technology Program	601	608	576	
Vehicle Technologies Program				
UPI/OMB Identifier 019-60-02-00-01-5000-04, IM System/Project Name EE Application & Data Hosting/Housing Internet Websites	1,598	1,873	2,111	IT hardware and software used for multiple, related, computing services. This includes design, development, help and other support, operations and maintenance. Service Level Agreement in place-NO. Costs Allocated based on Usage-NO. MS.
Total, Vehicle Technologies Program	1,598	1,873	2,111	
Weatherization & Intergovernmental Program				
UPI/OMB Identifier 019-60-02-00-01-5000-04, IM System/Project Name EE Application & Data Hosting/Housing Internet Websites	2,041	1,460	1,533	IT hardware and software used for multiple, related, computing services. This includes design, development, help and other support, operations and maintenance. Service Level Agreement in place-NO. Costs Allocated based on Usage-NO. MS.

(dollars in thousands)

	FY 2009	FY 2010	FY 2011	Description
UPI/OMB Identifier 019-20-04-00-01-1030-00, IM System/Project Name EE State Grant Administration	3,422	3,428	1,934	Investment develops mission program management functionality and transitions back office grant functions to DOE corporate iManage investment and Grants.gov in FY2010. Investment also maintains Windows-based client/server system WinSaga during transition.
Total, Weatherization & Intergovernmental Program	5,463	4,888	3,467	
Wind Energy and Hydropower				
UPI/OMB Identifier 019-60-02-00-01-5000-04, IM System/Project Name EE Application & Data Hosting/Housing Internet Websites	186	146	181	IT hardware and software used for multiple, related, computing services. This includes design, development, help and other support, operations and maintenance. Service Level Agreement in place-NO. Costs Allocated based on Usage-NO. MS.
Total, Wind Energy and Hydropower	186	146	181	
Golden Field Office				
UPI/OMB Identifier 019-60-02-00-01-5000-04, IM System/Project Name EE Application & Data Hosting/Housing Field Implementation	1,038	1,320	915	IT hardware and software used for multiple, related, computing services. This includes design, development, help and other support, operations and maintenance. Service Level Agreement in place-NO. Costs Allocated based on Usage-NO. MS.
UPI/OMB Identifier 019-60-02-00-01-5000-04, IM System/Project Name EE Cyber Security Field Implementation	1,317	1,678	1,157	Provides shared security services. Service Level Agreement in place-NO. Costs Allocated based on Usage-NO. CS.
UPI/OMB Identifier 019-60-02-00-01-5000-04, IM System/Project Name EE Enterprise Collaboration Services Field Implementation	1,049	1,335	924	Supports video distribution and conferencing services - includes hardware, software and support services (No LAN/WAN). Provides email, instant messaging, and collaborative tools. Service Level Agreement in place-NO. Costs Allocated based on Usage-NO. MS.
UPI/OMB Identifier 019-60-02-00-01-5000-04, IM System/Project Name EE Office Automation Field Implementation	1,077	1,369	949	Provides desktop computing services to users to include all general purpose, desktop computing hardware and software, components and services. Service Level Agreement in place-NO. Costs Allocated based on Usage-NO. ES.
UPI/OMB Identifier 019-60-02-00-01-5000-04, IM System/Project Name EE Telecommunications Networks Field Implementation	1,160	1,479	1,021	Provides networking services within complex, including hardware, software, and services. Local Area Network support. Service Level Agreement in place-NO. Costs Allocated based on Usage-NO. TS.
UPI/OMB Identifier 019-60-02-00-01-5000-04, IM System/Project Name EE Telephony Services Field Implementation	204	257	180	Provides voice services to users including hardware, software, services and communications not provided by WANs. Service Level Agreement in place-NO. Costs Allocated based on Usage-NO. TS.
Total, Golden Field Office	5,845	7,438	5,146	
Total, Direct-Funded IT Projects (Appropriation EERE)	27,449	36,704	34,822	

Outyear Direct-Funded IT Projects

(dollars in thousands)

	FY 2012	FY 2013	FY 2014	FY 2015	Description
Program Direction					
UPI/OMB Identifier 019-60-02-00-01-5000-04, IM System/Project Name EE Application & Data Hosting/Housing HQ	2,821	2,962	3,110	3,265	
UPI/OMB Identifier 019-20-01-12-02-1011-00, IM System/Project Name EE Corporate Management and Planning System	1,166	1,224	1,285	1,349	
UPI/OMB Identifier 019-60-02-00-01-5000-04, IM System/Project Name EE Cyber Security HQ	1,221	1,282	1,346	1,413	
UPI/OMB Identifier 019-60-02-00-01-5000-04, IM System/Project Name EE Enterprise Collaboration Services HQ	896	941	988	1,037	
UPI/OMB Identifier 019-60-02-00-01-5000-04, IM System/Project Name EE Office Automation HQ	1,342	1,409	1,479	1,553	
UPI/OMB Identifier 019-60-02-00-01-5000-04, IM System/Project Name EE Telecommunications Networks HQ	470	494	519	544	
UPI/OMB Identifier 019-60-02-00-01-5000-04, IM System/Project Name EE Telephony Services HQ	445	467	491	515	
Total, Program Direction	8,361	8,779	9,218	9,676	
Technology Advancement and Outreach					
UPI/OMB Identifier 019-60-02-00-01-5000-04, IM System/Project Name EE Application & Data Hosting/Housing Internet Websites	2,863	3,006	3,157	3,315	
Total, Technology Advancement and Outreach	2,863	3,006	3,157	3,315	
Biomass Program					
UPI/OMB Identifier 019-60-02-00-01-5000-04, IM System/Project Name EE Application & Data Hosting/Housing Internet Websites	232	244	256	269	
Total, Biomass Program	232	244	256	269	
Buildings Technologies Program					
UPI/OMB Identifier 019-60-02-00-01-5000-04, IM System/Project Name EE Application & Data Hosting/Housing Internet Websites	1,098	1,153	1,211	1,271	
Total, Buildings Technologies Program	1,098	1,153	1,211	1,271	
Federal Energy Management Program					

UPI/OMB Identifier 019-60-02-00-01-5000-04, IM System/Project Name EE Application & Data Hosting/Housing Internet Websites	395	415	435	457
UPI/OMB Identifier 019-20-01-12-02-1040-00, IM System/Project Name EE FEMP Utility Data Management System	571	599	629	660
Total, Federal Energy Management Program	966	1,014	1,064	1,117
Geothermal Technologies Program Total				
UPI/OMB Identifier 019-60-02-00-01-5000-04, IM System/Project Name EE Application & Data Hosting/Housing Internet Websites	131	138	145	152
Total, Geothermal Technologies Program Total	131	138	145	152
Hydrogen and Fuel Cell Technologies Program				
UPI/OMB Identifier 019-60-02-00-01-5000-04, IM System/Project Name EE Application & Data Hosting/Housing Internet Websites	348	365	383	402
Total, Hydrogen and Fuel Cell Technologies Program	348	365	383	402
Industrial Technologies Program				
UPI/OMB Identifier 019-60-02-00-01-5000-04, IM System/Project Name EE Application & Data Hosting/Housing Internet Websites	445	467	491	515
Total, Industrial Technologies Program	445	467	491	515
Solar Energy Technology Program				
UPI/OMB Identifier 019-60-02-00-01-5000-04, IM System/Project Name EE Application & Data Hosting/Housing Internet Websites	631	663	696	730
Total, Solar Energy Technology Program	631	663	696	730
Vehicle Technologies Program				
UPI/OMB Identifier 019-60-02-00-01-5000-04, IM System/Project Name EE Application & Data Hosting/Housing Internet Websites	1,678	1,762	1,850	1,943
Total, Vehicle Technologies Program	1,678	1,762	1,850	1,943
Weatherization & Intergovernmental Program				
UPI/OMB Identifier 019-60-02-00-01-5000-04, IM System/Project Name EE Application & Data Hosting/Housing Internet Websites	2,143	2,250	2,363	2,481
UPI/OMB Identifier 019-20-04-00-01-1030-00, IM System/Project Name EE State Grant Administration	3,593	3,773	3,961	4,159
Total, Weatherization & Intergovernmental Program	5,736	6,023	6,324	6,640

Wind Energy and Hydropower				
UPI/OMB Identifier 019-60-02-00-01-5000-04, IM System/Project Name EE Application & Data Hosting/Housing Internet Websites	195	205	215	226
Total, Wind Energy and Hydropower	195	205	215	226
Golden Field Office				
UPI/OMB Identifier 019-60-02-00-01-5000-04, IM System/Project Name EE Application & Data Hosting/Housing Field Implementation	1,090	1,145	1,202	1,262
UPI/OMB Identifier 019-60-02-00-01-5000-04, IM System/Project Name EE Cyber Security Field Implementation	1,383	1,452	1,525	1,601
UPI/OMB Identifier 019-60-02-00-01-5000-04, IM System/Project Name EE Enterprise Collaboration Services Field Implementation	1,102	1,157	1,215	1,275
UPI/OMB Identifier 019-60-02-00-01-5000-04, IM System/Project Name EE Office Automation Field Implementation	1,131	1,188	1,247	1,309
UPI/OMB Identifier 019-60-02-00-01-5000-04, IM System/Project Name EE Telecommunications Networks Field Implementation	1,218	1,279	1,343	1,410
UPI/OMB Identifier 019-60-02-00-01-5000-04, IM System/Project Name EE Telephony Services Field Implementation	214	225	236	248
Total, Golden Field Office	6,138	6,446	6,768	7,105
Total, Direct-Funded IT Projects (Appropriation EERE)	28,822	30,265	31,778	33,361

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

(dollars in thousands)

	FY 2009	FY 2010	FY 2011
Ames Laboratory			
Wind Energy	250	0	307
Vehicle Technologies	787	2,000	400
Industrial Technologies	435	560	250
Total, Ames Laboratory	1,472	2,560	957
Argonne National Laboratory (East)			
Hydrogen and Fuel Cell Technologies	13,147	11,983	12,100
Biomass and Biorefinery Systems R&D	2,755	2,500	2,500
Solar Energy	2,080	0	1,000
Wind Energy	554	932	786
Geothermal Technology	500	500	0
Water Power	15	924	896
Vehicle Technologies	39,369	35,424	30,000
Building Technologies	0	0	850
Industrial Technologies	4,134	3,152	2,536
Federal Energy Management Program	0	150	150
Program Support	152	1,010	2,760
Total, Argonne National Laboratory	62,706	56,575	53,578
Brookhaven National Laboratory			
Hydrogen and Fuel Cell Technologies	2,590	2,228	1,000
Solar Energy	470	470	470
Wind Energy	18	0	0
Vehicle Technologies	1,490	1,250	1,200
Industrial Technologies	60	0	0
Program Support	400	1,240	2,040
Total, Brookhaven National Laboratory	5,028	5,188	4,710

Chicago Operations Office			
Wind Energy	0	45	38
Total, Chicago Operations Office	0	45	38
Golden Field Office/Project Management Center			
Biomass and Biorefinery Systems R&D	2,588	2,044	2,044
Solar Energy	71,640	125,074	176,922
Wind Energy	4,173	10,592	52,937
Geothermal Technology	30,000	24,000	19,000
Water Power	36,824	39,718	29,327
Federal Energy Management Program	0	1,100	1,100
Weatherization and Intergovernmental Activities	9,795	8,000	8,000
Congressionally Directed Projects	228,803	292,135	0
Program Direction	26,544	29,073	54,412
Program Support	2,066	4,380	11,500
Total, Golden Field Office	412,433	536,116	355,242
Idaho National Laboratory			
Biomass and Biorefinery Systems R&D	8,544	11,896	11,896
Wind Energy	906	1,315	1,110
Geothermal Technology	350	250	1,000
Water Power	50	50	50
Vehicle Technologies	6,074	9,000	9,000
Industrial Technologies	2,103	902	739
Federal Energy Management Program	0	800	800
Program Support	0	950	750
Total, Idaho National Laboratory	18,027	25,163	25,345
Lawrence Berkeley National Laboratory			
Hydrogen and Fuel Cell Technologies	2,905	3,910	3,600
Solar Energy	150	400	400
Wind Energy	468	508	429
Geothermal Technology	2,000	1,000	5,000
Vehicle Technologies	12,436	14,317	15,000
Building Technologies	11,945	19,980	15,718
Industrial Technologies	1,625	2,390	2,390

Federal Energy Management Program	2,200	3,597	3,777
Weatherization and Intergovernmental Activities	400	500	725
Program Support	40	1,265	3,525
Total, Lawrence Berkeley National Laboratory	34,169	47,867	50,564
Lawrence Livermore National Laboratory			
Hydrogen and Fuel Cell Technologies	3,363	1,677	1,000
Wind Energy	999	1,281	1,081
Vehicle Technologies	2,827	3,700	4,000
Industrial Technologies	50	38	0
Total, Lawrence Livermore National Laboratory	7,239	6,696	6,081
Los Alamos National Laboratory			
Hydrogen and Fuel Cell Technologies	14,929	16,146	13,100
Biomass and Biorefinery Systems R&D	248	0	0
Wind Energy	111	503	424
Vehicle Technologies	1,038	580	1,000
Industrial Technologies	575	706	595
Program Support	0	500	750
Total, Los Alamos National Laboratory	16,901	18,435	15,869
National Energy Technology Laboratory			
Hydrogen and Fuel Cell Technologies	0	70	35
Biomass and Biorefinery Systems R&D	350	100	100
Wind Energy	65	0	0
Geothermal Technology	0	0	20,000
Federal Energy Management Program	3,740	3,251	6,000
Program Direction	14,231	15,534	28,561
Program Support	0	120	500
Total, National Energy Technology Laboratory	18,386	19,075	55,196
National Renewable Energy Laboratory			
Hydrogen and Fuel Cell Technologies	16,313	18,522	13,400
Biomass and Biorefinery Systems R&D	38,036	38,316	38,316
Solar Energy	67,201	75,393	75,433
Wind Energy	34,607	33,531	28,292

Geothermal Technology	2,000	1,000	5,000
Water Power	383	2,115	2,069
Vehicle Technologies	27,965	19,970	16,000
Building Technologies	10,858	18,161	26,783
Industrial Technologies	800	475	430
Federal Energy Management Program	3,300	5,893	6,000
Facilities and Infrastructure	76,000	19,000	57,500
Weatherization and Intergovernmental Activities	5,135	2,300	3,225
Program Support	8,267	10,385	19,110
Total, National Renewable Energy Laboratory	290,865	245,061	291,558
Oak Ridge National Laboratory			
Hydrogen and Fuel Cell Technologies	5,822	5,302	5,400
Biomass and Biorefinery Systems R&D	5,965	5,745	5,745
Solar Energy	276	200	100
Wind Energy	1,082	1,653	1,395
Geothermal Technology	300	0	0
Water Power	550	1,906	1,963
Vehicle Technologies	45,195	49,446	52,000
Building Technologies	10,002	16,731	9,002
Industrial Technologies	20,896	16,318	13,841
Federal Energy Management Program	2,860	4,013	4,572
Weatherization and Intergovernmental Activities	10,302	1,026	1,475
Program Support	40	1,692	3,350
Total, Oak Ridge National Laboratory	103,290	104,032	98,843

Pacific Northwest National Laboratory			
Hydrogen and Fuel Cell Technologies	6,410	6,985	5,600
Biomass and Biorefinery Systems R&D	9,855	10,822	10,822
Wind Energy	989	1,045	882
Water Power	150	1,540	1,888
Vehicle Technologies	11,204	8,433	10,000
Building Technologies	16,839	28,166	16,082
Industrial Technologies	835	671	1,369
Federal Energy Management Program	1,980	2,248	3,700
Program Support	661	1,842	2,985
Total, Pacific Northwest National Laboratory	48,923	61,752	53,328
Sandia National Laboratories			
Hydrogen and Fuel Cell Technologies	7,962	7,514	7,000
Biomass and Biorefinery Systems R&D	300	0	0
Solar Energy	19,828	28,572	27,693
Wind Energy	7,475	10,750	9,070
Geothermal Technology	1,700	1,700	5,000
Water Power	50	1,574	2,594
Vehicle Technologies	15,397	11,461	12,000
Federal Energy Management Program	220	100	323
Weatherization and Intergovernmental Activities	0	400	400
Program Support	1,120	1,975	3,825
Total, Sandia National Laboratories	54,052	64,046	67,905
Savannah River National Laboratory			
Hydrogen and Fuel Cell Technologies	3,750	3,592	2,300
Wind Energy	150	15	13
Total, Savannah River National Laboratories	3,900	3,607	2,313
Washington Headquarters			
Hydrogen and Fuel Cell Technologies	87,447	96,071	72,465
Biomass and Biorefinery Systems R&D	145,604	148,577	148,577
Solar Energy	10,769	16,891	20,380
Wind Energy	2,523	17,830	25,737
Geothermal Technology	6,472	15,550	0

Water Power	1,060	2,172	1,700
Vehicle Technologies	103,361	155,784	174,702
Building Technologies	88,469	138,962	162,263
Industrial Technologies	56,683	70,789	77,850
Federal Energy Management Program	7,700	10,848	15,850
Weatherization and Intergovernmental Activities	490,368	257,774	371,175
Re-ENERGYSE	0	0	50,000
Program Direction	86,845	95,393	117,035
Program Support	5,411	19,641	36,212
Total, Washington Headquarters	1,092,712	1,046,282	1,273,946
Subtotal, Energy Efficiency and Renewable Energy	2,170,103	2,242,500	2,355,473
Use of Prior Year Balances	-13,238	0	0
Total, Energy Efficiency and Renewable Energy	2,156,865	2,242,500	2,355,473

Site Descriptions

Ames Laboratory

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

Wind Energy

Ames National Laboratory will provide improvements to current short-term (up to 42 hour lead time) wind forecasting procedures that will decrease the impacts of variability in wind power production from large, multi-ray wind farms in the Central U.S. by combining ensembles of enhanced versions of the state-of-the-art forecast models with empirical methods of spatial-temporal statistical analysis and synthetic tools of data mining and artificial intelligence.

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 for the Industrial Materials and Nanomanufacturing activity areas, and focuses on nano-composites that improve degradation resistance and improve mechanical life of industrial tools and mechanical components subject to wear. The use of nano-particles for biorefining of non-food feedstocks is also being explored.

Argonne National Laboratory East

Argonne National Laboratory (ANL) is located in Argonne, Illinois, and is a multi-discipline laboratory providing support to Hydrogen and Fuel Cell Technologies, Biomass and Biorefinery Systems R&D, Solar Energy, Wind Energy, Geothermal Technology, Water Power, Vehicle Technologies, Buildings Technologies, Industrial Technologies, Federal Energy Management Program, and Program Support.

Hydrogen and 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 energy balance and emissions for biofuels in conventional and advanced vehicles, with and without fuel cells.

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

Solar Energy

ANL will work on a Programmatic Environmental Impact Statement for Concentrating Solar Power (CSP) technologies.

Wind Energy

ANL will assess and report on and 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 previously conducted strategic planning and analysis in support of enhanced geothermal technologies.

Water Power

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

Vehicle Technologies

ANL provides the Vehicle Technologies Program (VTP) with expertise in materials, combustion chemistry, electrochemistry, systems simulation, computational fluid dynamics, and techno-economic analysis. 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 VTP efforts to improve under-hood thermal management (including nanofluid technology and novel heavy-vehicle cooling systems) and to reduce aerodynamic drag on heavy vehicles. ANL 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 ultra capacitors. The lab uses both its system simulation and techno-economic analysis capabilities to support VTP planning and program evaluation with energy, economic, and environmental analyses. ANL also provides general technical and analytical support to VTP battery R&D, the Graduate Automotive Technology Education (GATE) activity, and VTP's student vehicle competitions.

Buildings Technologies

ANL will develop a new agent based commercial buildings sector model to study infrastructure, policy and behavioral issues relevant to meeting sector wide efficiency targets.

Industrial Technologies

ANL performs research for the Energy-Intensive Process R&D and Nanomanufacturing activities of ITP, including 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.

Federal Energy Management Program

ANL will provide technical analysis and support in areas relating to transportation technologies including idling reduction of all models of land-, sea-, and air-based vehicles and technology comparison and validation.

Program Support

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

Brookhaven National Laboratory

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

Hydrogen and Fuel Cell Technologies

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

Solar Energy

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

Wind Energy

BNL collaborates with the DOE Policy Office on analytical efforts focused on understanding the impact of DOE Applied Energy R&D and deployment activities on U.S. 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 included 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 supported Industrial Technologies R&D activities in the area of hierarchical nanoceramics for industrial process sensors. This project was completed in FY 2009.

Program Support

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

Chicago Operations Office

The Chicago Operations Office (COO) is located in Chicago, Illinois and provides support Wind Energy.

Wind Energy

COO will provide characterization of the complex flows over a dynamic two-dimensional wind turbine blade and develop strategies to control the blade to maximize efficiency and reduce undesired loading. This work should aid in improving the prediction of wind turbine performance and in investigating ways to control turbines to increase performance.

Golden Field Office/PMC

The Golden Field Office (GO) is located in Golden, Colorado, and provides project management and procurement support for Biomass and Biorefinery Systems R&D, Solar Energy, Wind Energy, Geothermal Technology, Water Power, Federal Energy Management Program, Weatherization and Intergovernmental Activities, Congressionally Directed Projects, Program Direction, and Program Support.

Biomass and Biorefinery Systems R&D

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

Solar Energy

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

Wind Energy

GO administers outreach to the States for Wind Powering America activities, monitors CDPs, and helps manage solicitations.

Geothermal Technology

GO will provide major support in the areas of project management and procurement for geothermal. These activities focus on Enhanced Geothermal Systems (EGS) RD&D that include field demonstration projects and a wide range of component R&D projects.

Water Power

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

Federal Energy Management Program

GO will conduct solicitations to award funding for direct project assistance, training and project validation for Energy Savings Performance Contracts.

Weatherization and Intergovernmental Activities

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

Congressionally Directed Projects

GO provided project management support for Hydrogen and Fuel Cell Technologies, Biomass and Biorefinery Systems R&D, Solar Energy, Wind Energy, Geothermal Technology, Water Power, Vehicle Technologies, Building Technologies, Industrial Technologies, Weatherization and Intergovernmental Activities, and crosscutting initiatives.

Program Direction

Administrative, management, and oversight functions will be performed from the Washington Headquarters, and the Project Management Centers (PMCs) located at GO, 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 stakeholders.

Program Direction funds the salary, benefits, and travel costs for FTEs of the GO PMC 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 behalf of Technology Advancement and Outreach, including work with the Ad Council on a National Energy Efficiency Public Information Campaign. GO also provides analytical support for major crosscutting issues, such as market and benefit analyses.

Idaho National Laboratory

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

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 and deployment-scale efforts. This work is performed in close collaboration with ORNL and NREL as necessary. INL will continue to 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 ultra capacitors for hybrid vehicles. The laboratory also conducts tests of high-power batteries, develops battery test procedures, tests and simulates hybrid vehicle performance, and develops energy storage models for electric and hybrid vehicles. INL conducts field testing and evaluations, and collects performance data from electric, plug-in hybrid and fuel cell light duty vehicles and infrastructure.

Industrial Technologies

Ongoing work at INL includes projects in Energy Intensive Processes   INL is assisting in the demonstration of a new process that uses steam to help wash black liquor from pulp, and is developing an improved, lower cost version of the Direct Evaporator Organic Rankine Cycle technology. INL also provides critical support in project management and analysis of ITP program activities.

Federal Energy Management Program

INL will provide ongoing maintenance to the FAST database as well as provide support and technical assistance to FEMP in its Federal Fleet Program.

Program Support

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

Lawrence Berkeley National Laboratory

Lawrence Berkeley National Laboratory (LBNL) is located in Berkeley, California, and is a multi-discipline laboratory providing support to Hydrogen and Fuel Cell Technologies, Solar Energy, Wind Energy, Geothermal Technology, Vehicle Technologies, Building Technologies, Industrial Technologies, Federal Energy Management Program, Weatherization and Intergovernmental Activities, and Program Support.

Hydrogen and Fuel Cell Technologies

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

Solar Energy

LBNL performs systems analysis for the program including cost and market analysis for both PV and CSP technologies.

Wind Energy

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

Geothermal Technology

LBNL will support RD&D on EGS including studies of geothermal reservoir dynamics and seismic phenomena. LBNL will analyze micro earthquake seismic data and vertical seismic profiling data from the EGS field projects and conduct research on tracers.

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

Industrial Technologies

LBNL supports the Plant Certification program, which is developing an ANSI-accredited certified practitioner program.

Federal Energy Management Program

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

Weatherization and Intergovernmental Activities

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

Program Support

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

Lawrence Livermore National Laboratory

Lawrence Livermore National Laboratory (LLNL) is located in Livermore, California, and is a multi-discipline laboratory providing support to Hydrogen and Fuel Cell Technologies, Wind Energy, Vehicle Technologies, and Industrial Technologies.

Hydrogen and Fuel Cell Technologies

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

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. LLNL will also 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 ultra capacitors based on nanostructure multilayer oxide materials. The lab's expertise in materials science is also applied to advanced automotive manufacturing concepts such as metal treatment using Plasma Surface Ion Implantation (PSII). LLNL's sensor expertise is applied to development of advanced NO_x sensors for diesel engines.

Industrial Technologies

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

Los Alamos National Laboratory

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

Hydrogen and 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 Energy

LANL conducts integration and resource planning; resource characterization and performance modeling; communication, policy and education support; and 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. LANL 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 Nanomanufacturing area, LANL is developing a technique to produce ultra-tough nano-composites for drill bit applications.

Program Support

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

National Energy Technology Laboratory

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

Hydrogen and Fuel Cell Technologies

In accordance with a Memorandum of Agreement with the Office of Fossil Energy, NETL co-manages fuel cell R&D 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.

Wind Energy

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

Geothermal Technology

NETL will conduct R&D in support of EGS advancement and will 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.

Federal Energy Management Program

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

Program Direction

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 NETL.

These functions include program and project management, coordination and liaison with other Federal Government organizations, with State and local governments, and stakeholders.

Program Support

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

National Renewable Energy Laboratory

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

Hydrogen and Fuel Cell Technologies

NREL leads the Systems Integration and Analysis activity 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 for Biomass and provides a broad range of analysis support across the program, including: 1) Biomass Scenario Model for feedstock production; 2) R&D state of technology for cellulosic ethanol, which provides guidance for the program’s R&D targets; 3) models of biochemical and thermo chemical processes to produce other advanced biofuels; 4) analytical models used to estimate the future (nth plant) biofuel production costs; and 5) systems integration for portfolio analysis. The program utilizes NREL capabilities to benchmark and validate industry-led R&D in the area of enzyme and ethanologen development. NREL operates two user facilities that support commercialization efforts: the Thermochemical Users Facility (TCUF) for syngas technologies; and the Alternative Fuels Users Facility (AFUF) for bioconversion technologies. NREL also actively supports the initial analysis and assessment activities for conversion of advanced feedstocks such as algae to biofuels. In coordination with ORNL, NREL will continue to support biofuels infrastructure development through intermediate ethanol blend testing on legacy vehicles, small engines, and materials.

Solar Energy

NREL serves as the lead laboratory for the Solar Energy Program. NREL conducts fundamental and applied materials research on PV devices, PV module reliability and systems development, data collection and evaluation on solar radiation, as well as on Concentrating Solar Power (CSP) technologies with an emphasis on parabolic trough technology, advanced thermal storage, and optical materials. Basic research teams investigate a variety of PV materials, such as amorphous silicon, polycrystalline thin films, high-efficiency materials and concepts, and high-purity silicon and compound semiconductors. NREL conducts simulated and actual outdoor tests on PV cells, modules, and arrays. The test results are used in developing standards and performance criteria for industry and to improve reliability.

Wind Energy

NREL is the lead laboratory for 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 that is required for sales and operation in many overseas markets. NWTC staff also implement 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 the Geothermal Program with geothermal technologies risk assessment, multi-year program planning, techno-economic analysis and system integration.

Water Power

NREL provides expertise in water power resource assessments, technology characterization activities, and development of international standards for comparison and evaluation of these technologies. NREL will provide supporting research and testing for marine and hydrokinetic (MHK) technologies, including research in the areas of mechanical engineering and machine performance, testing of hydrodynamics and sediments, development and testing of new materials, and modeling of water power systems and environmental interactions.

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 computerated design and engineering (CAD/CAE) for optimized vehicle system solutions in support of FreedomCAR and Fuels Partnership goals; and conducts 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; 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, primarily Building America (Residential Building Integration). NREL has integrated the BT Stage Gate process into the Building America and Commercial Buildings technical management processes. NREL also provides technical support to the implementation of Building America by conducting research, providing technical assistance to the teams and coordinating research among the partners, including the development and updating of tools such as Building Energy Optimization for the management of the project. For Commercial Buildings Integration, NREL provides technical support to the commercial building 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, as well as development and implementation of new models and features that expand the capabilities of EnergyPlus.

Industrial Technologies

NREL supports the 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 R&D program at NREL to advance U.S. energy policy. General Plant Project (GPP) investments support the safe and efficient operation of NREL and EERE programs, and provide for a minimum two percent recapitalization of real property assets in support of changing mission needs. General Purpose Equipment (GPE) investments acquire shared science and support capabilities and maintain EERE’s current equipment portfolio at NREL at a level of 50 percent (average) remaining portfolio value to ensure viability and readiness. Capital line item projects that include acquisition of new science and support capabilities, modification of existing capabilities, and improvements to NREL site infrastructure accommodate accelerated growth consistent with the EERE approved Ten Year Site Plan.

Weatherization and Intergovernmental Activities

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

Program Support

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

Oak Ridge National Laboratory

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

Hydrogen and 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 development efforts. ORNL will continue to lead updates for the Billion Ton Vision, a report that explores the feasibility of building a billion tons of feedstocks to convert to biofuels; the 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 as necessary. 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 provides assistance on biomass technology assessment and information transfer for the Integrated Biorefinery Platform.

Solar Energy

ORNL provides technical assistance for the Solar America Cities project.

Wind Energy

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

Geothermal Technology

ORNL previously performed R&D in wear-resistance nano-composite 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 participates in water power resource assessments, technology characterization activities, and will provide environmental studies for hydropower including research on fish passage, in-stream flow, and GHG emissions. ORNL will also provide research into water-use optimization for hydropower and support the quantification of hydropower’s ancillary benefits to the U.S. transmission grid.

Vehicle Technologies

ORNL provides VTP with expertise in materials, combustion, electrical engineering, systems analysis, vehicle testing and data collection, and techno-economic analysis. ORNL uses its materials expertise to develop and test a wide range of lightweight materials for vehicle applications, including carbon-fiber, lightweight alloys, and novel materials such as thermally-conducting carbon foams for high-performance engine radiators. ORNL also operates the High-Temperature Materials Lab as a user facility for materials characterization, funded by VTP. ORNL supports VTP’s combustion R&D with the development of in-cylinder diagnostics, development and testing of catalytic converters, measuring and modeling the chemical kinetics of emissions-treatment devices including NOx absorbers and selective catalytic reduction, and toxicity analysis of unregulated emissions from engines operating on advanced fuels. This work also supports VTP’s Fuels R&D activity by analyzing and modeling the fuel characteristics that affect emissions control and efficiency in diesel engines. ORNL uses its electrical engineering expertise to research, develop, and test power electronics (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 R&D for: Building America; space heating and cooling; and envelope and emerging technologies.

Industrial Technologies

ORNL conducts research and provides support in several ITP program areas including: Industrial Materials, Nanomanufacturing, Industrial Distributed Energy, Industrial Technical Assistance, Energy-Intensive Process R&D, and Fuel and Feedstock Flexibility. 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 Nanomanufacturing, 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 combined heat and power (CHP) systems, biomass opportunities, whole building design, and alterative financing.

Weatherization and Intergovernmental Activities

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

Program Support

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

Pacific Northwest National Laboratory

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

Hydrogen and 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 R&D on syngas, 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 also supports initial analysis and assessment activities for conversion of advanced feedstocks such as algae to biofuels and life cycle assessments of alternative fuels.

Wind Energy

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

Water Power

PNNL will provide identification, analysis, and prediction of environmental impacts from MHK energy production and provide support for research and testing for MHK technologies, hydropower water-use optimization, and studies of environmental hurdles for conventional hydropower, including fish passage, in-stream flow, and GHG emissions.

Vehicle Technologies

PNNL supports VTP primarily through their expertise in a variety of materials technologies. PNNL evaluates advanced energy storage materials for battery R&D. PNNL supports VTP materials R&D effort by developing energy-efficient production and processing techniques for magnesium, titanium, polymer, and 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 develops 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 R&D activities for building codes, appliance standards and lighting, and cross cutting economic and technical analyses. For Commercial Buildings Integration PNNL provides technical support to the commercial building national accounts and energy alliances in three commercial building segments: retail, commercial real estate, and hospitals.

Industrial Technologies

As part of Energy-Intensive Process R&D, PNNL works on a Sustainable Manufacturing Research Platform project team, developing and demonstrating a new technology as an alternative to conventional stamping technology.

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

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

Sandia National Laboratories

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

Hydrogen and Fuel Cell Technologies

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

Biomass and Biorefinery Systems R&D

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

Solar Energy

SNL supports the PV Energy Systems efforts with the principal responsibility for systems and balance-of-systems technology development and reliability. Indoor and outdoor measurement and evaluation facilities provide support to industry for cell, module, and systems measurement, evaluation, and analysis. Systems-level work concentrates on application engineering reliability, database development, and technology transfer. SNL also supports Concentrating Solar Power technologies emphasizing power tower R&D, dish R&D, and molten salt thermal storage research.

Wind Energy

SNL department staff work closely with counterparts at NREL 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 provide project monitoring and support to EGS field projects including review of geothermal site development issues, access to end users, land use, and data needs. SNL will conduct component research specific to EGS such as modeling and simulation of reservoir thermal drawdown and water availability. SNL also will play a role in cooperative bilateral projects with Iceland and support the International Partnership for Geothermal Technology.

Water Power

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

Vehicle Technologies

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

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. SPIA works with SNL to conduct technical and analytical work for a variety of technology areas, including analysis of carbon abatement through renewable portfolios and life cycle analysis. Commercialization activities include developing CRADAs, securing contracts with industry partners, and accelerating EERE technology into the marketplace.

Savannah River National Laboratory

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

Hydrogen and Fuel Cell Technologies

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

Wind Energy

SRNL will compute atmospheric refractivity fields to determine the siting conditions for proposed wind farm locations. Conditions leading to negative impacts can be determined from the refractivity fields to produce conditional probabilities for the occurrence or non-occurrence of wind turbine impact on radar applications. SRNL will evaluate current and proposed mitigation strategies based on actual radar beam propagation predictions through radar ray tracing methods and applied to existing wind farm sites where observations and best practices can be compared. Existing wind farms within line of site of radars will provide quantitative evaluation of impact forecasts.

Washington Headquarters

Washington, D.C. is the headquarters for the EERE 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 all EERE programs and activities.

Hydrogen and Fuel Cell Technologies
Funding Profile by Subprogram
(Non-comparable, as Appropriated, Structure)

(dollars in thousands)

	FY 2009 Current Appropriation[a]	FY 2009 Current Recovery Act Appropriation	FY 2010 Current Appropriation	FY 2011 Request
Hydrogen and Fuel Cell Technologies				
Fuel Cell Systems R&D	0	0	0	67,000
Hydrogen Fuel R&D	0	0	0	40,000
Hydrogen Production and Delivery R&D	10,000	0	15,000	0
Hydrogen Storage R&D	57,823	0	32,000	0
Fuel Cell Stack Component R&D	61,133	0	62,700	0
Transportation Fuel Cell Systems	6,435	0	3,201	0
Distributed Energy Fuel Cell Systems	9,750	13,157	11,410	0
Fuel Processor R&D	2,750	0	171	0
Systems Analysis	7,520	0	5,556	5,000
Market Transformation	4,747	29,810	15,026	9,000
Manufacturing R&D	4,480	0	5,000	5,000
Technology Validation	0	0	13,097	11,000
Safety and Codes & Standards	0	0	8,839	0
Education	0	0	2,000	0
Total, Hydrogen and Fuel Cell Technologies	164,638	42,967	174,000	137,000

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[a] SBIR/STTR funding transferred in FY 2009 was $3,858,000 to the SBIR program and $464,000 to the STTR program.

Hydrogen and Fuel Cell Technologies
Funding Profile by Subprogram
(Comparable funding in the FY 2011 Request)

(dollars in thousands)

	FY 2009 Current Appropriation[a]	FY 2009 Current Recovery Act Appropriation	FY 2010 Current Appropriation	FY 2011 Request
Hydrogen and Fuel Cell Technologies				
Fuel Cell Systems R&D	80,068	13,157	77,482	67,000
Hydrogen Fuel R&D	67,823	0	47,000	40,000
Systems Analysis	7,520	0	5,556	5,000
Market Transformation	4,747	29,810	25,865	9,000
Manufacturing R&D	4,480	0	5,000	5,000
Technology Validation	0	0	13,097	11,000
Total, Hydrogen and Fuel Cell Technologies	164,638	42,967	174,000	137,000

Public Law Authorizations:

P.L. 93-275, “Federal Energy Administration Act” (1974)
P.L. 93-577, “Federal Non-Nuclear Energy Research and Development Act” (1974)
P.L. 94-163, “Energy Policy and Conservation Act” (EPCA) (1975)
P.L. 94-413, “Electric and Hybrid Vehicle Research, Development and Demonstration Act” (1976)
P.L. 95-91, “Department of Energy Organization Act” (1977)
P.L. 95-238, Title III – “Automotive Propulsion Research and Development Act” (1978)
P.L. 96-512, “Methane Transportation Research, Development and Demonstration Act” (1980)
P.L. 96-294, “Energy Security Act” (1980)
P.L. 100-494, “Alternative Motor Fuels Act” (1988)
P.L. 101-566, “Spark M. Matsunaga, Hydrogen Research, Development, and Demonstration Act of 1990”
P.L. 102-486, “Energy Policy Act of 1992”
P.L. 104-271, “Hydrogen Future Act of 1996”
P.L. 109-58, “Energy Policy Act of 2005”
P.L. 110-140, “Energy Independence and Security Act of 2007

Mission

The mission of the Hydrogen and Fuel Cell Technologies (HFCT) Program is to reduce petroleum use, greenhouse gas (GHG) emissions and criteria air pollutants, as well as to contribute to a more diverse energy supply and more efficient domestic energy use by enabling the widespread commercialization and application of hydrogen and fuel cell technologies. The program’s key mission goals are to advance the research, development, demonstration and deployment (RDD&D) of these technologies in order to make them competitive with alternative technologies in cost, reliability and performance, and to reduce the institutional and market barriers to hydrogen and fuel cell commercialization.

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[a] SBIR/STTR funding transferred in FY 2009 was $3,858,000 to the SBIR program and $464,000 to the STTR program.

In the near term, increasing market penetration requires a sustained effort in Fuel Cell Systems R&D to deliver higher performance and lower cost material and components, and in Market Transformation as new applications become ready for commercialization. For the longer term, a sustained effort in Hydrogen Fuel R&D is necessary to provide alternate pathways from interim production of hydrogen from natural gas, to a diverse portfolio of energy resources, including domestic or renewable sources such as coal, nuclear, biomass, wind, solar, and agricultural and industrial waste.

In FY 2011, HFCT continues its RDD&D efforts on fuel cell systems for stationary, portable, and transportation applications. This effort aligns with DOE's portfolio of technologies for near-term impact, improved energy efficiency using multiple fuels, and job creation, consistent with the Presidential objectives. HFCT 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. In FY 2011, a new activity, Hydrogen Fuel R&D, is proposed to encompass R&D for fuel cell compatible fuel production, delivery and storage.

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 Environmental Protection Agency (EPA) criteria and other pollutants, and enhance energy security by increasing the production and diversity of domestic fuel supplies.

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 and considering the entire energy path, substantial reductions in CO_2 emissions and petroleum use 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. 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 (CHP) supply in data centers. Other early market applications include backup power for critical loads, such as telecommunications. 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 energy. 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.

FY 2011 activities integrate program R&D and the new program and sector base resulting from Recovery Act funded projects. Follow through is planned within each related activity to build the Nation's energy economy with sustained technology innovation and infrastructure at the scale and pace leveraged partnerships generated with an informed and energized public, Congress and private sector. This integrated targeted performance builds on both Recovery and RD&D will enable the realization of administration's goals and commitments to energy, the economy and climate. 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, HFCT contributes to reducing GHG by providing solutions for many applications. Hydrogen fuel cells are ideal for using flexible and clean hydrogen fuels for generating electricity or a combination of electricity and heat for use in commercial, industrial, or residential applications.

Energy Security

HFCT aims to enhance national energy security by reducing reliance on imported oil with widespread commercialization of fuel cells that use domestic and diverse sources of fuel. Fuel cells used for transportation applications can use fuel produced from a variety of energy sources including coal, natural gas, nuclear, wind, hydroelectric, solar, biomass, and geothermal resources, as well as industrial and agricultural waste streams, and landfill and wastewater treatment gas. Using fuel cells for CHP applications can currently utilize up to 85 percent of the energy content of fuel, compared to electricity from the grid which provides approximately 32 percent[a] of the energy content of the fuel.

Economic Impacts

The program contributes to economic growth in the U.S. by developing hydrogen and fuel cell technologies that lead to new jobs in domestic manufacturing, infrastructure development, and support services. In addition, the reduced dependence on petroleum by using renewably-produced hydrogen fuels 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 2011 through 2050 that would result from realization of the program goals: National Energy Modeling System – Government Performance and Results Act 2011 (NEMS-GPRA2011) for benefits through 2030, and Market Allocation Model – Government Performance and Results Act 2011 (MARKAL-GPRA2011) for benefits through 2050.[b] (See tables 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 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 (VTP) uses for GPRA 2011 analyses.

The preliminary program benefits illustrated in the following tables are based on an assumption that fuel cell and hydrogen fuel technologies will not be technically ready for widespread commercialization until 2020.

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[a] Annual Energy Review, 2008. Energy Information Administration. Washington. June, 2009: http://www.eia.doe.gov/emeu/aer/pdf/aer.pdf

[b] Additional information on EERE's impact analysis methodology and assumptions, as well as the final FY 2011 budget impact estimates, can be found at http://www1.eere.energy.gov/ba/pba/program_benefits.html

FY 2011 Primary Metrics

	Metric	Model	Year			
			2015	2020	2030	2050
Energy Security	Oil Imports Reduction, cumulative (Bil bbl)	NEMS	ns	ns	0.2	N/A
		MARKAL	ns	ns	ns	7.8
	Natural Gas Imports Reduction, cumulative (Tcf)	NEMS	ns	ns	ns	N/A
		MARKAL	ns	ns	ns	ns
Environmental Impacts	CO_2 Emissions Reduction, cumulative ($mtCO_2$)	NEMS	ns	ns	148	N/A
		MARKAL	ns	ns	ns	2365
	SO_2 Allowance Price Reduction ($/ton)	NEMS	ns	ns	ns	N/A
		MARKAL	N/A	N/A	N/A	N/A
	NO_x Allowance Price Reduction ($/ton)	NEMS	ns	ns	ns	N/A
		MARKAL	N/A	N/A	N/A	N/A
Economic Impacts	Primary Energy Savings, cumulative (quads)	NEMS	ns	ns	2.1	N/A
		MARKAL	ns	ns	ns	4.0
	Oil Savings, cumulative (Bil bbl)	NEMS	ns	ns	0.2	N/A
		MARKAL	ns	ns	ns	7.9
	Consumer Savings, cumulative (Bil $)	NEMS	ns	ns	14.9	N/A
		MARKAL	ns	19	149	1612
	Electric Power Industry Savings, cumulative (Bil $)	NEMS	ns	ns	7	N/A
		MARKAL	ns	ns	ns	ns
	Household Energy Expenditures Reduction ($/household/yr)	NEMS	ns	ns	30	N/A
		MARKAL	ns	ns	ns	2551

- “Reductions” and “savings” are calculated as the difference between results from the baseline case (i.e. no future DOE funding for this technology) and the program case (i.e. requested DOE funding for this technology is received and is successful).
- Oil impacts are shown as two metrics. "Oil Imports Reduction" refers only to reductions in oil imports; "Oil Savings" refers to savings (reduction) in total oil consumption.
- All cumulative metrics are based on results beginning in 2011.
- All monetary metrics are in 2007$.
- Cumulative monetary metrics are in 2007$ that are discounted to 2011 using a 3% discount rate.

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

FY 2011 Secondary Metrics

	Metric	Model	Year			
			2015	2020	2030	2050
Energy Security	Oil Imports Reduction, annual (Mbpd)	NEMS	ns	ns	0.1	N/A
		MARKAL	ns	ns	ns	2.75
	Natural Gas Imports Reduction, annual (Tcf)	NEMS	ns	ns	ns	N/A
		MARKAL	ns	ns	ns	ns
	MPG Improvement (%)	NEMS	ns	ns	2%	N/A
		MARKAL	ns	ns	ns	127%
Environmental Impacts	CO2 Emissions Reduction, annual (Mil mtCO2/yr)	NEMS	ns	ns	30.2	N/A
		MARKAL	ns	ns	ns	239
	CO2 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	0.02
	CO_2 Intensity Reduction of US Transportation Sector[4] (Kg CO2/mile)	NEMS	ns	ns	ns	N/A
		MARKAL	ns	ns	ns	0.09
Economic Impacts	Primary Energy Savings, annual (quads/yr)	NEMS	ns	ns	ns	N/A
		MARKAL	ns	ns	ns	1.0
	Oil Savings, annual (Mbpd)	NEMS	ns	ns	0.14	N/A
		MARKAL	ns	ns	0.04	3.04
	Consumer Savings, annual (Bil $)	NEMS	ns	ns	4.3	N/A
		MARKAL	ns	ns	8.4	376
	Electric Power Industry Savings, annual (Bil $)	NEMS	ns	ns	2.5	N/A
		MARKAL	ns	ns	ns	ns
	Energy Intensity of US Economy (energy/$GDP)	NEMS	ns	ns	ns	N/A
		MARKAL	ns	ns	ns	ns
	Net Energy System Cost Reduction, cumulative (Bil $)	NEMS	N/A	N/A	N/A	N/A
		MARKAL	ns	6	70	1405

- "Reductions" and "savings" are calculated as the difference between results from the baseline case (i.e. no future DOE funding for this technology) and the program case (i.e. requested DOE funding for this technology is received and is successful).
- Oil impacts are shown as two metrics. "Oil Imports Reduction" refers only to reductions in oil imports; "Oil Savings" refers to savings (reduction) in total oil consumption.
- All cumulative metrics are based on results beginning in 2011.
- All monetary metrics are in 2007$.
- Cumulative monetary metrics are in 2007$ that are discounted to 2011 using a 3% discount rate.

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

Contribution to the Secretary’s Goals and GPRA Unit Goal

HFCT contributes to two of the Secretary's goals as described below. The principal focus areas are energy efficiency, use of renewable energy, GHG reduction, and development of advanced technology.

Energy: Build a competitive, low-carbon economy and secure America’s energy future

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.

With improvements in materials and components resulting in increases in performance and cost decreases, fuel cell technology has the potential to gain significant market traction and have a major impact on the source and use of energy on a global scale. Fuel cells use energy that can be created from a diverse range of energy sources, including coal, natural gas and biological sources by gasification and reforming technologies; nuclear and solar energy through thermo-chemical reactions; and wind, hydroelectric and geothermal energy sources by use of electrolysis. Furthermore, fuels for fuel cells can be created from agricultural, food processing and industrial waste streams, and biogas from landfills and wastewater treatment plants. Fuel cells can be used for a vast range of applications including portable power devices, heat and power for buildings, material handling equipment, auxiliary power and transportation. Market penetration of fuel cell systems will be accelerated through the Market Transformation subprogram.

Innovation: Lead the world in science, technology, and engineering

This goal emphasizes breakthrough research; development of science and engineering talent; and coordination of R&D with other DOE programs, other Federal agencies, and internationally.

Basic science research develops fundamental understanding that contributes to the revolutionary advances necessary for meeting hydrogen storage targets and for enabling fuel production technologies such as enzyme catalysts and direct photo-catalysts. The HFCT program coordinates with DOE’s Office of Science in fields such as nanoscience, biological mechanisms of hydrogen production, and understanding hydrogen interactions with material surfaces. Fundamental understanding of hydrogen interaction mechanisms feeds into EERE applied R&D activities to enable breakthroughs in areas such as hydrogen storage, catalysis, and membranes. The program conducts monthly coordination group meetings between the DOE Offices of EERE, Science, Fossil Energy, and Nuclear Energy.

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

Annual Performance Results and Targets

Each of HFCT's performance metrics measures progress in both of the Secretarial priority areas listed above.

- For Fuel Cell Systems R&D, improvement of the catalyst utilization of fuel cells to 7.0 kW per gram of platinum group metal by 2014 will represent technology leadership and a significant movement towards commercial competitiveness for fuel cells in transportation applications, which could lead to significant reductions in the use of fossil fuels.
- For Hydrogen Fuel R&D, decreasing the capital cost by 80% for hydrogen production using renewable resources by 2015 will serve to measure development of advanced technology and will

make it possible to displace petroleum with renewable energy, reducing GHG emissions and supporting a low-carbon future.

- For Market Transformation and other deployment activities, market adoption of 12,000 kW (cumulative, starting in FY 2011) of fuel cell power by FY 2015 will demonstrate long-term environmental and energy-security benefits associated with fuel cell use. The introduction of this market-penetration metric in FY 2011 reflects the growing market acceptance of fuel cells in multiple applications (such as materials-handling equipment and telecommunications/data centers), as well as the auto-industry intent to introduce fuel cell vehicles by 2015.

Annual Performance Targets and Results

Secretarial Goal: Goal 1: Innovation: Lead the world in science, technology, and engineering
Goal 2: Energy: Build a competitive, low-carbon economy and secure America's energy future
GPRA Unit Program Goal: 01 Hydrogen and Fuel Cell Technologies
Subprogram: Fuel Cell Systems R&D

<table>
<tr><th>FY 2006</th><th>FY 2007</th><th>FY 2008</th><th>FY 2009</th><th>FY 2010</th><th>FY 2011</th><th>FY 2012</th><th>FY 2013</th><th>FY 2014</th><th>FY 2015</th></tr>
<tr><td colspan="10">Performance Measure: Improve the catalyst utilization of fuel cells, as measured in units of kW per gram of platinum group metal, from 2.8 kW/g in 2008 to 8.0 kW/g in 2015. (kW/g) [a]</td></tr>
<tr><td>T: NA
A: NA</td><td>T: NA
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A: NA</td><td>T: 4.0
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A:</td><td>T: 7.0
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A:</td></tr>
<tr><td colspan="10">Performance Measure: The FY 2011 performance measure was created for the new sub-program, Fuel Cell Systems R&D, which consolidates Fuel Cell Stack Components R&D, Transportation Fuel Cell Systems, Distributed Energy Fuel Cell Systems and Fuel Processor R&D. Previous year performance measures for this subprogram are not direct predecessor measures to the FY 2011 performance measure. These measures included below enabled the progress necessary to support the new FY 2011 Performance Measure.
FY 2006: DOE-sponsored laboratory scale research reduced the modeled technology cost to $110/kW for a hydrogen-fueled 80 kW fuel cell power system.
FY 2007: DOE-sponsored laboratory scale research reduced the modeled technology cost of a hydrogen-fueled 80kW fuel cell power system to $90/kW.
FY 2008: DOE-sponsored research reduced 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 contributed to the Department's goal of increased energy security and reduced greenhouse gas and pollutant emissions.
FY 2009: DOE-sponsored research reduced 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 contributed to the Department's goal of increased energy security and reduced greenhouse gas and pollutant emissions.
FY 2010: Improved 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.[b]</td></tr>
<tr><td>T: $110/kW
A: MET</td><td>T: $90/kW
A: MET</td><td>T: $70/kW
A: MET</td><td>T: $60/kW
A: MET</td><td>T: 3.0
A:</td><td>T: RETIRED
A: NA</td><td>T: NA
A: NA</td><td>T: NA
A: NA</td><td>T: NA
A: NA</td><td>T: NA
A: NA</td></tr>
</table>

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[a] As of January 21, 2010, the April futures price for platinum was $1,600 per troy ounce ($56 per gram). Usage of platinum for a 90 kW fuel cell stack would be 32g at the baseline (2008) level; achievement of the FY 2015 goal would reduce that to 11g, leading to a cost reduction of $1,170 at the January 21, 2010 April futures platinum price, not including the processing cost for the platinum-based catalyst.

[b] This measure was slightly revised for FY 2011. The FY 2010 actual should be considered trendable with the new FY 2011 measure.

Annual Performance Targets and Results

Secretarial Goal: Goal 1: Innovation: Lead the world in science, technology, and engineering
Goal 2: Energy: Build a competitive, low-carbon economy and secure America’s energy future
GPRA Unit Program Goal: 01, Hydrogen and Fuel Cell Technologies
Subprogram: Hydrogen Fuel R&D

FY 2006	**FY 2007**	**FY 2008**	**FY 2009**	**FY 2010**	**FY 2011**	**FY 2012**	**FY 2013**	**FY 2014**	**FY 2015**
Performance Measure: Relative to the 2010 baseline [a], decrease the capital cost for hydrogen production using renewable resources. (percent decrease)									
T: NA A: NA	T: NA A: NA	T: NA A: NA	T: NA A: NA	T: NA A: NA	T: 10% A:	T: 25% A:	T: 40% A:	T: 60% A:	T: 80% A:
Performance Measure: The FY 2011 performance measure was created in transition from reporting qualitative milestones to quantitative performance measures. Previous year performance measures for this subprogram are not direct predecessor measures to the FY 2011 performance measure. These measures included below enabled the progress necessary to support the new FY 2011 Performance Measure. FY 2007: Completed lab-scale electrolyzer test to determine whether it achieves 64 percent energy efficiency and evaluated 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]. FY 2008: Completed benchmark demonstration of reforming technologies and identified 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.									
T: NA A: NA	T: Qualitative A: MET	T: Qualitative A: MET	T: RETIRED A: NA	T: NA A: NA	T: NA A: NA	T: NA A: NA	T: NA A: NA	T: NA A: NA	T: NA A: NA

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[a] There are three pathways that may be addressed. Their 2010 baseline costs are: Electrolysis, $1.65/gge (gallon of gasoline equivalent); Aqueous phase reforming, $2.00/gge; Pyrolysis oil reforming, $2.45/gge.

Annual Performance Targets and Results

Secretarial Goal: Goal 1: Innovation: Lead the world in science, technology, and engineering
Goal 2: Energy: Build a competitive, low-carbon economy and secure America's energy future
GPRA Unit Program Goal: 1, Hydrogen and Fuel Cell Technologies
Subprogram: Market Transformation

FY 2006	**FY 2007**	**FY 2008**	**FY 2009**	**FY 2010**	**FY 2011**	**FY 2012**	**FY 2013**	**FY 2014**	**FY 2015**
Performance Measure: Total power capacity of new fuel cells placed in use each year, in megawatts.[a] (MW)									
T: NA A: NA	T: NA A: NA	T: NA A: NA	T: NA A: NA	T: NA A: NA	T: Baseline[b] A:	T: 0.5 A:	T: 0.8 A:	T: 1.1 A:	T: 1.5 A:

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[a] The FY 2011 performance measure was created in FY 2011 as a result of the elevated significance of the Early Market Activities in the Market Transformation sub-program through the 2009 Recovery Act. There are no formal previous year performance measures for this subprogram.

[b] A market analysis will establish the annual new fuel-cell installed capacity attributable to this activity in FY 2011.

Means and Strategies

HFCT 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.

HFCT employs the following means to accomplish its goals:

The program leverages its R&D activities by collaborating with other complementary programs within and outside DOE. For details, please see the Collaboration and Coordination section below.

HFCT employs the following strategies to accomplish its goals:

To organize R&D activities for hydrogen and fuel cell technologies, the program established RD&D subprograms. The subprograms have established cost, performance and/or durability goals to enable hydrogen and fuel cell technologies to be competitive with alternate technologies. For example, for stationary fuel cell systems to be competitive, the cost target is $750/kW, and the durability target is 40,000 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 the Energy Policy Act of 2005 (EPAct 2005) and EISA to achieve GPRA Unit goals.

The following external factors could affect the ability of the HFCT 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.

HFCT leverages its R&D activities by collaborating with other complementary programs within and outside of DOE.

- HFCT coordinates across five DOE Offices: EERE, Science, Nuclear Energy, Fossil Energy, and Electricity Delivery and Energy Reliability. HFCT 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 VTP, Biomass and Biorefinery R&D, Solar Technologies, Wind Energy, and Water Power and Federal Energy Management programs.
- Interagency Task Force: HFCT participates in the Task Force in accordance with EPAct 2005, to leverage and coordinate Federal resources and activities.
- International Partnership for Hydrogen and Fuel Cells in the Economy (IPHE): HFCT is DOE's primary representative to the IPHE, which strives to leverage R&D capabilities globally.
- FreedomCAR and Fuel Partnership: DOE (represented by VTP and HFCT) 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 HFCT'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. The list below summarizes validation and verification activities.

Data Sources:

- Merit Review and Peer Evaluation of R&D[a], 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; and
- 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 HFCT:

- 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)
- Catalyst utilization in fuel cells (2008, laboratory): 2.8 kW/gram
- Capital cost reduction (percentage) for hydrogen production using renewable resources (2010, projected commercialized). There are three pathways that may be addressed. The 2010 baseline costs are:
    - Electrolysis: $1.65/gge

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[a] 2009 Annual Merit Review and Peer Evaluation Report. U.S. Department of Energy, October, 2009. http://www.hydrogen.energy.gov/annual_review.html.

    - Aqueous phase reforming: $2.00/gge
    - Pyrolysis oil reforming: $2.45/gge
- Total power capacity of new fuel cells placed in use each year, in megawatts: baseline will be determined in FY 2011.

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:

- 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 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 PMM.
- Annual review of methods, and recomputations of potential benefits for GPRA.
- The Hydrogen Technical Advisory Committee (HTAC) reports regularly on recent significant accomplishments. In the 2009 *The State of Hydrogen and Fuel Cell Commercialization and Technical Development*[a], HTAC noted as specific examples of recent progress that, “In 2008, 3M Inc. announced that their membrane electrode assembly ... operated over 7,300 hours with load cycling, and Plug Power announced that it had reached 10,000 hours in field operation of their fuel cell packs designed for forklift duty cycles. These are major steps forward...”
- The National Academies' “Review of the Research Program of the FreedomCAR and Fuel Partnership - Second Report” (August 2008) noted that, “The ... Partnership is well planned, organized and managed. It is an excellent example of an effective industry/government cooperative effort ...”
- 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

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[a] 2008 Annual Report of The Hydrogen and Fuel Cell Technical Advisory Committee. Released May/June 2009: http://www.hydrogen.energy.gov/pdfs/2008_hftac_annual_report.pdf

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[a]. GAO recommended that program plans be updated to provide an overall assessment of what DOE reasonably expects to achieve by its technology readiness date.

- The program develops and implements planning documents and supports the development of technology roadmaps with industry.[b] 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.
- 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 HFCT objectives; 2) approach to performing R&D; 3) technical accomplishments and progress toward project and DOE goals; 4) technology transfer/collaborations with industry, universities, and/or 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.
- 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.

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[a] "Hydrogen Fuel Initiative" Report to Congressional Requesters, United States Government Accountability Office. January 2008. http://www.gao.gov/new.items/d08305.pdf

[b] Links to program plans, roadmaps and vision documents can be found at http://www.hydrogen.energy.gov/library.html.

Fuel Cell Systems R&D
Funding Schedule by Activity

	(dollars in thousands)		
	FY 2009	FY 2010	FY 2011
Fuel Cell Systems R&D	80,068	75,471	65,311
SBIR/STTR	0 [a]	2,011	1,689
Total, Fuel Cell Systems R&D	80,068	77,482	67,000

Description

In FY 2011, HFCT continues its R&D efforts on fuel cell systems for stationary, portable and transportation applications. Fuel Cell Systems R&D will further 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 the Fuel Cell Systems subprogram 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 associated economic and environmental benefits to expand into larger markets. As recommended in the 2008 National Research Council (NRC) report,[b] HFCT reallocated over the past three years funding to prioritize and emphasize the R&D that addresses the most critical barriers, such as membranes, catalysts, electrodes, and modes of operation. In addition, the program is emphasizing the development of carbon-free electrocatalysts. In 2011, the program is placing greater emphasis on the science and engineering at the cell level and, from a systems perspective, on integration and component interactions.

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 2011, the program will place significant emphasis on balance-of-plant component R&D (such as water transport, sensors, and air compression) that can lead to lower cost and lower parasitic loss. Fuel processors will enable 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

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[a] In FY 2009, $1,992,729 was transferred to the SBIR program from funding comparable to the FY 2011 Request, and $239,771 was transferred to the STTR program from funding comparable to the FY 2011 Request.

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

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 that have been developed will expand research capabilities. For example, neutron imaging has enabled the visualization of water transport within fuel cells while they are operating, providing validation for models used to optimize future designs.

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 include reduced petroleum consumption, reduced GHG and criteria emissions, and a more independent, diversified energy infrastructure.

Fuel cells use a highly efficient electrochemical process to produce electricity from a variety of fuels and have gained traction in the marketplace for applications that are proven to be economically feasible. 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 (such as material handling and airport ground support vehicles), backup power, APUs, primary power systems, CHP 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 HFCT focus emphasizes near and mid-term applications. As the industry matures through success of near-term applications, transportation applications will become more viable.

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. They can also be integrated into combined-heat-and-power (CHP) systems. In addition, fuel cells provide higher efficiency, and can make use of waste gases found at municipal landfills, agricultural sites, wastewater treatment plants, 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

Fiscal 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	36
2010	38	N/A
2011	40	N/A
2012	40	N/A
2013	40	N/A

Distributed Stationary Prime-Power (including CHP)

Fuel cells offer a highly efficient and fuel-flexible technology for distributed power generation and CHP systems. Key applications include primary power for critical load facilities and remote power applications, 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 have unique advantages in CHP applications. Currently in the U.S., 63 percent (or about 26 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. CHP systems 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: quiet and vibration-free operation, ability to use existing natural gas fuel supply, low operation and maintenance requirements, and ability to maintain high efficiency over a wide range of loads.

Backup Power

Fuel cells have emerged as an economically viable option for providing backup power, particularly for telecommunications towers, data centers, hospitals, and communications facilities for emergency services. Compared with batteries, fuel cell systems offer higher energy density and greater durability

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[a] Annual Energy Review, 2008. Energy Information Administration. Washington: June, 2009; http://www.eia.doe.gov/emeu/aer/pdf/aer.pdf.

[b] Combined Heat and Power: Effective Energy Solutions for a Sustainable Future. Oak Ridge National Laboratory, 2008; http://apps.ornl.gov/~pts/prod/pubs/ldoc13655_chp_report____final_web_optimized_11_25_08.pdf.

in harsh outdoor environments under a wide range of temperature conditions. Compared to generators, fuel cells are quieter and have low to zero emissions (depending on the fuel source). In addition, they require less maintenance than both generators and batteries. 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 run times 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, making 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 as batteries are discharged, their power output diminishes, 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 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 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. Fuel Cells can be used in EPA designated nonattainment areas, where emissions restrictions prevent use of other technologies such as ICE generators.

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

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

[b] 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. May 2009; http://www.hydrogen.energy.gov/pdfs/review09/fc_44_blake.pdf.

as 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 by-products, 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.

In the near term, a fuel cell vehicle fueled with hydrogen produced from natural gas can provide a pathway that reduces GHG emissions by at least 40 percent relative to a gasoline ICE vehicle, on a total life-cycle basis. In 15 to 20 years, when hydrogen from low-carbon sources (e.g. wind electrolysis, nuclear thermal processes, or biomass) is cost competitive, a fuel cell vehicle's GHG emissions would be 90 percent less relative to a gasoline ICE vehicle; 80 percent less than a plug-in hybrid electric vehicle (PHEV) fueled with gasoline and electricity; and 60 percent to 70 percent less than a PHEV fueled with cellulosic ethanol and electricity.[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]

Fuel Cell Power System Performance Metrics
80kW System Cost

Fiscal Year	Target $/kW	Actual $/kW
2002	N/A	275
2003	225	225
2004	200	200
2005	125	110
2006	110	108
2007	90	94
2008	70	73
2009	60	61

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

[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

Detailed Justification

(dollars in thousands)

	FY 2009	FY 2010	FY 2011
Fuel Cell Systems R&D	**80,068**	**75,471**	**65,311**

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 with expected advances in incumbent technologies.

In FY 2011, 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 as well as non-PGM catalyst approaches for long-term application. 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.

The Fuel Cell Systems R&D subprogram 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 will provide data for model validation. This effort will include measurement and modeling of mass and electronic/protonic transport in each layer and interface in an MEA.

In FY 2011, 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 2011 targets. Impurities present in both the fuel stream and the air intake have a negative impact on fuel cell performance and durability. In FY 2011, 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. In cooperation with the DOT's Hydrogen and Fuel Cell Bus Initiative, R&D will focus on fuel cell system performance related to the bus duty cycle.

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 that began in FY 2010 will continue in FY 2011 to prove the durability of full-scale systems as they approach their target specifications.

The program has been successful in reducing the cost of fuel cell stacks to less than 50 percent of the cost of the fuel cell system and will increase emphasis on the balance of plant in FY 2011. Water management continues to be a challenge due to extremes in ambient temperature, humidity, and pressures at which fuel cells must operate to ensure that the residual water in the system does not cause damage after shut-down if the water freezes. Projects will examine concepts for novel water management devices and fuel cell system configurations that facilitate water management. Fuel cell system performance modeling will optimize water management device concepts and configurations, and ensure development of robust solutions. Third-party evaluation of fuel cell stacks and systems will increase as these technologies mature.

In FY 2011, 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.

R&D for auxiliary power applications will focus on developing fuel cell systems for heavy duty trucks as an 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 VTP's 21CTP which does not include fuel cells. Since 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 2011, 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 are developed for applications that have preference for a particular type of fuel at the point-of-use. DOD for instance, has a very strong preference for diesel or JP8 (jet fuel) for logistical reasons and because the stability of these fuels in combat situations is well understood. There is also preference to supply APUs with the same fuel as the primary/propulsion system for logistical reasons, and because multiple fuel types are not presently available at all refueling locations. In some cases, such as wastewater treatment plants, specific sources of energy are co-located with electric loads. Fuel processing at point-of-use can reduce the delivery costs of fuel in dollars, energy, and emissions.

Processing conventional fuels (such as natural gas, propane, methanol, ethanol, biomass derived liquids, or diesel) allows direct hydrogen fuel cells to be used in locations where hydrogen is not yet available. 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

	(dollars in thousands)		
	FY 2009	FY 2010	FY 2011

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 conducts competitive awards and peer reviews.

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

SBIR/STTR	**0**	**2,011**	**1,689**

No funds were transferred to the SBIR and STTR programs in FY 2009 or FY 2010 because this is a new key activity. The amount shown in FY 2011 is the estimated requirement for the continuation of the SBIR and STTR programs.

Total, Fuel Cell Systems R&D	**80,068**	**77,482**	**67,000**

Explanation of Funding Changes

	FY 2011 vs. FY 2010 ($000)
Fuel Cell Systems R&D	
Fuel Cell Stack Component R&D, Distributed Energy Fuel Cell Systems, Transportation Fuel Cell Systems and Fuel Processors R&D were consolidated into the new Fuel Cell Systems R&D sub-program. The comparable decrease from the FY 2010 appropriation is $10,160, which will reduce funding for portable power and auxiliary power unit applications and certain stack components such as bipolar plates and membranes, due to recent progress.	-10,160
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.	-322
Total Funding Change, Fuel Cell Systems R&D	**-10,482**

Hydrogen Fuel R&D
Funding Schedule by Activity

(dollars in thousands)

	FY 2009	FY 2010	FY 2011
Hydrogen Fuel R&D	67,823	45,750	38,936
SBIR/STTR	0 [a]	1,250	1,064
Total, Hydrogen Fuel R&D	67,823	47,000	40,000

Description

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

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

In addition, the project portfolio for Hydrogen Fuel R&D applies to energy storage systems that enable intermittent, renewable energy resources and combined heat, hydrogen, and power (CHHP) applications.

Benefits

Hydrogen Fuel R&D supports the mission of HFCT by addressing critical challenges and developing new and advanced technologies to produce, deliver and store hydrogen from diverse domestic renewable resources. The benefits of the R&D will impact diverse applications such as stationary, portable and transportation systems, and includes the lowering of hydrogen cost on a cents/mile basis to a level less than or equivalent to gasoline used in conventional or hybrid vehicles.[b] The hydrogen production research will reduce the projected costs of hydrogen, which contributes to DOE's strategic, security, economic, and environmental goals. In addition, benefits include the ability to produce hydrogen using advanced technologies such as reforming of bio-derived liquids in a *single step*

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[a] In FY 2009, $1,229,110 was transferred to the SBIR program from funding comparable to the FY 2011 Request, and $147,890 was transferred to the STTR program from funding comparable to the FY 2011 Request.

[b] The hydrogen cost goal range of $2.00 to $3.00 per gasoline gallon equivalent (gge) is independent of the production pathway and is based on the National Academies' fuel efficiency improvement factors for fuel cell vehicles relative to gasoline and gasoline hybrid vehicles and the Energy Information Administration's "High A Case" 2015 gasoline price projection. This methodology will make hydrogen fuel less than or equivalent to gasoline on a cents-per-mile basis.

reaction to greatly improve efficiencies, microbial assisted electrolysis to surpass conventional electrolysis approaches, and *direct* conversion of solar energy to hydrogen such as using photoelectrochemical approaches, thereby completely eliminating conventional electrolysis.

Fuel storage is a key enabling technology for the advancement of hydrogen and fuel cell technologies for stationary power, portable power and transportation applications. The FY 2011focus will be the continuation of current storage engineering R&D and materials R&D activities from a small number of remaining storage material projects. The storage materials activities, which offer the ability to store hydrogen at higher energy densities than liquid hydrogen (71 g/L) by using solid-state materials approaches that do not require the high pressure of today's conventional storage tanks and may be able to store hydrogen at close to room temperatures, will include development of novel adsorptive materials that can potentially triple hydrogen storage capacity at four times less cost than conventional carbon fibers.

The research will enable the system volumetric (kWh/L) and gravimetric (kWh/kg or % by weight) storage capacities (while meeting cost targets) to be improved as indicated below.

Hydrogen Storage Performance Metrics (by fiscal year)

	2003[a]	2004	2005	2006	2007	2008	2009[b]	2010	2011
Materials-Based									
Volumetric (kWh/L)									
Target					1.2	1.2	0.9	0.9	
Actual	0.5	0.6	0.65	0.8	0.8	0.8	0.8		
Gravimetric (% by weight)									
Target	1	1.7		2.5	4.5	4.5	4.5	4.5	
Actual	1	1.7	1.9	2.3	3.0	3.0	3.4		

Detailed Justification

(dollars in thousands)

	FY 2009	FY 2010	FY 2011
Hydrogen Fuel R&D	**67,823**	**45,750**	**38,936**

The Hydrogen Fuel R&D subprogram combines the activities of the former Hydrogen Production & Delivery and Hydrogen Storage subprograms and refocuses the portfolio on

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[a] 2 kWh/kg = 6 percent hydrogen by weight. 6 percent hydrogen by weight storage system contains 6 kg of hydrogen in a system weighing 100 kg. 1 kg of hydrogen contains 33.3kWh (on a lower heating value basis), so 6 kg contains approximately 200kWh. A 200 kWh hydrogen/100 kg system = 2kWh/kg.

[b] Revised 2010 targets are 1.5 kWh/kg (4.5 percent by weight) and 0.9 kWh/L; revised 2015 targets are 1.8 kWh/kg (5.5 percent by weight) and 1.3 kWh/L and "Ultimate" full light-duty vehicle fleet targets are 2.5 kWh/kg (7.5 percent by weight) and 2.3 kWh/L.

breakthrough technologies and materials R&D to enable hydrogen production, delivery and storage for diverse fuel cell applications. It includes materials research for hydrogen production from renewables (e.g. photoelectrochemical and biological), materials development for pipelines and tanks, and materials for low pressure hydrogen storage.

Fuel Production and Delivery

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

Existing projects in the other renewable production pathways will be funded to develop breakthrough technologies and materials for large-scale centralized hydrogen production. In solar high-temperature water splitting, the program will continue development of two chemical cycles in the laboratory and then select one cycle for a small-scale, on-sun test by 2014. The program will collaborate closely on this effort with EERE's Solar Energy Technologies Program.

In photoelectrochemical water splitting hydrogen production, HFCT will continue to evaluate materials and systems and identify functional requirements for auxiliary devices. In collaboration with DOE's Office of Science, the program will complete development of photoelectrochemical materials and evaluate device configurations that are projected to achieve 2015 and 2020 program targets. Also in collaboration with the Office of Science, research will continue on biological micro-organism systems to achieve breakthroughs in hydrogen production efficiency using photolytic, photosynthetic, fermentation, and microbial electrolysis pathways.

In the hydrogen delivery area, the program will conduct research to reduce capital costs and increase energy efficiency of hydrogen delivery systems. The focus in FY 2011 will be on development of glass fiber composites and novel concepts to enable development of low cost hydrogen delivery. This effort will include coordination with DOT to facilitate the infrastructure required for the Hydrogen and Fuel Cell Bus Initiative.

Fuel Storage

To address the critical challenge of hydrogen storage for stationary, portable and transportation applications, the program will continue with its overarching strategy to conduct R&D through the framework of competitively awarded projects, which includes teams of university, industry and Federal Laboratory partners. These efforts will focus on applied, target-oriented research of advanced concepts, innovative chemistries and novel materials, with the potential to meet the following technical goals by 2015: storage density of 1.8 kWh/kg (5.5 percent hydrogen by weight) and 1.3 kWh/L or 40 g/L. These goals represent usable specific energy from hydrogen and energy density, respectively, from an entire storage system (including all hardware and materials), and are comparable to a greater than 300 mile driving range for light duty vehicles. Advanced concepts include high-capacity metal hydrides, chemical hydrogen storage materials including solid and liquid chemical hydrogen carriers and boron-based materials, sorbents including novel metal-carbon hybrids, metal-organic framework materials, polymers, and other nanostructured high surface area materials, as well as novel material synthesis and treatment processes. Building on the research conducted through the end of FY 2010, R&D will focus on the most promising material technologies down-selected from the overall portfolio at the end of FY 2010 that have the potential to meet the DOE 2015 system target. Research on material concepts with the potential to meet the ultimate DOE targets of 7.5 percent hydrogen by weight will also continue.

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

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

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

Research on sorbents focuses on innovative ways to store hydrogen with lower binding energies (as compared to metal hydrides and chemical hydrides) to enable close to room temperature storage at nominal pressure to meet the 2015 system targets. Following the FY 2009 materials down-select decision, the sorbent portfolio will focus on improving the volumetric capacity, reaction thermodynamics, and the transient performance of materials.

Engineering research focuses on utilizing the storage system requirements for light-duty vehicles to design innovative components and systems with the potential to meet DOE performance and cost targets. Efforts will continue to develop engineering and system models that address both subsystems and the fuel cycle.

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

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

	FY 2009	FY 2010	FY 2011
SBIR/STTR	**0**	**1,250**	**1,064**

No funds were transferred to the SBIR and STTR programs in FY 2009 and FY 2010 because this is a new key activity defined in the FY 2011 budget request. The FY 2011 amount shown is the estimated requirement for the continuation of the SBIR and STTR programs.

	FY 2009	FY 2010	FY 2011
Total, Hydrogen Fuel R&D	**67,823**	**47,000**	**40,000**

Explanation of Funding Changes

	FY 2011 vs. FY 2010 ($000)
Hydrogen Fuel R&D	
This activity consolidates and refocuses efforts in the former subprograms of Hydrogen Production and Delivery R&D and Hydrogen Storage R&D. By focusing the new Hydrogen Fuel R&D key activity to address critical challenges of hydrogen production, delivery and storage relevant to diverse applications, the proposed budget is more streamlined and will have more near-term impacts than the previous structure. The current structure is more focused on materials R&D and advanced concepts that have potential to achieve the targets required for long-term viability of fuel cell technology across stationary, portable and transportation sectors. The comparable decrease from the FY 2010 appropriation is $6,814, which will defer funding for new materials R&D for long-term hydrogen delivery technologies. Funding is retained for key activities in materials R&D such as metal hydrides, sorbents, and engineering for hydrogen storage as well as production and delivery R&D for materials and processes for hydrogen from renewable resources.	-6,814
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.	-186
Total Funding Change, Hydrogen Fuel R&D	**-7,000**

Systems Analysis
Funding Schedule by Activity

(dollars in thousands)

	FY 2009	FY 2010	FY 2011
Systems Analysis	7,520	5,408	4,867
SBIR/STTR	0	148	133
Total, Systems Analysis	7,520	5,556	5,000

Description

The Systems Analysis subprogram supports program decision-making by evaluating the risks and benefits of fuel cell technologies and pathways. These efforts clarify the economic, environmental, and energy security benefits of fuel cell applications, guide RDD&D priorities, and facilitate the formulation of targets for various technology components. Key outcomes of Systems Analysis include determining cost drivers, identifying technological gaps, validating research results, assessing market growth and job creation, and quantifying the reduction of greenhouse gas (GHG) emissions and petroleum use. Analysis conducted for various fuel cell applications considers parameters such as the type of fuel cell technology, the energy pathway, policy, and consumer preference.

The Systems Analysis subprogram applies specific technologies and their combinations to national and global-scale implementation scenarios. Investigations include the effects of different policy options, infrastructure and resource analysis, consumer choice, and market penetration. Additionally, Systems Analysis conducts risk analysis for HFCT subprograms to determine the probability of meeting program targets, and the influence subprogram resources have in realizing the economic, environmental, and energy security benefits of hydrogen and fuel cell technologies.

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 that contributes to: understanding and assessing market growth and job creation; technology needs and progress; potential environmental impacts; and the energy-related economic benefits of fuel cells across applications and for multiple fuel pathways. This analysis assesses technology manufacturing and market uptake, R&D gaps, planning and budgeting, and interactions with other energy domains. The subprogram results provide metrics for multiple components, subsystems and systems that are needed to determine customer requirements. Results also support annual updates to key program planning documents that provide the current direction and planned milestones for the program.

The subprogram is supported by multiple Research Development Investment Criteria (RDIC) factors: build on existing technology and complements current R&D; incorporate industry involvement in planning, industry cost-sharing, and performance indicators; and conduct competitive awards and peer reviews.

Detailed Justification

(dollars in thousands)

	FY 2009	FY 2010	FY 2011
Systems Analysis	**7,520**	**5,408**	**4,867**

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 2011, the subprogram will continue the development of new analytical models and tools to help quantify GHG, criteria pollutants and petroleum use reduction benefits, and identify research, environmental, and economic gaps for various applications, such as materials handling, stationary and portable power, and CHP. The new models, combined with existing systems analysis models, will enable the program to identify: resource limitations; options and opportunities for stationary power production from fuel cells; renewable fuel supply evolution; infrastructure issues and limitations; and the potential environmental impacts of wide scale commercialization. The environmental benefits of utilizing renewable fuels such as landfill gas, biogas and extraneous gas for stationary fuel cells will be assessed on a well-to-wheel basis. The subprogram will also evaluate the impact of fuel quality on stationary fuel cells to determine the cost and emission tradeoffs of fuel purification to fuel cell performance.

Building on efforts completed in FY 2010 to upgrade the Macro System Model (MSM), which provides overarching analysis for the program, additional linkages will be developed in FY 2011 to provide near- and mid-term analytical capabilities to evaluate the effects of integrating stationary fuel cells into the electricity supply sector on the energy market and job creation .

In collaboration with the Fuel Cells Systems R&D subprogram, the Systems Analysis 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 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 also be conducted.

	(dollars in thousands) FY 2009	FY 2010	FY 2011

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

	FY 2009	FY 2010	FY 2011
SBIR/STTR	**0**	**148**	**133**

In FY 2009, $172,116 and $20,709 were transferred to the SBIR and STTR programs respectively. The FY 2010 and 2011 amounts shown are estimated requirements for the continuation of the SBIR and STTR programs.

	FY 2009	FY 2010	FY 2011
Total, Systems Analysis	**7,520**	**5,556**	**5,000**

Explanation of Funding Changes

	FY 2011 vs. FY 2010 ($000)
Systems Analysis	
Updates to the Systems Analysis Plan; Technical Requirements Document; and the Multi-Year Research, Development and Demonstration Plan are expected to be largely completed with FY 2010 funds, and will not need additional funding in FY 2011.	-541
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.	-15
Total Funding Change, Systems Analysis	**-556**

Market Transformation
Funding Schedule by Activity
(Non-comparable, as-Appropriated, Structure)

(dollars in thousands)

	FY 2009	FY 2010	FY 2011
Market Transformation	4,747	15,005	8,899
Safety and Codes & Standards	0	8,592	0
Education	0	2,000	0
SBIR/STTR	0	268	101
Total, Market Transformation	4,747	25,865	9,000

Funding Schedule by Activity
(Comparable funding in the FY 2011 Request)

(dollars in thousands)

	FY 2009	FY 2010	FY 2011
Market Transformation	4,747	25,597	8,899
SBIR/STTR	0	268	101
Total, Market Transformation	4,747	25,865	9,000

Description

The goal of the Market Transformation subprogram is to accelerate the commercialization of fuel cell technologies to realize the benefits that are enabled by HFCT RD&D. To achieve this goal, Market Transformation works to eliminate non-technical barriers by facilitating the development of safe practices, codes and standards, raising public awareness, and stimulating the market and industry by providing financial assistance for demonstrating fuel cells in early-market applications. A structure change is proposed in FY 2011 that consolidates the previous Safety and Codes & Standards and Education activities along with previous early-market activities in Market Transformation, although funding for educational activities is deferred in FY 2011.

Safety, Codes & Standards

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

Early Market Activities

To facilitate early adoption of hydrogen and fuel cell technologies, HFCT has used cost-shared projects with partners from industry and government agencies (Federal, State and local) to deploy fuel cell systems in stationary and specialty vehicle applications while collecting data on operations and performance. For example, HFCT has coordinated with the Defense Logistics Agency (DLA) on the demonstration of fuel cell forklifts in their distribution centers both across the U.S. and abroad. DLA is the main provider of fuel and supplies for the Department of Defense and several civilian agencies. The demonstration has allowed collection of operations and performance data on fuel cells under real-world conditions, providing valuable feedback to manufacturers and the R&D program. Further funding for these early-market activities is deferred in FY 2011 in order to focus on critical safety, codes, and standards issues.

Education

Lack of awareness and information among the public and potential buyers is another barrier to the commercialization of fuel cells. The Market Transformation subprogram has disseminated information on fuel cell and fuel safety information and the merits of fuel cell technologies, although funding for educational activities is deferred in FY 2011. The activity may, in the future, also support workforce development activities for training the workforce to design, build, install, commission, repair, service, or decommission fuel cell systems as these systems are further developed.

Benefits

By increasing the volume of product purchases for early-market applications, FY 2009 Recovery Act and FY 2010 early-market activities have allowed domestic fuel cell manufacturers to accelerate development of high-volume and low-cost manufacturing capability, establish a component and material supplier base, and lower the cost of fuel cell power systems through manufacturing economies of scale. High-volume purchases exercise the processes required for commercialization beyond a fuel cell developer's R&D operations, and provide developers valuable experience for streamlining operations and resolving problems that occur in these processes. These processes have included the interaction of fuel cell developers with component and material suppliers, distributers, technicians that install and service equipment, end-users, and state and local code officials. Through real implementation of fuel cell technologies, early-market activities have included the assessment of infrastructure, codes and standards, financing and training needs required for large-scale commercialization. Based on these assessments, early-market activities more directly facilitate validation, codes and standards, education activities.

Stationary power provides a significant opportunity for fuel cells in near-term markets such as prime distributed power, emergency backup power, and residential or small commercial CHP units. In addition, specialty vehicles for material handling, i.e. lift trucks, auxiliary power units (APUs) for refrigeration, and long haul trucks are promising near-term applications. Each of these applications has the potential for a significant impact on U.S. energy use. Recovery Act and FY 2010 appropriations for Market Transformation focused on material handling equipment and backup power. In FY 2011, the subprogram will focus on auxiliary power and new primary stationary power applications (e.g. residential and small commercial CHP systems).

Material Handling

The market for forklifts was $3.2 billion in 2003 and is projected to grow to $5.2 billion in 2013. Current and projected market share of battery-powered forklifts is approximately 58 percent of the total forklift market.[a] Compared to battery-powered forklifts, fuel cell demonstrations show that fuel cells offer longer runtime, faster return to service, and constant power. This leads to higher productivity as fuel cell powered trucks can run at full speed 24 hours, seven days a week and can be refilled in less than a minute. Fuel cell lift trucks also have shown lower operating costs as the need for battery rooms is eliminated, creating more warehouse space. Compared to ICE-powered forklifts, fuel cell-powered lift trucks emit no criteria pollutants. Customer payback for fuel cell powered fork lifts has been estimated at less than two years, which is stimulating market demand without subsidies and outside of early Federal demonstration programs. For example, Central Grocers has 220 fuel cell lift trucks in one of its facilities handling all of its products with no Federal government interaction.[b]

Backup Power

The primary criteria for backup power purchasers are cost and reliability. A prime example is backup power for the telecom industry. Requirements are for six to eight hours of operation for backup generators, to a week or more to cover extended outages. Battery back-up systems provide power at the low end of the required time. Fuel cell systems are being commercially deployed, have shown excellent reliability, and can be less expensive than battery systems on a life-cycle basis, even without tax credits. Several hundred backup power systems are currently planned by industry (e.g., Sprint, AT&T) as a result of funding through the Recovery Act. It is estimated that the total U.S. market potential per year for 5kW fuel cell backup power units ranges between 130,000 and 190,000 units, or $2 to $3 billion.[c]

Auxiliary Power Units (APUs)

Long haul truck and locomotive idling consumes greater than 1 billion gallons of diesel fuel annually, resulting in 11 million tons of CO_2, 200,000 tons of NO_X and 5,000 tons of particulate matter emitted. The average class-8 sleeper truck idles 1,456 hours per year. The market for APUs on long-haul trucks is expected to increase substantially due to anti-idling legislation aimed at reducing these emissions. Fuel cell APUs can provide the electricity needed at much higher efficiencies and with much lower emissions. Cummins Power generation has calculated that a long-haul truck uses 2,000 gallons of diesel per year idling to run electrical loads off the main engine/generator, at an efficiency of about three percent. An SOFC APU running at only 20 percent efficiency would reduce this to 230 gallons

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[a] “Market Opportunity Assessment for Direct Hydrogen PEM Fuel Cells in Pre-Automotive Markets.” Battelle. May 2007; http://www.hydrogen.energy.gov/pdfs/review07/fc_26_mahadevan.pdf

[b] “Plug Power in the Marketplace.” Plug Power. June 2009; http://www.usfcc.com/resources/HouseBriefing_Plug_FritzIntwala6.12.09.pdf

[c] “Fuel Cells in Distributed Telecom Backup.” Citigroup Global Markets. August 2005; http://www.fuelcells.org/info/library/CitiGroupStationary-backup.pdf

per year, while an SOFC APU running at the DOE target 35 percent efficiency would reduce the consumption to 210 gallons.[a] In addition, APUs for truck refrigeration can provide similar energy savings. Diesel-fueled SOFC APUs are in the development stage, with units scheduled to be demonstrated in 2010.

Prime Power (Distributed Generation)

Distributed generation fuel cells are being sold in the marketplace today albeit at relatively high capital costs. Molten carbonate fuel cell (MCFC) systems are on the market for 300 to 3,000 kW applications. Existing installations operate on natural gas or bio-gas such as waste water treatment bio-gas. Electric efficiency is reported to be 47 percent.[b] Because of the relatively high temperature of operation (600-700ºC), high-quality waste heat is available for process or environmental (e.g., hot water) use. When the waste heat is captured and used, overall fuel efficiencies can be as high as 85 percent.

Phosphoric acid fuel cell (PAFC) systems are available in modules of 400 kW electric with strong CHP capabilities. Overall efficiencies of 80 percent or more can be realized.[c] Dozens have been installed world-wide and have demonstrated high efficiency, reliability, and availability. Capital cost is also relatively high with PAFCs.

Residential CHP

Fuel cells can provide electrical power and heat for hot water and space heating at a substantial cost savings (20 to 40 percent) where power and heat requirements are well matched, i.e., low natural gas cost, high electric rates. In addition, when configured properly, the system could also provide cooling duty. These units are especially attractive in areas with a high spark spread (ratio of electricity rates to natural gas costs). It is estimated that the available market in the U.S. is about 400,000 units per year.[d] Systems for residential CHP service are poised to enter the commercial market in the near-term. Japan demonstrated over 3,000 1kW units operating on natural gas, LPG, kerosene, and city gas. This fleet achieved an average energy savings of about 774 MJ per month and GHG reductions of 85 kg CO_2 per month.[e]

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[a] "Diesel Fueled SOFC Systems for Class 7/Class 8 On-Highway Truck Auxiliary Power." Cummins Power Generation. May 2009: http://hydrogen.energy.gov/pdfs/review09/fc_43_norrick.pdf

[b] "Matching Federal Government Energy Needs with Energy Efficient Fuel Cells." US Fuel Cell Council. April 2007: http://www1.eere.energy.gov/hydrogenandfuelcells/pdfs/fuel_cell_mtng_spitznagel.pdf

[c] "ETV Joint Verification Statement." Environmental Technology Verification Program, Environmental Protection Agency: http://www.nyserda.org/publications/ETV%20Reports/7009_ETV_vs_utc.pdf

[d] "Plug Power in the Marketplace." Plug Power. June 2009: http://www.usfcc.com/HouseBriefing_Plug_FritzIntwala6.12.09.pdf

[e] "Current Status of the Large-Scale Stationary Fuel Cell Demonstration Project in Japan." New Energy Foundation. November 2006: http://www.fuelcellseminar.com/assets/pdf/2006/Friday/1F/Nishikawa_Shinji_1020_1F_520(rv2)approved.pdf

Detailed Justification

	(dollars in thousands)		
	FY 2009	FY 2010	FY 2011
Market Transformation	**4,747**	**25,597**	**8,899**

Safety, Codes & Standards

In FY 2011, the Market Transformation activity will quantify the effects of fuel contaminants on fuel cell system components to support development of fuel quality standards, and will develop analytical methods to allow cost-effect verification of fuel purity. Metering technologies will also be supported to allow accurate measurement of delivered fuel. DOE will collaborate with DOT, EPA, NIST and other government agencies to ensure that fuel, fuel storage and dispensing standards development proceeds in agreement with existing regulatory authorities. The cooperating agencies will maximize available resources and expertise in areas such as alternative fuel vehicle dispensing measurement (NIST), vehicle safety (DOT National Highway Traffic Safety Administration) and international standards development (DOT, EPA). Analysis of potential accident scenarios to identify both potential alternative fuel systems weaknesses and to identify the R&D required to improve systems safety will also be conducted. The accident scenarios report will help guide a risk analysis effort that uses probabilistic risk analysis and failure modes affects analysis methods to quantitatively estimate systems risk. Risk assessment activities will provide information to guide the codes and standards development process. This information also will be made available to key industry stakeholders, such as fuel providers and insurers.

FY 2011 funding will facilitate the development of computational fluid dynamics models to support the risk assessment activities for fueling, production infrastructure, and transportation of alternative fuels in tunnels, garages, and other confined spaces. The activity will also conduct comprehensive R&D to characterize the release of alternative fuels when impeded by various obstacles/equipment to provide the input necessary to determine codes for setback distances. In addition, the PNNL Hydrogen Safety Panel will continue to monitor the safety of DOE hydrogen projects. The panel will conduct site visits, interviews and safety plan reviews of all DOE funded hydrogen projects.

In addition to R&D for safety, this activity will include training for fire fighters and fire department training coordinators, law enforcement personnel, and emergency medical technicians, as well as code officials, fire marshals, city planners, State government representatives, and other fuel cell users. Training for first responders and code officials facilitates the approval and implementation of fuel cell projects using alternative fuels. In FY 2011, training for first responders will update and expand the availability of DOE's "Introduction to Hydrogen Safety for First Responders." Building on prior year efforts, DOE will also expand the implementation and deployment of an introductory course designed specifically for code officials. Working with partners, the course will be made available to a national audience through distance learning and targeted, in-person training workshops in critical needs areas.

Early-Market Activities

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

To facilitate early adoption of hydrogen and fuel cell technologies, the Market Transformation subprogram has used cost-shared projects with partners from industry and government agencies (Federal, State and local) to deploy fuel cell systems in stationary and specialty vehicle applications. By leading the market in adoption of technologies that are near-viable commercially, Federal Agencies play a critical role in enhancing the market introduction of superior technologies. HFCT has coordinated with DOD in deploying fuel cell lift trucks in several locations and supports Federal deployments for backup power applications. All projects have incorporated a data collection element, providing important third-party test data that validate performance characteristics and help to increase consumer acceptance of fuel cell technologies.

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**	**268**	**101**

In FY 2009, no funds were transferred to the SBIR and STTR programs. The FY 2010 and 2011 amounts shown are the estimated requirements for the continuation of the SBIR and STTR programs.

Total, Market Transformation	**4,747**	**25,865**	**9,000**

Explanation of Funding Changes

	FY 2011 vs. FY 2010 ($000)
Market Transformation	
Safety, Codes and Standards activities are consolidated within this Market Transformation subprogram; however, that increase is offset by deferring early-market activities that constituted the Market Transformation budget in prior years. No funding for education activities is requested in FY 2011. The comparable decrease from the FY 2010 appropriation is $16,698, which will allow critical safety, codes and standards activities to continue while deferring funding for fuel cell deployment, real-world data collection for early market applications, and education activities.	-16,698
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.	-167
Total Funding Change, Market Transformation R&D	**-16,865**

Manufacturing R&D
Funding Schedule by Activity

(dollars in thousands)

	FY 2009	FY 2010	FY 2011
Manufacturing R&D	4,480	4,867	4,867
SBIR/STTR	0 [a]	133	133
Total, Manufacturing R&D	4,480	5,000	5,000

Description

The Manufacturing R&D subprogram will support the development of manufacturing processes in parallel with technology development critical for hydrogen and fuel cell components and systems. Through R&D, the subprogram develops and demonstrates technologies and processes that will reduce the cost of components and systems for fuel cells, storage, and hydrogen production for near term markets. The program's activities will address the challenges of moving the technology from the laboratory to the assembly line. The near-term goal for early markets is to lower fuel cell stack manufacturing cost by $1,000/kW from $3,000/kW to $2,000/kW. Research will be conducted in coordination with the Department of Commerce and OSTP's Interagency Working Group on Manufacturing R&D. The subprogram will address an array of fabrication and process techniques amenable to high volume production of fuel cells, hydrogen production, delivery, and storage components and systems. An R&D technology roadmap was developed with industry to identify critical technology development needs for high volume manufacturing of fuel cell and hydrogen systems.[b] The subprogram's initial focus will be manufacturing processes and techniques that are synergistic in terms of cross-cutting applications, such as high volume membrane fabrication techniques for both fuel cell stacks and electrolyzers.

Benefits

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

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[a] In FY 2009, $464,045 and $55,630 were transferred to the SBIR and STTR programs respectively.

[b] "Roadmap on Manufacturing R&D for the Hydrogen Economy." December 2005: http://www.hydrogen.energy.gov/pdfs/roadmap_manufacturing_hydrogen_economy.pdf

Detailed Justification

	(dollars in thousands)		
	FY 2009	FY 2010	FY 2011
Manufacturing R&D	**4,480**	**4,867**	**4,867**

In FY 2011, the subprogram will continue its collaborative research efforts involving universities, industry, and National Laboratories in the development of fabrication processes amenable to low-cost, high-volume manufacturing. Near-term activities will encompass R&D of technologies critical to an early start-up of high-volume commercialized products, such as: 1) membrane-electrode assemblies and gas diffusion layers for fuel cells, 2) distributed production systems and components, and 3) vessels for hydrogen storage and dispensing. Specific manufacturing R&D projects will be identified as technology roadmaps are updated.

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. The Manufacturing R&D Subprogram is consistent with the National Academies' recommendations, and is supported by multiple RDIC factors: it builds on existing technology and complements current R&D in support of the DOE Hydrogen Posture Plan; it incorporates industry involvement in planning, industry cost-sharing, performance indicators, and it is competitively awarded and peer reviewed.

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

In FY 2009, $464,045 and $55,630 were transferred to the SBIR and STTR programs respectively. The FY 2010 and 2011 amounts shown are estimated requirements for the continuation of the SBIR and STTR programs.

Total, Manufacturing R&D	**4,480**	**5,000**	**5,000**

Explanation of Funding Changes

	FY 2011 vs. FY 2010 ($000)
Manufacturing R&D	
No change.	0
Total Funding Change, Manufacturing R&D	**0**

Technology Validation
Funding Schedule by Activity

(dollars in thousands)

	FY 2009	FY 2010	FY 2011
Technology Validation	0	13,005	10,923
SBIR/STTR	0	92	77
Total, Technology Validation	0	13,097	11,000

Description

The primary goal of this learning demonstration is to validate progress towards the Fuel Cell Systems R&D fuel cell durability targets. The fuel cell technology validation effort will quantify the performance, reliability, durability, maintenance requirements and environmental benefits of fuel cells under real world conditions and provide valuable information to researchers to help refine and direct future R&D activities related to fuel cell systems. In addition, this effort will gather and analyze data on hydrogen production and storage systems to identify key technology gaps and future R&D efforts in hydrogen fuel R&D.

To bridge the gap between the laboratory and marketplace, technology validation is necessary to evaluate whether fuel cell products are ready for widespread market penetration. In these activities, fuel cell, fueling, and storage systems are proven in a broad range of operating environments. The systems are instrumented, operated as they would be by an end-user in a real environment and carefully observed. Results from these systems are used to guide R&D and programmatic decisions.

Detailed Justification

(dollars in thousands)

	FY 2009	FY 2010	FY 2011
Technology Validation	**0**	**13,005**	**10,923**

In FY 2010, the scope of activities expanded to collect and analyze data from stationary fuel cells, especially in early market applications. This effort will continue in FY 2011, and limited validation activities will be conducted to address fuel cell systems used in mass-transit, and additional stationary power applications. Demonstration projects continue with data collection and operation of backup power systems, specialty vehicles and light-duty vehicles. The program's validation activities will include fuel cell buses (FCB). Collaboration with the DOT includes validating fuel cell and hydrogen technologies in transit bus applications in coordination with the Federal Transit Administration, and harmonizing data collection efforts with other FCB demonstrations worldwide.

The Hydrogen Learning Demonstration projects began in 2004 to collect real-world operational data on fuel cell vehicles and hydrogen refueling infrastructure. Half of the Hydrogen Learning Demonstration projects have completed objectives in 2010, and the remainder of the Hydrogen

	(dollars in thousands)		
	FY 2009	FY 2010	FY 2011

Learning Demonstration projects, which include second generation vehicles, will conclude by the end of 2011.

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. The Technology Validation Subprogram is consistent with the National Academies' recommendations, and is supported by multiple RDIC factors: it builds on existing technology and complements current R&D in support of the DOE Hydrogen Posture Plan; it incorporates industry involvement in planning, industry cost-sharing, and performance indicators; and it is competitively awarded and peer reviewed.

SBIR/STTR	**0**	**92**	**77**

In FY 2009, $464,045 and $55,630 were transferred to the SBIR and STTR programs respectively. The FY 2010 and 2011 amounts shown are estimated requirements for the continuation of the SBIR and STTR programs.

Total, Technology Validation	**0**	**13,097**	**11,000**

Explanation of Funding Changes

	FY 2011 vs. FY 2010 ($000)
Technology Validation	
In 2010, two of the Hydrogen Learning Demonstration projects were completed, thus less funding is needed in FY 2011.	-2,082
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.	-15
Total Funding Change, Technology Validation	**-2,097**

Hydrogen and Fuel Cell Technologies FY 2010 - FY 2011 Crosswalk

FY 2010		FY 2011	
Hydrogen Production and Delivery R&D	**15,000**	**Hydrogen Fuel R&D**	**40,000**
Hydrogen Storage R&D	**32,000**		
Fuel Cell Stack Component R&D	**62,700**	**Fuel Cell Systems R&D**	**67,000**
Transportation Fuel Cell Systems	**3,201**		
Distributed Energy Fuel Cell Systems	**11,410**		
Fuel Processor R&D	**171**		
Systems Analysis	**5,556**	**Systems Analysis**	**5,000**
Manufacturing R&D	**5,000**	**Manufacturing R&D**	**5,000**
Technology Validation	**13,097**	**Technology Validation**	**11,000**
Market Transformation	**15,026**	**Market Transformation**	**9,000**
Safety and Codes & Standards	**8.839**		
Education	**2.000**		
TOTAL HFCT	**174,000**	**TOTAL HFCT**	**137,000**

Biomass and Biorefinery Systems R&D
Funding Profile by Subprogram
(Non-comparable, or as-Appropriated, Structure)

(dollars in thousands)

	FY 2009 Current Appropriation[a]	FY 2009 Current Recovery Act Appropriation[b]	FY 2010 Current Appropriation	FY 2011 Request
Biomass and Biorefinery Systems R&D				
Feedstock Infrastructure	15,092	41,174	36,993	26,000
Platforms Research and Development	51,993	65,395	85,108	80,000
Utilization of Platform Outputs R&D	147,160	670,569	97,899	114,000
Total, Biomass and Biorefinery Systems R&D	214,245	777,138	220,000	220,000

Funding Profile by Subprogram
(Comparable Structure to the FY 2011 Request)

(dollars in thousands)

	FY 2009 Current Appropriation[a]	FY 2009 Current Recovery Act Appropriation[b]	FY 2010 Current Appropriation	FY 2011 Request
Biomass and Biorefinery Systems R&D				
Feedstocks (formerly Feedstocks Infrastructure)	*15,092*	*41,174*	*36,993*	*26,000*
Conversion Technologies (formerly Platforms Research and Development)	*51,993*	*65,395*	*85,108*	*80,000*
Utilization of Platform Outputs R&D	147,160	670,569	97,899	0
Integrated Biorefineries	*0*	*0*	*0*	*54,000*
Analysis and Sustainability	*0*	*0*	*0*	*10,000*
Large Scale Biopower	*0*	*0*	*0*	*50,000*
Total, Biomass and Biorefinery Systems R&D	214,245	777,138	220,000	220,000

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[a] SBIR/STTR funding transferred in FY 2009 was $2,459,000 for the SBIR program and $296,000 for the STTR program.

[b] Facilities and Infrastructure includes $13.5 million for the Integrated Biorefinery Research Facility.

Public Law Authorizations:

P.L. 93-577, “Federal Non-nuclear Energy Research and Development Act” (1974)
P.L. 94-163, “Energy Policy and Conservation Act” (EPCA) (1975)
P.L. 94-385, “Energy Conservation and Production Act” (ECPA) (1976)
P.L. 95-91, “Department of Energy Organization Act” (1977)
P.L. 95-618, “Energy Tax Act” (1978)
P.L. 95-619, “National Energy Conservation Policy Act” (NECPA) (1978)
P.L. 95-620, “Powerplants and Industrial Fuel Use Act” (1978)
P.L. 96-294, “Energy Security Act” (1980)
P.L. 100-12, “National Appliance Energy Conservation Act” (1987)
P.L. 100-615, “Federal Energy Management Improvement Act” (1988)
P.L. 101-218, “Renewable Energy and Energy Efficiency Technology Competitiveness Act” (1989)
P.L. 101-549, “Clean Air Act Amendments” (1990)
P.L. 101-575, “Solar, Wind, Waste, and Geothermal Power Production Incentives Act” (1990)
P.L. 102-486, “Energy Policy Act of 1992”
P.L. 106-224, “Biomass Research and Development Act” (2000)
P.L. 107-171, “Farm Security and Rural Investment Act” (2002)
P.L. 108-148, “Healthy Forest Restoration Act” (2003)
P.L. 109-58, “Energy Policy Act of 2005”
P.L. 110-140, “Energy Independence and Security Act of 2007”
P.L. 110-234, “The Food, Conservation, and Energy Act of 2008”

Mission

The 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, 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 EISA 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.

The Biomass Program 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. Feedstocks and Conversion Technologies subprograms will focus on reducing the costs of feedstock and conversion technology options through risk laden, high-value R&D, while the collection of operational data from demonstrating integrated biorefineries at various scales will also reduce technology deployment risks for commercial partners. 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.

In addition to its ongoing support of the RFS, the program is also launching a similar effort for biopower, through a signature initiative involving large commercial demonstration projects comparable to biorefineries in scale. As with the program's biorefinery projects, this new initiative will address the entire supply chain from feedstock cultivation to large scale power generation, providing clean energy solutions for an emerging low carbon economy.

Meeting the RFS targets and accelerating the commercial sector adoption of biopower technologies requires the concerted efforts of Federal and State policy and decision makers; the industrial, agricultural, and environmental communities; and financial sector and business entrepreneurs. Diligent coordination of multidisciplinary scientific and engineering expertise of academia, the National Laboratories, and other external organizations is also critical for building a strong technology innovation foundation and providing the rigorous analytical insight needed to properly inform the program's R&D activities for success. The Biomass Program will work to strengthen such relationships, reaching out to experts in a diverse spectrum of organizations, while continuing important existing collaborations with other Federal programs and agencies such as DOE's Office of Science (Bioenergy Centers) and the U.S. Department of Agriculture (USDA). New partnerships with other DOE programs, State, and federal agencies will be leveraged in the launch of the new large scale biopower subprogram. Through these coordinated efforts and strategic investments in the development of sustainable biomass technologies, the program is working to provide solutions that can help ensure America's energy, environmental, and economic security.

FY 2011 investments complement activities initiated with Recovery Act funds. Recovery activities include: accelerated intermediate blends testing and existing commercial scale biorefinery projects; the establishment of new advanced biofuels and algal biofuels R&D consortia; biofuels infrastructure and sustainability activities; and the selection of pilot and demonstration scale integrated biorefinery projects for the validation of a greater diversity of advanced biofuels technologies through a new solicitation. FY 2011 activities will build upon historic clean energy investments in the Recovery Act to further the Nation's energy goals through sustained technology innovation and continued investments in enabling infrastructure. This integrated targeted performance builds on both Recovery and RD&D will enable the realization of administration's goals and commitments to energy, the economy and climate. 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 RDD&D 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.[a] Biopower technologies, if applied in a regionally appropriate manner, also have the potential to reduce fossil carbon contributions to atmospheric GHG accumulation. The Biomass Program's current activities directly support meeting the goals of EISA. Even with anticipated benefits associated with EISA already included in their baseline (and thus, not attributed to the program), DOE models still predict that the program's activities will result in additional cumulative CO_2 emissions reductions of more than 200 million metric tons by 2030.

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

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, biofuels, and biopower. The development of production distribution infrastructure and the creation of related goods and services throughout the supply chain will create new green jobs. The increased production of biofuels and biopower has the potential to help reshape markets, reinvigorate rural economies, and support a sustainable new generation of transportation technologies capable of reducing fossil 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. Though anticipated benefits associated the EISA have already been included in their baselines, DOE models still predict that the program's activities will result in additional cumulative oil import reductions of up to 770 million barrels by 2030.

Economic Impact

The Biomass Program pursues its mission through a 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. While the most significant benefits are expected to be a reduction of oil imports and CO_2 emissions, consumers will benefit as well saving on the order of $60 billion by 2030.

The metrics benefits tables that follow show the estimated benefits from 2015 through 2050 that would result from realization of the program's goals.[a] These benefits are achieved by targeted Federal investments in technology R&D 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 tables also reflect 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 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. The metrics by which expected outcome benefits are measured are identical. This standardization of method and metrics is part of DOE's efforts to make all program stated benefits comparable.

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[a] Additional information on EERE's impact analysis methodology and assumptions, as well as the final FY 2011 budget impact estimates, can be found at http://www1.eere.energy.gov/ba/pba/program_benefits.html.

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 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 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 Biomass program R&D activities.

While the EISA RFS mandates that 36 billion gallons of renewable fuel 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, thus annual savings attributed to the program 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 as a result of market forces finally catching up, the magnitude of benefits does not return to the level of prior year estimates by 2050.

Some benefits may be shown as lower than projected in previous budgets. This is due to the models' inclusion of the effects of legislation such as EISA 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 R&D efforts.

The benefits are generated by modeling both the program goal and baseline cases[b] within two energy-economy models: NEMS-GPRA11 for benefits through 2030, and MARKAL-GPRA11 for benefits through 2050. The following tables display the full list of modeled benefits.

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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-GPRA11 analysis, the program case results in cellulosic ethanol production beginning sooner than in the baseline, which requires a smaller EISA RFS waiver and leads to some oil and carbon savings.

[b] Baseline cases utilize data from the updated *Annual Energy Outlook 2009* Reference Case Service Report, April 2009

FY 2011 Primary Metrics

	Metric	Model	Year			
			2015	2020	2030	2050
Energy Security	Oil Imports Reduction, cumulative (Bil bbl)	NEMS	ns	ns	0.77	N/A
		MARKAL	0.01	0.08	0.53	2.3
	Natural Gas Imports Reduction, cumulative (Tcf)	NEMS	ns	ns	0.09	N/A
		MARKAL	ns	ns	ns	ns
Environmental Impacts	CO_2 Emissions Reduction, cumulative (Mil $mtCO_2$)	NEMS	ns	28	396	N/A
		MARKAL	2.4	26	238	1195
	SO_2 Allowance Price Reduction ($/ton)	NEMS	ns	ns	ns	N/A
		MARKAL	N/A	N/A	N/A	N/A
	NO_x Allowance Price Reduction ($/ton)	NEMS	ns	ns	ns	N/A
		MARKAL	N/A	N/A	N/A	N/A
Economic Impacts	Primary Energy Savings, cumulative (quads)	NEMS	ns	ns	ns	N/A
		MARKAL	ns	ns	ns	ns
	Oil Savings, cumulative (Bil bbl)	NEMS	ns	ns	0.91	N/A
		MARKAL	0.02	0.09	0.62	2.9
	Consumer Savings, cumulative (Bil $)	NEMS	ns	ns	58	N/A
		MARKAL	ns	ns	82	202
	Electric Power Industry Savings, cumulative (Bil $)	NEMS	ns	ns	12	N/A
		MARKAL	ns	0.22	1.25	ns
	Household Energy Expenditures Reduction ($/household/yr)	NEMS	ns	ns	80	N/A
		MARKAL	ns	ns	73.63	28.1
	Jobs, cumulative (net added jobs)	NEMS	NA	NA	NA	NA
		MARKAL	NA	NA	NA	NA

- “Reductions” and “savings” are calculated as the difference between results from the baseline case (i.e. no future DOE funding for this technology) and the program case (i.e. requested DOE funding for this technology is received and is successful).

- Oil impacts are shown as two metrics. "Oil Imports Reduction" refers only to reductions in oil imports; "Oil Savings" refers to savings (reduction) in total oil consumption.

- All cumulative metrics are based on results beginning in 2011.
- All monetary metrics are in 2007$.
- Cumulative monetary metrics are in 2007$ that are discounted to 2011 using a 3% discount rate.

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

FY 2011 Secondary Metrics

	Metric	Model	Year			
			2015	2020	2030	2050
Energy Security	Oil Imports Reduction, annual (Mbpd)	NEMS	ns	ns	0.3	N/A
		MARKAL	ns	ns	0.2	0.3
	Natural Gas Imports Reduction, annual (Tcf)	NEMS	ns	ns	ns	N/A
		MARKAL	ns	ns	ns	ns
	MPG Improvement (%)	NEMS	ns	1%	3%	N/A
		MARKAL	ns	ns	ns	ns
Environmental Impacts	CO2 Emissions Reduction, annual (Mil mtCO2/yr)	NEMS	ns	7.3	59	N/A
		MARKAL	ns	8.6	38	57
	CO2 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 (Kg CO2/kWh)	NEMS	ns	ns	ns	N/A
		MARKAL	ns	ns	ns	ns
	CO_2 Intensity Reduction of US Transportation Sector (Kg CO2/mile)	NEMS	ns	ns	ns	N/A
		MARKAL	ns	ns	ns	ns
Economic Impacts	Primary Energy Savings, annual (quads/yr)	NEMS	ns	ns	ns	N/A
		MARKAL	ns	ns	ns	ns
	Oil Savings, annual (Mbpd)	NEMS	ns	0.04	0.29	N/A
		MARKAL	0.01	0.06	0.24	0.38
	Consumer Savings, annual (Bil $)	NEMS	ns	ns	16	N/A
		MARKAL	ns	0.1	27	11
	Electric Power Industry Savings, annual (Bil $)	NEMS	ns	0.8	3.0	N/A
		MARKAL	ns	ns	ns	ns
	Energy Intensity of US Economy (energy/$GDP)	NEMS	ns	ns	ns	N/A
		MARKAL	ns	ns	ns	ns
	Net Energy System Cost Reduction, cumulative (Bil $)	NEMS	N/A	N/A	N/A	N/A
		MARKAL	0.9	7.6	48	157
	Jobs, annual (net added jobs/yr)	NEMS	NA	NA	NA	NA
		MARKAL	NA	NA	NA	NA

- "Reductions" and "savings" are calculated as the difference between results from the baseline case (i.e. no future DOE funding for this technology) and the program case (i.e. requested DOE funding for this technology is received and is successful).
- Oil impacts are shown as two metrics. "Oil Imports Reduction" refers only to reductions in oil imports; "Oil Savings" refers to savings (reduction) in total oil consumption.
- All cumulative metrics are based on results beginning in 2011.
- All monetary metrics are in 2007$.
- Cumulative monetary metrics are in 2007$ that are discounted to 2011 using a 3% discount rate.

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

Contribution to the Secretary's Goals and GPRA Unit Program Goals

The Biomass Program contributes to two of the Secretary's goals as described below.

Energy: Build a competitive, low-carbon economy and secure America's energy future

The program also 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.

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.

The program's commercial, demonstration and pilot scale projects involve private sector employment. 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.

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.

Innovation: Lead the world in science, technology, and engineering

The program coordinates with DOE's Office of Science, National Science Foundation (NSF), and academic institutions to ensure that the program's R&D work 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 partner groups.

Contribution to GPRA Unit Program Goal 6 (Biomass and Biorefinery Systems R&D)

The program directly supports DOE's priority of developing the 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 the energy supply. It also addresses the goals and recommendations of the Farm Security and Rural Investment Act of 2002; the Energy Policy Act of 2005 (EPAct 2005); EISA; and the Food, Conservation, and Energy Act of 2008 (FCEA).

To increase the probability of success, the program funds key technology pathways that contribute to the achievement of this goal. To realize this, an intermediate programmatic cost-competitive ethanol target has been established based on EIA oil price projections. Currently the

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[a] Numbers are estimates provided in NREL's 2002 Design Report: http://www.nrel.gov/docs/fy02osti/32438.pdf

cost target is $1.76 per gallon of ethanol by 2012 (in 2007$), which includes feedstock and conversion costs. The program's technology pathways and respective contributions are:

Feedstocks Contributions:

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

Conversion Technologies:

- Biochemical conversion 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 for launching the next generation of biofuels technology from a wide range of feedstocks; and,
- Thermochemical conversion R&D will focus on technologies for converting feedstocks and bioconversion process residues into cost competitive commodity fuels (e.g. ethanol, gasoline, and diesel). 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.

Integrated Biorefineries:

- 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 RFS. The program will continue to support commercial and demonstration biorefinery projects in FY 2011, in addition to Recovery Act funded pilot and demonstration scale projects. These projects are critical to validate technical and economic feasibility of their respective integrated biorefineries to enable commercialization.

Analysis and Sustainability:

- Provides critical quantitative data, validation, and risk and feasibility assessments to inform not only all programmatic decision-making and strategic planning, but also external policy and private sector partners in the nascent domestic cellulosic and advanced biofuels industry. This work is critical in the successful establishment of a sustainable and economically viable U.S. cellulosic biofuels industry.

Large Scale Biopower:

- A signature biopower initiative will be launched that leverages external partnerships, involving the R&D for the production and use of biochar to minimize boiler derating; feasibility and analysis of biopower using advanced technology for feedstocks and gas clean-up; engineering design, environmental assessment and permitting; and construction of large biopower projects to prove the technical, economic, and environmental viability of large scale power generation from cellulosic biomass.

Annual Performance Results and Targets

The program's performance measures are particularly aligned with the Secretary's goal for Energy: Build a competitive low carbon economy and secure America's future. Specifically, the Program is focused on reducing the production costs of biofuels, biopower and bioproducts, and demonstrating at various scales of deployment that these technologies can be sustainable, technically feasible, and economically viable. The Program achieves this by partnering with National Laboratories, universities, industry, and other government entities.

Recovery Act funding has enabled the Program to broaden its portfolio of RD&D (i.e. biofuels and bioproducts). A significant portion of the Recovery Act funds enabled the Program to increase the number of industrial lead projects to develop and validate biorefinery technologies. Economic conditions have created challenges securing private financing for this nascent industry delaying the development and deployment of these innovative technologies. Recovery Act investments enable DOE to be a cost share partner to catalyze the new industry's growth in these difficult economic times. Projects funded under the Recovery Act support the EISA RFS aggressive goals for biofuels. Pending EPA rulings on direct and indirect land use, and EPA's RFS projects could impact the industry's growth, including international developments. Pending climate change legislation could also impact the industry's growth.

Annual Performance Targets and Results

Secretarial Goal: Energy: Build a competitive, low-carbon economy and secure America's energy future

GPRA Unit Program Goal: GPRA Unit Program Goal 06 (Biomass and Biorefinery Systems R&D)

Subprogram Name: Feedstock

FY 2006	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
Performance Measure: Improve the sustainably harvestable yield in average dry matter (DM) tons per acre to support the development of a sustainable feedstock supply and enable the provision of a supply of biomass feedstocks sufficient for a growing bio-based industry[a].									
T: NA A: NA	T: NA A: NA	T: NA A: NA	T: NA A: NA	T: NA A: NA	T: 1.3 A:	T: 2.0 A:	T: 3.9 A:	T: 5.8 A:	T: 7.3 A:
Performance Measure: The FY 2011 performance measure was created in transition from reporting qualitative milestones to quantitative performance measures. Previous year performance measures for this subprogram are not direct predecessor measures to the FY 2011 performance measure. These measures included below enable the progress necessary to support the new FY 2011 Performance Measure. FY 2008: 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.[b] FY 2009: 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. FY 2010: 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.									
T: NA A: NA	T: NA A: NA	T: Qualitative A: MET	T: Qualitative A: MET	T: Qualitative A:	T: RETIRED A: NA	T: NA A: NA	T: NA A: NA	T: NA A: NA	T: NA A: NA

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[a] Assumptions: 1) Sustainable access to feedstock is based on: Erosion < T, Soil Carbon Impact ≥ 0 (T = USDA Acceptable soil loss/acre); 2) Yields are estimated based on DOE Regional Feedstock Partnership field trials initial results and modeling efforts.

[b] FY 2008 and FY 2009 targets are in both feedstock availability and logistics performance measure tables because these targets were required to include cost targets though the focus of those FY targets were on sustainable production. Note the 2012 cost goals associated with the FY 2008 and FY 2009targets are not comparable from year to year due to changes in feedstock logistics costs analysis (inclusion of grower payment). The feedstock logistics cost goals are also not intended to be a performance measurement for sustainability production, and therefore were not included in the Target or Actual reporting for FY 2008 and FY 2009 for this performance measure.

<table>
<tr><td colspan="10">Annual Performance Targets and Results

Secretarial Goal: Energy: Build a competitive, low-carbon economy and secure America's energy future
GPRA Unit Program Goal: GPRA Unit Program Goal 06 (Biomass and Biorefinery Systems R&D)
Subprogram Name: Feedstock</td></tr>
<tr><th>FY 2006</th><th>FY 2007</th><th>FY 2008</th><th>FY 2009</th><th>FY 2010</th><th>FY 2011</th><th>FY 2012</th><th>FY 2013</th><th>FY 2014</th><th>FY 2015</th></tr>
<tr><td colspan="10">Performance Measure: Reduce feedstock supply system logistics cost in dollars per dry matter ton ($/DM ton, in $2007) to support the development of cost-effective, high tonnage feedstock logistics systems and enable the supply of biomass feedstocks for a growing bio-based industry.</td></tr>
<tr><td>T: NA
A: NA</td><td>T: NA
A: NA</td><td>T: NA
A: NA</td><td>T: NA
A: NA</td><td>T: NA
A: NA</td><td>T: $36.10
A:</td><td>T: $35.00
A:</td><td>T: $34.00
A:</td><td>T: $33.20
A:</td><td>T: $32.50
A:</td></tr>
<tr><td colspan="10">Performance Measure: The FY 2011 performance measure was created in transition from reporting qualitative milestones to quantitative performance measures. Previous year performance measures for this subprogram are not direct predecessor measures to the FY 2011 performance measure. These measures included below enable the progress necessary to support the new FY 2011 Performance Measure.

FY 2007: 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.

FY 2008: 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.

FY 2009: 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.

FY 2010: Achieve a modeled dry herbaceous feedstock logistics cost of $37.80 per dry ton (excluding grower payment, in 2007$).</td></tr>
<tr><td>T: NA
A: NA</td><td>T: Qualitative
A: MET</td><td>T: NA[a]
A: NA</td><td>T: NA[1]
A: NA</td><td>T: $37.80
A: TBD</td><td>T: RETIRED
A: NA</td><td>T: NA
A: NA</td><td>T: NA
A: NA</td><td>T: NA
A: NA</td><td>T: NA
A: NA</td></tr>
</table>

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[a] FY 2008 and FY 2009 targets are in both the feedstock availability and logistics performance measure tables because these targets were required to include 2012 cost targets even though the focus of those targets were on sustainable production. Note the 2012 cost goals associated with the FY 2008 and FY 2009 targets are not comparable from year to year due to changes in feedstock logistics costs analysis. Note the cost targets do not include the grower payment.

Annual Performance Targets and Results

Secretarial Goal: Energy: Build a competitive, low-carbon economy and secure America's energy future

GPRA Unit Program Goal: GPRA Unit Program Goal 06 (Biomass and Biorefinery Systems R&D)

Subprogram Name: Biochemical Conversion

FY 2006	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
Performance Measure: Reduce the modeled ethanol biochemical conversion cost in $/gallon of ethanol (in $2007).									
T: NA A: NA	T: NA A: NA	T: NA A: NA	T: NA A: NA	T: NA A: NA	T: $1.08[a]/gal A:	T: $0.92[b]/gal A:	T: $0.84[c]/gal A:	T: $0.78/gal A:	T: $0.76/gal A:
Performance Measure: The FY 2011 performance measure was created in transition from reporting qualitative milestones to quantitative performance measures. Previous year performance measures for this subprogram are not direct predecessor measures to the FY 2011 performance measure. These measures included below enable the progress necessary to support the new FY 2011 Performance Measure. FY 2006: 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 2007. FY 2007: 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. FY 2008: 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 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. FY 2009: 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 pound by 2012 (in $2007). Reduced sugar costs will reduce cellulosic ethanol costs, leading to increased adoption of ethanol and reduced consumption of petroleum. FY 2010: Achieve reduction of 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 competitive range of $1.76-2.06/gallon by 2012 (in 2007$).									
T: $0.125/ pound sugar A: MET	T: $0.125/ pound sugar A: MET	T: $0.13/ pound sugar (2007$) A: MET	T: $0.12/ pound sugars (2007$) A: MET	T $1.33/ gal ethanol conversion cost A:	T: RETIRED A: NA	T: NA A: NA	T: NA A: NA	T: NA A: NA	T: NA A: NA

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[a] FY 2011: This contributes to the overall modeled production cost of $1.68, dependent on a feedstock cost of $52.00/dry ton.

[b] FY 2012: This contributes to the overall modeled production cost of $1.49, dependent on a feedstock cost of $50.90/dry ton.

[c] FY 2013: Continued modeled ethanol conversion cost reductions result from improvements in alternative processing configurations and enhanced feedstock processing capabilities. Alternative processing could include, but is not limited to, consolidated processes, alternative enzymes systems and fermentation organisms. This additional information is valid for FY 2013 – FY 2015.

Annual Performance Targets and Results

Secretarial Goal: Energy: Build a competitive, low-carbon economy and secure America's energy future

GPRA Unit Program Goal: GPRA Unit Program Goal 06 (Biomass and Biorefinery Systems R&D)

Subprogram Name: Thermochemical Conversion

FY 2006	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
Performance Measure: Reduce the modeled minimum ethanol selling price per gallon of ethanol to support the 2012 thermochemical conversion goal, and longer term for years 2013-2015, for a modeled minimum fuel selling price per gallon of hydrocarbon fuel. The performance measures are strategically shifting from cellulosic ethanol to drop in hydrocarbon fuels.									
T: NA A: NA	T: NA A: NA	T: NA A: NA	T: NA A: NA	T: NA A: NA	T: $1.70 A:	T: $1.57 A:	T: $2.80 A:	T: $2.70 A:	T: $2.62 A:
Performance Measure: The FY 2011 performance measure was created in transition from reporting qualitative milestones to quantitative performance measures. Previous year performance measures for this subprogram are not direct predecessor measures to the FY 2011 performance measure. These measures included below enable the progress necessary to support the new FY 2011 Performance Measure. FY 2007: Demonstrate conversion of 50 percent of non-methane (C2+ higher) hydrocarbons that result in a syngas cost of $7.15/MBtu in 2007. FY 2008: 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. FY 2009: 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). FY 2010: 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.									
T: NA A: NA	T: $7.15/MBtu modeled syngas cost A: MET	T: $6.88/MBtu modeled syngas cost A: MET	T: $1.97/gal modeled ethanol price A: MET	T: $1.90/gal modeled ethanol price A:	T: RETIRED A: NA	T: NA A: NA	T: NA A: NA	T: NA A: NA	T: NA A: NA

Annual Performance Targets and Results

Secretarial Goal: Energy: Build a competitive, low-carbon economy and secure America's energy future

GPRA Unit Program Goal: GPRA Unit Program Goal 6 (Biomass and Biorefinery Systems R&D)

Subprogram Name: Integrated Biorefineries

FY 2006	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
Performance Measure: Validate the total production capacity of 100 million gals (MG) of advanced biofuels by 2014[a]									
T: NA A: NA	T: NA A: NA	T: NA A: NA	T: NA A: NA	T: NA A: NA	T: 5 MG additional capacity A:	T: 45 MG additional capacity A:	T: 30 MG additional capacity A:	T: 20 MG additional capacity A:	T: TBD A:
Performance Measure: The FY 2011 performance measure was created in transition from reporting qualitative milestones to quantitative performance measures. Previous year performance measures for this subprogram are not direct predecessor measures to the FY 2011 performance measure. These measures included below enable the progress necessary to support the new FY 2011 Performance Measure. FY 2007: 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. FY 2008: Approve a final engineering design package of at least one commercial scale biorefinery capable of processing up to 700 metric tonnes 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. FY 2009: **(1)** 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; **(2)** 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; **(3)** 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 $2.01-2.87 per gallon estimated cost competitive target range in integrated biorefineries by 2017 (in 2007$). FY 2010: **(1)** Initiate construction of two additional commercial-scale biorefinery projects selected in FY 2007 (three in total); **(2)** 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; **(3)** 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 $2.01-2.87 per gallon estimated cost competitive target range in integrated biorefineries by 2017 (in 2007$).									
T: NA A: NA	T: Qualitative A: MET	T: Qualitative A: MET	T: Qualitative A: MET[b]	T: Qualitative A:	T: RETIRED A: NA	T: NA A: NA	T: NA A: NA	T: NA A: NA	T: NA A: NA

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[a] This annual performance measure assumes successful NEPA compliance, secured financing, and positive decisions on stage gate reviews for biorefinery projects to remain on schedule. A cumulate production is not assumed since going concern operations is outside the control of departmental scope and funding. It is expected that these projects will lead to commercial scale replications.

[b] The FY 2009 performance targets for Integrated Biorefineries were tracked and reported as three separate performance targets. (1) met, (2) unmet, (3) met

Annual Performance Targets and Results

Secretarial Goal: Energy: Build a competitive, low-carbon economy and secure America's energy future

GPRA Unit Program Goal: GPRA Unit Program Goal 6 (Biomass and Biorefinery Systems R&D)

Subprogram Name: Large Scale Biopower

FY 2006	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
Performance Measure: Complete phased implementation of a biopower strategy leading to the construction of up to 100MW of new generation capacity by 2015.[a]									
T: NA A: NA	T: NA A: NA	T: NA A: NA	T: NA A: NA	T: NA A: NA	T: Qualitative[b] A:	T: Qualitative[c] A:	T: Qualitative[d] A:	T: Qualitative[e] A:	T: Qualitative[f] A:

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[a] The biopower strategy can be implemented with a distributed, central generator, or co-firing concept. The assessment of progress includes completing a Level I engineering and cost assessment.

[b] FY 2011: Phase 1: Conduct a competitive solicitation for large scale biopower and biochar R&D projects. The large scale biopower projects will have a combined generation capacity of 500 MW operational by 2017. Initiate feedstock studies to assess sustainable feedstock supply for potential biopower sites.

[c] FY 2012: Phase 2: Select and award a large scale biopower project(s) and initiate preliminary engineering design and NEPA.

[d] FY 2013: Complete NEPA compliance process and Level II engineering design for biopower project(s).

[e] FY 2014: Initiate construction of at least one large scale biopower project(s). Complete R&D on biochar and biopower.

[f] FY 2015: Complete construction of at least one biopower project, which is to become fully operational by the end of FY 2016 and has a minimum generation capacity of 100 MW.

Means and Strategies

The Biomass Program will use various means and strategies 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. Various external factors 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 partnerships with appropriate cost sharing to attract innovation and ensure investment value;
- 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 that include technology experts;
- Commercial and demonstration scale validation of integrated biorefineries and biopower through competitive solicitations to validate economic and technical feasibility in order to facilitate commercialization; and,
- Input from peer reviews.[a] Peer reviews of program plans and activities aim to obtain expert, independent opinions on the program’s goals and objectives; feasibility of reaching the goals; 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, research will develop handling and conversion technologies specific to feedstock properties and validate technical performance and projected economics at industrial scale;
- Collaborate with the DOE Office of Science to further basic research related to Biochemical conversion R&D, such as overcoming the recalcitrance of certain biomass feedstocks. Additionally, the 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;
- 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 coproducts to continue to grow beyond the limitations of present commodity crop and forest resources;
- 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;
- 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

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[a] The most recent program peer review was held in July 2009. For more information, please visit: http://www.obpreview2009.govtools.us/.

efficient enzymes. Moreover, as biorefinery plants mature, advanced thermochemical technologies (e.g., catalytic hydroprocessing) will be pursued to increase biofuels production and value;

- Support R&D focused on the production of biochar for biopower applications to minimize feedstock issues; and,
- Utilize guidance from the Biomass Technical Advisory Committee and the Biomass R&D Board authorized under FCEA to integrate R&D across agencies.

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;
- General capital market conditions and the availability of external finance for private sector RD&D partners from both private sector and public sources external to the program; 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.

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 advanced conversion processes and techniques, which will help define the future of advanced biorefineries;
- 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 biorefineries 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 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 per FCEA;
- 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; and,
- Partnerships with the DOE Offices of Electricity Delivery and Energy Reliability, Fossil Energy, and Federal Energy Regulatory Commission to develop biopower activities.

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 other government organizations. The sections below summarize validation and verification activities.

Data Sources:

- The Renewable Fuels Association's production statistics[a];
- Energy Information Administration (EIA) reports and statistics[b];
- Data and reports from the USDA National Agricultural Statistics Service[c]; and
- Individual projects develop production cost and quantity estimates for biofuel intermediates, ethanol, and other fuels and chemicals (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 (approximately $0.97 per gallon of ethanol produced via a biochemical conversion pathway, in $2007). A more vigorous analysis is underway for woody feedstocks; however, a 2007 baseline of $67.55 per dry ton for woody feedstocks (approximately $1.58 per gallon of ethanol produced via a thermochemical conversion pathway, in 2007$) is currently being used.
- In 2005[d], Thermochemical conversion 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 Conversion Technologies section).
- In 2005[a], Biochemical R&D baseline mature conversion costs for dry corn stover to ethanol was $1.79 per gallon (2007$) based on bench scale data (see figure in the Conversion Technologies section).

R&D projects use an analysis model to generate "nth plant"[e] cost and bench scale performance data based on generic NREL integrated biorefinery designs. The biorefinery projects funded under the Integration of Biorefinery Technologies subprogram will validate 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

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[a] Accessible at: http://www.ethanolrfa.org/industry/statistics/

[b] For examples, see: Annual Energy Review, http://www.eia.doe.gov/aer/, Renewable Energy Annual http://www.eia.doe.gov/cneaf/solar.renewables/page/rea_data/rea_sum.html, and Annual Energy Outlook http://www.eia.doe.gov/oiaf/aeo/

[c] USDA National Agricultural Statistics Service website: http://www.nass.usda.gov/

[d] Note: The 2005 baselines have been adjusted to $2007 for consistency with current numbers.

[e] The "nth plant" concept involves the assumption that commercial-scale operation and cumulative production will lead to continuous improvement and diminished risk, which significantly enhance technical and economic success. Return calculations are relegated to typical supply/demand economics.

possible to disseminate the specific economic and technical performance data due to proprietary restrictions. Therefore, the program will use an aggregate performance metric for 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 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 the Performance Measurement Manager (PMM, the DOE quarterly performance progress review of budget targets);
- Continue to conduct the transparent oversight and performance management initiated by Congress and the Administration;
- Annual review of methods, and updated analysis of potential benefits for 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:

- Relevance to overall DOE objectives;
- Approach to performing R&D;
- Technical accomplishments and progress toward project and DOE goals;
- Technology transfer/collaborations with industry/universities/laboratories; and
- 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 documentation of experimental and/or analytic results as evidence of success. The evidence is listed in material supporting the DOE Joule performance tracking system. Peer reviews are conducted by independent personnel from industry, academia and other governmental agencies.

Feedstocks
Funding Schedule by Activity
(Non-comparable, or as Appropriated, Structure)

	(dollars in thousands)		
	FY 2009	FY 2010	FY 2011
Feedstock Infrastructure	15,092	26,776	21,420
Algae	0	9,250	3,895
SBIR/STTR	0 [a]	967	685
Total, Feedstock Infrastructure	15,092	36,993	26,000

Feedstocks
Funding Schedule by Activity
(Comparable Structure to the FY 2011 Request)

	(dollars in thousands)		
	FY 2009	FY 2010	FY 2011
Feedstocks (formerly Feedstock Infrastructure)			
Sustainable Production	*5,000*	*6,600*	*10,710*
Logistics	*10,092*	*20,176*	*10,710*
Algae	0	9,250	3,895
SBIR/STTR	0[a]	967	685
Total, Feedstocks	15,092	36,993	26,000

Description

Modifications are proposed to the budget structure to better reflect Feedstocks activities. The two tables above show a comparable and non-comparable funding profile at the subprogram key activity level.

Feedstocks activities are critically important to increasing the availability and accessibility of domestic biomass resources and improving the infrastructure technologies needed to reliably supply cellulosic and alternative feedstocks to future large-scale biorefineries at reasonable costs. Investments in resource availability and feedstock logistics systems development are 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

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[a] SBIR/STTR funding transferred in FY 2009 was $364,000 for to the SBIR program and $44,000 for the STTR program.

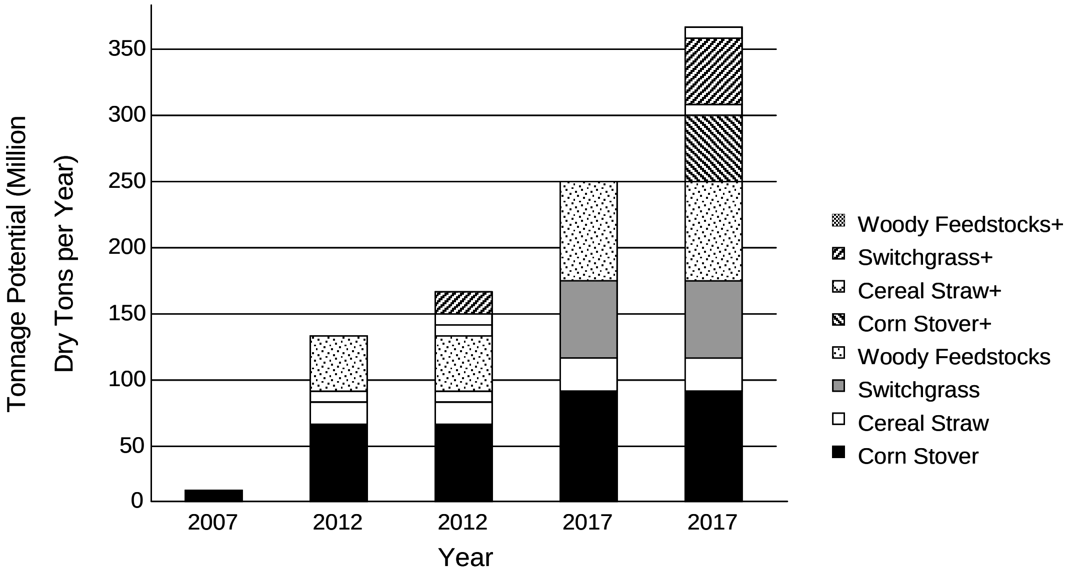
environmental criteria and societal values. The overarching strategic goal is to develop technologies to provide reliable, cost-competitive, and environmentally sustainable biomass feedstock supplies for the U.S. biofuels industry in partnership with USDA and other key stakeholders from all sectors. Three key activities have been defined for addressing this overarching strategic goal: Sustainable Production, Logistics, and Algae.

Benefits

To increase feedstock production, the major focus is on support of Regional Biomass Feedstock Development 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 by 2012. 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 governments, 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 will 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 validate the percentage of resources that could be recovered cost effectively and sustainably. The annual feedstock production performance targets established by the program measure the sustainably harvestable yield in dry matter tons per acre, supporting this trajectory through quantifiable incremental increases in production efficiency. A new effort is also being established to explore the viability of algae as a biofuels feedstock.

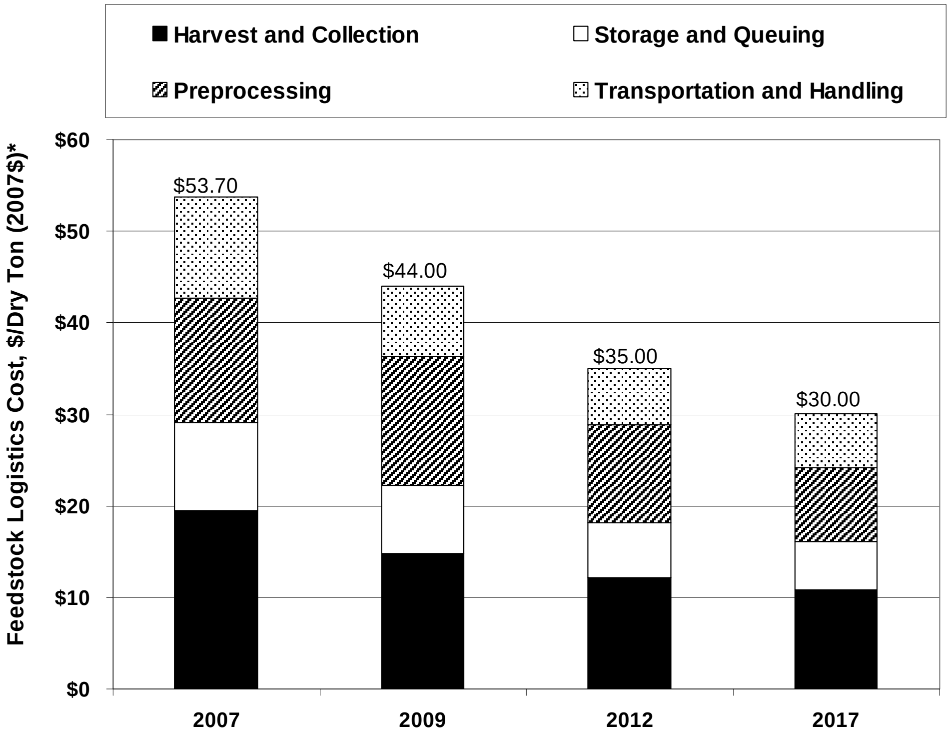
Projected Feedstock Availability at Specified Minimum Grower Payments



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 demonstration 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 14 lbs per cubic foot. Providing a denser feedstock will have positive cost ramifications throughout the feedstock supply chain. Indicators of progress toward this goal include cost shared industrial partnerships for developing feedstock logistics systems. To track progress toward this goal, the program has established an annual performance target which measures the supply system logistics cost in dollar per dry matter ton, and directly correlates with the logistics goal described above.

Feedstock Logistics Cost Projections



*Excludes grower payment

Year	2007	2009	2012	2017
Total, Feedstocks Logistics, $/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

Section 228 of EISA required DOE to report the potential of microalgae as a feedstock for biofuels. This report concluded that microalgae are a potentially viable feedstock in the long-term, though algal biofuel technologies are still in relatively early stages of development. The Biomass Program also sponsored an algal biofuels workshop in December 2008 and published a Request for Information on a draft roadmap in June 2009. The final roadmap is under revision and will include public comments and be broader than the workshop topics in order to include additional algal research. The feedstock production component of microalgae development will be integrated with algae efforts within the program as algal biofuels challenges are addressed across the supply chain.

Feedstocks activities are an integral part of the Biomass Program's partnered strategic pathway of advancing biomass technologies from basic science to applied research and demonstration, 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 2009	FY 2010	FY 2011
Sustainable Production	**5,000**	**6,600**	**10,710**

Sustainable Production addresses resource assessment, yield improvement, sustainable feedstock systems development, and biomass quality. The major component of this effort is the continuation of existing feedstock production trials with the Regional Biomass Feedstock Development Partnerships (now in the fourth feedstock growing year of the six year study). These replicated field trials are organized by feedstock type (energycane, miscanthus, switchgrass, sorghum, hybrid poplar, willow, and Conservation Reserve Program land) to realize the resource potential of biomass feedstocks for advanced biofuels production on a regional basis. In FY 2011, the trials will include increased emphasis on environmental sustainability, including measuring fluxes of water, soil carbon, and GHG emissions. Additionally, corn stover removal field testing will validate and enhance a tool developed by USDA's Agricultural Research Service and Idaho National Laboratory (INL) to measure the sustainability of corn stover removal from the field, and incorporate of results into resource assessment analysis activities. 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.

Logistics	**10,092**	**20,176**	**10,710**

In partnership with industry, Feedstock Logistics R&D addresses barriers associated with accessing and delivering the feedstock supply to an integrated biorefinery. This work involves the following unit operations: harvesting, collection, preprocessing, storage, queuing, handling, and transport for all major feedstock categories of cellulosic biomass (e.g., wet, dry and woody). Feedstocks' efforts have expanded from laboratory design work into industrial partnerships that will improve the operation and efficiency of feedstock collection and delivery systems through competitively awarded projects initiated in late FY 2009. In collaboration with the Integrated Biorefineries subprogram, a deployable process demonstration unit (PDU) housed at INL will continue to be developed for feedstock logistics systems. The PDU will be completed in FY 2011 and available for use by industrial partners on a cost-shared basis.

Algae	**0**	**9,250**	**3,895**

The feedstock production component of microalgae development will be integrated with algae efforts within the program as algal biofuels challenges are addressed across the supply chain. The major components of this effort include: 1) resource assessments of the algae production inputs; 2) environmental assessments of the impacts of growing algae at scale, and 3) research of problems at the feedstock-fuel conversion interface. Analytical and spatial modeling efforts will be directed to expand the current knowledge of algae production requirements. These include assessments on the availability of land, water and micronutrients on a national scale. Results of these modeling and analysis projects will be the inputs into a national GIS assessment tool, which can be used for visualization of scenarios of future biofuels development. This tool will inform industrial stakeholders' decision-making processes, and ultimately address whether the production of four billion gallons of algal biofuels can be achieved domestically by 2022. Research and modeling activities at the National Laboratories can also help determine likely environmental impacts associated with producing algal biofuels at that scale, under different production scenarios. In addition, research will begin on characterizing basic properties of the likely algae feedstocks to ensure compatibility and integration with the available downstream fuel conversion processes.

SBIR/STTR	**0**	**967**	**685**

In FY 2009, $364,000 and $44,000 were transferred to the SBIR and STTR programs respectively. The FY 2010 and FY 2011 amounts shown are estimated requirements for the continuation of the SBIR and STTR program.

Total, Feedstocks (formerly Feedstock Infrastructure)	**15,092**	**36,993**	**26,000**

Explanation of Funding Changes

	FY 2011 vs. FY 2010 ($000)
Sustainable Production The increase reflects the reclassification of funds through the creation of a new activity within a new subprogram. This represents an increase compared to the FY 2010 request.	+4,110
Logistics The increase reflects the reclassification of funds through the creation of a new activity within a new subprogram. This represents a significant decrease compared to the FY 2010 request.	-9,466
Algae This new activity is comprised of new algae projects involving: feasibility, environmental, and resource assessments; exploration of conversion interface issues; and, organism characterization.	-5,355

	FY 2011 vs. FY 2010 ($000)
SBIR/STTR	
Changes in the SBIR/STTR funding are a direct result of changes in the funding of program activities.	-282
Total Funding Change, Feedstocks (formerly Feedstock Infrastructure)	**-10,993**

Conversion Technologies
Funding Schedule by Activity
(Non-comparable, or as Appropriated, Structure)

(dollars in thousands)

	FY 2009	FY 2010	FY 2011
Platforms Research and Development			
Thermochemical Platform R&D	19,861	27,263	30,184
Biochemical Platform R&D	32,132	30,769	47,710
Algae	0	24,829	0
SBIR/STTR	0 [a]	2,247	2,106
Total, Platforms Research and Development	51,993	85,108	80,000

Conversion Technologies
Funding Schedule by Activity
(Comparable Structure to the FY 2011 Request)

(dollars in thousands)

	FY 2009	FY 2010	FY 2011
Conversion Technologies (formerly Platforms Research and Development)			
Thermochemical	*19,861*	*27,263*	*30,184*
Biochemical	*32,132*	*30,769*	*47,710*
Algae	0	24,829	0
SBIR/STTR	0 [a]	2,247	2,106
Total, Conversion Technologies	51,993	85,108	80,000

Description

Modifications are proposed to the budget structure to better reflect Conversion Technologies activities. The two tables above show a comparable and non-comparable funding profile at the subprogram key activity level. The historical “Products Development” activity previously under the “Utilization of Platform Outputs R&D” subprogram has been consolidated with the new Biochemical activity to better reflect the present organizational structure of the program and its relationship to biochemical pathways. The Conversion Technologies subprogram supports the advancement of Thermochemical and Biochemical technologies for converting feedstocks and intermediates into quality, cost-competitive liquid transportation fuels, materials, and other chemicals. Thermochemical conversion R&D focuses

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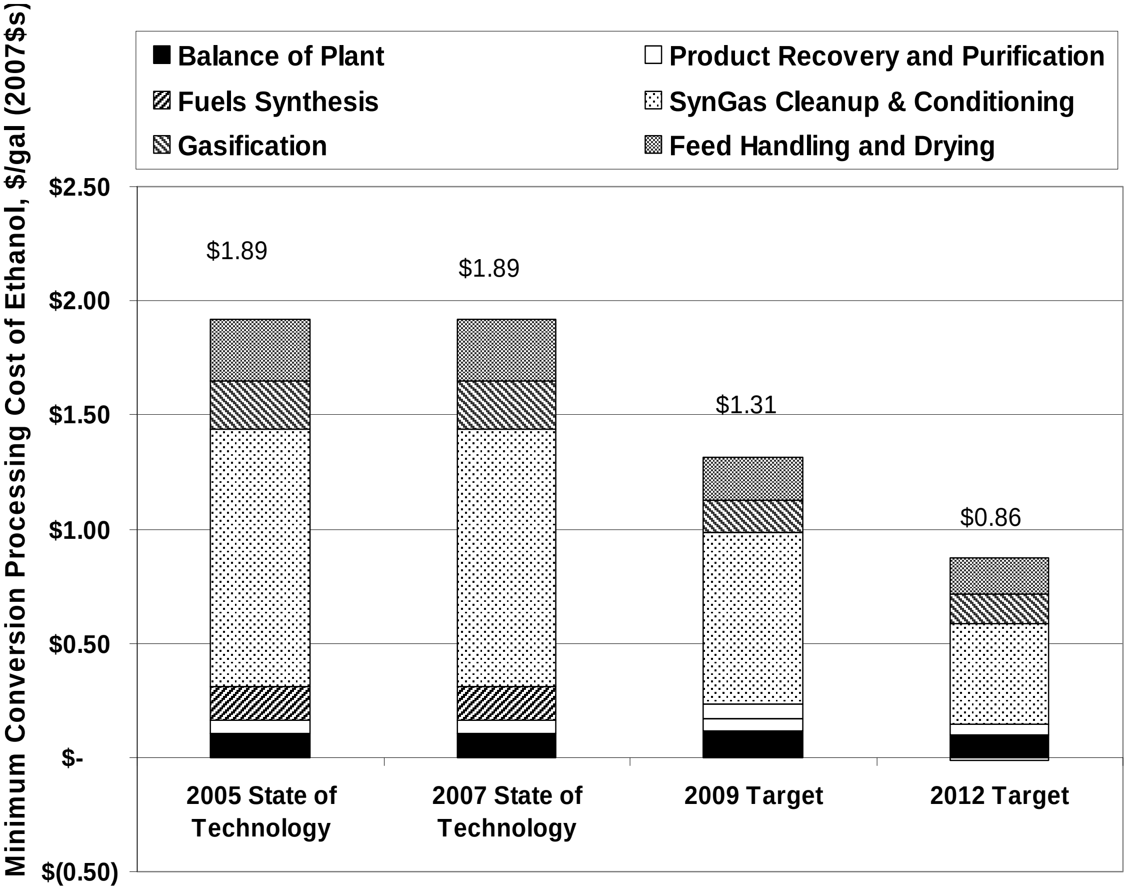
[a] SBIR/STTR funding transferred in FY 2009 was $1,255,000 for the SBIR program and $150,000 for the STTR program.

on reducing the costs associated with producing liquid transportation biofuels from gasification and pyrolysis technologies, which includes R&D in feedstock interface, thermochemical processing, intermediate cleanup and conditioning, and upgrading for fuel synthesis. Biochemical conversion R&D will focus on process integration supported by further improvements to feedstock interface (pre-processing), pretreatment, enzymatic and chemical hydrolysis, and fermentation. These integrated steps are required to reduce production costs and therefore enable economically viable cellulosic ethanol production by biorefineries. This includes continued funding to projects associated with solicitations initiated in FY 2007 and 2008, including the development of improved cellulases with increased activities.

Benefits

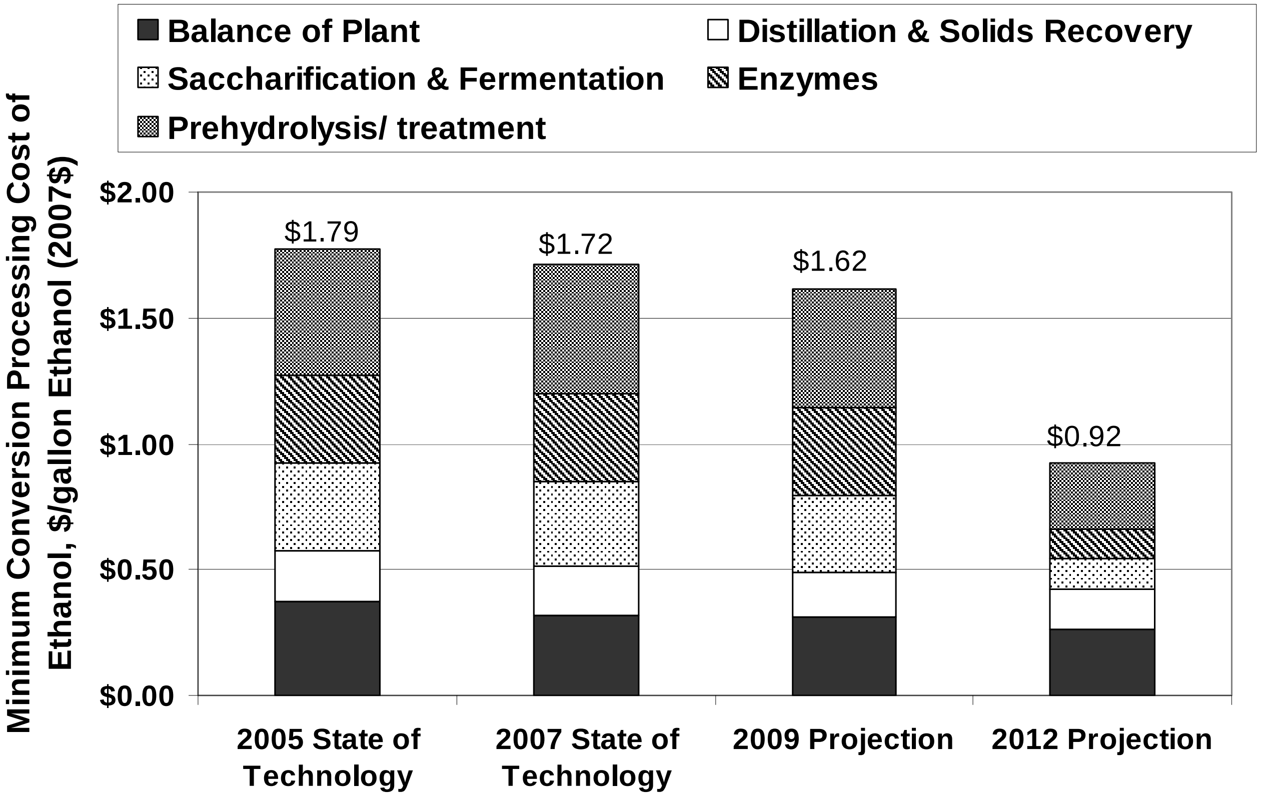
This R&D work will result in the development of technologies capable of converting biomass feedstocks into biofuels. The technical projections for the two conversion R&D areas comprising the Conversion Technologies subprogram align their progress with the achievement of modeled ethanol costs supporting the overall Biomass Program target of $1.76 per gallon of cellulosic ethanol in 2012 (in $2007). The Conversion Technologies annual performance targets for FY 2011 support this trajectory toward this 2012 programmatic cost target. The two sets of charts and tables below contain the Biomass Program's current conversion cost projections, which are used to make modeled ethanol selling price (MESP) projections. In the longer term (for years 2013-2015), the Thermochemical conversion performance measures are strategically shifting from cellulosic ethanol to drop in hydrocarbon fuels.

Thermochemical Conversion 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

Biochemical Conversion to Ethanol



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

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

	2005 State of Technology	2007 State of Technology	2009 Projection	2012 Projection
Processing Total	**$1.79**	**$1.72**	**$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

Detailed Justification

(dollars in thousands)

	FY 2009	FY 2010	FY 2011
Thermochemical	**19,861**	**27,263**	**30,184**

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 R&D supports the reduction of costs associated with 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 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 2011 activities include the continuation of technology validation to economically convert biomass feedstocks, forest residues and other woody resources to synthesis gas or bio-oils that are suitable for fuels and co-products. The target for gasification and subsequent ethanol production is a modeled conversion cost of $0.97/gallon of ethanol ($2007, feedstock cost of $51.80/dry ton). This conversion cost is associated with a modeled minimum ethanol selling price (MESP) of $1.70/gallon in 2011 ($2007, feedstock cost $51.80/dry ton). The data for completing this modeling target will be produced through 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 2011) and pyrolysis oil to liquid fuel conversion technologies (initiated in FY 2008, and planned to be completed in 2011). A go/no go decision will be made in FY 2010 on whether the current R&D programs to enable the modeled ethanol cost to attain the programmatic 2012 target should be redirected in FY 2011 or FY 2013. A new competitive solicitation will support pyrolysis oil production R&D and subsequent upgrading. In addition, a competitive solicitation for research in support of non ethanol infrastructure compatible biofuels, including but not limited to new catalysts for upgrading of bio-oil will be conducted.

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 and applied understanding of the factors controlling thermochemical conversion is needed to be able to develop new or improved technologies that increase 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. 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.

Biochemical	**32,132**	**30,769**	**47,710**

Biochemical conversion R&D focuses on reducing the cost of converting lignocellulosic biomass to mixed, dilute sugars, and further conversion to liquid fuels, like ethanol. Additional support is provided to advance technologies needed for successful integrated biorefineries and support in realizing the program's overall 2012 cost target. To ensure this trajectory is maintained, a FY 2011 annual performance target of a modeled conversion cost of $1.08 per gallon of ethanol has been established, which contributes to the projected achievement of a modeled MESP of $1.68 per gallon in FY 2011 ($2007, with an estimated feedstock cost of $52.00/dry ton).

In FY 2011, Biochemical conversion R&D will have an increased focus on the integration of the individual process steps into a continuous process, especially the interdependencies of the hydrolysis and pretreatment steps. Additionally, efforts will continue toward reducing cellulosic biofuel costs by focusing on barriers related to feedstock interface, pretreatment, hydrolysis and fermentation processes. The continued 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.

Specific objectives include improved hydrolysis methods to reduce the modeled enzyme costs by $0.05, or by 29 percent. 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 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 additional feedstocks (e.g. energy crops, other agricultural residues, algal biomass) are considered.

To improve overall efficiency and reduce conversion cost, enzyme development work started in FY 2008 will be combined with results from ethanologen development projects initiated in FY 2007 as they are completed in FY 2010. This and other related efforts will result in a greater degree of process integration between the unit operations (pretreatment, saccharification and fermentation steps) needed to achieve programmatic cost targets.

Activities will also include continuing support of public-private partnered projects from the FY 2008 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. Biochemical R&D will also involve completing activities selected from the FY 2007 solicitation to support development of fermentative organisms.

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 in FY 2011. Barriers and technical challenges identified in the first of a kind integrated biorefineries under development will determine the necessary fundamental research needs. These efforts will provide the basic science groundwork to develop applied, and ultimately integrated, process solutions for biomass conversion. Specifically, this work will produce advanced conversion processes and techniques for future biorefinery concepts.

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.

Algae	**0**	**24,829**	**0**

The FY 2010 appropriations directed $35 million to algae, $25 million was categorized under the Platform R&D subprogram with the remainder categorized under the Feedstock Infrastructure subprogram. Funding for these activities is requested within the Feedstock Infrastructure subprogram in FY 2011.

SBIR/STTR	**0**	**2,247**	**2,106**

In FY 2009, a total of $1,255,000 and $150,000 was transferred to the SBIR and STTR programs, respectively. The FY 2010 and FY 2011 amounts shown are estimated requirements for the continuation of the SBIR and STTR program.

Total, Conversion Technologies	**51,993**	**85,108**	**80,000**

Explanation of Funding Changes

	FY 2011 vs. FY 2010 ($000)
Thermochemical	
The increase in funding enables the commencement of new R&D in two key areas: 1) pyrolysis oil production and subsequent upgrading; and 2) non food infrastructure compatible fuels. These new solicitations will target industrial partners, National Laboratories and universities for the latest technology and transformative research ideas in support of the EISA RFS targets for advanced biofuels and the drive towards cost effective infrastructure compatible biofuels. Solicitations will allow for core technology development, as well as scale-up of near term options in order to accelerate deployment.	+2,921
Biochemical	
This 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. The increase in funding is due to the reclassification of funding through the consolidation of the old “Utilization of Platform Outputs R&D” subprogram “Products Development” key activity into the new Biochemical line item. These structural changes are proposed to better integrate the ethanologen and funal genomics work conducted under Products into the Biochemical Conversion resulting in a more effective mechanism for integrated biochemical conversion cost reductions.	+16,941
Algae	
Funding for Algae is now categorized in Feedstock subprogram (formerly Feedstock Infrastructure).	-24,829
SBIR/STTR	
Changes in the SBIR/STTR funding are a direct result of changes in the funding of program activities.	-141
Total Funding Change, Conversion Technologies	**-5,108**

Utilization of Platform Outputs R&D
Funding Schedule by Activity

(dollars in thousands)

	FY 2009	FY 2010	FY 2011
Utilization of Platform Outputs R&D			
Integration of Biorefinery Technologies	131,483	83,949	0
Products Development	15,677	13,262	0
SBIR/STTR	0 [a]	688	0
Total, Utilization of Platform Outputs R&D	147,160	97,899	0

Description

Modifications are proposed to the budget structure to better reflect Integrated Biorefineries activities. The key activities of the Utilization of Platform Outputs R&D subprogram are proposed as follows: Integration of Biorefinery Technologies has been renamed and established as the new Integrated Biorefineries subprogram; and the Products Development key activity has been merged with the new Biochemical key activity under the new Conversion Technologies subprogram (formerly Platforms Research and Development).

Detailed Justification

(dollars in thousands)

	FY 2009	FY 2010	FY 2011
Integration of Biorefinery Technologies	**131,483**	**83,949**	**0**

This key activity is proposed as “Integrated Biorefineries,” a separate subprogram.

Products Development	**15,677**	**13,262**	**0**

Work under this key activity is proposed to continue through the “Biochemical” activity under “Conversion Technologies.” This change is proposed to more accurately reflect the program’s organizational structure and the nature of this work being done.

SBIR/STTR	**0**	**688**	**0**

In FY 2009, a total of $840,000 and $100,000 was transferred to the SBIR and STTR programs respectively. The FY 2010 amount shown is the estimated requirements for the continuation of the SBIR and STTR program.

Total, Utilization of Platform Outputs R&D	**147,160**	**97,899**	**0**

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[a] SBIR/STTR funding transferred in FY 2009 was $840,000 for the SBIR program and $100,000 for the STTR program.

Explanation of Funding Changes

	FY 2011 vs. FY 2010 ($000)
Integration of Biorefinery Technologies	
This work has been reclassified as a new subprogram, “Integrated Biorefineries.”	-83,949
Products Development	
This activity is being discontinued. Relevant work will continue under the “Biochemical” key activity of the “Conversion Technologies” subprogram.	-13,262
SBIR/STTR	
Changes in the SBIR/STTR funding are a direct result of changes in the funding of program activities.	-688
Total Funding Change, Utilization of Platform Outputs R&D	**-97,899**

Integrated Biorefineries
Funding Schedule by Activity

	(dollars in thousands)		
	FY 2009	FY 2010	FY 2011
Integrated Biorefineries	0	0	53,849
SBIR/STTR	0	0	151
Total, Integrated Biorefineries	0	0	54,000

Description

Modifications are proposed to the budget structure to better reflect Integrated Biorefineries activities. The historical Integration of Biorefinery Technologies activity that had been requested under the Utilization of Platform Outputs R&D subprogram is proposed to be renamed and established as the Integrated Biorefineries subprogram.

An integrated biorefinery is defined as an operation using biomass feedstocks that produces a fungible biofuel and other bioproducts (including heat and power). These integrated biorefineries ultimately support meeting the EISA RFS targets for advanced biofuels. The Integrated Biorefineries subprogram'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 biorefinery pathways to enable a broad spectrum of biomass resources that can be used to produce a variety of biofuels. Integrated Biorefineries activities facilitate the integrated demonstration and validation of suites of technologies including those developed by the Feedstocks and Conversion Technologies subprograms.

The program will focus on implementing public-private cost-shared, demonstration, and commercial-scale biorefinery projects converting a wide spectrum of feedstocks to advanced biofuels, biopower, and bioproducts. The projects will demonstrate and validate biorefinery concepts to reduce technological and financial risks, which ultimately enables 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. These cost-shared partnerships will continue to provide important operational data and processing costs to alleviate the high technical risk of processing longer term, unconventional feedstocks such as algae, which will help encourage capital investment.

Benefits

Integrated Biorefineries' commercial deployment efforts are central to the Biomass Program's strategy to support the EISA RFS by helping the U.S. biofuels industry overcome key technical and economic barriers in order to rapidly produce advanced biofuels at the volumetric targets needed to achieve the RFS. The Biomass Program is currently working with four competitively selected industry partners to establish biorefineries at full commercial scale, with another eight industry partners for biorefineries at 10 percent of full commercial scale. These projects will demonstrate and validate integrated processes for converting biomass into fuels and co-products. Following successful demonstrations, private sector partner project replication is expected. These replications will enable the achievement of the volumetric targets of the EISA RFS. These activities promote large-scale market adaptation and private sector acceptance of biofuels and co-products from a diversity of feedstocks. This is expected to attract additional sources of financial capital at competitive rates and accelerate biorefinery commercialization and, thus, oil displacement. An annual performance target has been established to monitor progress of these deployment activities in support of the EISA RFS volumetric advanced biofuels goal of 21 billion gallons by 2022. For FY 2011, this target is the completion of engineering design and the commencement of construction of three biorefinery projects.

Detailed Justification

(dollars in thousands)

	FY 2009	FY 2010	FY 2011
Integrated Biorefineries	**0**	**0**	**53,849**

In FY 2011, Integrated Biorefineries will continue cost-shared partnerships from competitive solicitations to demonstrate integrated biorefineries. Specifically, the program will continue to support multi-year financial assistance agreements from public-private partnerships selected in FY 2007 and 2008 for commercial and demonstration scale biorefineries, involving the production of transportation fuels and co-products (such as materials, chemicals, heat and power). Funding levels will be determined on a project by project basis, as cost-share partners meet the necessary requirements to move from phase one awards (pre-construction engineering design, NEPA compliance) to phase two awards (facility construction). The Recovery Act funded pilot and demonstration scale projects selected for up to $483 million from a competitive solicitation. In addition, $81 million is expanding an existing commercial scale project (previously selected in 2007 from a competitive solicitation).

SBIR/STTR	**0**	**0**	**151**

The FY 2011 amount shown is the estimated requirements for the continuation of the SBIR and STTR program.

Total, Integrated Biorefineries	**0**	**0**	**54,000**

Explanation of Funding Changes

	FY 2011 vs. FY 2010 ($000)
Integrated Biorefineries Funding continues to support the multi-year financial assistance agreements for commercial and demonstration scale integrated biorefinery projects initiated from prior year solicitations. Due to the reclassification of these funds at the subprogram level in the proposed budget structure, this appears to be an increase; however, this is technically a decrease of approximately $79 million below the amount requested in FY	+53,849

	FY 2011 vs. FY 2010 ($000)
2010 (of which $5 million was intended for the support of Biofuels Infrastructure activities scheduled to completion in FY 2010). This substantial decrease is due to both the acceleration through Recovery Act funding of large integrated biorefinery projects and the variance in project implementation schedules and related fiscal needs of projects still engaged in early phases of development in FY 2011.	
SBIR/STTR	
Changes in the SBIR/STTR funding are a direct result of changes in the funding of program activities	+151
Total Funding Change, Integrated Biorefineries	**+54,000**

Analysis and Sustainability
Funding Schedule by Activity

(dollars in thousands)

	FY 2009	FY 2010	FY 2011
Analysis and Sustainability			
Systems Analysis	0	0	4,000
Crosscutting Sustainability	0	0	4,000
Systems Integration	0	0	2,000
Total, Analysis and Sustainability	0	0	10,000

Description

The Biomass Program's Analysis and Sustainability activities play a vital role in supporting decision-making, demonstrating progress towards established goals, directing research activities, and are instrumental in setting the entire biofuel value chain on an environmentally sustainable and economically viable course. Relationships with experts at the National Laboratories, institutions of higher learning, and a myriad of external stakeholders are leveraged to obtain the best qualitative information and quantitative data possible. The newly proposed Analysis and Sustainability subprogram is subdivided in to three key activities: Systems Analysis, Crosscutting Sustainability, and Systems Integration.

The Biomass Program is committed to all aspects of environmental sustainability, including climate change, biological diversity, water quality and conservation, and soil quality. The Program seeks to prevent negative environmental impacts by working closely with stakeholders to identify and plan for potential consequences up front by developing prevention and contingency mitigation strategies. The Biomass Program also recognizes the critical importance of understanding and mitigating land use change associated with biomass production. To this end, it is supporting efforts toward land use change model development, which complements work by DOE's Office of Science, EPA and leading universities on the subject.

Benefits

Through quantification, analysis activities give the Biomass Program context and justification for decisions regarding the future direction and scope of the Biomass Program's R&D work. This information is critical to sound management of the Biomass Program's R&D portfolio and the establishment, adaptation, and fulfillment of its vision in a dynamic context of rapid technological progress and great economic and environmental uncertainty. This critical information enables the Biomass Program to better inform policy makers and private sector stakeholders, shaping the growth of America's nascent cellulosic and advanced biofuels industries.

Detailed Justification

(dollars in thousands)

	FY 2009	FY 2010	FY 2011
Systems Analysis	**0**	**0**	**4,000**

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

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

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

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

A near term objective is to establish a transparent methodology for evaluating and comparing technologies, practices and inputs on this basis. To better address the air quality implications of producing and consuming biofuels on a wells-to-wheels basis, the Biomass Program is studying the emissions characteristics of advanced biofuels such as green gasoline, green diesel, and pyrolysis oils. Work is also underway to quantify the impact of water and input use on ground and surface water. Moreover, these activities are being coordinated with the Feedstocks subprogram for a better understanding of soil nutrient and carbon flux.

Crosscutting Sustainability activities support the reduction of the environmental footprint of biofuels relative to conventional fuels through the strategic development and application of appropriate technologies. Energy and GHG emissions benefits of biofuels are modeled, lifecycle assessments of alternative fuels are conducted (and compared to conventional fuels), and existing models are being updated with current soil carbon and land use change data.

	(dollars in thousands)		
	FY 2009	FY 2010	FY 2011
Systems Integration	**0**	**0**	**2,000**

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

Specific activities include the following: systems engineering and strategic planning process facilitation (change control, MYPP, analysis planning); creation of an integrated baseline (data reconciliation between databases); and performance verification (risk assessment of pilot and demonstration scale projects, independent project analysis). FY 2011 activities also include the incorporation of DOE integrated biorefinery project data into state of technology metrics, and the public deployment of a streamlined version of the Biomass Scenario Model for use by the research community.

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

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

Explanation of Funding Changes

	FY 2011 vs. FY 2010 ($000)
Systems Analysis	
The increase is due to the reclassification of crosscutting funds into a new activity in the revised budget structure. The level of funding is consistent with FY 2010 request for these activities.	+4,000
Crosscutting Sustainability	
The increase is due to the reclassification of crosscutting funds into a new key activity in the revised budget structure. The level of funding is consistent with FY 2010 request for these activities.	+4,000
System Integration	
The increase reflects the reclassification of crosscutting funds into a new activity in the revised budget structure, and is consistent with funding of these activities in recent years.	+2,000
Total Funding Change, Analysis and Sustainability	**+10,000**

Large Scale Biopower
Funding Schedule by Activity

	(dollars in thousands)		
	FY 2009	FY 2010	FY 2011
Large Scale Biopower	0	0	49,580
SBIR/STTR	0	0	420
Total, Large Scale Biopower	0	0	50,000

Description

Beginning in FY 2011, the Biomass Program will evaluate the potential to produce large commercial scale power plants using biomass or biomass derived fuel to produce renewable electric power. Biomass power generation has the potential to deliver a significant amount of renewable electricity in the U.S. over the next 30 years and contribute to GHG reductions and sustainable development. According to the Biomass Producers Association, over 100 biomass power plants are connected to the electrical grid in the U.S.[a] The potential for biopower is highlighted in the Energy Information Administration's (EIA) 2010 Annual Energy Outlook where it is estimated that, excluding hydroelectricity, renewable energy consumption in the electric power sector is projected to grow from 1.2 quadrillion Btu in 2008 to 4.3 quadrillion Btu in 2035.[b] EIA attributed the largest sources of growth in renewable energy use in the AEO2010 reference case to biomass and wind.[c]

A biopower generating plant has the capability to use logging residues, intermediate thinnings, wood chips, or processed fuels produced from biomass including torrefied briquettes, upgraded pyrolysis oil or synthesis gas. Various approaches will be assessed: 1) centralized, in which a single large scale power facility is fed by a distributed network of biomass conversion facilities producing energy dense, transportable fuel intermediates such as pellets, syngas or pyrolysis oil; and, 2) decentralized, that would include replicating smaller scale power facilities on the order of 50 to 100 MW that could also be integrated with a biofuel producing integrated biorefinery or involve co-firing. Feasibility studies will be competitively selected to evaluate different options and benchmark the state of technology.

It is estimated that two million dry tons of biomass will be required per year to generate 500 MW of biopower.[d] To determine if this application is feasible, detailed resource assessments and regional supply curves will be required to identify potential sites, evaluate competing uses for the forestry, wood residues and other biomass resources, and determine the availability of water, labor and reliable transportation systems to ship the fuel intermediate to the generating plant.

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[a] Galbraith, Kate. "As Biomass Power Rises, a Wood-Fired Plant Is Planned in Texas." *The New York Times.* August 29, 2009. Page C4: http://www.nytimes.com/2008/08/29/business/29biomass.html

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

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

[d] Based on program calculations using a lower heating value of 8,200 Btus/pound of biomass, an operating factor of 85%, and boiler efficiency of 35%; for the generation of 500 MW

The program will include an evaluation of multiple technology approaches that includes conducting focused R&D on developing an optimized biochar fuel, feedstock logistics and sustainability, fuel characteristics and feed methods, flue gas clean-up, and power generation and integration with other biomass users, such as integrated biorefineries. Options will be evaluated to determine the most cost effective way to sustainably generate 500 MW of electrical power from biomass while achieving the greatest reductions in greenhouse gases.

Benefits

Synergies are expected to result from the collaborative implementation of this initiative. Relationships with industry and their supporting regional infrastructure will be fortified and leveraged, and new interagency and external stakeholder partnerships will be developed such as a new collaboration between OE, FE, and the Biomass Program, and interactions with FERC. The demonstration, deployment, and validation of biopower technologies at scale will help build a bridge from a fossil carbon-based energy economy to one based on renewable energy systems. Successful deployment will accelerate industry adoption of clean energy technologies and create green jobs in the renewable power sector and biomass supply chain. To ensure measureable progress toward the successful large scale deployment of biopower technologies, annual performance targets have been established to produce 500 MW of biopower by FY 2017.

This work is intended to validate alternative means for low carbon power generation through investment in promising clean energy technologies. The Biomass Program will support and help the utility industry identify technical and economic barriers to large scale electricity generation from biomass; assess the feasibility of large-central biopower production facilities to produce lower-cost, lower emission generating electricity; and identify resource logistics that enable the number or size of these generating facilities and their economic viability.

Detailed Justification

(dollars in thousands)

	FY 2009	FY 2010	FY 2011
Large Scale Biopower	**0**	**0**	**49,580**

In FY 2011, a Request for Proposal (RFP) will be initiated for feasibility studies. The feasibility studies will include the following major considerations:

- Detailed resource assessment to include feedstocks, water, and labor;
- Regional supply curves to include an assessment of sustainability;
- Siting and permitting studies;
- Scoping study of potential technologies meeting near-term scale-up potential or useable in retrofitting existing facilities;
- Appropriate environmental studies and pathway to accelerate NEPA;
- Detailed cost estimates for potential power generation and biomass conversion facilities;
- Cost-benefit analysis on feedstock type and delivery systems;

(dollars in thousands)

	FY 2009	FY 2010	FY 2011

- Impact studies for jobs, community, etc.;
- Additional energy impact on the U.S.; and
- An assessment of potential GHG emission reductions.

Information from the feasibility studies will be used to downselect at least one large scale biopower demonstration project. The approach and scenario that are selected will be based on the outcome of the initial feasibility study. An industry cost share of 60 percent will be required.

	FY 2009	FY 2010	FY 2011
SBIR/STTR	**0**	**0**	**420**

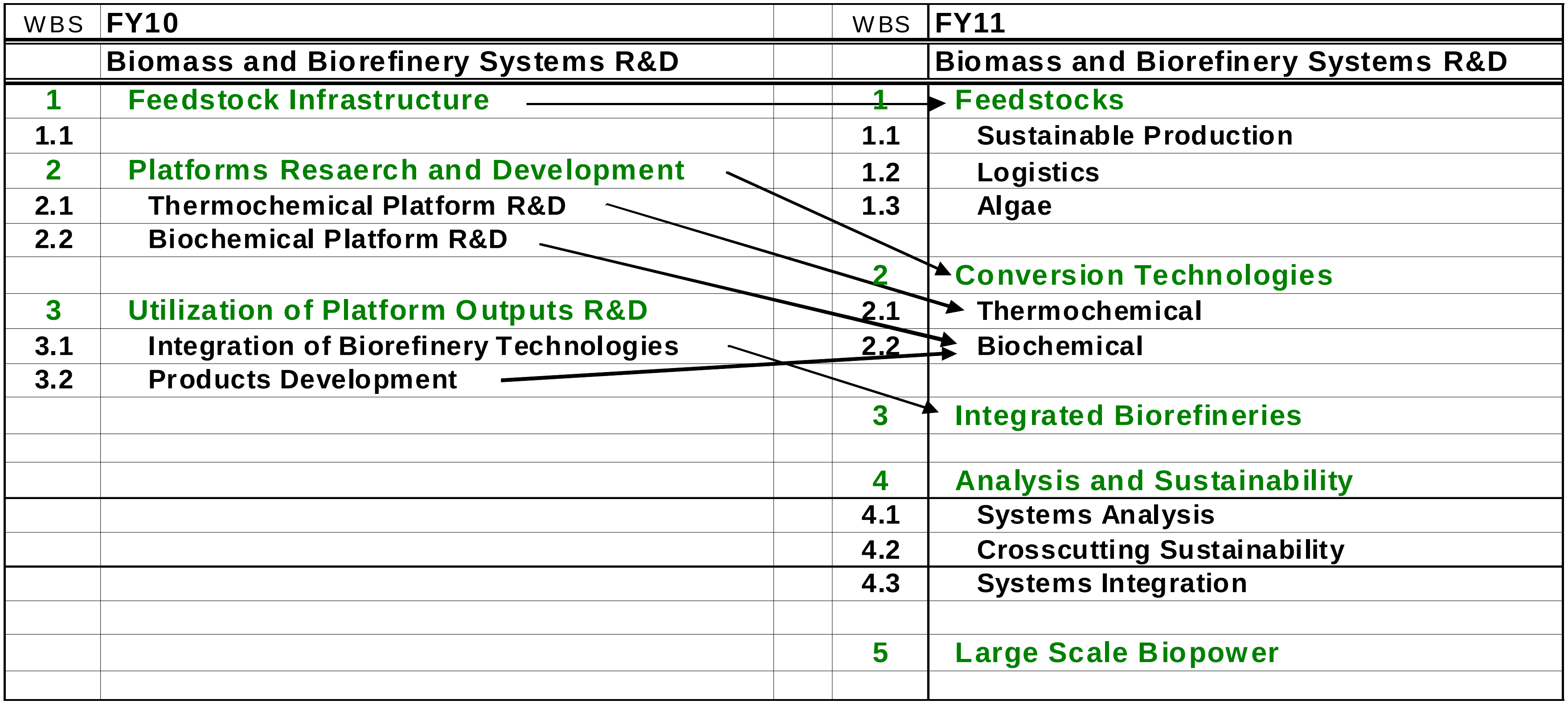
The FY 2011 amount shown is the estimated requirements for the continuation of the SBIR and STTR program.

	FY 2009	FY 2010	FY 2011
Total, Large Scale Biopower	**0**	**0**	**50,000**

Explanation of Funding Changes

	FY 2011 vs. FY 2010 ($000)
Large Scale Biopower	
This increase supports the establishment of a new subprogram for an entirely new DOE initiative that takes advantage of the improvements in thermal efficiency of power generation systems. These activities will address challenges from optimizing fuel type, feedstock logistics, regional supply issues, sustainability, including resources such as water, labor and grid limitations. The intent is to build and operate a biomass power facility with an efficiency in excess of 50 percent that will create green jobs, and provide cost-effective renewable power. This effort is a critical first step toward the implementation of large utility scale production of renewable electric power from biomass. In subsequent years, appropriate technologies can then be deployed at commercial scale to prove economic viability and establish a sustainable supply chain. These pioneering efforts are intended to create new economic opportunities, including jobs, across the supply chain and make a significant contribution to domestic renewable energy generation, further diversifying the U.S. renewable portfolio for enhanced energy and economic security.	+49,580
SBIR/STTR	
Changes in the SBIR/STTR funding are a direct result of changes in the funding of program activities	+420
Total Funding Change, Large Scale Biopower	**+50,000**

Biomass Program FY 2010 – FY 2011 Crosswalk



WBS	FY10		WBS	FY11
	Biomass and Biorefinery Systems R&D			Biomass and Biorefinery Systems R&D
1	Feedstock Infrastructure		1	Feedstocks
1.1			1.1	Sustainable Production
2	Platforms Resaerch and Development		1.2	Logistics
2.1	Thermochemical Platform R&D		1.3	Algae
2.2	Biochemical Platform R&D			
			2	Conversion Technologies
3	Utilization of Platform Outputs R&D		2.1	Thermochemical
3.1	Integration of Biorefinery Technologies		2.2	Biochemical
3.2	Products Development			
			3	Integrated Biorefineries
			4	Analysis and Sustainability
			4.1	Systems Analysis
			4.2	Crosscutting Sustainability
			4.3	Systems Integration
			5	Large Scale Biopower

Solar Energy
Funding Profile by Subprogram

(dollars in thousands)

	FY 2009 Current Appropriation[a]	FY 2009 Current Recovery Act Appropriation	FY 2010 Current Appropriation	FY 2011 Request
Solar Energy				
Photovoltaic R&D	142,793	46,535	128,490	152,000
Concentrating Solar Power	29,621	30,872	49,720	98,200
Systems Integration	0	23,966	23,250	30,698
Market Transformation	0	14,590	23,540	21,500
Fuels from Sunlight Hub	0	0	22,000	0
Total, Solar Energy	172,414	115,963	247,000[b]	302,398

Public Law Authorizations:

P.L. 93-409, “Solar Heating and Cooling Demonstration Act” (1974)
P.L. 94-163, “Energy Policy and Conservation Act” (EPCA) (1975)
P.L. 94-385, “Energy Conservation and Production Act” (ECPA) (1976)
P.L. 95-91, “Department of Energy Organization Act” (1977)
P.L. 95-590, “Solar Photovoltaic Energy Research, Development and Demonstration Act” (1984)
P.L. 95-619, “National Energy Conservation Policy Act” (NECPA) (1978)
P.L. 96-294, “Energy Security Act” (1980)
P.L. 101-218, “Renewable Energy and Energy Efficiency Technology Competitiveness Act of 1989”
P.L. 101-575, “Solar, Wind, Waste, and Geothermal Power Production Incentives Act of 1990”
P.L. 102-46, “Solar, Wind, Waste, and Geothermal Power Production Incentives Technical Amendments Act” (1991)
P.L. 102-486, “Energy Policy Act of 1992”
P.L. 109-58, “Energy Policy Act of 2005”
P.L. 110-140, “Energy Independence and Security Act of 2007”

Mission

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

Benefits

The U.S. is the world’s largest consumer of electricity and, at the same time, has the largest solar resource of any industrialized country.[c] Developing technologies that can reliably and affordably harvest this resource will greatly enhance National energy security while reducing the threat of global

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[a] SBIR/STTR funding transferred in FY 2009 was $2,308,000 for the SBIR program and $278,000 for the STTR program.

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

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

warming and providing high-paying jobs in the U.S. . To accomplish this mission, the Solar Program invests in two basic types of solar technologies – PV which convert the sun's energy directly into electricity, and 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. The Solar Program supports a broad spectrum of R&D activities from university-led efforts focused on next generation PV devices and processes, to industry-led R&D partnerships, known as "Technology Pathway Partnerships (TPPs)," which address the issues of cost, performance and reliability associated with each technology pathway. Partners include industry, universities, laboratories, and other governmental entities broadening the base and increasing the likelihood of achieving the Solar Program's goals. Program modeling suggests that, in 2015, outcomes and benefits could include 5 to 10 GW of cumulative new solar electric generating capacity installed in the U.S.

During the past decade, demand for and production of solar energy systems have been growing very rapidly. Worldwide, the grid-connected solar PV market has grown at a compound annual growth rate (CAGR) of 54 percent over the past 10 years, 56 percent from 2003 to 2008, and over 70 percent from 2007 to 2008. Growth in the U.S. was also strong, with a 5 year CAGR of 37 percent for the grid plus off-grid market, accelerating to 63 percent from 2007 to 2008.[a] CSP technologies have also experienced growth in recent years, with 430 MW of grid-tied capacity installed worldwide through 2008, and 419 MW of this capacity installed in the Southwestern U.S.[b] Demand for and production of both PV and CSP solar energy systems is expected to continue to rapidly grow over the next couple of decades, due to a combination of: declining system costs; technology improvement; increasing concern about environmental challenges (such as climate change) and national security; government policy and incentives associated with these concerns; and tremendous interest in and investment by the private sector. Possible near-, mid-, and long-term scenarios for solar technologies are:

- 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, as presented in the benefits table below, suggest that by 2030, the Solar Program can directly contribute to private sector development of more than 70 GW of electric and power which will reduce carbon emissions by more than 40 million metric tons, and can increase to nearly 2.5 gigatons by mid-century.

The proposed FY 2011 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

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[a] Navigant. Analysis of Worldwide Markets for Photovoltaic Products & Five-Year Application Forecast 2008/2009. Palo Alto, CA: Navigant Consulting. 2009: http://www.navigantconsulting.com

[b] Prometheus Institute. Concentrating Solar Power: Technology, Costs and Markets. Cambridge, MA: Prometheus Institute for Sustainable Development. 2008: http://www.gtmresearch.com/report/concentrating-solar-power-technology-cost-and-markets

generated from solar competitive with conventional grid electricity by 2015, addressing market barriers, and accelerating the development of advanced and next generation PV technology. Specific projects include: PV Incubator; PV Supply Chain; a solar-wide lab call for projects in next-generation PV technologies and CSP materials; upgrades to the National Solar Thermal Test Facility at Sandia National Laboratories (SNL); Solar Energy Grid Integration Systems (SEGIS); high penetration PV; Solar America Cities; and solar workforce development activities. FY 2011 activities integrate program R&D and the new program and sector base resulting from Recovery Act funded projects. Follow through is planned within each related activity to build the Nation's energy economy with sustained technology innovation and infrastructure at the scale and pace leveraged partnerships generated with an informed and energized public, Congress and private sector. This integrated targeted performance builds on both Recovery and RD&D will enable the realization of administration's goals and commitments to energy, the economy and climate. Decision makers and the public can track the progress of these activities at: www.energy.gov/recovery/index.htm.

In addition several structural changes within the Solar Energy Program were implemented in FY 2010. Solar currently consists of four subprograms: two technology-based, PV & CSP; and two crosscutting, Systems Integration and Market Transformation. This structure allows the program to preserve 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, such as systems analysis, resource assessment, and technical outreach. 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 the U.S. energy system.

Climate Change

The Solar Program's RDD&D activities all support the achievement of a National reduction in GHG emissions. Solar technologies have the potential for significantly displacing fossil-based electricity generation, thus reducing the amount of carbon emitted into the atmosphere. For example, DOE analysis detailed in the benefits table that follows suggests that by 2030 the Solar Program's activities could directly contribute to a cumulative reduction of more than 40 million metric tons of CO_2. By mid-century these benefits could increase to nearly 2.5 gigatons.

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 other fossil-based electricity generation for transportation purposes. The combination of solar and PHEVs could help the U.S. move to a much more secure and sustainable transportation system.

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 nearly $25 billion (primarily in the form of savings on consumer electricity bills). Consumer savings could grow rapidly to more than $170 billion by mid-century (see table below).

The benefit tables below show the estimated benefits from 2015 through 2050 that would result from realization of the program's goals[a]. These benefits are achieved by targeted Federal investments in technology R&D 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. Thus is it very likely that the data reported in the benefits tables below underestimate the potential benefits from solar energy technologies, particularly in a future including climate and related policies aimed at encouraging the transition to clean energy technologies. In essence, the availability of low-cost solar energy technologies will be more valuable in a carbon constrained future; yet, DOE's current benefits calculation methodology excludes these types of considerations.

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, which included R&D to improve solar technologies, as well as market transformation efforts. This standardization of method and metrics is part of DOE's efforts to make all program stated benefits comparable.

Prospective benefits are calculated as the arithmetic difference between the baseline 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). In addition, in 2008 Congress extended and modified the investment tax credit for solar technologies, and in 2009 Congress passed the American Reinvestment and Recovery Act (Recovery Act). These acts included several important authorizations to advance solar power which included training workforce and R&D to improve solar technologies. These new 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-GPRA11 for benefits through 2030, and MARKAL-GPRA11 for benefits through 2050. The full list of modeled benefits appears below.

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[a] Additional information on EERE's impact analysis methodology and assumptions, as well as the final FY 2011 budget impact estimates, can be found at http://www1.eere.energy.gov/ba/pba/program_benefits.html.

FY 2011 Primary Metrics

	Metric	Model	Year			
			2015	2020	2030	2050
Energy Security	Oil Imports Reduction, cumulative (Bil bbl)	NEMS	ns	ns	ns	N/A
		MARKAL	ns	0.01	0.04	0.10
	Natural Gas Imports Reduction, cumulative (Tcf)	NEMS	ns	ns	ns	N/A
		MARKAL	ns	0.58	3.18	17.7
Environmental Impacts	CO_2 Emissions Reduction, cumulative (Mil mtCO_2)	NEMS	ns	ns	84	N/A
		MARKAL	9.3	22	40	2440
	SO_2 Allowance Price Reduction ($/ton)	NEMS	ns	ns	ns	N/A
		MARKAL	N/A	N/A	N/A	N/A
	NO_x Allowance Price Reduction ($/ton)	NEMS	ns	ns	ns	N/A
		MARKAL	N/A	N/A	N/A	N/A
Economic Impacts	Primary Energy Savings, cumulative (quads)	NEMS	0.01	0.07	0.31	N/A
		MARKAL	ns	na	ns	9.47
	Oil Savings, cumulative (Bil bbl)	NEMS	ns	ns	ns	N/A
		MARKAL	ns	ns	ns	0.10
	Consumer Savings, cumulative (Bil $)	NEMS	ns	ns	24	N/A
		MARKAL	5.3	9.0	25	172
	Electric Power Industry Savings, cumulative (Bil $)	NEMS	3.2	11	43	N/A
		MARKAL	na	ns	ns	42
	Household Energy Expenditures Reduction ($/household/yr)	NEMS	ns	ns	30	N/A
		MARKAL	na	ns	14	63

- "Reductions" and "savings" are calculated as the difference between results from the baseline case (i.e. no future DOE funding for this technology) and the program case (i.e. requested DOE funding for this technology is received and is successful).
- Oil impacts are shown as two metrics. "Oil Imports Reduction" refers only to reductions in oil imports; "Oil Savings" refers to savings (reduction) in total oil consumption.
- All cumulative metrics are based on results beginning in 2011.
- All monetary metrics are in 2007$.
- Cumulative monetary metrics are in 2007$ that are discounted to 2011 using a 3% discount rate.

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

FY 2011 Secondary Metrics

	Metric	Model	Year			
			2015	2020	2030	2050
Energy Security	Oil Imports Reduction, annual (Mbpd)	NEMS	ns	ns	ns	N/A
		MARKAL	ns	na	ns	0.01
	Natural Gas Imports Reduction, annual (Tcf)	NEMS	ns	ns	ns	N/A
		MARKAL	ns	0.23	0.28	1.44
	MPG Improvement (%)	NEMS	ns	ns	ns	N/A
		MARKAL	ns	ns	ns	ns
Environmental Impacts	CO2 Emissions Reduction, annual (Mil mtCO2/yr)	NEMS	ns	ns	17.7	N/A
		MARKAL	3.33	1.81	0.53	239.36
	CO2 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 (Kg CO2/kWh)	NEMS	ns	ns	ns	N/A
		MARKAL	ns	ns	ns	0.03
	CO_2 Intensity Reduction of US Transportation Sector (Kg CO2/mile)	NEMS	ns	ns	ns	N/A
		MARKAL	ns	ns	ns	ns
Economic Impacts	Primary Energy Savings, annual (quads/yr)	NEMS	ns	0.03	0.12	N/A
		MARKAL	ns	na	ns	1.51
	Oil Savings, annual (Mbpd)	NEMS	ns	ns	ns	N/A
		MARKAL	ns	ns	ns	0.03
	Consumer Savings, annual (Bil $)	NEMS	ns	ns	3.1	N/A
		MARKAL	1.9	0.2	5.5	54
	Electric Power Industry Savings, annual (Bil $)	NEMS	1.6	2.2	9.0	N/A
		MARKAL	na	ns	2.25	23
	Energy Intensity of US Economy (energy/$GDP)	NEMS	0.01	0.01	0.02	N/A
		MARKAL	ns	ns	ns	0.05
	Net Energy System Cost Reduction, cumulative (Bil $)	NEMS	N/A	N/A	N/A	N/A
		MARKAL	4.16	9.1	18.4	54.7

- "Reductions" and "savings" are calculated as the difference between results from the baseline case (i.e. no future DOE funding for this technology) and the program case (i.e. requested DOE funding for this technology is received and is successful).
- Oil impacts are shown as two metrics. "Oil Imports Reduction" refers only to reductions in oil imports; "Oil Savings" refers to savings (reduction) in total oil consumption.
- All cumulative metrics are based on results beginning in 2011.
- All monetary metrics are in 2007$.
- Cumulative monetary metrics are in 2007$ that are discounted to 2011 using a 3% discount rate.

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

Contribution to the Secretary's Goals and GPRA Unit Program Goals

The Solar Program activities contribute to two of the Secretary's goals as described below.

Energy: Build a competitive, low-carbon economy and secure America's energy future

The Solar Program demonstrates and facilitates the deployment of a range of solar energy technologies by working with the National Laboratories, universities, private sector partnerships, and other non-profit research organizations on cutting edge R&D on a wide range of solar energy technologies and pursuing systems integration and market transformation activities.

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

The 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. These collaborative activities will facilitate the widespread deployment of cost-competitive solar technologies which will affect global climate change by decreasing the carbon intensity of electricity generation.

Innovation: Lead the world in science, technology, and engineering
The principal way the Solar Energy Program invests in transformational science is by supporting cutting edge research at National Laboratories, universities, and with industry on topics such as thermal storage for CSP and new device architectures for PV. 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). The Solar Program also participates in the Intergovernmental Panel on Climate Change (IPCC) and contributes to IEA solar related tasks.

Contribution to GPRA Unit Program Goal 3 (Solar Energy)

The Solar Energy Program contributes to the Department's strategic goals 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.

Annual Performance Results and Targets

Performance measures enable the Program to better gauge its mission of: accelerating solar energy technology commercialization, establishing and tracking targets for cost reductions, increasing installed capacity, and high grid penetration necessary for increasing demand. The process involves diverse partnerships, all of which help solidify and strengthen the science, technology and engineering base within the U.S. Advances in solar energy technology require a wide range of skill-sets and jobs, which will be in greater demand as R&D, manufacturing, and installations continue to grow.

<table>
<tr><td colspan="10">Annual Performance Targets and Results

Secretarial Goal: Goal 1: Innovation: Lead the world in science, technology, and engineering
Goal 2: Energy: Build a competitive, low-carbon economy and secure America’s energy future
GPRA Unit Program Goal: 03 Solar Energy
Subprogram: Photovoltaics</td></tr>
<tr><th>FY 2006</th><th>FY 2007</th><th>FY 2008</th><th>FY 2009</th><th>FY 2010</th><th>FY 2011</th><th>FY 2012</th><th>FY 2013</th><th>FY 2014</th><th>FY 2015</th></tr>
<tr><td colspan="10">Performance Measure: Reduce the levelized cost of solar electricity from photovoltaics for residential applications (cents per kilowatt hour)[a]</td></tr>
<tr><td>T: NA
A: NA</td><td>T: NA
A: NA</td><td>T: 14-23
A: MET</td><td>T: 17-20
A: MET</td><td>T: 15-18
A:</td><td>T: 12-17
A:</td><td>T: 11-16
A:</td><td>T: 9-15
A:</td><td>T: 8-14
A:</td><td>T: 6-11
A:</td></tr>
<tr><td colspan="10">Performance Measure: Prior to 2008, the metrics $/Watt and module conversion efficiency were used for different PV technology types. However, through time these metrics became a less encompassing and representative measure of the Program's overall progress. This was coupled with a stronger industry emphasis on the levelized cost of electricity (LCOE) measured in $/kWh, since the latter can be used to better compare not only the cost of electricity generation from both conventional and renewable energy technologies, but also generation from central and distributed systems. As the Program became better designed to respond to LCOE, the metric was changed to $/kWh and split into commercial and residential targets to more accurately reflect divides within the solar market.

FY 2006: 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.

FY 2007: 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.</td></tr>
<tr><td>T: $1.90
A: MET</td><td>T: $1.80
A: MET</td><td>T: RETIRED
A: NA</td><td>T: NA
A: NA</td><td>T: NA
A: NA</td><td>T: NA
A: NA</td><td>T: NA
A: NA</td><td>T: NA
A: NA</td><td>T: NA
A: NA</td><td>T: NA
A: NA</td></tr>
</table>

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[a] The LCOE is a cost per unit energy value that is calculated by unitizing the present value of the total life-cycle system cost and total generation of the system. Some of the DOE funded PV companies are requested to provide LCOE ranges, which are used to determine if Program targets are being met. These companies calculate LCOE with the Solar Advisor Model, a National Renewable Energy Laboratory modeling tool, and the results are verified by the Solar Program. The cost targets listed above include Federal tax incentives.

Annual Performance Targets and Results

Secretarial Goal: Goal 1: Innovation: Lead the world in science, technology, and engineering
Goal 2: Energy: Build a competitive, low-carbon economy and secure America's energy future
GPRA Unit Program Goal: 03 Solar Energy
Subprogram: Photovoltaics

FY 2006	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
Performance Measure: Reduce the levelized cost of solar electricity from photovoltaics for commercial applications (cents per kilowatt hour)[a]									
T: NA A: NA	T: NA A: NA	T: 14-23 A: MET	T: 12-16 A: MET	T: 10-14 A:	T: 8-12 A:	T: 7-10 A:	T: 6-9 A:	T: 5-7 A:	T: 4-6 A:
Performance Measure: Prior to 2008, the metric of module conversion efficiency was used for different PV technology types. However, the Solar Program felt that through time this became a less encompassing measure of the Program's progress. As the Program became better designed to respond to levelized cost of energy (LCOE), the metric was changed to $/kWh and split into commercial and residential targets to more accurately reflect divides within the solar market. FY 2006: Develop thin-film PV modules with an 11.2 percent conversion efficiency that are capable of commercial production in the U.S. FY 2007: Develop thin-film PV modules with an 11.8 percent conversion efficiency that are capable of commercial production in the U.S.									
T: 11.2% A: MET	T: 11.8% A: MET	T: RETIRED A: NA	T: NA A: NA	T: NA A: NA	T: NA A: NA	T: NA A: NA	T: NA A: NA	T: NA A: NA	T: NA A: NA

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[a] The LCOE is a cost per unit energy value that is calculated by unitizing the present value of the total life-cycle system cost and total generation of the system. Some of the DOE funded PV companies are requested to provide LCOE ranges, which are used to determine if program targets are being met. These companies calculate LCOE with the Solar Advisor Model, a National Renewable Energy Laboratory modeling tool, and the results are verified by the Solar Program. The cost targets listed above include available Federal tax incentives.

Annual Performance Targets and Results

Secretarial Goal: Goal 1: Innovation: Lead the world in science, technology, and engineering
Goal 2: Energy: Build a competitive, low-carbon economy and secure America's energy future
GPRA Unit Program Goal: 03 Solar Energy
Subprogram: Concentrating Solar Power

FY 2006	**FY 2007**	**FY 2008**	**FY 2009**	**FY 2010**	**FY 2011**	**FY 2012**	**FY 2013**	**FY 2014**	**FY 2015**
Performance Measure: Reduce the levelized cost of solar electricity from CSP for utility applications.[a] (cents per kilowatt hour)									
T: 12-14 A: MET	T: 11-13 A: MET	T: 11-13 A: MET	T: 11-13 A: UNMET[b]	T: 10-12 A:	T: 10-11 A:	T: 9-10 A:	T: 9-10 A:	T: 9-10 A:	T: 8-9 A:

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[a] The LCOE is a cost per unit energy value that is calculated by unitizing the present value of the total life-cycle system cost and total generation of the system. The National Renewable Energy Laboratory inputs parameters such as system component costs, location, financing, and policy incentives into the Solar Advisor Model, a modeling tool that calculates LCOE.

[b] The National Renewable Energy Laboratory (NREL) performed a comprehensive cost analysis of a parabolic trough plant in 2009, which indicated that several cost factors were higher than previously expected. In particular, nitrate salt (the thermal storage media) prices were at historic highs, despite the economic slowdown in 2009. The result of 13-15 cents/kilowatt hour in a best modeled cost exceeded the FY 2009 target range.

<table>
<tr><td colspan="10">Annual Performance Targets and Results

Secretarial Goal: Goal 1: Innovation: Lead the world in science, technology, and engineering
Goal 2: Energy: Build a competitive, low-carbon economy and secure America’s energy future</td></tr>
<tr><td colspan="10">GPRA Unit Program Goal: 03
Subprogram: Systems Integration</td></tr>
<tr><td>FY 2006</td><td>FY 2007</td><td>FY 2008</td><td>FY 2009</td><td>FY 2010</td><td>FY 2011[a]</td><td>FY 2012</td><td>FY 2013</td><td>FY 2014</td><td>FY 2015</td></tr>
<tr><td colspan="10">Performance Measure: Provide enabling technologies for >5% annual solar energy penetration into two types of distribution feeder circuits, in support of achieving the Solar Vision Goal of 15% of electricity demand from solar energy by 2030.[a] (percent penetration/number of distribution feeder circuits)</td></tr>
<tr><td>T: NA
A: NA</td><td>T: NA
A: NA</td><td>T: NA
A: NA</td><td>T: NA
A: NA</td><td>T: NA
A: NA</td><td>T: >5% /2
A:</td><td>T: >5% /4
A:</td><td>T: >10% /2
A:</td><td>T: >10% /4
A:</td><td>T: >15% /
A:</td></tr>
<tr><td colspan="10">Performance Measure: The FY 2011 performance measure was created in transition from reporting qualitative milestones to quantitative performance measures. The previous year’s performance measure for this subprogram is not a direct predecessor measures to the FY 2011 performance measure. However, the FY 2010 measure is enabling the progress necessary to support the new FY 2011 Performance Measure.

FY 2010: Identify at least 5 SEGIS awards to move into prototype development in Phase II. (awards)</td></tr>
<tr><td>T: NA
A: NA</td><td>T: NA
A: NA</td><td>T: NA
A: NA</td><td>T: NA
A: NA</td><td>T: 5
A: NA</td><td>T: NA
A: NA</td><td>T: NA
A: NA</td><td>T: NA
A: NA</td><td>T: NA
A: NA</td><td>T: NA
A: NA</td></tr>
</table>

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[a] Actual penetration may vary depending on load and other energy sources’ characteristics. High penetration targets will be affected by timely completion of interconnection standard on distributed resource island systems (IEEE 1547.4). These are yearly targets. Additional information is valid for FY 2011 – FY 2015. There are many types of distribution circuit feeders depending on customer class (residential, commercial, industrial), location (urban, rural), voltage level (12.47 kV, 4.16 kV, etc.), and strength of the system where they are connected (weak, strong). The same penetration level in two different feeders can result in different impacts, and for this reason, it is important to understand the range of impacts. Demonstrating the target penetration levels on at least two types of distribution circuit feeders will help utilities feel more comfortable with installing PV systems on a larger percentage of their distribution systems. Percent penetration is PV energy divided by load energy served by the feeder, over one year. Five percent PV penetration by energy is about 15% by capacity (defined as rated PV capacity divided by feeder peak load).

Annual Performance Targets and Results

Secretarial Goal: Goal 1: Innovation: Lead the world in science, technology, and engineering
Goal 2: Energy: Build a competitive, low-carbon economy and secure America's energy future
GPRA Unit Program Goal: 03 Solar Energy
Subprogram: Market Transformation

FY 2006	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011[a]	FY 2012	FY 2013	FY 2014	FY 2015
Performance Measure: Reduce market barriers and support domestic market growth to enable increasing annual solar installations in the U.S. (megawatts installed per year)[a]									
T: NA A: NA	T: NA A: NA	T: NA A: NA	T: NA A: NA	T: NA A: NA	T: 600 MW A:	T: 800 MW A:	T: 1 GW A:	T: 2 GW A:	T: 3 GW A:
Performance Measure: The FY 2011 performance measure was created in transition from reporting qualitative milestones to quantitative performance measures. The previous year's performance measure for this subprogram is not a direct predecessor measure to the FY 2011 performance measure. However, the FY 2010 measure is enabling the progress necessary to support the new FY 2011 Performance Measure. FY 2010: Complete technical assistance to 20 of the 25 Solar America Cities to address issues such as financing, permitting, city planning, and outreach. The Market Transformation sub-program's out-year goals are not tied to 2010 AEO estimates. However, they are moderately conservative estimates based on a few different resources, including capacity goals from the Program's draft version of the Solar Vision Study, and the Interstate Renewable Energy Council's 2009 Updates & Trends Report (technical assistance).									
T: NA A: NA	T: NA A: NA	T: NA A: NA	T: NA A: NA	T: 20 A: NA	T: NA A: NA	T: NA A: NA	T: NA A: NA	T: NA A: NA	T: NA A: NA

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[a] Installation targets may be affected by the state of the private financial markets, technology development risks, transmission availability and siting issues. These are yearly targets. Additional information is valid for FY 2011 – FY 2015.

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 such as:

- Performing RDD&D activities in partnership with coalitions of industry members, universities, National Laboratories and/or States to reduce costs;
- Increasing PV module efficiency, system reliability, and manufacturing capability; developing lower cost production processes for cells and modules;
- Selecting technology pathways for accelerated development of improved manufacturing methods, materials use, defect control and throughput;
- Increasing the efficiency and reliability of CSP systems;
- Developing low-cost thermal storage for CSP systems;
- Conducting systems integration activities such as technology modeling and analysis to help identify research priorities;
- Identifying the barriers and benefits of grid integration;
- Working with Solar America Cities to build sustainable solar infrastructures, while assisting a second round of cities in defining and launching their activities;
- Conducting other market transformation activities to identify and address market barriers to solar technology usage, and promote market expansion opportunities; and
- Coordinating with EERE’s Buildings Technologies Program (BTP) to accelerate deployment of higher-efficiency buildings incorporating PV technologies.

Strategies include working collaboratively with stakeholders on program, policy, management and legislative initiatives and approaches, such as:

- Working with cost-shared partnerships consisting of industry members, universities, National Laboratories, States and/or other governmental entities to solve scientific and technical barriers to improve performance and reliability, while reducing cost in PV and CSP technology pathways;
- Working 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
- Collaborating with DOE’s Office of Science on solar R&D, and with BTP and the Federal Energy Management Program (FEMP), and DOE’s Office of Electricity on deployment opportunities, and with other agencies such as the Defense Advanced Research Projects Agency (DARPA), the Bureau of Land Management (BLM), and others.

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;
- Utility barriers and pricing strategies; and
- The price of carbon in current and future emission trading schemes.

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

- Ensure that the 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:	• Solar Program Peer Reviews (2009, 2007, 2005) • National Solar Technology Roadmaps (2007) • Sargent and Lundy, Assessment of Parabolic Trough and Power Tower Solar Technology Cost and Performance Forecasts (2003)[a]
Baselines:	The Solar Program's 2010 baselines are: • $0.15 to $0.18/kWh for residential PV; • $0.10 to $0.14/kWh for commercial PV; and • $0.10 to $0.12/kWh for utility-scale CSP technologies.
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;

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[a] "Assessment of Parabolic Trough and Power Tower Solar Technology Cost and Performance Forecasts." Sargent & Lundy LLC Consulting Group. Chicago. October 2003: http://www.nrel.gov/docs/fy04osti/34440.pdf

- Specialized program evaluation studies to examine process, impacts, or market baseline and effects, as appropriate;
- Continue to conduct the transparent oversight and performance management initiated by Congress and the Administration;
- Quarterly and annual assessment of program and management results based performance through the Performance Measurement Manager (PMM, the DOE quarterly performance progress review); and
- Annual review of methods, and re-computation of potential benefits for GPRA.

Data Storage:	EIA and other organizations; both the National Renewable Energy Laboratory (NREL) and SNL 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.

Photovoltaic R&D
Funding Schedule by Activity

(dollars in thousands)

	FY 2009	FY 2010	FY 2011
Photovoltaic R&D	142,793	126,332	149,021
SBIR/STTR	0 [a]	2,158	2,979
Total, Photovoltaic R&D	142,793	128,490	152,000

Description

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 eight to 16 times a typical compact fluorescent light bulb. The module comprises 50 to 60 percent of the levelized cost of energy (LCOE) 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.

The Photovoltaic R&D (PV) subprogram seeks to achieve its goals by accelerating R&D on technology with the highest potential to reach cost competitiveness by 2015, investing in technologies with capability of reaching long-term carbon reduction goals, and ensuring a sustainable PV manufacturing base for the U.S. PV industry.

For FY 2011, the PV subprogram's priorities are:

- Invest in projects that leverage DOE funds for maximum impact, anticipate industry needs, and contain sufficient risk and promise to justify government funds;
- Produce R&D results and meet all annual technical milestones of multi-year cost-shared contracts under competitive solicitations to reduce costs;
- Advance module and system manufacturing technologies to achieve higher performance and lower-cost products with faster throughput;

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[a] SBIR/STTR funding transferred in FY 2009 was $2,075,920 for the SBIR program and $239,080 for the STTR program.

- Continue reliability research to increase the lifetime of PV components and systems, and prove the bankability of new PV technologies.

Benefits

The Solar Program goal of achieving cost-competitive solar electricity translates to a range of costs based on commercial and residential markets.[a]

For PV, the estimated cost ranges for market-specific cost-competitive electricity generation in 2015 are:

- 4-6¢/kWh for commercial markets; and
- 6-11¢/kWh for residential markets.

Because the Solar Program is designed to affect the LCOE, the program changed the primary metrics from $/W to $/kWh. In addition, the metric was split into commercial 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. Achieving the cost-of-energy goals will stimulate market take-up that will produce the estimated associate energy, environmental and economic benefits. 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 (fiscal year)						
	2003	2004	2005	2006	2007	2008	2009
Levelized Electricity Cost from PV Systems ($/kWh)[b]							
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	0.12-0.20
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	0.12-0.20

	Planned (fiscal year)			
	2009	2010	2011	2015
Levelized Electricity Cost from Residential PV Systems ($/kWh)				
Target	0.17-0.20	0.15-0.18	0.12-0.17	0.06-0.11
Levelized Electricity Cost from Commercial PV Systems ($/kWh)				
Target	0.12-0.16	0.10-0.14	0.08-0.12	0.04-0.06

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[a] The cost targets include Federal tax incentives and are modeled at high production costs.

[b] The Levelized Cost of Electricity (LCOE) is the principal 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. NREL developed the Solar Advisor Model (SAM), a robust model that considers the climatic variables which impact solar energy generation for hundreds of U.S. locations. SAM was used by the Solar Program to calculate LCOE and determine if its technical goals were met.

Detailed Justification

(dollars in thousands)

	FY 2009	FY 2010	FY 2011
Photovoltaic R&D	**142,793**	**126,332**	**149,021**

The PV subprogram consists of five projects: Advanced PV R&D, PV Prototype Development, PV Product & Process Development, Measurement & Characterization, and Test & Evaluation.

The Advanced PV R&D (Approximate funding $29.0M)

Next Generation PV: 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. R&D on non-traditional PV technologies is essential to ensure innovation and support the development and expansion of advanced PV options. This effort consists of work on cutting-edge next generation R&D, which currently includes technologies such as plasmonics, organic cells, and multiple exciton generation (MEG), helping bridge the gap between basic science and technology development. These three year projects reach go/no-go decision points in FY 2009 and FY 2010. Projects that reached go/no-go decisions in FY 2009 have been approved for continuation. A new Next Generation PV solicitation issued in calendar year 2010 will support a new round of university and start-up company projects in FY 2011. FY 2011 activities will focus on the evaluation and support of these next-generation projects.

National Laboratory Research: A diverse National Laboratory research portfolio is another important part of Advanced PV R&D, covering R&D 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 on improvements that industry can adopt in the future.

Seed Funds: In addition to the core National Laboratory R&D program, “seed” funds are being provided to the National Laboratories to refresh DOE’s in-house PV research portfolio with early stage technology projects.

PV Prototype Development (Approximate funding $19.0M)

Pre-Incubator: The Pre-Incubator targets small businesses in the concept verification stage and bridges their development to a proof-of-concept prototype. It is intended to help companies reach the stage of development between laboratory concept and pilot scale prototype. The companies are partnered with experts and capabilities at NREL, reducing project implementation risk and increasing the likelihood that the performance and reliability objectives can be achieved.

Process Development Integration Laboratory (PDIL): The new manufacturing-development focused PDIL, housed in the Science and Technology Facility at NREL, gives stakeholders an extra level of insight into product development of all PV material technologies with specialized equipment that simultaneously allows the creation and analysis of PV devices. With the capability to study their processes in more depth as the cells are made, the improvement in manufacturing will be accelerated.

Commercialization CRADA Activities: This Industrial CRADA program funds scientists at NREL to work with companies who have the best overlap with NREL capabilities. After scientists and companies have had some initial conversations and a proposed CRADA, NREL conducts an internal proposal competition to select companies. Another off-shoot of this program, begun in FY 2010, is the

Innovation by Design Program, which funds teams of NREL scientists to initiate research aimed to create a new and complete PV product ready for commercialization within 18 months.

PV Product & Process Development (Approximate funding $78.0M)

University Process and Product: This activity, 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 offers 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.

PV Incubator: The PV Incubator program, 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 and fourth rounds planned for FY 2010 and FY 2011, respectively. All performers will continue to work closely with the Laboratories to deliver new module prototypes and demonstrate ≥ 3MW of pilot production within 18 months of project start. 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.

Technology Pathway Partnerships (TPP): The TPPs are developing systems that 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. In phase one, TPPs are developing new PV solutions for the residential, commercial, and utility market sectors of grid-tied electric power. In FY 2010, the third year of the first phase, the partnerships focused on development, testing, demonstration, validation, and interconnection of new PV components, systems, and manufacturing equipment. Results from these projects will help inform a solicitation for a second round of projects in FY 2011, when the second phase of the TPPs will be offered. As there has been significant growth in the solar marketplace since the original conception of the TPP program in 2006 and now, the second phase of the TPPs will be refocused on partnerships targeting higher risk technologies that will further accelerate cost reductions within the 2015 timeframe.

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

PV Manufacturing Initiative: FY 2011 will represent the first full year of funding for the PV Manufacturing initiative started in FY 2010. This initiative intends to accelerate the commercialization and cost reduction of PV technologies by coordinating solutions across industry that will facilitate PV manufacturing in the U.S. The natural result of this initiative will be the creation of a robust U.S. PV manufacturing base and the development of a workforce with the critical skills required to meet these goals. The initiative will involve consortia of industry and university partners, and facilities to speed the implementation of new cutting edge technologies that provide needed manufacturing process expertise.

Measurement and Characterization (M&C) (Approximate funding $12.0M)

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

Test & Evaluation (Approximate funding $14.0M)

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 *PV Community Project* is a coordinated effort on data collection, validation, and analysis of commercial PV systems and components for reliability improvements launched in FY 2010 in collaboration with the GSA green Federal building initiative. Technical assistance will continue to be provided in FY 2011 on validation and analysis of performance of installed PV systems, as well as on lab analyses of failed components/systems to investigate reliability issues (failure causes and degradation mechanisms). The collected data and analysis information will be shared with the industry through a web-based PV operational performance database. In FY 2011, 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.

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

SBIR/STTR	**0**	**2,158**	**2,979**

In FY 2009, $2,075,920 and $239,080 was transferred to the SBIR and STTR program. FY 2010 and FY 2011 amounts shown are estimated requirements for continuation of the SBIR and STTR program.

Total, Photovoltaic R&D	**142,793**	**128,490**	**152,000**

Explanation of Funding Changes

	FY 2011 vs. FY 2010 ($000)
Photovoltaic R&D	
The increase in PV subprogram funding reflects the first year of full funding for the PV Manufacturing Initiative. Initiated in FY 2010, this effort will accelerate commercialization and cost reduction of PV technologies.	+ 22,689
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.	+ 821
Total Funding Change, Photovoltaic R&D	**+ 23,510**

Concentrating Solar Power
Funding Schedule by Activity

(dollars in thousands)

	FY 2009	FY 2010	FY 2011
Concentrating Solar Power	29,621	49,023	96,825
SBIR/STTR	0 [a]	697	1,375
Total, Concentrating Solar Power	29,621	49,720	98,200

Description

Over 350 MW of concentrating solar power (CSP) has been 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 RD&D 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.

CSP systems concentrate sunlight to produce 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 CO_2. Although CSP plants can be configured in all sizes, they are most cost effective when they generate greater than 100 MW.[b] Size and economical energy storage make CSP systems strong candidates for centralized power applications by utilities.

Storage is particularly important for utility solar projects because the addition of energy storage alleviates 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 has the potential in some configurations of actually reducing the cost of power generated by the plant. Storage 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 can then provide a double benefit to consumers: lower cost and power on demand.

The CSP subprogram in FY 2011 will focus on three major areas: 1) R&D of low cost systems that include thermal storage to achieve cost competitiveness in the intermediate and baseload power markets; 2) establishment of a demonstration program of new CSP technologies that could lead to over 1 GW of projects and 3) assisting industry in the deployment of projects by working with the Bureau of Land Management (BLM) in identifying BLM-managed land environmentally suitable for utility-scale solar projects and addressing issues related to water consumption and transmission.

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[a] SBIR/STTR funding transferred in FY 2009 was $232,080 for the SBIR program and $38,920 for the STTR program.

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

Benefits

Today, in areas with favorable conditions and considering the current tax incentives, CSP technology can generate electricity at costs as low as $0.10-0.12/kWh. The goal for CSP is being cost-competitive at 8-9¢/kWh in the intermediate power market by 2015 with a modest (six hours) amount of storage. The long-term goal for CSP systems is to be cost competitive in the baseload power market with significant amounts (12 to 17 hours) of thermal storage 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. One of the key technology pathway metrics is parabolic trough annual system efficiency since this has a very direct impact on levelized energy costs. 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 (in Fiscal Years)

	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 (in Fiscal Years)[a]

	Historic & Planned									
	2003	2004	2005	2006	2007	2008	2009	2010	2011	2015
Levelized Electricity Cost from Utility-scale CSP[b]										
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	0.11-0.13	0.10-0.12	0.10-0.11	0.08-0.09
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	0.13-0.15[c]			

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[a] In this table, years indicate the years in which field verification of modeled cost occurs.

[b] The cost targets include Federal tax incentives.

[c] The National Renewable Energy Laboratory (NREL) performed a comprehensive cost analysis of a parabolic trough plant in 2009, which indicated that several cost factors were higher than previously expected. In particular, nitrate salt (the thermal storage media) prices were at historic highs, despite the economic slowdown in 2009. This resulted in a best modeled cost that exceeded the FY 2009 target range.

Detailed Justification

	(dollars in thousands)		
	FY 2009	FY 2010	FY 2011
Concentrating Solar Power (CSP)	**29,621**	**49,023**	**96,825**

The resurgence of interest in CSP by utilities and plans for several gigawatts of projects has led to a more diversified effort by DOE to facilitate the deployment of the technology. Prior to FY 2007, the CSP activity was centered on laboratory R&D assisting industry. Lab R&D has grown with the increased emphasis on CSP. However, it is now a much smaller percentage of the budget as the amount of funding for industry projects has grown. Solicitations in FY 2007 and FY 2008 led to 27 R&D contracts with industry and universities. Two additional solicitations were initiated in FY 2009; one solicitation focused on the development of low cost systems that include up to 17 hours of thermal storage, and one solicitation (funded by the Recovery Act) focused on advanced thermal storage concepts. All of these were developed with the intent of developing components and systems that could lower cost.

Although many of the research contracts established under these solicitations will continue in FY 2011, emphasis in FY 2011 will shift to the demonstration of advanced concepts at a scale sufficiently large to show that they are financeable for full scale projects. This demonstration activity is meant to bridge the gap between laboratory prototype and commercial product. In FY 2008, a Solar Programmatic Environmental Impact Statement (PEIS) was initiated in partnership with BLM, which led to the identification of 24 solar zones comprising 676,000 acres in FY 2009. This initial PEIS was funded by the Market Transformation subprogram. If this land is fully populated with solar projects and adequate transmission was available, it could provide over 10% of the nation's electrical needs.

Industry's success in deploying projects is essential if DOE's cost goal for CSP is to be attained. As with most new technologies, there is a learning curve that leads to cost reduction as more and more product is built. Experience with technologies such as computers, cell phones, wind turbines, and PV has proven the significant impact on lowering cost associated with large production. An in-depth study of CSP technology showed that the cost would be reduced as much by industry deployment of its technology as reduced from R&D. [a] The CSP subprogram is now addressing both of these elements through: R&D coordinated among National Laboratories, industry and universities; demonstrations of the best innovative new technology; and facilitating industry's deployment of projects through working on land and transmission issues. This strategy offers the best approach for rapid cost reduction.

CSP Research & Development (Approximate funding $28.2M):

The program issued a solicitation in FY 2007 for industry to work on "next generation" technology that could achieve its 2015 goal of being competitive in the intermediate power market. The solicitation 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

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[a] "Assessment of Parabolic Trough and Power Tower Solar Technology Cost and Performance Forecasts." Sargent and Lundy. 2003: http://www.nrel.gov/csp/pdfs/34440.pdf

and innovative new concepts such as linear Fresnel. In FY 2010, most of those contracts moved into Phase II (build and evaluate prototypes). The evaluation of those prototypes will be completed in FY 2011 and some may qualify for a demonstration project.

A solicitation issued in FY 2008 focusing on establishing the technical feasibility of several storage concepts and identifying the potential for near-term thermal storage demonstrations resulted in 15 contracts (industry and university). Research areas include the addition of nano-particles to increase the heat capacity of molten salt, high strength concrete and several phase change materials as storage media, and thermo-chemical storage. Phase II of these contracts, prototype development and evaluation, began in FY 2010 and continue in FY 2011.

A solicitation was released in FY 2009 challenging industry to develop CSP systems capable of operating competitively in the baseload power market. This is a stretch goal for CSP because baseload power is fueled primarily by coal, which is the least expensive fossil fuel. In order to meet this goal, CSP systems that operate at higher temperatures are likely to be required. Higher temperature operation results in higher system efficiency and enables thermal storage systems to be less costly. These contracts began in FY 2010 and Phase I (feasibility and design studies) will continue in FY 2011.

Laboratory R&D (Approximate funding $20.0M)

Industry often has expressed to DOE that it highly values the assistance provided by SNL and NREL. In FY 2010, Recovery Act funding was used to upgrade and expand facilities at the two labs to enable better technical assistance to industry in developing new concepts and providing unbiased evaluations of their technology. Recovery Act funding also enabled a solicitation focused on thermal storage that resulted in awards to five National Laboratories that had not previously been involved with CSP. The labs conduct their own R&D and also closely coordinate among themselves and with industry to ensure integration of R&D and avoid duplication of activities. In FY 2011, laboratory R&D will expand in the areas of dish/engine and parabolic trough technologies, thermal storage, and new R&D efforts will begin in the area of power towers.

CSP Demonstration (Approximate funding $50.0M)

The goal of this effort is to help industry demonstrate new CSP technology that helps achieve either the 2015 or 2020 cost goals. Demonstrations will be of either an entire system or a module of a system that is sufficiently large to represent an entire system. DOE expects several types of CSP technologies will be demonstrated. The demonstration activity will consist of two phases: 1) cost-shared projects of 1 MW to 5 MW at industrial sites or a DOE site; and 2) full size projects of up to 250 MW at a DOE site. DOE will not cost share in the full size projects, but instead will work with BLM to provide access to land that has been environmentally permitted and access to transmission. The developer would be responsible for obtaining a power purchase agreement (PPA) and financing for the full size project. DOE is working with BLM to identify land suitable for the demonstration projects. In FY 2010, DOE and BLM will select an area where the demonstrations will be located and release a solicitation requesting applications for demonstrations. During FY 2011, demonstration projects will be selected and work will begin on developing the demonstration area by providing infrastructure such as roads and utilities, working with the Western Area Power Authority (WAPA) to gain access to transmission, and performing an environmental impact statement of the area. Construction of the demonstrations will begin during FY 2011.

	FY 2009	FY 2010	FY 2011
SBIR/STTR	**0**	**697**	**1,375**

In FY 2009, a total of $232,080 and $38,920 was transferred to the SBIR and STTR programs. The FY 2010 and 2011 amounts shown are estimated requirements for the continuation of the SBIR and STTR program.

	FY 2009	FY 2010	FY 2011
Total, Concentrating Solar Power	**29,621**	**49,720**	**98,200**

Explanation of Funding Changes

	FY 2011 vs. FY 2010 ($000)
Concentrating Solar Power	
The increase in funding is for a CSP demonstration project which has the potential to accelerate the first substantial deployment of new, advanced CSP technology in the U.S. Southwest by two to three years. It is expected that these demonstrations will stimulate the deployment of up to 1,000 MW of CSP projects.	+ 47,802
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.	+ 678
Total Funding Change, Concentrating Solar Power	**+ 48,480**

Systems Integration
Funding Schedule by Activity

(dollars in thousands)

	FY 2009	FY 2010	FY 2011
Systems Integration	0	23,055	30,440
SBIR/STTR	0	195	258
Total, Systems Integration	0	23,250	30,698

Description

Systems Integration activities address the technical barriers to wide scale deployment of distributed and central station solar technologies in the U.S. These activities include intensive measurement and analyses of resource availability and system performance under various high-penetration scenarios, along with the development of new components and systems to enable further market penetration. This subprogram emphasizes 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 Technology Pathway Partnership (TPP) awards.

Systems Integration also features development of integration devices (i.e., inverters, controllers) and interfaces to energy management systems, which are required to integrate solar energy systems into end-use locations and the electricity grid. A key application area is in residential/commercial/industrial buildings, where Systems Integration activities coordinate with Energy Efficiency and Renewable Energy's (EERE) Building Technology Program (BTP) to provide thermal energy and electricity, generated from solar energy technology, needed for a zero-energy building (or home). Similar coordination is ongoing 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 testing and characterization activities will continue to enhance the development of models such as the Solar Advisor Model (SAM), validating component/system models, and integrating varying modeling platforms for collaborative development and use.

Benefits

Systems Integration activities provide enabling technologies along with technology evaluation tools and methodologies to support meeting the goals of high-penetration levels of grid-tied solar electric generation. In FY 2011, new models based on extensive operational data will be developed to fully characterize the grid impacts of 10 to 20 percent (by energy) penetration of solar electric technologies at transmission and distribution levels. Additionally, the Solar Energy Grid Integration System (SEGIS) program will produce functional pilot production "energy management systems" for distributed photovoltaic systems, enabling a new level of sophistication in the integration of grid-connected PV systems, information technology, and optimal control of energy generation and use.

Detailed Justification

(dollars in thousands)

	FY 2009	FY 2010	FY 2011
Systems Integration	**0**	**23,055**	**30,440**

Systems Integration contains five primary activities: Systems Modeling & Analysis, Technology Development, System Testing and Characterization, Resource and Safety R&D, and Codes & Standards.

System Modeling & Analysis

Activities will continue in benchmarking, modeling, and analysis for PV systems and their integration into the distribution and transmission systems.

PV Systems: Validation of models for annual energy production will continue to include data collected from PV installations at select locations representative of the range of solar irradiation environment and weather conditions in the U.S. The inclusion of these representative datasets will further validate the modeling of performance of PV systems operating in all U.S. regions. In FY 2011, the subprogram will also support continuing development and enhancements for SAM, guided by the needs of the SAM user forum, as well as market, value, and policy analyses. Performance modeling platforms will be developed to support analysis of the inherent variability of grid-connected solar electric systems.

Distribution Models: Barriers to high penetration scenarios include technical, operational, market, and regulatory concerns. In the area of technical concerns, electric utilities are resistant to large-scale PV penetration and concerned about the ability of the distribution grid to operate within design tolerances when faced with an increasing percentage of the generation mix being supplied by variable sources. Technical concerns involve the grid stability, voltage regulation, power quality (voltage rise, sags, flicker, and frequency fluctuations), and protection and coordination. The current utility grid was designed to accommodate power flows from the central generation source to the transmission system and eventually to the distribution feeders. Operationally, protection systems were not designed to coordinate with power systems that back feed power onto the grid. A key to understanding these impacts is the ability to accurately model the performance of PV systems in electrical distribution system modeling packages.

Transmission Models: In FY 2011, the Program will work with DOE's OE to address the lack of access to electrical transmission, a major inhibitor to the increased use of utility-scale solar systems. The Program will provide resource information and analyses that recommend optimum routes for new transmission lines to enable utility-scale solar systems to be moved from arid areas of the Southwest U.S. to major population centers throughout the Western U.S. In addition, the Program will address the variability of solar electric systems and ensure seamless integration into the transmission system.

Technology Development

Activities will focus on developing technologies that enable the high-penetration of solar electric systems into the electricity grid. This area focuses on inverter development, solar energy storage, communications protocols, and balance of systems.

Inverter and Communications Development: The Program will address the need to improve the reliability of the inverter and other balance of system (BOS) components. Emphasis will be placed on reducing life-cycle costs by: increasing mean-time-between-failure (MTBF) of inverters and battery charge controllers; developing higher performance technologies through advanced solutions to thermal management and surge protection; and optimizing designs to achieve "plug and play" ability. While today's inverters are designed to disconnect from the utility grid during abnormal conditions, as penetration grows, inverters must be designed to ride-through disturbances. New inverter-utility communications protocols and standards will be required.

In FY 2011, the final stage of development under the SEGIS contracts with industry will be completed with pilot production of advanced inverters and energy management systems with improved reliability, enhanced value and reduced cost. This completion will advance the SEGIS products to the stage ready for commercialization.

Energy Storage: New awards planned for FY 2011 will support development of advanced concepts in technology development, including energy storage systems for integration with PV operations through the SEGIS-Advanced Concepts (AC) solicitation. SEGIS-AC 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.

Resource & Safety R&D

In FY 2011, the Program will improve resource maps for both PV and CSP technologies with an emphasis on providing data to assist industry in site selection and better assurance to utilities and financial institutions on system performance. Main activities will include: development, validation, and dissemination of reliable, accurate solar resource information; improvements of the quality and completeness of the National Solar Radiation Database; benchmarking U.S. solar databases against international data sets following internationally established protocols; and provision of solar products and tools to stakeholders through accessible web-based mechanisms and outreach activities. The Program will also develop a better method of accurately forecasting the solar resource from satellite data, establishing a standard system of collecting data at specific sites, and disseminating resource information to project developers.

System Testing and Characterization

The Program will continue to support projects awarded by the FY 2009 High Penetration Solar Development solicitation that improve modeling tools based on the field verification of high penetration levels of PV into the distribution grid. In addition, the Program will continue work with utilities and industry partners to collect data from multi-megawatt systems to characterize the variable output for other utility partners.

Codes & Standards

The Solar America Board of Codes and Standards ("Solar ABCs") will be in the fourth year of activity in FY 2011. 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 numerous stakeholders, including State and local governments, the solar manufacturing community, non-profits, and others. In addition, DOE and NREL will hold the first codes and standards workshop concerning high penetration.

SBIR/STTR	**0**	**195**	**258**

Since this new subprogram began in FY 2010, no SBIR/STTR funding was transferred for FY 2009. The FY 2010 and 2011 amounts shown are estimated requirements for the continuation of the SBIR and STTR program.

Total, Systems Integration	**0**	**23,250**	**30,698**

Explanation of Funding Changes

	FY 2011 vs. FY 2010 ($000)
Systems Integration	
The increase in funding will be used for activities addressing the technical barriers to wide scale deployment of solar technologies by modeling performance and analyzing the effect on the grid, developing new technologies that integrate with the smart grid, testing fielded systems, measuring the solar resource to assess variability, and developing and implementing codes and standards.	+ 7,385
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.	+ 63
Total Funding Change, Systems Integration	**+ 7,448**

Market Transformation
Funding Schedule by Activity

(dollars in thousands)

	FY 2009	FY 2010	FY 2011
Market Transformation	0	23,540	21,500
Total, Market Transformation	0	23,540	21,500

Description

The Solar Program recognizes it is critically important 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. The specific goal is to support domestic market growth to enable 600 MW of solar installations in the U.S. in FY 2011. 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 2009	FY 2010	FY 2011
Market Transformation	**0**	**23,540**	**21,500**

The Market Transformation subprogram is divided into several projects: Codes & Standards, Workforce Development, State & Local Outreach, Utility & Consumer Outreach, and Market Transformation Research.

Workforce Development: This professional development program supports the training and certification of solar installers and code officials in order to create a qualified workforce that can install PV systems in sufficient quantities to meet Solar Program goals. FY 2011 efforts will support the administration of a national solar workforce development consortium, with a focus on analysis and outreach to leverage the Recovery Act-funded regional train-the-trainer educational institutions.

State & Local Outreach

Solar America Cities: The Solar Program is supporting direct technical partnerships that work to overcome key barriers to significant solar penetration and leverage the advanced efforts occurring throughout the U.S. on a local level. The Solar America Cities activity works closely with 25 U.S. city partners committed to using solar power to help address implementation issues such as financing, permitting, city planning, stakeholder engagement, and grid integration. FY 2011 funds will be used to support the network of Solar America Cities and other local governments with crosscutting analysis and targeted technical assistance on high value topics. Cities will be encouraged to share best practices through the use of interactive tools and discussion opportunities provided by DOE. DOE will also fund the second year of the Solar America Cities Technical Outreach effort to bring the lessons learned and advanced approaches of the 25 Solar America City partnerships to local governments across the country.

State Outreach: The State Outreach project accelerates innovative approaches to solar implementation by key state decision-makers by providing technical information and peer sharing opportunities on solar technologies and related policy topics. FY 2011 funds will support the second year of competitively-selected multi-year awards to organizations providing solar tools and regional outreach services to key state decision-makers such as State energy office staff, public utility commissioners, and State legislators.

Large Scale Solar Implementation and Environmental Impact: This activity seeks to increase CSP and utility-scale PV market penetration by: providing State and regional organizations with information on the impact of State incentives on the cost of solar power, solar resource assessment and transmission issues, and the job impacts of PV/CSP projects; supporting the Western Governors' Association's Clean and Diversified Energy Initiative and Renewable Energy Zone project; and engaging in regional planning processes.

In addition, DOE is working with BLM on an initial Solar Programmatic Environmental Impact Statement (PEIS). After receiving over 200 applications for utility-scale solar projects, BLM requested assistance from DOE to accelerate the deployment of these large (>100 MW) projects. In FY 2008, the PEIS was initiated in partnership with BLM which led in FY 2009 to the identification of 24 solar study zones comprising 676,000 acres. After a public comment period, these zones may be revised or new zones added in FY 2010. Each of the solar zones has the characteristics required for CSP projects (intense sunlight, flat land, and minimal environmental impact). Public comments resulting from the PEIS have increased the environmental sensitivity of the Solar Program and led to new research activities exploring methods of reducing water consumption and mitigating impact on animal habitat.

Utility & Consumer Outreach

This activity features technical outreach and communications activities to engage utility executives and other key utility staff in the wide scale adoption of solar technologies. 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. FY 2011 funds will support the second year of competitively-selected multi-year awards to organizations providing solar tools and outreach services to investor-owned utilities, municipal utilities, and cooperatives.

Solar America Showcases: This 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.

Government Solar Installation Program (GSIP): In response to EPAct Section 931, this activity promotes third-party financing to capitalize large installations on Federal sites. The Program will work with EERE's 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 Research: The Solar Regional Analysis Network (SRAN) is a new market transformation activity launched in FY 2010 and continued in FY 2011. SRAN 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 share results with key stakeholders. This regional approach will complement the Solar Program's traditional top-down, Federal approach to advancing the U.S. solar marketplace. SRAN 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, SRAN will further solar professional development by attracting and educating a new generation of 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. In FY 2011, DOE anticipates providing a second year of funding to four SRAN universities selected in FY 2010, with the potential to add more in later fiscal years.

Total, Market Transformation	**0**	**23,540**	**21,500**

Explanation of Funding Changes

	FY 2011 vs. FY 2010 ($000)
Market Transformation	
This reduction is due to the transfer of codes and standards activities to the Systems Integration subprogram. This transfer will better align the activity with high penetration PV modeling, standards development, and grid impact analysis	- 2,040
Total Funding Change, Market Transformation	**- 2,040**

Fuels from Sunlight Hub
Funding Schedule by Activity

	(dollars in thousands)		
	FY 2009	FY 2010	FY 2011
Fuels from Sunlight Hub	0	21,446	0
SBIR/STTR	0	554	0
Total, Fuels from Sunlight Hub	0	22,000[a]	0

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 addressing climate change and 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.

This Hub is managed by the Office of Science, with technical collaboration and support from the Solar Program. Initial funding for this Hub was provided within the FY 2010 EERE appropriation. Funding for this Hub is requested by the Office of Science in FY 2011.

Benefits

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 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.

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

Detailed Justification

(dollars in thousands)

	FY 2009	FY 2010	FY 2011
Fuels from Sunlight Hub	**0**	**21,446**	**0**

No funding is being requested for the Hub in FY 2011 within the Solar Program as funds are requested by DOE's Office of Science.

	FY 2009	FY 2010	FY 2011
SBIR/STTR	**0**	**554**	**0**

The FY 2010 amount shown was the estimated requirement for the continuation of the SBIR and STTR program as requested in the FY 2010 budget. No funding is requested in FY 2011, therefore no funding will be transferred.

	FY 2009	FY 2010	FY 2011
Total, Fuels from Sunlight Hub	**0**	**22,000**	**0**

Explanation of Funding Changes

	FY 2011 vs. FY 2010 ($000)
Fuels from Sunlight Hub	
No funding is requested within EERE for this Hub for FY 2011.	- 22,000
Total Funding Change, Fuels from Sunlight Hub	**- 22,000**

Wind Energy
Funding Profile by Subprogram

(dollars in thousands)

	FY 2009 Current Appropriation[a]	FY 2009 Current Recovery Act Appropriation	FY 2010 Current Appropriation	FY 2011 Request
Wind Energy				
Technology Viability	31,370	83,332	47,090	90,325
Technology Application	23,000	23,600	32,910	32,175
Total, Wind Energy	54,370	106,932	80,000	122,500

Public Law Authorizations:

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

Mission

The mission of the Wind Energy Program is to 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.[b] Since 2000, domestic wind energy generating capacity has significantly expanded, increasing from about 2.5 GW of installed capacity to over 25 GW by the end of 2008, demonstrating its promise as an affordable energy supply option.[c] In 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.[d] 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 such as grid integration, equipment reliability and costs, government policies, public acceptance, minimizing environmental impact and siting, and establishing a

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[a] SBIR/STTR funding transferred in FY 2009 was $582,000 for the SBIR program and $70,000 for the STTR program.

[b] World Wind Energy Report 2008, World Wind Energy Association, February 2009. http://www.wwindea.org/home/images/stories/worldwindenergyreport2008_s.pdf

[c] 2008 Wind Technologies Market Report, DOE/GO-102009-2868, July 2009. http://www1.eere.energy.gov/windandhydro/pdfs/46026.pdf

[d] 20% Wind Energy by 2030: Increasing Wind Energy's Contribution to U.S. Electricity Supply, DOE/GO-102008-2567, May 2008. http://www1.eere.energy.gov/windandhydro/wind_2030.html

qualified workforce. The expansion of domestic wind energy generation 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. In addition, expanding the affordability of 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 large scale 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 2011 Budget investments complement funds provided by the Recovery Act that expand wind energy R&D efforts through targeted activities that include R&D industry partnerships, a large wind turbine blade test facility, an upgraded 2.5 MW drive train test stand at the National Wind Technology Center, a new large dynamometer test facility (5 MW-15 MW), and a university R&D consortium. FY 2011 activities will build upon historic clean energy investments in the Recovery Act to further the Nation's energy goals through sustained technology innovation and continued investments in enabling infrastructure. This integrated targeted performance builds on both Recovery and RD&D will enable the realization of administration's goals and commitments to energy, the economy and climate. 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 can approach 500 million metric tons ($MMTCO_2$) by 2030.[a]

Energy Security

As a domestic energy source, wind requires no imported fuel. DOE estimates show that the program's activities could reduce natural gas imports by a cumulative 2.5 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 Impacts

The U.S. is a prime location for developing wind resources, providing local businesses with 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, as wind plant development creates jobs during both the construction phase and operations/maintenance phase of the plant. Tax revenues from wind plants can be a major revenue source for funding local and state government services.

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[a] Primary Metrics for FY 2011 Budget Request, see included table

The tables below show the estimated benefits from 2015 through 2050 that would result from realization of the program's goals.[a] EERE estimates of economic impact show cumulative consumer savings in 2030 could approach $60 billion, and additional industry savings near $30 billion.[b] These benefits are achieved by targeted Federal investments in technology R&D 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 benefits are generated by modeling both the program goal and baseline cases[c] within two energy-economy models: NEMS-GPRA11 for benefits through 2030, and MARKAL-GPRA11 for benefits through 2050. The following tables display the full list of modeled benefits.

The tables also reflect 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 is 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.

Additionally, the "20% Wind Energy by 2030" report published in May 2008 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

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[a] Additional information about EERE's impact analysis methodology and assumptions, as well as the final FY 2011 budget impact estimates, can be found at http://www1.eere.energy.gov/ba/pba/program_benefits.html

[b] Primary Metrics for FY 2011 Budget Request, see included table

[c] Baseline cases utilize data from the updated *Annual Energy Outlook 2009* Reference Case Service Report, April 2009

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 May 2008 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 scenario also identified an eight 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.[a]

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[a] Additional information on EERE's impact analysis methodology and assumptions, as well as the final FY 2011 budget impact estimates, can be found at http://www1.eere.energy.gov/ba/pba/program_benefits.html

FY 2011 Primary Metrics

	Metric	Model	Year			
			2015	2020	2030	2050
Energy Security	Oil Imports Reduction, cumulative (Bil bbl)	NEMS	ns	ns	ns	N/A
		MARKAL	ns	ns	ns	ns
	Natural Gas Imports Reduction, cumulative (Tcf)	NEMS	0.1	0.5	1.0	N/A
		MARKAL	ns	0.5	2.6	8.3
Environmental Impacts	CO_2 Emissions Reduction, cumulative (Mil mtCO_2)	NEMS	101	241	476	N/A
		MARKAL	25	47	134	3208
	SO_2 Allowance Price Reduction ($/ton)	NEMS	ns	ns	ns	N/A
		MARKAL	N/A	N/A	N/A	N/A
	NO_x Allowance Price Reduction ($/ton)	NEMS	ns	ns	ns	N/A
		MARKAL	N/A	N/A	N/A	N/A
Economic Impacts	Primary Energy Savings, cumulative (quads)	NEMS	0.7	1.7	2.9	N/A
		MARKAL	ns	ns	ns	11
	Oil Savings, cumulative (Bil bbl)	NEMS	ns	ns	ns	N/A
		MARKAL	ns	ns	ns	0.01
	Consumer Savings, cumulative (Bil $)	NEMS	14	31	58	N/A
		MARKAL	ns	ns	14	55
	Electric Power Industry Savings, cumulative (Bil $)	NEMS	ns	ns	ns	N/A
		MARKAL	9.2	15.5	31.3	0.69
	Household Energy Expenditures Reduction ($/household/yr)	NEMS	ns	ns	ns	N/A
		MARKAL	ns	ns	ns	ns
	Jobs, cumulative (net added jobs)	NEMS	NA	NA	NA	NA
		MARKAL	NA	NA	NA	NA

- "Reductions" and "savings" are calculated as the difference between results from the baseline case (i.e. no future DOE funding for this technology) and the program case (i.e. requested DOE funding for this technology is received and is successful).
- Oil impacts are shown as two metrics. "Oil Imports Reduction" refers only to reductions in oil imports; "Oil Savings" refers to savings (reduction) in total oil consumption.
- All cumulative metrics are based on results beginning in 2011.
- All monetary metrics are in 2007$.
- Cumulative monetary metrics are in 2007$ that are discounted to 2011 using a 3% discount rate.

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

FY 2011 Secondary Metrics

	Metric	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	ns	N/A
		MARKAL	ns	0.19	0.23	0.31
	MPG Improvement (%)	NEMS	ns	ns	ns	N/A
		MARKAL	ns	ns	ns	ns
Environmental Impacts	CO2 Emissions Reduction, annual (Mil mtCO2/yr)	NEMS	37	20	36	N/A
		MARKAL	8.8	0.27	34	251
	CO2 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	0.01	0.01	N/A
		MARKAL	ns	ns	ns	0.04
	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	Primary Energy Savings, annual (quads/yr)	NEMS	ns	ns	ns	N/A
		MARKAL	ns	ns	ns	1.3
	Oil Savings, annual (Mbpd)	NEMS	ns	ns	ns	N/A
		MARKAL	ns	ns	ns	ns
	Consumer Savings, annual (Bil $)	NEMS	2.1	4.7	3.5	N/A
		MARKAL	ns	ns	15	5.2
	Electric Power Industry Savings, annual (Bil $)	NEMS	ns	ns	2.79	N/A
		MARKAL	ns	ns	ns	ns
	Energy Intensity of US Economy (energy/$GDP)	NEMS	ns	ns	ns	N/A
		MARKAL	ns	ns	ns	0.05
	Net Energy System Cost Reduction, cumulative (Bil $)	NEMS	N/A	N/A	N/A	N/A
		MARKAL	6.3	16	34	84
	Jobs, annual (net added jobs/yr)	NEMS	NA	NA	NA	NA
		MARKAL	NA	NA	NA	NA

- "Reductions" and "savings" are calculated as the difference between results from the baseline case (i.e. no future DOE funding for this technology) and the program case (i.e. requested DOE funding for this technology is received
- Oil impacts are shown as two metrics. "Oil Imports Reduction" refers only to reductions in oil imports; "Oil Savings" refers to savings (reduction) in total oil consumption.
- All cumulative metrics are based on results beginning in 2011.
- All monetary metrics are in 2007$.
- Cumulative monetary metrics are in 2007$ that are discounted to 2011 using a 3% discount rate.

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

Contribution to the Secretary's Goals and GPRA Unit Program Goals

The Wind Energy Program contributes the Secretary's goals as shown below.

Innovation: Lead the world in science, technology, and engineering

The Wind Energy Program addresses basic and applied science through partnerships with 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 program supports active collaboration across government, industry, and international organizations. Industry collaboratives address important industry needs such as reliability and wind turbine gearbox failure analysis. Environmental and transmission cooperation is supported through the National Wind Coordinating Collaborative. Wind energy expertise is provided to regulatory agencies such as the Department of the Interior, Federal Aviation Administration (FAA), and Federal Energy Regulatory Commission (FERC). The Wind Energy Program is highly engaged in international technical and policy collaboration through the International Energy Agency (IEA).

Energy: Build a competitive, low-carbon economy and secure America's energy future

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. Technology acceptance activities address environmental and siting barriers to large scale wind energy deployment and work to develop wind energy markets in high wind resource areas.

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.

Concerns about climate change have spurred many industries, policy makers, environmentalists, and utilities to call for reductions in GHG emissions. Although the cost of reducing emissions is uncertain, the most affordable near-term strategy likely involves wider deployment of currently available energy efficiency and clean energy technologies. Wind power is one of the potential supply-side solutions to the climate change problem. Under the 20 percent wind scenario, a cumulative total of 7,600 $MMTCO_2$ would be avoided by 2030, and more than 15,000 $MMTCO_2$ would be avoided through 2050.

Contribution to GPRA Unit Program Goal 04 (Wind Energy)

The Wind Energy Program's key contribution to Clean Secure Energy 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 (LWST) (Utility-Scale)[a]
  - By 2020, reduce the unsubsidized cost of energy from land based wind energy systems operating in Class 4 wind regimes by 1.6 cents/kWh from a 2009 baseline of 8.0 cents/kWh; and
  - By 2020, reduce the unsubsidized cost of Energy from shallow water offshore wind energy systems operating in Class 6 wind regimes by 3.0 cents/kWh from a 2009 baseline of 16.0 cents/kWh.
- 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).
- Technology Application:
  - By 2012, complete program activities addressing electric power market rules, interconnection impacts, operating strategies, and system planning needed for wind energy to compete without disadvantage to serve the Nation's energy needs; 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.

Performance metrics and baselines for the LWST activities were updated in 2009 to reflect recent market and technology developments. The Wind Energy Program is in the process of reevaluating performance metrics and baselines for the other key activities and anticipates that these efforts will be complete in FY 2011.

Annual Performance Results and Targets

Current FY 2011 and out-year targets include Cost of Energy (COE) reduction targets for land-based and shallow water offshore utility wind energy and deployment targets for utility, as well as distributed wind energy. COE reductions are vital for wind energy to compete economically against conventional sources of electrical generation. New aggressive offshore COE reduction targets are a reflection of an increased funding commitment for offshore R&D. The utility scale deployment targets have transitioned from the number of States with at least 100 MW installed to the number of States with at least 1,000 MW installed. The increased capacity associated with these goals is a result of rapid deployment in many states in the last several years.

Both COE performance measures and deployment performance measures align with the Secretary’s Goals and the Wind Program’s mission. As stated by the Wind Program mission, increasing the development and deployment of reliable, affordable, and environmentally sustainable wind and water power technologies to realize the benefits of domestic renewable energy production will be facilitated. COE goals align with the Secretary’s Goals to lead the world in science, technology, and engineering and build a competitive, low-carbon economy and secure America’s energy future by narrowing federal wind energy R&D efforts to focusing on the leading edge R&D required to significantly lower the cost of the technology. These efforts will thereby increase wind energy’s viability within the framework of a low carbon economy. Deployment goals also align with the Secretary’s goals by focusing the market,

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[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). COE 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.

integration, and public outreach activities necessary to increase the use of low carbon wind energy technologies.

For FY 2011, COE performance targets are updated to reflect unsubsidized wind energy costs. In addition, the new performance targets assume a more realistic 20 year project life, rather than the 30 year project life used in prior years. The FY 2011 performance targets are also updated with new baseline costs. The FY 2011 COE targets are formatted as a cost reduction target to support an improved methodology, enabling the Wind Energy Program to better attribute reductions in the modeled cost of wind energy to R&D activities. This also allows the program to better ascertain the impact of its efforts compared to variation caused by commodity price fluctuations.

Recent increases in commodity prices (including steel and copper), changes in exchange rates of foreign currencies, and turbine supply and demand imbalances have significantly increased the installed capital cost of domestic and offshore wind energy projects. These externalities greatly contributed to changes in the Program’s metrics, including new baselines and updated COE performance targets for FY 2011. The baselines presented for the FY 2011 performance targets will continue to be reviewed and validated. Limited data is currently available to verify the preliminary offshore COE baseline and annual COE targets, which may continue to be updated in the future as more extensive data becomes available. Ongoing analysis by NREL suggests that offshore wind COE in the U.S. may be significantly higher than the COE projected in the FY 2006 through FY 2010 COE performance targets. NREL is currently developing updated COE baselines, which will be used to improve the COE targets for FY 2012. In addition to updated COE targets, the program is improving the current methodology for modeling annual COE reductions attributable to its R&D portfolio. The existing methodology [the Annual Turbine Technology Update (ATTU)] will be improved with new methods which are more capable of normalizing the annual modeled COE to better understand impacts of market variations.

Annual Performance Targets and Results

Secretarial Goal: Goal 1: Innovation: Lead the world in science, technology, and engineering
Goal 2: Energy: Build a competitive, low-carbon economy and secure America's energy future
GPRA Unit Program Goal: 04 Wind Energy
Subprogram: Technology Viability

FY 2006	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
Performance Measure: Reduce the modeled land-based wind cost of energy, in cents per kWh, in Class 4 wind speed areas (7.25 m/s mean wind speed at 50m above ground) from a 2009 baseline of 8.0 cents/kWh.[a] (cents per kWh)									
T: NA A: NA	T: NA A: NA	T: NA A: NA	T: NA A: NA	T: NA A: NA	T: 0.10 A:	T: 0.20 A:	T: 0.40 A:	T: 0.70 A:	T: 0.90 A:
Performance Measure: Reduce the modeled shallow water cost of energy, in cents per kWh, in Class 6 wind speed areas (9.25 m/s mean wind speed at 50m above ground) from a 2009 baseline of 16.0 cents/kWh. (cents per kWh)									
T: NA A: NA	T: NA A: NA	T: NA A: NA	T: NA A: NA	T: NA A: NA	T: 0.10 A:	T: 0.20 A:	T: 0.4 A:	T: 0.8 A:	T: 1.3 A:
Performance Measure: 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). (cents per kWh)									
T: 4.2 A: 3.9	T: 4.1 A: 3.8	T: 4.0 A: 4.05	T: 3.9 A: 4.02	T: 3.8 A:	T: RETIRED A: NA	T: NA A: NA	T: NA A: NA	T: NA A: NA	T: NA A: NA
Performance Measure: 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. (cents per kWh)									
T: 9.3 A: 9.3	T: 9.25 A: 9.25	T: 9.2 A: 9.2	T: 9.15 A: NA[b]	T: 9.1 A:	T: RETIRED A: NA	T: NA A: NA	T: NA A: NA	T: NA A: NA	T: NA A: NA

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[a] Cumulative modeled cost reduction, in cents/kWh, of wind power due to Wind Energy Program R&D activities. Baseline costs are unsubsidized, preliminary and subject to change for FY 2011, pending the results of a validated assessment of current land and offshore costs of energy already in process at NREL as of January 2010. Accurate baseline costs ensure that the program is able to provide realistic benefits analyses to DOE management, as well as reliable inputs to internal program planning.

[b] The 2009 modeled COE was not calculated due to the large divergence in market conditions and deterioration of assumptions in the original model. The model has been updated for FY 2011.

<table>
<tr><td colspan="10">Annual Performance Targets and Results

Secretarial Goal: Goal 1: Innovation: Lead the world in science, technology, and engineering
Goal 2: Energy: Build a competitive, low-carbon economy and secure America’s energy future
GPRA Unit Program Goal: 04 Wind Energy
Subprogram: Technology Viability</td></tr>
<tr><th>FY 2006</th><th>FY 2007</th><th>FY 2008</th><th>FY 2009</th><th>FY 2010</th><th>FY 2011</th><th>FY 2012</th><th>FY 2013</th><th>FY 2014</th><th>FY 2015</th></tr>
<tr><td colspan="10">Performance Measure: Units of new distributed wind turbines deployed in the market annually. (units of new distributed wind turbines)</td></tr>
<tr><td>T: NA
A: NA</td><td>T: NA
A: NA</td><td>T: 500
A: 763</td><td>T: 600
A: 4321</td><td>T: 800
A:</td><td>T: 1,,000
A:</td><td>T: 1200
A:</td><td>T: 1,400
A:</td><td>T: 1,700
A:</td><td>T: 2,200
A:</td></tr>
<tr><td colspan="10">Performance Measure: Prior year performance targets were replaced by deployment targets to support a programmatic shift to testing and certification activities as distributed wind technology systems increased market penetration. As a consequence, a cost of energy target is no longer representative of the Wind Program's activities. Progress made by these activities is now represented by deployment goals.

FY 2006: COE Target: 11-16 cents per kWh in Class 3 winds.

FY 2007: COE Target: 10-15 cents per kWh in Class 3 winds.</td></tr>
<tr><td>T: 11-16
A: MET</td><td>T: 10-15
A: MET</td><td>T: RETIRED
A: NA</td><td>T: NA
A: NA</td><td>T: NA
A: NA</td><td>T: NA
A: NA</td><td>T: NA
A: NA</td><td>T: NA
A: NA</td><td>T: NA
A: NA</td><td>T: NA
A: NA</td></tr>
</table>

Annual Performance Targets and Results

Secretarial Goal:
Goal 1: Innovation: Lead the world in science, technology, and engineering
Goal 2: Energy: Build a competitive, low-carbon economy and secure America’s energy future
GPRA Unit Program Goal: 04 Wind Energy
Subprogram: Technology Application

FY 2006	**FY 2007**	**FY 2008**	**FY 2009**	**FY 2010**	**FY 2011**	**FY 2012**	**FY 2013**	**FY 2014**	**FY 2015**
Performance Measure: Number of States with at least 1000 MW of wind energy installed. (number of states)									
T: NA A: NA	T: NA A: NA	T: NA A: NA	T: 4 A: MET	T: 10 A:	T: 11 A:	T: 12 A:	T: 13 A:	T: 14 A:	T: 15 A:
Performance Measure: Number of States with at least 100 MW of wind energy installed. (number of states)									
T: 19 A: UNMET	T: 20 A: MET	T: 22 A: MET	T: 27 A: MET	T: 30 A:	T: 30 A:	T: RETIRED A: NA	T: NA A: NA	T: NA A: NA	T: NA A: NA

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.

The Wind Energy Program will be implemented through the following means:

- Utility scale, land based wind systems technology R&D will be conducted through cost shared public-private partnerships and Cooperative Research and Development Agreements (CRADAs). Partnerships and 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 effective and efficient generators. Laboratory-based supporting research and testing 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 assessed a favorable market for a U.S. offshore wind industry during a program review in FY 2009.
- The Wind Energy Program will invest in offshore wind turbine technology R&D to promote and accelerate responsible U.S. commercial offshore wind project development. Investments will address common barriers and risks to offshore projects: financial, regulatory, technical, environmental, and social, and support an offshore wind energy demonstration project. The program will support specific analytical studies, outreach programs and R&D initiatives addressing barriers and risks of these offshore developments for the benefit of all stakeholders.
- The Wind Energy Program has been conducting independent testing and certification of distributed wind turbine technology since FY 2008. This activity will continue to help the small wind industry build credibility, increase consumer confidence in small wind turbines, and stabilize the market. For more than a decade, the program has partnered 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 2011 and beyond.

- The Wind Energy Program will expand its efforts in all areas to address the technical barriers to integrating increasing amounts of wind energy into our Nation's generation mix. The program will expand and refine data sets of wind resource potential throughout the country, as well as addressing challenges of 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, and 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.
- Manufacturing and supply chain development activities will focus on component and manufacturing process R&D, quality assurance and ensuring adequate supplies of raw materials, as well as strategic planning, technical assistance and support materials for new industry entrants. The Program will establish a public/private collaborative effort through a broad engagement of the industry and other stakeholders. Identifying factors needed for highly competitive industry growth will guide the activity, capitalizing on regional advantages and production synergies for select components while facilitating manufacturing production across the U.S.
- Dedicated outreach efforts will improve the technology acceptance of wind energy. 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. This effort will continue to expand regional relationships in FY 2011, 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 geopolitical boundaries. Open and clear dialogue with appropriate stakeholders is necessary for making informed and long-lasting energy and environmental decisions.

The Wind Energy Program will implement the following strategies:

- The state of progress in advanced wind energy technology R&D 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 wind turbine performance and reliability. Cooperative R&D is performed with the IEA, academia, and the National Laboratories.
- For offshore wind rules and regulations, the program provides technical expertise to the Department of the Interior's Minerals Management Service (DOI MMS) with regard to developing codes and standards for the permitting of offshore wind turbine structures.
- The program will provide leadership to the wind industry through stakeholder outreach and environmental and siting R&D to reduce the barriers to large-scale wind energy deployment. To reduce barriers to wind energy deployment the program works with state energy offices, research institutions, and experts in the field to develop resources necessary for market adoption. To address radar and other military issues affected by wind turbines, the program works closely with the Federal

Aviation Administration (FAA) and the Department of Defense. Environmental siting issues are worked with wind energy stakeholder groups and industry representatives.

- For transmission and integration of wind into the electrical grid, the program will work with DOE's Office of Electricity Delivery and Energy Reliability and transmission/distribution industry groups.

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

- 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;
- Availability of wind and power data from wind energy installations; and
- Delays in development of national transmission infrastructure.

In carrying out the program's mission, the Wind Energy Program collaborates in several important activities, including:

- Program activities are often dependent upon outputs from academia, manufacturers, developers, and National Laboratories;
- Research plans and priorities, as set forth in the "20% Wind Energy by 2030" report are prepared by DOE with input from National Laboratories, the American Wind Energy Association (AWEA), and other wind industry stakeholders;
- 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 Office of Electricity Delivery and Energy Reliability 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 DOI MMS;
- Industry and R&D directions for the production of hydrogen for energy use, and for other non-energy uses;
- Cooperative R&D 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 “2008 Wind Technologies Market Report,” July 2009. (http://www1.eere.energy.gov/windandhydro/pdfs/46026.pdf)
- DOE Report “20% Wind Energy by 2030,” May 2008. (http://www.windpoweringamerica.gov/pdfs/20_percent_wind_2.pdf)
- “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: http://www.nmsu.edu/~tdi/Wind/39851.pdf
- “Low Wind Speed Technologies Annual Turbine Technology Update (ATTU): Process for Land-Based Utility-based Technology,” NREL Report #TP-50037505, June 2005.
- FY 2008 Wind Energy Program Peer Review.
- American Wind Energy Association (AWEA)/Global Energy Concepts Wind Plant Database, reviewed by EIA, contain proprietary data.
- AWEA Small Wind Turbine Industry Roadmap: http://www.awea.org/smallwind/documents/31958.pdf

Baselines: Low Wind Speed Technology: $0.08 $2000/kWh in FY 2009 for land-based applications in Class 4 winds; $0.16 $2009/kWh in FY 2009 for shallow water offshore applications in Class 6 winds.

Distributed Wind Technology: 2,400 turbines deployed in distributed wind applications in 2007.

Technology Application: Eight states in 2002 with at least 100 MW wind installed, and six states in FY 2008 with at least 1,000 MW installed.

Frequency: Annual.

Evaluation: In carrying out the program’s mission, the 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;
- Specialized program evaluation studies to examine progress and process impacts;
- Continue to conduct the transparent oversight and performance management initiated by Congress and the Administration;
- Quarterly and annual assessment of program and management results based performance through the Performance Measurement Manager (PMM, the DOE

quarterly performance progress review); and

- Annual review of methods, and re-computation of potential benefits for GPRA.

Data Storage: Web, paper publications and online storage.

Technology Viability
Funding Schedule by Activity

(dollars in thousands)

	FY 2009	FY 2010	FY 2011
Technology Viability			
Low Wind Speed Technology (LWST – Utility-Scale Large Systems)	4,522	15,907	12,040
Distributed Wind Technology (DWT - Small Systems)	3,495	5,907	5,332
Supporting Research and Testing (SR&T)	23,353	24,353	22,141
Offshore Wind Technology	0	0	49,020
SBIR/STTR	0[a]	923	1,792
Total, Technology Viability	31,370	47,090	90,325

Description

Technology Viability activities advance wind turbine components and systems through targeted public/private R&D partnerships and CRADAs. These activities are supported by research and testing that brings specialized technical expertise, comprehensive design and analysis tools, and unique testing facilities to address market barriers to wind technology.

Technology Viability activities focus on R&D 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. Emphasis is placed on Low Wind Speed Technology (LWST) because the resource potential and transmission system availability for areas that have relatively low wind are significantly higher than those with high wind. The focus of Distributed Wind Technology (DWT) is to expand the market for distributed wind technologies five-fold from 2007, the baseline year.

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 aims to reduce risks that undermine the growth potential of wind energy in the U.S. by improving cost, performance, and reliability of wind technology. The LWST activity focuses on 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 and reliability of utility-scale and distributed wind systems.

Through independent testing, the DWT activity helps the small wind industry establish credibility. The program's support for a certification body will help consumers discern the quality of small turbine

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[a] SBIR/STTR funding transferred in FY 2009 was $582,000 for the SBIR program, and $70,000 for the STTR program.

products. 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.

In FY 2011, progress towards reducing modeled cost of energy for land based and offshore systems will help to accelerate market penetration of wind technology. The goal for reduction in costs for land based systems for FY 2011 is 0.10 cents per kWh from a 2009 baseline of 8.0 cents per kWh, and the goal for reduction in costs for offshore systems for FY 2011 is 0.20 cents per kWh from a 2009 baseline of 16.0 cents per kWh. This will allow the Wind Energy Program to make progress toward the overall goal of 1.6 cents per kWh reduction in modeled cost of energy from land based systems and 3.0 cents per kWh for offshore systems by 2020. FY 2011 activities in DWT will result in the deployment of 1,000 new systems that will enable industry expansion and the overall goal of 12,000 units by 2015.

Detailed Justification

(dollars in thousands)

	FY 2009	FY 2010	FY 2011
Low Wind Speed Technology (LWST – Utility-Scale Large Systems)	**4,522**	**15,907**	**12,040**

The LWST activity primarily addresses barriers identified in the program technology roadmap through public/private partnerships, CRADAs, and subcontracts. LWST targets specific components of a wind turbine, including the rotor, drivetrain, tower and foundation. Public/private partnerships and CRADAs support the adoption of technology developments and emerging innovation. They are accomplished in collaboration with DOE's National Laboratories and concentrate on three technical areas: 1) conceptual design studies; 2) component development and testing; and 3) full turbine prototype development and testing.

The Recovery Act enabled a substantial improvement of domestic LWST activity in FY 2009 and FY 2010 by funding a large blade testing facility. The blade testing facility will support R&D activities which identify design and manufacturing flaws prior to commercial deployment, resulting in improved product reliability and complementing FY 2011 LWST activities.

In 2011, the program will continue to lower the cost of energy for wind turbine systems through existing and new LWST partnerships and CRADAs. Following up on last year's successful initiation of the Gearbox Reliability Collaborative (GRC) to address gearbox design and reliability issues, laboratory and field testing activities will continue. In addition to the GRC, a Blade Reliability Collaborative began in FY 2010. This effort is expected to require a significant investment in materials research, inspection methods, and blade testing. In FY 2011, these collaborative efforts, along with the Turbine Operation and Maintenance Reliability Database activity, are key to the program's goal of addressing turbine reliability and performance issues.

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[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 2009	FY 2010	FY 2011
Distributed Wind Technology (DWT - Small Systems)	**3,495**	**5,907**	**5,332**

DWT will continue to 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 in developing regional testing capabilities across the U.S.

Supporting research and testing is an integral part of the DWT effort which 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 2011 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; and 3) collaboration with turbine manufacturers to develop a mid-size turbine prototype or value engineered unit.

Supporting Research and Testing (SR&T)	**23,353**	**24,353**	**22,141**

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

Through the National Laboratories, specialized technical expertise, comprehensive design and analysis tools, and the unique testing facilities are utilized to solve 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. In support of LWST activities in many areas including the following:

- 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. 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 complete 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. Site specific design covers the development of systematic methods for specifying site energy, load conditions, and turbine inflow characterization.
- Drivetrain and Power Electronics – The generator, gearbox, and power converter represent roughly 25 percent of the installed capital cost of a modern wind turbine. Research and testing in

these areas will contribute to improvements in converter, advanced gearbox and generator designs.

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. 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.

The Recovery Act enabled a substantial expansion of domestic SR&T capabilities in FY 2009 and FY 2010 by providing funding for upgraded dynamometer test facilities. The dynamometer testing facilities will improve reliability by investigating gearbox failures, validating gearbox design codes and developing permanent-magnet generator designs, enabling enhanced FY 2011 SR&T activities.

In FY 2011 the program will perform detailed testing and analysis of drive train and blade performance and reliability using NWTC testing facilities. A more detailed R&D plan for the DOE 1.5 MW wind turbine will be developed and the initial phase of performance testing will begin in 2010. NREL will continue to support the commissioning of the Massachusetts Large Blade Test Facility. R&D activities for investigating impact of large wind turbines on radar systems will continue.

Offshore Wind Technology	**0**	**0**	**49,020**

The offshore wind technology activity will address the barriers to deployment and long term success of major offshore wind energy plants. Accelerated development of operational offshore wind turbine projects will resolve technical and environmental challenges and help to accelerate progress toward 20 percent wind energy by 2030.

In FY 2009 and FY 2010, the program applied resources to offshore wind technology research to analyze the potential of offshore wind energy development. These offshore activities were included under LWST, amounting to nearly $5 million. New 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 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 better characterize the technical, market and governmental constraints to offshore wind technology deployment.

In FY 2011 DOE will invest in specific activities that promote and accelerate responsible U.S. commercial offshore wind project development. Investments will address common barriers and risks to offshore projects: financial, regulatory, technical, environmental, and social. As a cornerstone of this effort, an offshore demonstration project will be selected for implementation support via competitive solicitation. DOE funds will be applied to up to 20 percent of the cost of developing the project infrastructure.. Concurrent with this targeted offshore infrastructure development, the program will support specific analytical studies, collaborative efforts and R&D initiatives addressing barriers and risks of these offshore developments for the benefit of all stakeholders. Specific activities include: assessment of offshore wind resources, ocean monitoring, and environmental impacts; R&D related to cost-effective offshore foundations, enhanced turbine reliability, domestically manufactured components and specialized installation vessels; and design and planning of electrical cabling and utility interconnection. The program will also position DOE in a pivotal role by engaging all stakeholders through interagency, Federal/state, and public/private collaboration to address common issues including marine and spatial planning, siting, and environmental impact mitigation. Investment will facilitate acceleration of more than 3 GW of currently planned offshore projects in the U.S. Lessons learned and technical advances from the DOE offshore program will benefit all stakeholders and siting strategies for future projects in all coastal and Great Lakes regions of the U.S.

SBIR/STTR	**0**	**923**	**1,792**

In FY 2009, $630,000 was transferred to the SBIR and STTR programs. The FY 2010 and FY 2011 amounts shown are estimated requirements of the continuation of the SBIR and STTR program, and the increase is directly related to the increase in Technology Viability funding.

Total, Technology Viability	**31,370**	**47,090**	**90,325**

Explanation of Funding Changes

	FY 2011 vs. FY 2010 ($000)
Low Wind Speed Technology (LWST – Utility-Scale Large Systems)	
Reduction reflects the funding for offshore wind technology development that was supported under LWST in FY 2010. Offshore funds will be tracked separately beginning in FY 2011.	-3,867
Distributed Wind Technology (DWT – Small Systems)	
The small wind independent testing effort under DWT will be scaled back in order to focus on midsize turbine development beginning in FY 2011.	-575
Supporting Research and Testing (SR&T)	
Reduction reflects the funding for offshore wind supporting research and testing that was supported under SR&T in FY 2010. Offshore funds will be tracked separately in FY 2011.	-2,212
Offshore Wind Technology	
In FY 2011, DOE will invest in specific RD&D activities that promote and accelerate responsible U.S. commercial offshore wind project development. Investments will address common barriers and risks to offshore projects - financial, regulatory, technical, environmental, and social. Specific activities include: assessment of offshore wind resources and environmental impacts; R&D related to cost-effective offshore foundations, enhanced turbine reliability, domestically manufactured components and specialized installation vessels; and design and planning of electrical cabling and utility interconnection. The program will benefit the Nation by engaging all offshore energy stakeholders through interagency, Federal/State, and public/private collaboration to support DOE goals of clean, affordable, reliable domestic energy supply.	+49,020
SBIR/STTR	
Changes in the SBIR/STTR funding are a direct result of changes in the funding of program activities.	+869
Total Funding Change, Technology Viability	**+43,235**

Technology Application
Funding Schedule by Activity

(dollars in thousands)

	FY 2009	FY 2010	FY 2011
Technology Application			
Systems Integration	16,000	19,714	21,016
Technology Acceptance	7,000	13,130	11,130
SBIR/STTR	0	66	29
Total, Technology Application	23,000	32,910	32,175

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 prepare and accelerate the market adoption of wind technologies.

Technology Application focuses on resolving institutional issues, providing state and regional energy sector outreach, advancing wind component manufacturing and supply-chain, and investigating and mitigating social, environmental and wildlife issues associated with wind energy development. Systems Integration focuses on anticipating and overcoming technical issues associated with interconnecting greater amounts of wind and other renewable energy to the electricity system. Systems Integration will also work to expand the manufacturing supply chain to support large-scale wind energy deployment. Technology Acceptance helps to mitigate environmental and siting barriers, develop an adequate workforce, and accelerate the development of wind energy markets. Technology Acceptance outreach activities help stakeholders and officials understand wind energy technologies and how wind can be integrated into their State energy systems.

The following table provides expected annual indicators of progress for Technology Application:

Fiscal Year

Technology Application - # of States with over 100 MW installed

	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Target	22	27	30	–	–	–	–	–	–	–	–
Actual	19	26	–	–	–	–	–	–	–	–	–

Technology Application - # of States with over 1,000 MW wind installed

	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Target		4	10	11	12	13	14	15	–	–	–
Actual		9	–	–	–	–	–	–	–	–	–

The number of states with over 100 or 1,000 MW installed is used as a way to measure the success of the Technology Application 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 amount of wind energy deployed (i.e., 100 MW or 1,000 MW) was determined to be the best indicator of deployment progress at the state level, as it shows that the regulatory, transmission planning, environmental, and siting permitting processes have advanced to a level where large wind projects can be developed and made operational.

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. Manufacturing and supply chain activities will focus on component and manufacturing process R&D, quality assurance and ensuring adequate supplies of raw materials, as well as strategic planning, technical assistance and support materials for new industry entrants. The principal groups of companies who stand to gain from these activities include turbine "original equipment manufacturers" (OEM's), major component manufacturers, and balance system suppliers. The outcome expected from these activities is the increase of the amount of domestic turbine production.

Dedicated outreach efforts will be completed by the Technology Acceptance activity. Laboratory and contract staff supply fact-based 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.

FY 2011 activities in Technology Application will result in six States with 1,000 MW installed capacity and contribute to the overall goal of 15 States with 1,000 MW installed capacity by 2018 indicating that these states have overcome the necessary barriers to large wind project deployment.

Detailed Justification

(dollars in thousands)

	FY 2009	FY 2010	FY 2011
Systems Integration	**16,000**	**19,714**	**21,016**

Systems Integration addresses technical barriers to interconnecting large amounts of wind energy into the Nation's bulk power system and supporting operational evaluations. In FY 2011 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 will continue on grid interconnection issues related to wind energy, with a specific emphasis on support for interconnection wide transmission planning efforts.

The program will accelerate wind resource characterization and measurement at modern wind turbine hub heights in areas around the country with high levels of wind potential, and will improve understanding and analysis of wind characteristics in areas where wind energy projects are established or are being planned. Efforts are underway to develop a multi-agency collaborative aimed in collectively evaluating and measuring National wind resource potential. The data collected through this activity will be used to improve wind modeling efforts and will be compiled in a comprehensive national database of wind energy resource, 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 further developed and validated in utility control room operations for effectiveness in mitigating wind energy integration 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, power marketing administrations, regulatory agencies, system operators, and system reliability organizations.

Wind energy technical interconnection support will be provided to assist implementation of interconnection-wide, and other transmission planning, to assist utility planning efforts centered on fostering transmission access for commercially viable large-scale wind energy development. Implementation action will also be coordinated with key electric power market development activities, including designation of regional renewable energy development zones.

In FY 2011, an expanded area of focus will include collaborating with industry and other partners to increase the domestic content of wind energy systems. This effort is critical to meeting wind energy goals while also contributing to overall economic growth and re-tooling the currently idled industrial capability. Furthermore, it is clear that expansion of the domestic supply chain and manufacturing capability must be accompanied by standardization and certification activities that ensure an increasing level of product quality, in order to alleviate reliability concerns that pose a major risk to rate of industry investment and growth. Coordination with the Department of Commerce to partner with state and regional organizations and industry will facilitate this expansion.

The effort will promote collaborative action among all key stakeholders and address issues ranging from: availability of basic materials; enlarging the supply chain of key specialized components used in turbine assembly; and availability of sufficient specialty products and sub-systems comprising the balance of the installed turbine system.

Wind turbine blade manufacturing relies heavily on manual processes, raising product cost and challenging quality assurance. The program’s continuing activities for blade manufacturing process improvement will focus on enabling industry to validate new manufacturing processes via demonstration using a common blade mold provided by the program. This industry collaboration will allow objective assessment of the viability of multiple approaches to advanced manufacturing processes

A concerted Government/industry initiative to address these pressing issues in a strategic, comprehensive and coordinated manner can mitigate the risks of the domestic industry not meeting key supply chain goals. Risks of an underperforming industry include:

- An inadequate supply to meet product demand within time limits acceptable to project investors;
- Continued dominance of foreign firms in supplying key product-differentiating components; and
- An inability of U.S. companies to comply with quality assurance and performance standards unique to the wind industry.

(dollars in thousands)

	FY 2009	FY 2010	FY 2011
Technology Acceptance	**7,000**	**13,130**	**11,130**

FY 2011 activities will 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 capacity in an environmentally sensitive manner.

Activities will also continue to emphasize efforts to assess and mitigate effects of wind turbines on Federal mission areas, such as military, aviation and weather radar, homeland security, and the environment. These efforts include: working with stakeholders to address the siting risks associated with wind technology and projects; promoting government consensus on regulatory or process requirements; developing tools for industry to assess and mitigate Federal mission area, wildlife, and other environmental risks from wind; and providing facts to the public on the risks and benefits associated with wind energy. Many of these efforts will be applicable to local and regional siting and permitting proceedings.

SBIR/STTR	**0**	**66**	**29**

The FY 2010 and FY 2011 amounts shown are estimated requirements of the continuation of the SBIR and STTR program, and the increase is directly related to the decrease in Technology Application funding

Total, Technology Application	**23,000**	**32,910**	**32,175**

Explanation of Funding Changes

	FY 2011 vs. FY 2010 ($000)
Systems Integration	
Additional funding will investigate the impact of reliably integrating higher levels of wind energy into the bulk power system. Analysis will include investigation of integration tools such as the use of demand response, as well as further explore sources of grid flexibility including the deployment of energy storage technologies.	+1,302
Technology Acceptance	
FY 2010 funding levels enabled the program to dedicate resources to support community and tribal wind. The results of FY 2010 activities will be assessed in FY 2011 to determine future opportunities.	-2,000
SBIR/STTR	
Changes in the SBIR/STTR funding are a direct result of changes in the funding of program activities.	-37
Total Funding Change, Technology Application	**-735**

Geothermal Technology

Funding Profile by Subprogram

(dollars in thousands)

	FY 2009 Current Appropriation[a]	FY 2009 Current Recovery Act Appropriation	FY 2010 Current Appropriation	FY 2011 Request
Geothermal Technology				
Enhanced Geothermal Systems	43,322	393,106	44,000	55,000
Total, Geothermal Technology	43,322	393,106	44,000	55,000

Public Law Authorizations:
P.L. 93-410, "Geothermal Energy Research, Development, and Demonstration Act of 1976"
P.L. 95-91, "Department of Energy Organization Act" (1977)
P.L. 95-618, "Energy Tax Act of 1978"
P.L. 96-294, "Energy Security Act" (1980)
P.L. 101-218, "Renewable Energy and Energy Efficiency Technology Competitiveness Act of 1989"
P.L. 101-575, "Solar, Wind, Waste, and Geothermal Power Production Incentives Act of 1990"
P.L. 102-486, "Energy Policy Act of 1992"
P.L. 109-58, "Energy Policy Act of 2005"
P.L. 110-140, "Energy Independence and Security Act of 2007"

Mission

The mission of the Geothermal Technology Program (GTP) is to conduct research, development, and demonstration to establish Enhanced Geothermal Systems as a major contributor for baseload electricity generation.

Benefits

Accomplishing the mission will benefit the clean supply side of DOE's energy security equation by accelerating the arrival and use of energy from geothermal sources. 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 (EGS) to contribute 100,000 MWe baseload generating capacity to the U.S. energy supply by 2050. The U.S. Geological Survey augmented the MIT analysis with a mean estimate of 517,000 MWe of electric power generation resource potential in the Western U.S. Ultimately, commercial EGS could provide significant amounts of clean baseload domestic power and contribute to the security and diversity of U.S. energy supplies.

Today, grid-connected high temperature hydrothermal systems are well established. In the midterm, next generation geothermal plants using EGS technology could come online, greatly expanding the utilization of U.S. geothermal resources. In the long term, EGS could be a major source of baseload electricity for large regions. When implemented, EGS will avoid greenhouse gas (GHG) emissions.

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[a] SBIR/STTR funding transferred in FY 2009 was $605,000 for SBIR program, and $73,000 for 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

Typical EGS power plants will use more advanced closed loop conversion systems that will not add CO_2, NO_x, or other GHGs to the atmosphere. 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 future as predicted by the MIT study.

In support of the Secretary's strategic priorities, geothermal technology increases energy options and reduces dependence on fossil fuels, thereby increasing the flexibility of the market to meet U.S. needs and reduce GHG emissions.

GTP pursues its mission primarily through the set of integrated activities that are designed to increase the use of domestic renewable electricity generation 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 through reduction in fossil fuel consumption.

Climate Change

Current geothermal power plants emit on average 16 times less CO_2 than the average U.S. coal power plant per kilowatt of electricity produced. CO_2 emission abatement is estimated to increase from less than one million metric tons CO_2 ($MMTCO_2$) in 2015 to nearly 600 $MMTCO_2$ in 2050.[a]

Economic Impact

Cumulative consumer savings are estimated to reach more than $25 billion by 2050.

The proposed FY 2011 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. Recovery Act funds will support three new field demonstrations and 45 new advanced technology R&D projects. These demonstrations and R&D projects will help drive economic recovery, job creation, and economic growth and will enhance the geothermal technology and business workforces. The Recovery Act projects will address barriers that will enable high impact innovation that will encourage an unprecedented scale of EGS development. FY 2011 activities will build upon historic clean energy investments in the Recovery Act to further the Nation's energy goals through sustained technology innovation and continued investments in enabling infrastructure. This integrated approach, building on the Recovery Act and continuing RD&D, will enable the realization of administration's goals and commitments to energy, the economy and climate. To enable decision makers and the public to follow performance and plans, the program posts its progress at: http://www.energy.gov/recovery/index.htm.

The benefits metrics tables below show the estimated benefits from 2015 through 2050 that would result from realization of GTP's goals. These benefits are achieved by targeted Federal investments in technology R&D 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 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 GTP'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

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[a] National Renewable Energy Laboratory analysis, Primary Metrics for FY 2011 in the following tables.

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 RD&D exists. The baseline case is intended to represent the future without the effect of GTP, 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 is 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 GTP'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 GTP.

The benefits are generated by modeling both the program goal and baseline cases[a] within two energy-economy models: NEMS-GPRA11 for benefits through 2030, and MARKAL-GPRA11 for benefits through 2050. The following tables display the full list of modeled benefits.

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[a] Baseline cases utilize data from the updated *Annual Energy Outlook 2009* Reference Case Service Report, April 2009

FY 2011 Primary Metrics

	Metric	Model	Year			
			2015	2020	2030	2050
Energy Security	Oil Imports Reduction, cumulative (Bil bbl)	NEMS	ns	ns	0.2	N/A
		MARKAL	0.0	0.0	0.0	0.0
	Natural Gas Imports Reduction, cumulative (Tcf)	NEMS	ns	ns	ns	N/A
		MARKAL	0.0	0.0	0.1	0.2
Environmental Impacts	CO_2 Emissions Reduction, cumulative (Mil mtCO_2)	NEMS	ns	ns	77	N/A
		MARKAL	0	0	77	587
	SO_2 Allowance Price Reduction ($/ton)	NEMS	ns	ns	ns	N/A
		MARKAL	N/A	N/A	N/A	N/A
	NO_x Allowance Price Reduction ($/ton)	NEMS	ns	ns	ns	N/A
		MARKAL	N/A	N/A	N/A	N/A
Economic Impacts	Primary Energy Savings, cumulative (quads)	NEMS	ns	ns	ns	N/A
		MARKAL	ns	ns	ns	ns
	Consumer Savings, cumulative (Bil $)	NEMS	ns	ns	9	N/A
		MARKAL	ns	ns	16	26
	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	ns	N/A
		MARKAL	ns	ns	ns	ns

- "Reductions" and "savings" are calculated as the difference between results from the baseline case (i.e. no future DOE funding for this technology) and the program case (i.e. requested DOE funding for this technology is received and is successful).
- All cumulative metrics are based on results beginning in 2011.
- All monetary metrics are in 2007$.
- Cumulative monetary metrics are in 2007$ that are discounted to 2011 using a 3% discount rate.

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

FY 2011 Secondary Metrics

	Metric	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	0.0	N/A
		MARKAL	ns	ns	ns	ns
	MPG Improvement (%)	NEMS	ns	ns	ns	N/A
		MARKAL	ns	ns	ns	0%
Environmental Impacts	CO2 Emissions Reduction, annual (Mil mtCO2/yr)	NEMS	ns	ns	19	N/A
		MARKAL	ns	ns	10.6	26.2
	CO2 Intensity Reduction of US Economy (Kg CO2/$GDP)	NEMS	ns	ns	ns	N/A
		MARKAL	ns	ns	ns	0.00
	CO_2 Intensity Reduction of US Power Sector (Kg CO2/kWh)	NEMS	ns	ns	ns	N/A
		MARKAL	ns	ns	ns	ns
	CO_2 Intensity Reduction of US Transportation Sector (Kg CO2/mile)	NEMS	ns	ns	ns	N/A
		MARKAL	ns	ns	ns	ns
Economic Impacts	Consumer Savings, annual (Bil $)	NEMS	ns	ns	3.2	N/A
		MARKAL	ns	ns	ns	ns
	Primary Energy Savings, annual (quads/yr)	NEMS	ns	ns	ns	N/A
		MARKAL	ns	ns	ns	ns
	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	ns	N/A
		MARKAL	ns	ns	ns	ns
	Net Energy System Cost Reduction, cumulative (Bil $)	NEMS	N/A	N/A	N/A	N/A
		MARKAL	ns	ns	0.53	7.24

- “Reductions” and “savings” are calculated as the difference between results from the baseline case (i.e. no future DOE funding for this technology) and the program case (i.e. requested DOE funding for this technology is received and is successful).
- All cumulative metrics are based on results beginning in 2011.
- All monetary metrics are in 2007$.
- Cumulative monetary metrics are in 2007$ that are discounted to 2011 using a 3% discount rate.

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

Contribution to the Secretary's Goals and GPRA Unit Program Goals

GTP contributes to several of the Secretary's goals.

Energy: Build a competitive, low-carbon economy and secure America's energy future

GTP develops advanced EGS technology that the private sector requires to deploy clean, safe, low carbon, indigenous geothermal energy.

GTP coordinates with the U.S. Departments of Education and Labor, 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.

GTP coordinates with Iceland and Australia under the International Partnership for Geothermal Technology, and also coordinates with the U.S. State Department and U.S. Department of Commerce, and additional countries including Canada, New Zealand, Switzerland, and Indonesia to establish mutually-agreeable geothermal research areas that ultimately lead to greater geothermal deployment and lower GHG emissions.

Innovation: Lead the world in science, technology, and engineering

GTP coordinates with the Department of the Interior, academic institutions, and DOE's Offices of Science and Fossil Energy to ensure that the program's R&D work 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 involves direct interaction between these partners.

Contribution to GPRA Unit Program Goal 3 (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 hot 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. Geothermal electricity generation has the potential to offset coal, natural gas, nuclear, and foreign oil as a supply of baseload energy in the electrical energy market.

Annual Performance Results and Targets

The GTP performance measure is critical for the successful development of EGS resources. High flow rates extract large quantities of heat from the stimulated rock and are necessary for the eventual commercialization of EGS. The development of a commercial quality EGS reservoir through innovative technology supports Secretarial Goal 1: Lead the world in science, technology, and engineering, and also supports Secretarial Goal 2: Build a competitive, low-carbon economy and secure America's energy future (EGS resources are a low carbon, indigenous source of energy). Recovery Act funding supports both new EGS field demonstrations and new EGS component R&D. Internationally, GTP monitors and evaluates EGS activities performed in other countries with active EGS research programs such as Australia and European countries. GTP coordinates technology development with Iceland and Australia under the International Partnership for Geothermal Technology (IPGT), and also collaborates with other countries through the International Energy Agency. Through the IPGT, GTP seeks to exchange research results, best practices, and lessons learned. Additionally, because EGS is a low carbon baseload power generator, it could play an integral role in future power generation scenarios initiated by pending climate change legislation.

Annual Performance Targets and Results

Secretarial Goal: Goal 1: Innovation: Lead the world in science, technology, and engineering
Goal 2: Energy: Build a competitive, low-carbon economy and secure America's energy future
GPRA Unit Program Goal: 05 Geothermal Technologies
Subprogram: Enhanced Geothermal Systems

<table>
<tr><th>FY 2006</th><th>FY 2007</th><th>FY 2008</th><th>FY 2009</th><th>FY 2010</th><th>FY 2011</th><th>FY 2012</th><th>FY 2013</th><th>FY 2014</th><th>FY 2015</th></tr>
<tr><td colspan="10">Performance Measure: Increase average total flow rate per production well in kilograms/second for EGS field site.[a]</td></tr>
<tr><td>T: NA
A: NA</td><td>T: NA
A: NA</td><td>T: NA
A: NA</td><td>T: NA
A: 0.1</td><td>T: NA
A: NA</td><td>T: 12
A:</td><td>T: 13
A:</td><td>T: 15
A:</td><td>T: 17
A:</td><td>T: 20
A:</td></tr>
<tr><td colspan="10">Performance Measure: The FY 2011 performance measure was created in transition from reporting qualitative milestones to quantitative performance measures. Previous year performance measures for this subprogram are not direct predecessor measures to the FY 2011 performance measure. These measures included below enabled the progress necessary to support the new FY 2011 Performance Measure.
FY 2006: 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.
FY 2007: Complete an interim report on EGS technology evaluation, and report on completion of program activities and projects funded in FY 2006.
FY 2008: Conclude EGS technology evaluation and publish a new Geothermal Program Plan.
FY 2009: Determine actual (baseline) pre-stimulation reservoir flow rate for at least one EGS field site.
FY 2010: Modeled 10% increase in flow rate for EGS field site demo.</td></tr>
<tr><td>T: NA
A: MET</td><td>T: NA
A: MET</td><td>T: NA
A: MET</td><td>T: NA
A: MET</td><td>T: NA
A:</td><td>T: RETIRED
A: NA</td><td>T: NA
A: NA</td><td>T: NA
A: NA</td><td>T: NA
A: NA</td><td>T: NA
A: NA</td></tr>
</table>

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[a] Annual flow rate targets increase due to cumulative impact of GTP efforts, valid FY 2011 to FY 2015. Baseline established at the Desert Peak site in Nevada as 0.1 kilograms/second in FY 2009. FY 2011 to FY 2015 flow rates are estimates and these flow rates may be revised.

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, continue work on 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” was developed for GTP during FY 2009.[a]

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 resulted in less wait time for rigs to drill geothermal wells. In addition, the following external factors could affect GTP’s ability to achieve its mission:

- Demand for electricity;
- Availability of conventional energy supplies;
- Regulatory and environmental requirements;
- State Renewable Portfolio Standards (RPS);
- Availability of prospective land for geothermal leasing;
- Market incentives;
- Cost of competing technologies;
- State and Federal tax incentives and implementation of other policies at both levels;

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[a] Program plan can be found at: http://www1.eere.energy.gov/geothermal/plans.html.

- Proximity of transmission grid and resolution of grid choke points.

GTP collaborates with the Department of the Interior, academic institutions, and DOE's Offices of Science and Fossil Energy 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 involves direct interaction between these partners.

Validation and Verification

To validate and verify program performance, 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/) "Geothermal Risk Mitigation Strategies Report," 2008, Deloitte (http://www1.eere.energy.gov/geothermal/publications.html)
Baselines:	EGS pre-stimulation well flow rate as determined in FY 2009
Evaluation:	GTP will continue to conduct and build upon the transparent oversight and performance management initiated for the Recovery Act. GTP conducts annual merit reviews of program activities using independent technology experts. Quarterly and annual assessment of program and management results-based performance are reviewed through Performance Measure Management (the DOE quarterly performance progress review of budget targets); GTP reviews quarterly and annual technical and financial reports through project management by Golden Field Office. GTP will maintain updates of its RD&D projects employing full transparency on its website. Lessons learned and techniques developed will be posted on the GTP website.
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.

Enhanced Geothermal Systems
Funding Schedule by Activity

	(dollars in thousands)		
	FY 2009	FY 2010	FY 2011
Enhanced Geothermal Systems			
Enhanced Geothermal Systems	43,322	43,120	53,989
SBIR/STTR	0 [a]	880	1,011
Total, Enhanced Geothermal Systems	43,322	44,000	55,000

Description

Commercial geothermal developments depend on three resource factors to produce energy: heat, water, and permeability. Heat is present virtually everywhere at depth, while 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. GTP seeks to demonstrate the ability to create an EGS reservoir capable of producing 5 MWe by 2015, and eventually improve EGS technology that provides the private sector with the tools and knowledge to install 50 GWe by 2030.

EGS generally involves drilling a well into hot rock, fracturing the rock to improve permeability, drilling a second well into the fractured rock, and circulating a fluid through the fractured rock to extract the in situ heat. This “heat mining” mimics naturally-occurring, conventional hydrothermal reservoirs, and includes the advantage that EGS can be created in distinct units and sized to fit the need or expanded to meet increased needs.

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.

GTP promotes the advancement of EGS through an integrated portfolio of cost-shared research and field demonstrations. Field demonstrations focus 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 or greenfield areas to develop, test, and perfect the tools needed to fracture hot rock and manage heat extraction. 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.

A core of research projects will be performed through cost-shared awards to the private sector and academic institutions via competitive solicitations. National Laboratories with unique expertise in the subject areas will conduct the balance of the competitively-selected research projects. Field demonstrations with the private sector and academic institutions via competitive solicitations will validate the commercialization potential of EGS. Periodic technology evaluations will be performed by

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[a] SBIR/STTR funding transferred in FY 2009 was $605,000 for SBIR program, and $73,000 for the STTR program.

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 seeks 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.

Benefits

This subprogram will provide the technology needed to create and manage EGS reservoirs that mine heat from rock and transport the heat to the surface for electricity generation. Geothermal power generation requires large flow rates of hot water of nearly constant temperature flowing from the geothermal wells to the power plant for the life of the project. Typically the flow rate is measured in kilograms per second per well as shown in the Annual Performance Targets. Commercially-mature EGS flow rates are expected to be in the range of 70 to 80 kilograms per second per well, though this has not been validated with field testing yet. Higher flow rates per well are more economical because fewer production wells are used which reduces the cost of developing the well field. In FY 2011 progress will be made toward increasing the EGS flow rate to 12 kg per second, moving EGS technology closer to market readiness. Ultimately, market entry will be cost phased where geothermal costs and existing market electricity prices produce favorable production conditions. Prospects at the margins of existing geothermal production fields with existing infrastructure initially may provide the most favorable economic conditions.

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. A successful system demonstration may foster rapid growth in the use of geothermal energy in the future. A DOE-sponsored analysis published in January 2007 by an MIT-led panel shows the potential for EGS to contribute 100,000 MWe to the U.S. energy supply by 2050.[a] Carbon avoidance analysis performed by NREL shows EGS has the potential to substantially reduce GHG emissions.

Detailed Justification

	(dollars in thousands)		
	FY 2009	FY 2010	FY 2011
Enhanced Geothermal Systems	**43,322**	**43,120**	**53,989**

During FY 2011, GTP will continue three EGS demonstrations at field sites selected in FY 2008, and at three additional field sites selected under the Recovery Act. The purpose of the field sites is to demonstrate reservoir creation through hydraulic, chemical, thermal or other stimulation methods and the recovery of heat from the stimulated rock volume using water as the heat mining fluid. Additional

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[a] 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

field demonstrations will support higher production well flow rates and allow innovative heat extraction techniques to be perfected that will eventually lead to commercial applications. GTP also issued an EGS demonstration solicitation in FY 2010 to evaluate innovative, environmentally benign technologies. Activities at two EGS demonstration field sites, Desert Peak, NV, and Coso, CA, may be concluded based on their contributions to the EGS knowledge base. GTP will continue priority R&D resulting from solicitations and lab calls issued in FY 2008, FY 2009, and FY 2010 that support reservoir stimulation, fracture mapping, fluid circulation, and EGS-related drilling and energy conversion. Complementary activities will include low temperature geothermal, international, induced seismicity, analysis, and planning. GTP will collaborate with the Department's Office of Science on geophysical research and development and modeling efforts which address induced seismicity, water availability, and other potential lifecycle risks associated with EGS.

	FY 2009	FY 2010	FY 2011
SBIR/STTR	**0**	**880**	**1,011**

In FY 2009, $605,000 and $73,000 were transferred to the SBIR and STTR programs respectively. The FY 2010 and 2011 amounts shown are estimated requirements for the continuation of the SBIR and STTR program.

	FY 2009	FY 2010	FY 2011
Total, Enhanced Geothermal Systems	**43,322**	**44,000**	**55,000**

Explanation of Funding Changes

	FY 2011 vs. FY 2010 ($000)
Enhanced Geothermal Systems	
This increase funds collaborative R&D with DOE's Office of Science on geophysical R&D and modeling efforts which address induced seismicity, water availability, and other potential lifecycle risks associated with EGS, and an increased effort on low temperature geothermal including fluids co-production from oil and gas operations and fluids from geo-pressured resources.	+10,869
SBIR/STTR	
Changes in the SBIR/STTR funding are a direct result of changes in the funding of program activities.	+131
Total Funding Change, Enhanced Geothermal Systems	**+11,000**

Water Power

Funding Profile by Subprogram

(dollars in thousands)

	FY 2009 Current Appropriation[a]	FY 2009 Current Recovery Act Appropriation	FY 2010 Current Appropriation	FY 2011 Request
Water Power	39,082	31,667	50,000	40,488
Total, Water Power	39,082	31,667	50,000	40,488

Public Law Authorizations:

P.L. 109-58, “Energy Policy Act of 2005”
P.L. 110-140, “Energy Independence and Security Act of 2007”

Mission

The mission of the Water Power Program is to research, test, and develop innovative technologies capable of generating renewable, environmentally responsible, and cost-effective electricity from water. These include marine and hydrokinetic (MHK) technologies, a suite of renewable technologies that harness the energy from untapped wave, tidal, current and ocean thermal resources, as well as technologies and processes to improve the efficiency, flexibility, and environmental performance of conventional hydropower (CH) generation, which may 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 (R&D) of innovative water power technologies and growth of a viable water power industry directly contribute to strengthening U.S. scientific discovery, promoting clean and secure energy, increasing economic prosperity, and demonstrating U.S. leadership in addressing climate change. MHK technologies represent a substantial opportunity for the U.S. to engage directly in an emerging area of energy science while developing an entirely new suite of renewable technologies to reduce emissions, revitalize stagnant sectors of the economy, and help States meet energy and climate objectives and requirements such as Renewable Portfolio Standard (RPS) targets.

CH generates approximately 67 percent[b] of the Nation’s renewable energy supply. The re-establishment of Federal R&D for CH demonstrates a commitment to quickly expand carbon-free generation and to ensure that this large renewable energy resource is an effective and environmentally responsible instrument for reducing greenhouse gas (GHG) emissions by developing alternatives to fossil fuels and increasing the ability of the U.S. electricity system to integrate renewable energy technologies.

The FY 2011 budget complements funds provided by the Recovery Act, including providing funds for feasibility studies that will assess the potential for incremental or new hydropower generation through capacity and efficiency upgrades, powering existing non-powered dams, and adding new pumped

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[a] SBIR/STTR funding transferred in FY 2009 was $820,000 for the SBIR program and $98,000 for the STTR program.

[b] “Electricity Net Generation from Renewable Energy by Energy Use Sector and Energy Source.” Renewable Energy Consumption and Electricity Preliminary Statistics, 2008. July 2009: http://www.eia.doe.gov/cneaf/alternate/page/renew_energy_consump/table3.html

storage hydropower capacity. These feasibility studies will identify the projects that can most quickly and cost-effectively increase generation. The program is also investing in hydropower grid services projects undertaken in partnership with industry that will improve methods for applying and valuing the ancillary benefits of conventional and pumped storage hydropower assets to meet the needs of the Nation's changing electricity grid. These projects augment the program's Hydropower Modernization Initiative funded by the Recovery Act. FY 2011 activities will build upon historic clean energy investments in the Recovery Act to further the Nation's energy goals through sustained technology innovation and continued investments in enabling infrastructure. To enable decision makers and the public to follow performance and plans for this initiative, the program will post its progress at: http://www.energy.gov/recovery/index.htm.

Climate Change

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

Energy Security

The program's investments in the assessment 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 reliable energy sources with possible base-load contributions. Wave and tidal resources are highly predictable and often close to load centers. Investment in hydropower efficiency and infrastructure will increase generation and flexibility of domestic assets and allow for dramatically higher levels of renewable energy to be integrated into the U.S. electric grid.

Economic Impact

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

Contribution to the Secretary's Goals and GPRA Unit Program Goals

The Water Power Program contributes to two of the Secretary's goals:

Energy: Build a competitive, low-carbon economy and secure America's energy future

The program provides funding for MHK technologies, which represent a suite of renewable energy technologies available to reduce emissions and meet RPS targets. The program is assessing opportunities for new and incremental hydropower generation through: efficiency and capacity upgrades at existing hydropower facilities; powering existing non-powered dams; existing and new small hydropower; and adding new pumped storage hydropower capacity.

The program is investing in feasibility studies to identify and support opportunities to increase incremental and new hydropower generation, which will contribute to lowering GHG emissions by increasing the amount of generation derived from these assets and reducing use of electricity generated from high GHG emitting sources.

The development of a substantial MHK industry in the U.S. could drive billions of dollars of investment in heavy industrial and maritime sectors, as well as in advanced electrical systems and materials common to many renewable technologies. Investment in CH focuses on the construction, manufacturing, engineering, and environmental science sectors. The further development of each industry has the potential to employ a significant skilled workforce.

The program supports device and component testing, development and deployment for industry and universities to reduce capital costs and improve quality, and quantity and reliability of MHK technologies. The program provides U.S. input into the development of international standards for MHK technologies, partners with the global community and Federal regulatory agencies, coordinates in international partnerships, and facilitates DOE's leadership role in investigating the potential environmental impacts of ocean energy systems. To better understand and ensure the economic benefits of water power, the program is assessing the potential employment and economic impact of both MHK and CH on a regional basis.

Innovation: Lead the world in science, technology, and engineering

The program established two university-led National Marine Renewable Energy Centers to serve as a nexus between industry, academia, and National Laboratories to research and test new MHK technologies. The program also established key partnerships with teams of National Laboratories to leverage their unique capabilities in developing innovative technologies and assessing the potential from untapped wave, current and ocean thermal resources. The program also engages in international collaboration for R&D and provides U.S. input to the global community on developing international standards for MHK technologies.

Contribution to GPRA Unit Program Goal 62 (Water Power)

The Water Power Program's key contribution to Strategic Theme 1, Energy Security, is through R&D of MHK and CH technologies capable of generating renewable, environmentally responsible, and cost-effective electricity from water to reduce fossil fuel consumption and improve energy independence.

Supporting program's activities for MHK technologies include:

- MHK technology testing, development and deployment: The program will establish baseline cost of energy estimates for wave, tidal, current, in-stream hydrokinetic and ocean thermal conversion technologies through detailed life-cycle cost assessments, device testing, as well as through industry and National Laboratory-led projects to develop, test, and refine MHK devices.
- MHK technology resource assessments: The program will complete current, river in-stream, and ocean thermal energy conversion resource assessments and complete an integrated MHK resource database.
- MHK environmental impact and project siting analysis: The program will complete a framework to assist developers and regulators in assessing and minimizing the environmental impacts of proposed MHK projects.

CH activities include:

- CH technology development and deployment: The program will complete detailed resource assessments for powering non-powered dams and small hydropower development. The program will complete 20 initial feasibility studies to identify opportunities for efficiency and capacity upgrades, powering existing non-powered dams, and adding new pumped storage hydropower capacity to quickly and cost-effectively capitalize on opportunities that would increase generation.

- CH market development and grid services: The program will: (1) quantify the ancillary benefits of hydropower, including the ability to integrate variable renewable resources; and (2) support hydropower R&D through the development of engineers and scientists at U.S. universities.

Annual Performance Results and Targets

The program will test two MHK devices in FY 2011 as it ramps up testing activities to generate data to identify baseline cost of energy and device performance. This initiative, plus supporting the construction of the nation's first open-water grid connected test facilities, helps support the development of the U.S. MHK industry and contributes directly to the Secretary’s goal Innovation: Leading the world in science, technology, and engineering. In addition, the program has worked with industry partners, as well as the National Laboratories to test, develop, and refine MHK devices to support the identification of technology improvement opportunities. These efforts will support a future out-year performance target to reduce the cost of energy for MHK technologies.

Substantial electricity generation gains can be made at existing hydroelectric facilities through capacity and efficiency upgrades, presenting an opportunity to expand clean renewable generation within the U.S. energy portfolio that contributes to the Secretary's goal Energy of Building a competitive, low carbon-economy and securing America's energy future. To assess opportunities for incremental or new hydropower generation quickly, cost-effectively, and within the context of environmental sustainability, the Program will conduct 20 feasibility studies at hydroelectric facilities, non-powered dams, or pumped storage hydropower sites in FY 2011. The Program's number of feasibility studies conducted performance measure is intended to lead to an FY 2013 performance measure of monitoring the number of megawatts of incremental hydropower generated at sites identified through the feasibility studies.

Annual Performance Targets and Results

Secretarial Goal: Goal 1: Innovation: Lead the world in science, technology, and engineering
Goal 2: Energy: Build a competitive, low-carbon economy and secure America's energy future
GPRA Unit Program Goal: 62 – Water Power Program

Subprogram: Water Power

<table>
<tr><th>FY 2006</th><th>FY 2007</th><th>FY 2008</th><th>FY 2009</th><th>FY 2010</th><th>FY 2011</th><th>FY 2012</th><th>FY 2013</th><th>FY 2014</th><th>FY 2015</th></tr>
<tr><td colspan="10">Performance Measure: Test marine and hydrokinetic devices and components to determine baseline cost, performance, and reliability.[a] (number of devices tested).</td></tr>
<tr><td>T: NA
A: NA</td><td>T: NA
A: NA</td><td>T: NA
A: NA</td><td>T: NA
A: NA</td><td>T: NA
A: NA</td><td>T: 2
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A:</td></tr>
<tr><td colspan="10">Performance Measure: The FY 2011 performance measure was created in transition from reporting qualitative milestones to quantitative performance measures. Previous year performance measures for this subprogram are not direct predecessor measures to the FY 2011 performance measure. These measures included below laid the foundation for the FY 2011 Performance Measure.
FY 2009: Complete draft Multi-Year Program Plan.
FY 2010: Identify priority research areas to reduce project development costs by completing environmental impact assessment of marine and hydrokinetic energy development.</td></tr>
<tr><td>T: NA
A: NA</td><td>T: NA
A: NA</td><td>T: NA
A: NA</td><td>T: Qualitative
A:MET</td><td>T: Qualitative
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A: NA</td><td>T: NA
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[a] Testing of devices will allow the program to establish baseline for cost of energy and performance, identify technology improvement opportunities, and is intended to lead to a future outyear performance target of reducing cost of energy for these technologies. Number of devices is cumulative from FY 2011.

Annual Performance Targets and Results

Secretarial Goal: Goal 1: Innovation: Lead the world in science, technology, and engineering
Goal 2: Energy: Build a competitive, low-carbon economy and secure America's energy future

GPRA Unit Program Goal: 62 – Water Power Program

Subprogram: Water Power

FY 2006	**FY 2007**	**FY 2008**	**FY 2009**	**FY 2010**	**FY 2011**	**FY 2012**	**FY 2013**	**FY 2014**	**FY 2015**
Performance Measure: Complete feasibility studies at facilities to identify opportunities for at least 5 percent increased CH electricity generation through efficiency and capacity upgrades, powering existing non-powered dams, and adding new pumped storage hydropower capacity.[a] (number of completed feasibility studies)									
T: NA A: NA	T: NA A: NA	T: NA A: NA	T: NA A: NA	T: NA A: NA	T: 10 A:	T: 40 A:	T: 75 A:	T: 100 A:	T: 125 A:
Performance Measure: The FY 2011 performance measure was created in transition from reporting qualitative milestones to quantitative performance measures. Previous year performance measures for this subprogram are not direct predecessor measures to the FY 2011 performance measure. These measures included below enabled the progress necessary to support the new FY 2011 Performance Measure. FY 2010: Complete analysis of generation and water flow data at 20 percent of the hydropower projects in the U.S to establish baseline data.									
T: NA A: NA	T: NA A: NA	T: NA A: NA	T: NA A:NA	T: Qualitative A:	T: RETIRED A: NA	T: NA A: NA	T: NA A: NA	T: NA A: NA	T: NA A: NA

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[a] FY 2012 to FY 2015 is cumulative. These studies will assess the potential for incremental or new hydropower generation at candidate sites and will identify those where generation can be deployed most quickly and cost-effectively. This measure is intended to lead to an additional performance measure starting in FY 2013 of megawatts of incremental hydropower generated at sites identified through the feasibility studies.

Means and Strategies

The Water Power 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 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 MHK 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.
  - MHK 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.
  - CH 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 within the National Laboratory network to accelerate the technical development and commercial deployment of water power systems.
  - MHK 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.
  - CH 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 MHK technologies, with the goal of determining cost, performance and reliability characteristics.
- Regular communication with stakeholders to understand R&D needs and concerns, to provide useful and timely information on the development of technologies and projects, and the availability of valuable development and testing resources.
- Conduct strategic planning to solicit industry and public stakeholders' input on formulating the direction of the program 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.

The program will implement the following strategies:

Strategies for MHK technology development and testing

- Facilitate in-water device testing for higher maturity technologies
- Support rigorous device testing process for developing technologies
- Support R&D to identify technology improvement opportunities
- Collect and disseminate validated cost and performance data for technologies and projects

Strategies for MHK market development, project siting and resource assessments

- Study and validate estimates of extractable energy by resource and technology type
- Support the generation of site-specific environmental data
- Improve the prediction, monitoring, and evaluation of environmental impacts
- Collect, synthesize, evaluate and disseminate existing impact information
- Build consensus among stakeholders on a framework to minimize and mitigate potential impacts
- Develop and disseminate information that directly affects the MHK industry
- Engage in strategic partnerships with wave, tidal, and ocean thermal technology developers and 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.

Strategies for CH technology development and deployment

- Support site-specific feasibility studies to identify opportunities for new or incremental hydropower generation through capacity and efficiency upgrades at existing facilities, powering existing non-powered dams, and adding new pumped storage hydropower capacity
- Support adding additional net generation at sites identified by feasibility studies where generation can be deployed most quickly and cost-effectively
- Facilitate upgrades of existing hydropower facilities with state-of the art technology
- Develop data to identify opportunities to reduce costs and increase generation
- Support the development and testing of new advanced technologies and tools, including advanced pumped storage
- Support application of advanced materials and manufacturing methods

Strategies for CH grid services and environmental impacts and siting

- Support hydropower grid services projects to accurately assess current and potential value of conventional and pumped storage hydropower ancillary benefits
- Support development of efficient markets to increase value of these benefits
- Develop technologies/methods to reduce environmental impacts and regulatory constraints
- Spur innovation and stimulate industry hydropower R&D capacity outside government
- Develop Federal program for low-impact certification standards
- Develop and disseminate information that directly affect the development of CH

These means and strategies will serve to identify and focus 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, reducing the industry's barriers to deployment will result in significant cost savings and reductions in GHG emissions, reliance on carbon emitting power generation, and fuel imports.

The following external factors could affect the Water Power Program's ability to achieve its benefits:

- Application of state or Federal tax or other incentives, including the inclusion of hydropower in current or future state or Federal Renewable Energy Standards and Renewable Portfolio Standards targets;
- Federal, state and regional regulatory actions affecting water power technologies, including the licensing/permitting processes for private and Federal construction;
- Implementation of other policies at the national level, including Federal efforts to reduce carbon and criteria pollutants;
- The results of ongoing marine spatial planning and coastal zone management processes at state and Federal levels;
- 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; and
- The state of internationally recognized standards and certification.

The program collaborates with 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, including the Federal Energy Regulatory Commission (FERC) and the Minerals Management Service (MMS), 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. In addition, the program benefits from the strong capabilities within the DOE National Laboratories from both the former Hydropower Program and technology programs that share complementary elements to conduct resource assessments, test, develop, and refine advanced water power technologies, develop international standards, and study potential environmental impacts of these technologies.

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 baseline data and sources:

Data Sources:

- "Assessment of Waterpower Potential and Development Needs," EPRI, Palo Alto, CA: 2007. 1014762. (http://www.epriweb.com/public/000000000001014762.pdf)
- Avery, W.H., Wu, C., *Renewable Energy from the Ocean, A Guide to OTEC*. New York, NY: Oxford University Press, 1994. (ISBN #: 0195071999)
- Bedard, R. Siddiqui, O. Previsic, M., and Polagye, B. "Economic Assessment Methodology for Tidal In- Stream Power Plants", EPRI-TP-002 NA Rev 2, June 10, 2006. (http://oceanenergy.epri.com/attachments/streamenergy/reports/002_TP_Econ_Methodology_06-10-06.pdf)
- Brown, S. and Garnant, G. "Advanced-Design Turbine at Wanapum Dam Improves Power Output, Helps Protect Fish." *Hydro Review*, April 2006.
- Hagerman, G. and Bedard, R. "E2I/EPRI Specification – Guidelines for Preliminary Estimation of Power Production by Offshore Wave Energy Conversion Devices" E2I/EPRI-WP-US-001, December 22, 2003. (http://oceanenergy.epri.com/attachments/wave/reports/001_WEC_Power_Production.pdf)
- Hagerman, G., Polagye, B., Bedard, R., and Previsic, M. "Methodology for Estimating Tidal Current Energy Resources and Power Production by Tidal In-Stream Energy Conversion (TISEC) Devices" EPRITP- 001-NA Rev 3, September 29, 2006. (http://oceanenergy.epri.com/attachments/streamenergy/reports/TP-001_REV_3_BP_091306.pdf)
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- Supporting Attainment of Our Renewable Energy Goals," *Hydro Review*, April 2009 (http://www.bcse.org/images/pdf/pumped%20storage%20paper%20april%202009.pdf)
- Odeh, M. "A Summary of Environmentally Friendly Turbine Design Concepts." DOE/ID/13741: July 1999. (http://hydropower.inel.gov/turbines/pdfs/doeid-13741.pdf)
- Previsic, M., Siddiqui, O., and Bedard, R. "EPRI Global E2I Guideline: Economic Assessment Methodology for Offshore Wave Power Plants" E2I/EPRI WP-US-002 Rev 4, November 30, 2004. (http://oceanenergy.epri.com/attachments/wave/reports/002_Rev_4_Econ_Methodology_RB_12-18-04.pdf)
- Previsic, M. and Bedard, R., "Methodology for Conceptual Level Design of tidal In-Stream Energy Conversion (TISEC) Power Plants", EPRI TP-005 NA, August 26, 2005. (http://oceanenergy.epri.com/attachments/streamenergy/reports/005TISECSystemLevelConceptualDesignMethodologyRB08-31-05.pdf)
- Takahashi, P. and Trenka, A, Ocean Thermal Energy Conversion, John Wiley & Sons, 1996. (ISBN #: 0471960098)

Baselines: The program is in the process of establishing baseline cost of energy and performance for MHK by collecting and analyzing data from its device testing program, lifecycle cost analyses projects, and technology development, testing and deployment projects. CH baseline capacity is 78,000 MW and pumped storage capacity is 20,000 MW (2007).[a] Net electricity generation from CH was 248 TWh in 2008.[b]

Frequency: Annual.

Data Storage: Web, paper publications and on-line storage.

Evaluation: In carrying out its 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;
- MHK 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 CH, 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 water power projects;
- Conduct strategic planning process to engage industry and public stakeholders' input in formulating the direction of the program 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 the Administration.

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[a] Nameplate Capacity. Existing Capacity by Energy Source. EIA: Electric Power Annual 2007 http://www.eia.doe.gov/cneaf/electricity/epa/epat2p2.html.

[b] Electricity Net Generation from Renewable Energy by Energy Use Sector and Energy Source. Renewable Energy Consumption and Electricity Preliminary Statistics, 2008 (Release Date: July 2009) http://www.eia.doe.gov/cneaf/alternate/page/renew_energy_consump/table3.html.

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 Performance Measurement Manager (PMM) 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.

Water Power
Funding Schedule by Activity

(dollars in thousands)

	FY 2009	FY 2010	FY 2011
Water Power	39,082	48,669	39,411
SBIR/STTR	0[a]	1,331	1,077
Total, Water Power	39,082	50,000	40,488

Description

For Marine and Hydrokinetic (MHK) technologies and Conventional Hydropower (CH), the program focuses on two broad areas of research: Technology Development and Market Acceleration. Technology Development includes research to reduce costs and facilitate technology design, development, deployment, and operation; improve device and system reliability and performance; and understand and characterize various technology types. The program also seeks to support development of technical standards for technology performance, testing, and evaluation. Market Acceleration includes research to reduce the time, costs and negative impacts associated with project deployment and siting, and includes projects to quantify the potential magnitude and location of water power resources in the U.S. The program supports projects to understand and improve the environmental performance of water power technologies, as well as identify and address policy and market barriers to water power development and deployment, and generates and disseminates information to reduce such barriers.

Marine & Hydrokinetic Technologies

The program is in a unique position to help make MHK energy a commercial reality by funding activities in the areas of technology development and market acceleration that will reduce costs, improve performance, and reduce barriers to deployment across the industry. To date, there are only a handful of wave and current technologies that have proceeded to tank and open water testing. There are currently approximately 200 preliminary permits issued for both wave and current projects. To date only one U.S. run-of-river project has been issued an amended hydroelectric license. This project has been deployed and began feeding electricity to the grid in December 2008.

MHK Technology Development

The program's goal is to facilitate the reduction of the cost of energy for MHK technologies and improve performance by investing in projects to increase device efficiency, improve device availability and reliability, optimize array efficiency and reduce development, deployment, operations and maintenance cost. Specific activities include facilitating in-water device testing, supporting rigorous development and testing processes for developing technologies, collecting and disseminating validated cost and performance data, and developing numerical and physical tools to assist industry in device and system design and operation.

MHK Market Acceleration

Market acceleration projects aim to help reduce barriers and facilitate deployment across the MHK industry, including projects to assess the total quantity, locations, and characteristics of MHK resources in the U.S., and projects focused on reducing the costs, time, and potential environmental impacts

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[a] SBIR/STTR funding transferred in FY 2009 was $820,000 for the SBIR program and $98,000 for the STTR program.

associated with the deployment of these technologies. Activities include: studying and validating estimates of extractable energy by resource and technology type; supporting the generation of site-specific environmental data; improving the prediction, monitoring and evaluation of environmental impacts; and collecting, synthesizing and disseminating this data to build consensus among stakeholders on a framework for mitigating and minimizing potential impacts.

Conventional Hydropower

CH in the U.S. generated 248 TWh in 2008 the most of any renewable energy technology and close to six percent of the Nation's total electricity supply.[a] Substantial generation gains can be made through upgrades at existing facilities and present an opportunity to expand clean renewable generation within the U.S. energy portfolio. The program's activities include feasibility studies to assess opportunities to increase, in an environmentally responsible way, new and incremental hydropower generation, support the opportunities that can most quickly and cost-effectively increase generation, quantify and maximize the full value of conventional and pumped storage hydropower to the transmission grid, and reduce environmental and siting constraints.

CH Technology Development

Hydropower technology development and deployment activities are aligned to increase efficiency and capacity via upgrades at existing facilities, support the addition of new capacity at non-powered dams and constructed waterways, facilitate the development of small hydropower and pumped storage hydropower resources, and reduce the cost and uncertainty associated with the adoption of advanced technologies through deployment, demonstrations, and testing. The program supports the development of advanced technologies that will contribute to significant gains in efficiency and generating capacity, including advanced turbine designs that incorporate fish-friendly and other improved environmental features, other design improvements including aerating and re-regulating weirs, and advanced components.

CH Market Acceleration

The program seeks to stimulate the licensing of new hydropower projects, including pumped storage hydropower, and to help maximize the value of hydropower ancillary benefits to the U.S. electric grid. To stimulate licensing, the program funds projects to improve the environmental performance of hydropower and address environmental and other public concerns to help reduce the corresponding regulatory constraints. This includes supporting the development of technologies and methods that reduce environmental impacts. To maximize the value of hydropower to the grid, the program is investing in projects to accurately assess the current and potential value of hydropower ancillary benefits, support growth of an efficient market to increase the value of these benefits, and facilitate development and deployment of advanced pumped storage technologies. The program will also launch a university hydropower program to stimulate new academic interest and develop a new generation of engineers and scientists in the hydropower industry.

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[a] Net Generation by Energy Source: Total (All Sectors). Report # DOE/EIA-0383. August 2009: http://www.eia.doe.gov/cneaf/electricity/epm/table1_1.html

Benefits

MHK Technologies

The program's technology development and testing projects will provide data and analysis necessary to establish baseline cost of energy and performance, identify cost reduction and performance improvement opportunities, and support the development of economically-viable technologies that can contribute to the Nation's renewable energy portfolio. The program is launching a device testing initiative to conduct tank and open-water testing to collect and analyze data to establish baseline cost of energy and performance. In FY 2011, the program will test at least two MHK devices, progressing to testing devices in open-water settings by FY 2013. The program will fund industry-led projects to design, model, test, and refine MHK devices. The program will also fund National Laboratory-led projects to study mechanical engineering, machine performance and hydrodynamics, and projects to model water power systems and develop advanced materials. The information resulting from these activities will help the program establish a baseline for cost of energy and performance, and identify technology improvement opportunities. This will allow the program to set an outyear annual performance target for reducing cost of energy.

The program's investment in resource assessments, cost analyses, and environmental studies will allow the program to accurately assess the potential for all forms of MHK energy and reduce barriers to accelerate the development of this full potential. Resource assessments will help to determine the available, extractable and cost-effective MHK resources in the U.S. Technology-neutral cost analyses and models will validate device testing results and help establish baseline cost of energy. Environmental studies will identify strategies to minimize time, costs and potential environmental effects associated with siting and deploying MHK systems. These studies will lower project development costs and reduce overall environmental impacts.

Conventional Hydropower

Further developing incremental hydropower generation will provide clean, renewable electricity and reduce the country's dependence on imported energy and fossil fuels. The program will complete 20 feasibility studies at existing hydroelectric facilities, non-powered dams, or pumped storage hydropower sites in FY 2011 to support adding increased generation at identified sites by FY 2013. These feasibility studies will provide the program with data necessary to quantify and identify candidate sites where generation can be deployed most quickly and cost-effectively. To increase the value of hydropower into the U.S. electric grid, the program will support studies to better quantify and maximize conventional and pumped storage hydropower's ancillary benefits. Increased hydropower and advanced hydropower systems, such as scalable and variable-speed pumped storage, could allow for 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. The program will also support projects to study hydropower water-use optimization to increase the operational efficiency and environmental performance of hydroelectric power plants.

Increased operational efficiency allows for more power to be generated at any given site without increasing water usage. Improved environmental performance will help reduce regulatory constraints on licensing for new projects. It will also result in increased power generation and quality by mitigating existing environmental impacts associated with flexible scheduling, as well as reduce cumulative impacts and stresses on wildlife and the environment.

Detailed Justification

(dollars in thousands)

	FY 2009	FY 2010	FY 2011
Water Power	**39,082**	**48,669**	**39,411**

MHK activities concentrate on: (1) understanding the full-range of MHK 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 MHK resources in the U.S. and identify prime domestic resource areas; (4) investigating potential environmental impacts of MHK technologies and how projects can be sited to mitigate or minimize these impacts; and (5) the development of international MHK energy standards. (Approximate funding $19.5 million)

CH activities focus on: (1) increasing incremental hydropower, including: advanced hydropower systems and modernization technologies to increase efficiency and capacities at existing power stations, developing power stations at existing non-powered dams and in constructed waterways, adding new pumped storage hydropower capacity 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 renewable resources. (Approximate funding $19.5 million)

SBIR/STTR	**0**	**1,331**	**1,077**

In FY 2009, $820,000 was transferred to the SBIR and $98,000 was transferred to STTR programs. The FY 2010 and 2011 amounts shown are estimated requirements for the continuation of the SBIR and STTR program.

Total, Water Power	**39,082**	**50,000**	**40,488**

Explanation of Funding Changes

	FY 2011 vs. FY 2010 ($000)
Water Power	
Funds provided in FY 2010 are sufficient to continue resource and technology assessments initiated in 2008 and 2009 and to initiate a number of new projects. For marine and hydrokinetics, the new FY 2010 activities included wave and hydrokinetic technology research, development, and testing, environmental impact assessments and permitting assistance, and comprehensive cost and resource assessments by resource and technology type. For conventional hydropower, the program began comprehensive resource assessments and project-level feasibility studies across the existing conventional hydropower infrastructure to identify opportunities for increased incremental generation, ancillary benefits, and improved environmental performance. In FY 2011, the Program will continue and build upon activities begun in FY 2010, as well as begin to support the development of cost-effective incremental hydropower opportunities identified in 2010.	-9,258
SBIR/STTR	
Changes in the SBIR/STTR funding are a direct result of changes in the funding of program activities.	-254
Total Funding Change, Water Power	**-9,512**

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

(dollars in thousands)

	FY 2009 Current Appropriation[a]	FY 2009 Current Recovery Act Appropriation	FY 2010 Current Appropriation	FY 2011 Request
Vehicle Technologies				
Hybrid Electric Systems	122,698[b]	0	145,733	164,965
Advanced Combustion Engine R&D	39,657	0	57,600	57,600
Materials Technology	38,786	0	50,723	50,723
Fuels Technology	19,560	0	24,095	11,000
Technology Integration	46,442[c]	0	33,214	41,014
Commercial Vehicle Integration/X-Prize	0	109,249	0	0
Subtotal, Vehicle Technologies	267,143	109,249	311,365	325,302
Advanced Battery Manufacturing	0	1,990,000	0	0
Transportation Electrification	0	398,000	0	0
Alternative Fueled Vehicles	0	298,500	0	0
Total, Vehicle Technologies	267,143	2,795,749	311,365[d]	325,302

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[a] In FY 2009, $5,443,000 was transferred to the SBIR program and $652,000 to the STTR program.

[b] Includes Technology Validation activities previously funded in the Hydrogen and Fuel Cell Technologies (HFCT) Program in years prior to FY 2009.

[c] Includes Safety and Codes and Standards, and Education activities previously funded in the HFCT Program in years prior to FY 2009.

[d] Technology Validation, Safety and Codes and Standards, and Education were transferred back to the HFCT Program in FY 2010.

Vehicle Technologies
Funding Profile by Subprogram
(Comparable Structure to the FY 2011 Request)

(dollars in thousands)

	FY 2009 Current Appropriation[a]	FY 2009 Current Recovery Act Appropriation	FY 2010 Current Appropriation	FY 2011 Request
Vehicle Technologies				
Batteries and Electric Drive Technology (Formerly Hybrid Electric Systems)	*101,572*[b]	0	*101,405*	*120,637*
Vehicle and Systems Simulation and Testing	*21,126*	0	*44,328*	*44,328*
Advanced Combustion Engine R&D	39,657	0	57,600	57,600
Materials Technology	38,786	0	50,723	50,723
Fuels Technology	19,560	0	24,095	11,000
Outreach, Deployment & Analysis (Formerly Technology Integration)	*46,442*[c]	0	*33,214*	*41,014*
Commercial Vehicle Integration/X-Prize	0	109,249	0	0
Subtotal, Vehicle Technologies	267,143	109,249	311,365	325,302
Advanced Battery Manufacturing	0	1,990,000	0	0
Transportation Electrification	0	398,000	0	0
Alternative Fueled Vehicles	0	298,500	0	0
Total, Vehicle Technologies	267,143	2,795,749	311,365[d]	325,302

Public Law Authorizations:

P.L. 95-91, “U.S. Department of Energy Organization Act” (1977)
P.L. 102-486, “Energy Policy Act of 1992”
P.L. 109-58, “Energy Policy Act of 2005”
P.L. 110-140, “Energy Independence and Security Act of 2007”

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[a] In FY 2009, $5,443,000 was transferred to the SBIR program and $652,000 to the STTR program.

[b] Includes Technology Validation activities previously funded in the HFCT Program in years prior to FY 2009.

[c] Includes Safety and Codes and Standards, and Education activities previously funded in the HFCT Program in years prior to FY 2009.

[d] Technology Validation, Safety and Codes and Standards, and Education were transferred back to the HFCT Program in FY 2010.

Mission

The mission of the Vehicle Technologies program (VTP) is to develop more energy-efficient and environmentally friendly highway transportation technologies (for both cars and trucks) that will enable America to use significantly less petroleum and reduce greenhouse gas (GHG) emissions while meeting or exceeding drivers' performance expectations and environmental requirements.

Modifications are proposed to the budget structure of two subprograms to better reflect VTP activities.

Benefits

The VTP mission and activities contribute directly to the DOE and Secretarial goals of leading the world in science, technology and engineering, and building a competitive, low-carbon economy to secure America's energy future.

VTP focuses on highway vehicles (passenger and commercial), which account for 55 percent of total U.S. oil use ─ more than all U.S. domestic oil production. 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. Because of 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 goals:

- Within 10 years (by 2020) save more oil than currently imported from the Middle East and Venezuela combined (about 3.5 mbpd);
- Invest in developing advanced vehicles, including the development and deployment of enough advanced battery manufacturing capacity to support 500,000 plug-in hybrid electric vehicles a year by 2015;
- Improve the fuel economy of new vehicles to achieve an average CAFE standard of 35.5 mpg by 2016.

The three goals are supported by DOE's R&D investments in vehicle energy efficiency and petroleum displacement, as well as by Recovery Act efforts to establish manufacturing for advanced vehicles, demonstration of advanced vehicles, and improved fuels infrastructure and utilization. While the third goal, CAFE, is not specifically targeted by either R&D or Recovery Act funds, DOE's research enables manufacturers to use some results to meet their specific near-term fuel economy goals. CAFE improvements by the OEMs are expected to be drawn from a number of technology areas that will include both engine efficiency improvements, as well as vehicle weight reduction, improved aerodynamics, lower rolling resistance tires, hybridization, and other efficiency improvements. The program targets are designed to take vehicle improvements well beyond those needed to meet CAFE. The chance of achieving these three important goals has been greatly enhanced by the Recovery Act investments of up to $2.8 billion in advanced efficiency technologies for highway transportation. Recovery Act funds are expected to hasten the introduction of PHEVs and other advanced efficiency

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[a] Remarks on Jobs, Energy Independence, and Climate Change, President Barack Obama, Jan. 26, 2009 http://www.whitehouse.gov/blog_post/Fromperiltoprogress/

technologies in cars and trucks, and to lower their cost by establishing manufacturing capacity for batteries and electric drives. Investments are being made in higher efficiency combustion engines, commercial vehicle efficiency, ethanol and biodiesel deployment, battery and electric drive manufacturing, and vehicle electrification deployment and infrastructure development. Funds are targeted to speed the use and lower the cost of vehicles with these improvements.

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. Non-petroleum fuels, such as ethanol, natural gas, electricity, and biodiesel, can also reduce 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 3.0 billion barrels of oil, nearly 1.4 gigatons of carbon dioxide, and consumer savings of at least $300 billion based on EERE metrics analyses. Projections based on the MARKAL model indicate that by 2050 the benefits could increase dramatically, to cumulative reductions of more than 20 billion barrels of oil, nearly 9 gigatons of carbon, and greater than $2 trillion in consumer savings.

Climate Change:

VTP contributes to reducing GHGs (most importantly 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 example, a hybrid vehicle that combines advanced, more efficient combustion with lightweight materials and a hybrid drive-train could easily double the fuel efficiency of a conventional vehicle – resulting in half the GHG emissions. If all available efficiency technologies were utilized, the vehicle could achieve triple the fuel efficiency, and produce one-third the GHG emissions of a conventional vehicle.

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 take advantage of E85, where available, and to choose the type of fuel to use based on price and availability. PHEVs will allow consumers to displace fuel use with electricity, based on price and convenience. PHEVs with flex-fuel engines will provide "all of the above" flexibility in achieving benefits and in choosing energy sources.

Achievement of VTP's goals is expected to displace 1.1 mbpd of imported oil in 2030 and nearly 3 mbpd in 2050, based on energy-economy models. This displacement will yield energy security benefits by diversifying the U.S. energy base and increasing energy productivity which, in turn, lowers GHG, provides clean, secure energy, and stimulates economic prosperity.

In the nearer term, program R&D is expected to contribute up to half of the oil savings needed from highway transportation to achieve the President's 10 year oil reduction goal. These savings, about 1.8 mbpd, will be comprised of contributions from PHEVs, HEVs, commercial vehicle improvements, 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 lower oil imports, and improve 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. Achieving the VTP goals for reducing the cost of advanced vehicle technologies will save the consumer money that can stimulate other areas of the national economy and hasten the adoption of efficient vehicles. The technology streams being pursued by VTP will help to sustain the Nation's economic development and its mobility while improving the infrastructure, the environment, and security.

The benefits tables that follow 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 R&D 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 tables also reflect the increasing penetration of VTP's technologies over time as performance and cost goals are met. Not included are future policies, regulatory mechanisms, or other incentives that could 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 calculated using the same fundamental methodology,[b] per OMB's request to make all programs' outcomes comparable. The effects of the approximately $2.8 billion of Recovery Act funding associated with VTP are not considered in the benefits analyses.

Because of the inclusion of EISA provisions into the baseline model, consideration of a baseline has become more complex. EISA was not included in the modeling for the FY 2010 budget request. EISA requires increased use of alternative fuels and sets higher fuel economy standards relative to current law. The difference between the baseline case and the program goal case are the economic, environmental, and security benefits. For example, achievement of program goals results in a reduction in cumulative net consumer expenditures of $300 billion dollars by 2030 and $2 trillion by 2050. The achievement of the program's goals would also result in carbon emissions reductions of nearly 1.3 gigatons by 2030 and 9 gigatons by 2050.

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[a] The starting point for the baseline case is the EIA's "reference case," as published in the AEO 2007: http://www.eia.doe.gov/oiaf/archive/aeo07/ 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.

[b] 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.

The technologies that VTP is developing will help meet these requirements more economically. Therefore, both EISA and the baseline incorporate many of the benefits expected to emerge from VTP's R&D program targets. The model does not estimate the extent to which VTP's R&D program contributes towards cost-effectively implementing EISA – and hence does not provide a comprehensive accounting of the benefits of the program.

Note that the slow growth in vehicle benefits in this and the next table is the direct result of the large size of America's vehicle fleet, over 240 million vehicles, and the market-based pace of replacement. With a passenger vehicle life of between 15 and 20 years (and greater for most commercial vehicles), it will take a long time to replace all vehicles. Speed of replacement with high efficiency vehicles is also slowed by the rate at which new technology is introduced to the market by the manufacturers. Past performance shows that new technology can take 15 years or longer to attain maximum penetration and does not always reach 100 percent. Penetration rates can be faster for the most driven commercial vehicles where both fleet turnover (three years or less) and fast technology penetration are the result of high mileage driving and the economics of annual fuel cost (up to $100,000 per truck annually for long haul commercial trucks).

The models used to estimate these benefits assume an increase in 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 benefits are generated by modeling both the program goal and baseline cases[a] within two energy-economy models: NEMS-GPRA11 for benefits through 2030, and MARKAL-GPRA11 for benefits through 2050. The following tables display the full list of modeled benefits.

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[a] Baseline cases utilize data from the updated *Annual Energy Outlook 2009* Reference Case Service Report, April 2009

FY 2011 Primary Metrics

	Metric	Model	Year			
			2015	2020	2030	2050
Energy Security	Oil Imports Reduction, cumulative (Bil bbl)	NEMS	ns	0.39	3.27	N/A
		MARKAL	0.06	0.29	2.46	20
	Natural Gas Imports Reduction, cumulative (Tcf)	NEMS	ns	ns	ns	N/A
		MARKAL	ns	0.33	1.8	5.41
Environmental Impacts	CO_2 Emissions Reduction, cumulative (Mil mtCO_2)	NEMS	ns	159	1381	N/A
		MARKAL	22.78	183	1402	8846
	SO_2 Allowance Price Reduction ($/ton)	NEMS	ns	ns	ns	N/A
		MARKAL	N/A	N/A	N/A	N/A
	NO_x Allowance Price Reduction ($/ton)	NEMS	ns	ns	ns	N/A
		MARKAL	N/A	N/A	N/A	N/A
Economic Impacts	Primary Energy Savings, cumulative (quads)	NEMS	ns	2.3	18	N/A
		MARKAL	0.03	0.36	8.2	98
	Oil Savings, cumulative (Bil bbl)	NEMS	0.03	0.42	3.7	N/A
		MARKAL	0.08	0.37	3.2	22
	Consumer Savings, cumulative (Bil $)	NEMS	ns	44	427	N/A
		MARKAL	ns	ns	307	2127
	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	340	N/A
		MARKAL	ns	88	494	1585
	Jobs, cumulative (net added jobs)	NEMS	NA	NA	NA	NA
		MARKAL	NA	NA	NA	NA

- “Reductions” and “savings” are calculated as the difference between results from the baseline case (i.e. no future DOE funding for this technology) and the program case (i.e. requested DOE funding for this technology is received and is successful).

- Oil impacts are shown as two metrics. "Oil Imports Reduction" refers only to reductions in oil imports; "Oil Savings" refers to savings (reduction) in total oil consumption.

- All cumulative metrics are based on results beginning in 2011.
- All monetary metrics are in 2007$.
- Cumulative monetary metrics are in 2007$ that are discounted to 2011 using a 3% discount rate.

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

FY 2011 Secondary Metrics

	Metric	Model	Year			
			2015	2020	2030	2050
Energy Security	Oil Imports Reduction, annual (Mbpd)	NEMS	ns	0.3	1.1	N/A
		MARKAL	0.1	0.2	1.1	2.9
	Natural Gas Imports Reduction, annual (Tcf)	NEMS	ns	ns	ns	N/A
		MARKAL	ns	0.1	0.2	0.2
	MPG Improvement (%)	NEMS	ns	2.3%	12%	N/A
		MARKAL	0.9%	0.9%	6.0%	43%
Environmental Impacts	CO2 Emissions Reduction, annual (Mil mtCO2/yr)	NEMS	ns	47	188	N/A
		MARKAL	8	56	240	498
	CO2 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 (Kg CO2/kWh)	NEMS	ns	ns	ns	N/A
		MARKAL	ns	ns	ns	ns
	CO_2 Intensity Reduction of US Transportation Sector (Kg CO2/mile)	NEMS	ns	0.02	0.04	N/A
		MARKAL	ns	0.01	0.05	0.10
Economic Impacts	Primary Energy Savings, annual (quads/yr)	NEMS	0.11	0.7	2.5	N/A
		MARKAL	0.01	0.1	1.7	7.5
	Oil Savings, annual (Mbpd)	NEMS	0.06	0.3	1.3	N/A
		MARKAL	0.08	0.2	1.6	3.4
	Consumer Savings, annual (Bil $)	NEMS	ns	19	83	N/A
		MARKAL	ns	ns	118	358
	Electric Power Industry Savings, annual (Bil $)	NEMS	ns	ns	ns	N/A
		MARKAL	ns	ns	1.38	7.0
	Energy Intensity of US Economy (energy/$GDP)	NEMS	0.01	0.04	0.12	N/A
		MARKAL	ns	0.01	0.09	0.27
	Net Energy System Cost Reduction, cumulative (Bil $)	NEMS	N/A	N/A	N/A	N/A
		MARKAL	0.4	26	291	1602
	Jobs, annual (net added jobs/yr)	NEMS	NA	NA	NA	NA
		MARKAL	NA	NA	NA	NA

- "Reductions" and "savings" are calculated as the difference between results from the baseline case (i.e. no future DOE funding for this technology) and the program case (i.e. requested DOE funding for this technology is received

- Oil impacts are shown as two metrics. "Oil Imports Reduction" refers only to reductions in oil imports; "Oil Savings" refers to savings (reduction) in total oil consumption.

- All cumulative metrics are based on results beginning in 2011.

- All monetary metrics are in 2007$.

- Cumulative monetary metrics are in 2007$ that are discounted to 2011 using a 3% discount rate.

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

Contribution to the Secretary's Goals and GPRA Unit Program Goals

VTP contributes to two of the Secretary's goals as described below.

Innovation: Lead the world in science, technology, and engineering

VTP works with DOE's Office of Science and National Laboratories for better scientific understanding and improved computational tools, for instance to develop and improve materials models using advanced computational resources. VTP has also worked with the Office of Science to define basic research needs to improve the fundamental understanding of battery electrochemistry and to identify opportunities for improving battery energy storage using nanotechnology. Additionally, VTP collaborates with industry and universities to improve the fundamental understanding of materials used for electric drives, vehicle weight reduction, and better efficiency.

Energy: Build a competitive, low-carbon economy and secure America's energy future

VTP is working to transform highway transportation efficiency through development of new combustion engine, battery, lightweight material, and energy-management technologies for both passenger vehicles and commercial vehicles. Every area of activity includes industrial participation with the aim of translating R&D into products and jobs as quickly as possible. VTP also supports universities in training the future engineering workforce that will continue to develop and utilize advanced highway transportation technologies.

VTP's mission directly advances this priority by providing technologies that decrease energy use in highway transportation. VTP 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. VTP works with industry, universities, and the National Laboratories to understand and improve the opportunities for PHEV vehicles including limitations and opportunities for vehicle-to-grid connectivity, electric range optimization, and recharging options. VTP evaluates alternative fuels for broader and faster petroleum displacement. VTP also develops and demonstrates improved combustion efficiency for more effective utilization of alternative fuels.

The key program contribution to the Energy goal is the direct reduction of petroleum use. VTP 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 and buses). 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 demonstrate key technology pathways that contribute to achievement of reduced oil use:

Battery and Electric Drive Technology subprogram:

- Reduce the production cost of an electric traction drive system that can deliver 55kW of peak power for 18 seconds and 30kW of continuous power, from $22/kW in 2008 to $12/kW in 2015, enabling cost competitive market entry of PHEVs and HEVs (Power Electronics and Electric Motor R&D).
- Reduce the production cost of a high energy battery from $1,000/kWh in 2008 to $300/kWh by 2014, enabling cost competitive market entry of PHEVs (Battery/Energy Storage).

Vehicle and Systems Simulation and Testing subprogram:

- Demonstrate market readiness of PHEV technologies by 2015.

Advanced Combustion R&D subprogram and Fuels Technology subprogram:

- Improve the fuel economy of gasoline passenger vehicle by 25 percent and diesel passenger vehicles by 40 percent in 2015;
- Increase the thermal efficiency of commercial vehicle engines by 20 percent in 2015 and by 30 percent in 2018. (The passenger and commercial vehicle goals will be met while utilizing an advanced fuel formulation that incorporates a non-petroleum based blending agent to reduce petroleum dependence and enhance combustion efficiency);
- Increase the efficiency of thermoelectric generators to convert waste heat to electricity from 8 percent to greater than 15 percent by 2015.

Materials Technology subprogram:

- By the end of 2015, validate (to within 10 percent uncertainty) the cost-effective reduction of the weight of passenger vehicle body and chassis systems by 50 percent with safety, performance, and recyclability comparable to 2002 vehicles (Lightweight Materials Technology).

Outreach, Deployment, and Analysis subprogram:

- Achieve a petroleum reduction of 2.5 billion gallons per year by 2020 through the adoption of alternative fuel vehicles and infrastructure.

The proposed FY 2011 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. FY 2011 activities will build upon historic clean energy investments in the Recovery Act to further the Nation’s energy goals through sustained technology innovation and continued investments in enabling infrastructure. This integrated targeted performance builds on both Recovery and RD&D to enable the realization of administration’s goals and commitments to energy, the economy and climate. 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.

Annual Performance Results and Targets

VTP’s performance measures directly correspond to Secretarial Goals and the Program’s mission of creating economic prosperity, reducing energy demand from highway transportation and deploying cost-effective low-carbon clean energy technologies. These measures evolve as necessary to meet changing requirements. For example, in recent years, the VTP program has placed increased emphasis on technologies for plug-in hybrid electric vehicles (PHEVs), in particular, the development of advanced high-energy batteries for PHEVs and EVs.

The following examples illustrate how VTP correlates its objectives to the Secretarial Goals and the Program mission:

Technology developments: VTP works to improve the technologies needed for more efficient highway vehicles such as high energy batteries, combustion processes, lighter materials, and improved electric drives. The program collaborates with the Office of Science, DOE’s National Laboratories, industry stakeholders and universities to reach these objectives.

Industry growth and development: VTP is working to transform highway transportation efficiency through its development of new technologies for both passenger vehicles and commercial vehicles. Every area of activity includes industrial participation, translating into further collaboration and job creation. In addition, improvements in technology are transferred to industry, ensuring the global competitiveness of U.S. companies and enhanced job creation. As with industry, VTP supports universities to train the future engineering workforce that will continue to develop and utilize advanced highway transportation technologies.

Regulatory requirements: VTP activities respond to existing and proposed regulatory requirements and forecasts by providing input to legislation, and developing technologies that enable industry to meet regulatory requirements that allow such requirements to be modified in response to changing needs.

The VTP battery performance target reflects changes in the performance measure from the cost of a high-power 25kW battery for hybrid electric vehicles to a performance measure of cost/kWhr for high-energy batteries for plug-in hybrid vehicles and electric vehicles. The change is in recognition of the greater economic and environmental benefits resulting from larger reductions in oil use and CO_2 emissions possible through this technology. Additionally, although not a part of the R&D portfolio, Recovery Act funding of $1.99 billion for Advanced Battery Manufacturing will help to ensure that domestic sources of batteries are available in the future.

Annual Performance Targets and Results

Secretarial Goal: Goal 1: Innovation: Lead the world in science, technology, and engineering
Goal 2: Energy: Build a competitive, low-carbon economy and secure America's energy future
GPRA Unit Program Goal: 02 Advanced Vehicle Technologies
Subprogram: Batteries and Electric Drive Technology (Formerly Hybrid Electric Systems)

FY 2006	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
Performance Measure: Reduce the cost of electric-drive technologies. ($/kilowatt peak)									
T: NA A: NA	T: $9/kW peak[a] A: MET	T: $22/kW peak[b] A: MET	T: $19/kW peak A: MET	T: $19/kW [c] peak A:	T: $18/kW peak[d] A:	T: $17/kW peak A:	T: $16/kW peak A:	T: $14/kW peak A:	T: $12/kW peak[e] A:
Performance Measure: Reduce the cost of energy storage for PHEVs. ($/kilowatt-hour)									
T: NA A: NA	T: NA A: NA	T: NA A: NA	T: NA A: NA	T: NA A: NA	T: $700/kW-hr[f] A:	T: $500/kW-hr A:	T: $400/kW-hr A:	T: $300/kW-hr A:	T: $270/kW-hr[g] A:
Performance Measure: 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. (Storage batteries are a key cost and performance component for hybrid vehicles, which offer improved fuel economy).[h] (kilowatt hour)									
T: $750 A: MET	T: $700 A: MET	T: $625 A: MET	T: $550 A: MET	T: $500 A:	T: RETIRED A: NA	T: NA A: NA	T: NA A: NA	T: NA A: NA	T: NA A: NA

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[a] Demonstrated in a 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. The FY 2007 cost target was for a component of the electric drive, an electric motor, and cannot be put on a comparable basis with the systems cost targets beginning in FY 2008.

[b] 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.

[c] The FY 2010 cost target remained the same as in FY 2009 ($19/kW peak), but at an increased power density (2.0 kW/l in FY 2009 versus 2.2 kW/l in FY 2010).

[d] Demonstrate with data and modeling a combined inverter/motor of 1.1 kW/kg, 2.7 kW/liter and cost of $18/kW peak. (Additional information valid FY 2011 – FY 2014).

[e] Demonstrate with data and modeling a combined inverter/motor of 55 kW peak power for 18 seconds and 30 kW continuous and cost of $12/kW peak.

[f] Measure is focused on modeled cost of a high-energy Li-ion battery assuming production of 100,000 units. Therefore, high volume battery manufacturing is included in the cost estimate. Credit for Recovery Act battery manufacturing lower capital expense is not included in the target estimate, and could result in a slightly lower cost. Storage batteries are a key cost and performance component of PHEVs. Reducing cost enables cost competitive market entry. (Additional information valid FY 2011 – FY 2015).

[g] Emphasis in FY 2015 will transition to the electric vehicle battery development.

[h] The FY 2011 performance measure reflects the transition from energy storage technologies for hybrid electric vehicles (high power batteries) to high energy batteries for plug-in hybrid vehicles.

Annual Performance Targets and Results

Secretarial Goal: Goal 1: Innovation: Lead the world in science, technology, and engineering
Goal 2: Energy: Build a competitive, low-carbon economy and secure America's energy future
GPRA Unit Program Goal: 02 Advanced Vehicle Technologies
Subprogram: Vehicle and Systems Simulation and Testing (Formerly Hybrid Electric Systems/Vehicle and Systems Simulation and Testing)

FY 2006	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
Performance Measure: Increase cumulative miles of PHEV/EV testing. (million miles tested)									
T: NA A: NA	T: NA A: NA	T: NA A: NA	T: NA A: NA	T: NA A: NA	T: 15M [a] A:	T: 62M A:	T: 102M A:	T: 107M A:	T: 112M [b] A:

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[a] Complete development, validation, and transfer to industry of standard modeling tool.

[b] Demonstrate market readiness of PHEVs; complete 112 million miles of PHEV and EV testing.

Annual Performance Targets and Results

Secretarial Goal: Goal 1: Innovation: Lead the world in science, technology, and engineering
Goal 2: Energy: Build a competitive, low-carbon economy and secure America's energy future
GPRA Unit Program Goal: 02 Advanced Vehicle Technologies
Subprogram: Advanced Combustion Engine R&D

FY 2006	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
Performance Measure: Improve modeled fuel economy for passenger and commercial vehicles solely from improvements in powertrain efficiency . (fuel economy percentage, passenger%/commercial%)									
T: NA A: NA	T: NA A: NA	T: NA A: NA	T: NA A: NA	T: NA A: NA	T: 10% / 5% [a] A:	T: 15% / 10% A:	T: 20% / 15% A:	T: 23% / 18% A:	T: 25% / 20% [bc] A:
Performance Measure: Increase the energy conversion efficiency of thermoelectric devices. (conversion percentage)									
T: NA A: NA	T: NA A: NA	T: NA A: NA	T: NA A: NA	T: NA A: NA	T: 8%[d] A:	T: 10% A:	T: 12% A:	T: 14% A:	T: 15% [e] A:
Performance Measure: The FY 2011 performance measure was created to transition from reporting peak engine efficiency results to reporting increases in fuel economy (MPG) due to improvements in overall engine efficiency. Previous year performance measures for this subprogram are predecessor measures to the FY 2011 performance measure. These measures, included below, enabled the progress necessary to support the new FY 2011 Performance Measure. FY 2006: Achieve 41 percent brake thermal efficiency for light-duty vehicle combustion engines and 50 percent brake thermal efficiency while meeting EPA 2010 emission standards for heavy vehicle combustion engines. FY 2007: Internal combustion laboratory demonstrated engine efficiency for light-duty vehicles of 42 percent. FY 2008: Internal combustion laboratory demonstrated engine efficiency for light-duty vehicles of 43 percent. FY 2009: Internal combustion laboratory demonstrated engine efficiency for light-duty vehicles of 44 percent. FY 2010: Internal combustion laboratory demonstrated engine efficiency for light-duty vehicles of 45 percent.									
T: 41% A: MET	T: 42% A: MET	T: 43% A: MET	T: 44% A: MET	T: 45% A: NA	T: RETIRED A: NA	T: NA A: NA	T: NA A: NA	T: NA A: NA	T: NA A: NA

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[a] Increases in fuel economy (passenger vehicles / commercial vehicles) result from improvements in powertrain efficiency. Baselines are relative to MY 2010 gasoline vehicles and 42 percent engine efficiency for commercial engines. (Additional information valid FY 2011 – FY 2014).

[b] Demonstrate 25 percent increase in fuel economy of passenger vehicles and 20 percent for commercial vehicles through improvements in powertrain efficiency.

[c] While the commercial vehicle target goal is expressed in terms of engine efficiency improvement, for a fixed drive cycle and a comparable vehicle, an improvement in engine efficiency will result in a comparable improvement in fuel economy.

[d] Modeling and laboratory data predict the conversion efficiency from engine waste heat to electricity of a thermoelectric device rated at 750W output. (Additional information valid FY 2011 - FY 2014)

[e] Demonstrated conversion efficiency from engine waste heat to electricity of a thermoelectric device rated at 750W output.

<table>
<tr><td colspan="10">Annual Performance Targets and Results
Secretarial Goal: Goal 1: Innovation: Lead the world in science, technology, and engineering
Goal 2: Energy: Build a competitive, low-carbon economy and secure America’s energy future
GPRA Unit Program Goal: 02 Advanced Vehicle Technologies
Subprogram: Materials Technologies</td></tr>
<tr><th>FY 2006</th><th>FY 2007</th><th>FY 2008</th><th>FY 2009</th><th>FY 2010</th><th>FY 2011</th><th>FY 2012</th><th>FY 2013</th><th>FY 2014</th><th>FY 2015</th></tr>
<tr><td colspan="10">Performance Measure: Validate (to within 10 percent uncertainty) the cost-effective reduction of the weight of passenger vehicle body and chassis systems by 50 percent with safety, performance, and recyclability comparable to 2002 vehicles. (percentage)</td></tr>
<tr><td>T: NA
A: NA</td><td>T: NA
A: NA</td><td>T: NA
A: NA</td><td>T: NA
A: NA</td><td>T: NA
A: NA</td><td>T: MODEL[a]
A:</td><td>T: -25%[b]
A:</td><td>T: -40%
A:</td><td>T: -50%
A:</td><td>T: [c]
A:</td></tr>
<tr><td colspan="10">Performance Measure: The FY 2011 performance measure was created to transition from development and design to validation. Prior year measures focused on models that analyzed components using lighter weight materials and enabled this sub program to focus on the design of lighter weight assemblies that are made of several components. The milestone for FY 2011 focuses on the development of the design for the assemblies that make up the lighter weight vehicle and the milestones for FY 2012 through 2015 focus on validating the weight reduction of the vehicle.
FY 2006: 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.
FY 2007: Reduce the modeled weight of a mid-sized passenger vehicle body and chassis components by 10 percent relative to baseline.
FY 2008: Reduce the modeled weight of a passenger vehicle body and chassis system by 25 percent relative to the 2002 baseline.
FY 2009: Reduce the modeled weight of a passenger vehicle body and chassis system by 40 percent relative to 2002 baseline.
FY 2010: Reduce the modeled weight of a passenger vehicle body and chassis system by 50 percent relative to 2002 baseline.</td></tr>
<tr><td>T: NA
A: NA</td><td>T: 10%
A: MET</td><td>T: 25%
A: MET</td><td>T: 40%
A: MET</td><td>T: 50%
A: NA</td><td>T: RETIRED
A: NA</td><td>T: NA
A: NA</td><td>T: NA
A: NA</td><td>T: NA
A: NA</td><td>T: NA
A: NA</td></tr>
</table>

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[a] Completion of design and cost model for multi-materials vehicles (MMV) for validating assessments of weight reduction in 2012 to 2014.

[b] Modeled vehicle weight reduction achievable at comparable cost, performance, safety, and recyclability compared to baseline vehicle. (Additional information valid FY 2011 – FY 2014).

[c] Assess progress and determine need to continue – go/no go.

Annual Performance Targets and Results

Secretarial Goal: Goal 1: Innovation: Lead the world in science, technology, and engineering
Goal 2: Energy: Build a competitive, low-carbon economy and secure America's energy future
GPRA Unit Program Goal: 02 Advanced Vehicle Technologies
Subprogram: Outreach, Deployment, and Analysis (Formerly Technology Integration)

FY 2006	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
Performance Measure: Reduce the use of petroleum through the adoption of alternative fuel vehicles and infrastructure. (millions of gallons per year)									
T: NA A: NA	T: NA A: NA	T: NA A: NA	T: NA A: NA	T: NA A: NA	T: 600M A:	T: 700M A:	T: 800M A:	T: 900M A:	T: 1,000M A:

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 achievement of VTP’s goals.

To accomplish its goals VTP supports 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:

- Reduce the weight of vehicles (up to 30 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);
- Improve hybrid electric vehicle component efficiency (up to 50 percent improvement in fuel economy); and
- Improve PHEV components (up to 300 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. As the Recovery Act investments continue, the results will be incorporated in VTP’s strategic planning process and R&D pathways/alternatives will be adjusted to achieve maximum benefit A program’s goal may be elevated and the market introduction of new efficiency technologies may be accelerated.

In addition to the main R&D pathways, the program strategy includes support of other activities to facilitate market adoption of new technologies, train new engineers in advanced technologies, and inform the program's own strategic planning.

VTP employs the following means to achieve its goals:

- Participates in an effort to integrate and harmonize R&D pathways across DOE's energy research programs, described more completely in the collaboration section that follows.
- Funds and facilitates demonstration and deployment of prototype/pre-prototype vehicles to identify and eliminate technology flaws prior to technology introduction.
- Funds technology development opportunities that lead to further cost reductions and/or performance improvements.
- Supports university-oriented activities that 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.
- Funds market and economic analyses needed to properly inform the program's technology strategies and multi-year plans.
- Reviews the program's goals, activities, and progress 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 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 engines for alternative/renewable fuels / blends	Enable cost-competitive plug-in hybrid vehicles
Program Performance Measures:		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 alternative/renewable fuel blends.	Reduce high-energy battery cost. Field demonstrations of PHEVs.

External factors affect the ability of VTP to achieve its long-term goals and benefits. Primary external factors that could interfere are:

- Ethanol distribution infrastructure: Successful deployment of alternative fuel vehicles (AFVs) 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 (three to five years), recent oil prices have risen from the $40s per barrel to over $140, then rapidly declining into the $30s per barrel, and back into the $50s again. Consumer interest in alternative fuels and high efficiency vehicles generally follows price fluctuations.
- Market Inertia: The rate at which new efficiency technology is adopted by vehicle manufacturers influences the rate at which efficient vehicles are adopted in the market. With annual sales averaging about 16 million personal vehicles per year (this dropped to about 13 million vehicles in 2008 and 10 million vehicles in 2009), replacement of all lower efficiency vehicles would take at least 15 years, assuming all new vehicles had higher efficiency. This drop was due to challenges faced by the U.S. auto industry and the economy, in general.

- VTP's important efforts includes collaborating and engaging with industry, other Federal agencies, State and local governments, and as opportunities arise, with foreign governments and international organizations. VTP's principal EERE counterparts are the Biomass and Biorefinery Systems R&D, Building Technologies, and Hydrogen and Fuel Cell Technologies programs. VTP's principal DOE counterparts are the Office of Electricity Delivery and Energy Reliability, and Office of the Science's Basic Energy Sciences (BES) Program. 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 Vehicle Technologies 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.

Currently, the principal collaborations are:

- FreedomCAR and Fuel Partnership: DOE (represented by VTP and the Hydrogen and 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, combustion engines for the nearer term, and fuel-cell hybrids for the long term.
- 21st Century Truck Partnership (21CTP): 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, cleaner, and safer. 21CTP focuses 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.

The program also collaborates directly with other Federal agencies. For example, VTP is collaborating with the Environmental Protection Agency (EPA) to promote the adoption of idling-reduction technologies and practices for trucks and buses.

Validation and Verification

To validate and verify program performance, VTP conduct internal and external reviews and audits. These programmatic activities are subject to review at various times by Congress, DOE's Inspector General, and NAS. VTP 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:	▪ Combustion engine 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 2008 ($1,000/kWh), and

- Integrated electric propulsion system cost in 2005 ($35/kW peak). (Note: cost values are not adjusted for inflation.)

Frequency: Peer reviews are conducted in alternate years for FreedomCAR and Fuel Partnership, and 21CTP.

Data Storage: EE Corporate Planning System

Evaluation: In carrying out the program's mission, VTP 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:

- 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 VTP;
- 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 PMM (the DOE quarterly performance progress review of budget targets);
- Annual review of methods, and computation of the potential benefits for GPRA;
- Peer reviews of the FreedomCAR and Fuel Partnership, and 21CTP 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; and
- Continual development of the transparent oversight and performance management initiated by Congress and the Administration.

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.

Batteries and Electric Drive Technology
Funding Schedule by Activity
(Non-Comparable, or as-Appropriated, Structure)

(dollars in thousands)

	FY 2009	FY 2010	FY 2011
Hybrid Electric Systems			
Vehicle and Systems Simulation and Testing	21,126	43,732	43,732[a]
Technology Validation	14,789	0 [b]	0
Energy Storage R&D	69,425	76,271	93,992
Advanced Power Electronics and Electric Motors R&D	17,358	22,295	23,267
SBIR/STTR	0 [c]	3,435	3,974
Total, Hybrid Electric Systems	122,698	145,733	164,965

Batteries and Electric Drive Technology
Funding Schedule by Activity
(Comparable Structure to the FY 2011 Request)

(dollars in thousands)

	FY 2009	FY 2010	FY 2011
Batteries and Electric Drive Technology (formerly Hybrid Electric Systems)			
Vehicle and Systems Simulation and Testing	*0*	*0*	*0*
Technology Validation	14,789	0 [d]	0
*Battery/*Energy Storage R&D	69,425	76,271	93,992
Advanced Power Electronics and Electric Motors R&D	17,358	22,295	23,267
SBIR/STTR	*0* [e]	2,839	3,378
Total, Batteries and Electric Drive Technology	101,572	101,405	120,637

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[a] In FY 2011, this activity is elevated to become its own subprogram, and funding of $44,328 ($43,732 VSST plus $596 SBIR/STTR) is shown in that subprogram description.

[b] Technology Validation was transferred back to the HFCT Program from the Vehicle Technologies program in FY 2010.

[c] In FY 2009, $2,687,400 was transferred to the SBIR program and $322,488 to the STTR program.

[d] See note b.

[e] On a comparable basis, $2,419,575 was transferred to the SBIR program and $290,349 to the STTR program in FY 2009.

Description

The Battery and Electric Drive Technology (BEDT) subprogram contains all of the activities of the former Hybrid Electric Systems subprogram except for Vehicle Systems Simulation and Testing (VSST). The proposed budget structure change gives batteries and electric/hybrid vehicles a dedicated budget line, while separating the crosscutting and non-electric/hybrid activities that are included in VSST.

The BEDT subprogram funds R&D on the core technologies necessary for hybrid and electric vehicles to achieve significant improvements in fuel economy without sacrificing safety, the environment, performance, or affordability. The subprogram focuses its work on the basic building-blocks of electric drive vehicles: advanced batteries and power electronics & electric motors (the electric drive).

- Battery/Energy Storage R&D (formerly Energy Storage R&D) addresses the first building block of a hybrid-electric vehicle: electricity storage. The needs of “regular” hybrid vehicles and plug-in hybrids are similar, but not identical: plug-in hybrids 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 is the collection of all the electric and electronic devices that tie the power stored in the battery to the vehicle's drivetrain: power control circuits, charging circuits, electric motors, logic to synchronize the power from the battery and motors with the main vehicle engine, and other related components. The power electronics for a plug-in hybrid will be considerably more complex than for a regular hybrid to accommodate additional charging modes and more complex driving modes.

In FY 2011 the BEDT subprogram will continue to accelerate the development of low-cost, high-energy batteries and corresponding improvements to the electric drive systems (motors, power electronics, and electric controls) needed for cost-effective plug-in hybrid electric vehicles. Plug-in hybrids offer the potential to provide significant additional fuel savings benefits, particularly for commuter and local driving, for either combustion or fuel cell powered hybrid passenger vehicles.

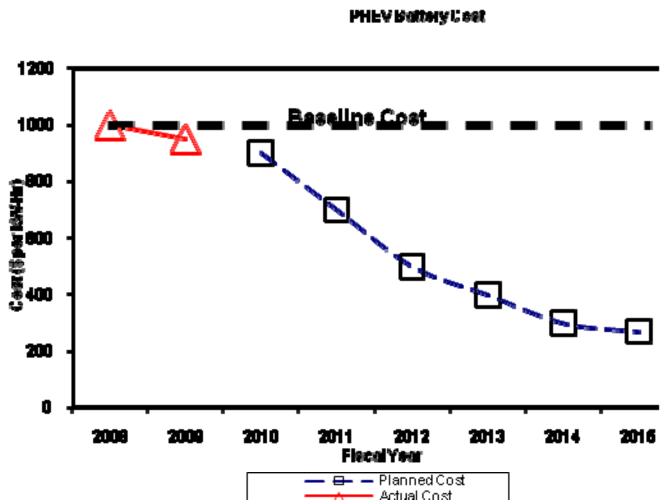
Benefits

The BEDT subprogram supports VTP 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 Battery and Electric Drive Technology subprogram that can contribute to meeting national energy security, environmental, and economic objectives:

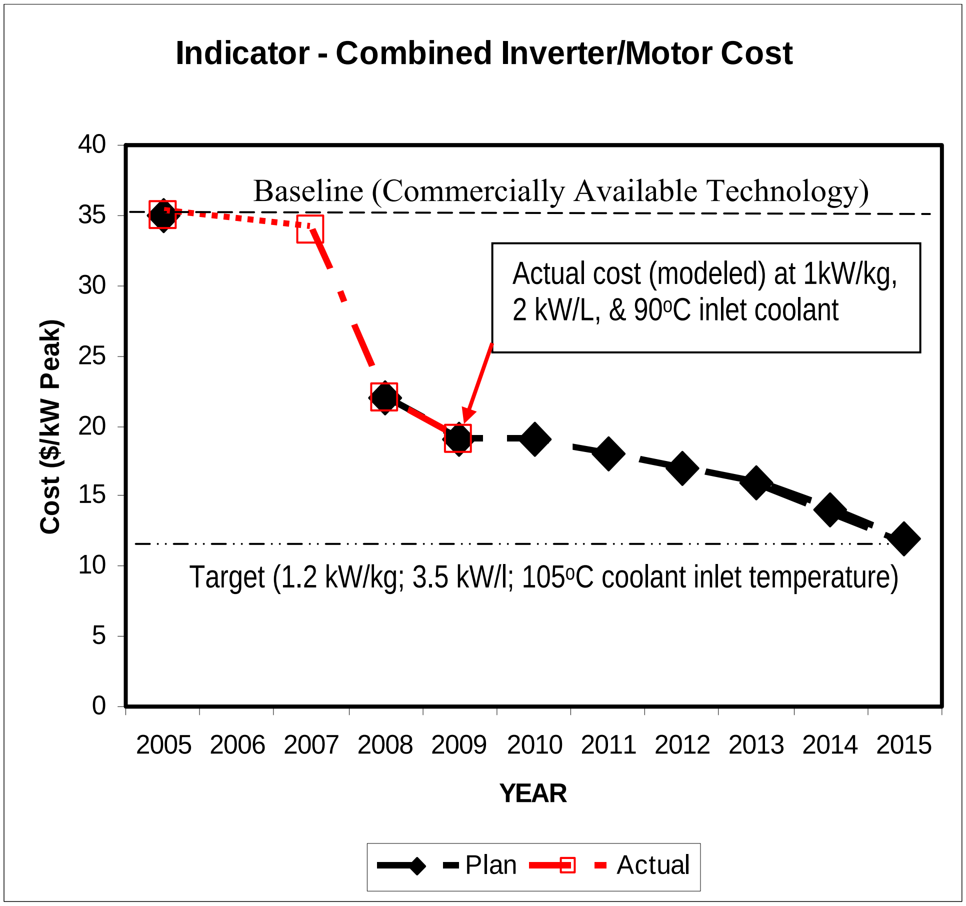
- By 2014, develop a PHEV battery that enables a 40 mile all-electric range for 15 years and costs $3,400 ($300/KWh).
- By 2015, reduce the production cost of an electric traction drive system that can deliver 55kW of peak power for 18 seconds and 30kW of continuous power from $22/kW in 2008 to $12/kW, enabling cost competitive market entry of PHEVs and HEVs.
- Reduce the production cost of a high energy battery from $1,000/kWh in 2008 to $300/kWh by 2014, enabling cost competitive market entry of PHEVs.
- Develop an integrated electric propulsion system that costs no more than $12/kW peak and can deliver at least 55 kW of power for 18 seconds and 30 kW of continuous power, with a lifetime of 15 years when operated with an inlet coolant temperature of 105^{o}C.

The effects of the Recovery Act funding for the manufacturing of advanced batteries and electric drive components are not considered in the analyses that evaluate the impact of R&D on battery or electric drive component cost which already assume high volume manufacturing. Recovery Act funds are expected to hasten the introduction of PHEV and other electric drive vehicles, and to attain the modeled cost goals.

Progress for energy storage and electric propulsion system R&D is indicated by cost per kilowatt-hour battery system and combined inverter/motor cost estimated for a production level of 100,000 systems per year. Actual and projected progress for PHEV battery cost and integrated inverter/ motor cost indicators are shown graphically below:



Note: 2008 value is baseline.



Note: 2005 and 2007 "Actual" data are cost for commercially available systems.

In 2008 and subsequent years, "Actual" represents program results (modeled).The FY 2007 cost target is not shown because it was for a component of the electric drive,an electric motor, and cannot be put on a comparable basis with the systems cost targets beginning in FY 2008.

Detailed Justification

	(dollars in thousands)		
	FY 2009	FY 2010	FY 2011
Vehicle and Systems Simulation and Testing	**0**	**0**	**0**

The Vehicle and Systems Simulation and Testing (VSST) activity has been elevated to a subprogram and is described in the next subprogram. VSST integrates the modeling, systems analysis, and testing efforts that support VTP.

Technology Validation	**14,789**	**0**	**0**

In FY 2010 the Technology Validation activity was transferred from VTP to the Fuel Cell Technologies program as part of a reprioritization of fuel cell and hydrogen-related work.

Battery/Energy Storage R&D	**69,425**	**76,271**	**93,992**

The Battery/Energy Storage R&D activity is the new name of the Energy Storage R&D activity which clearly indicates that this activity contains the effort for battery R&D.

The Battery/Energy Storage R&D activity supports the development of advanced high-energy batteries for PHEVs and EVs, high-power batteries for HEVs, and R&D into advanced materials to enable the development of next generation batteries and systems. Low-cost, abuse-tolerant batteries with higher energy, higher power, and lower weight are needed for the development of the next-generation of HEVs, PHEVs, and pure EVs. Lithium-based batteries offer the potential to meet all three applications. However, other innovative technologies like ultracapacitors and advanced lead acid batteries offer the promise of significantly lower cost with possibly similar performance in high power applications. Thus, those technologies are also being researched, tested, and developed.

The Battery/Energy Storage activity coordinates with other DOE programs working in advanced battery technologies to maximize returns on DOE's investments. Close cooperation with BES of the Office of Science provides valuable technical and programmatic support. The activity also coordinates with the Battery/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.

An important focus of the R&D is advanced materials to enable sufficiently high energy density to meet the weight and volume requirements for the 40-mile PHEV application. The activity's development for near-term commercialization is focused on systems for a 10-mile application (mainly using existing chemistries) to investigate life and abuse issues and to reduce cost. The goal is to reduce the cost of the PHEV battery to $300/kWh by 2014.

Full system development continues in cooperation with industry both through the United States Advanced Battery Consortium (USABC) and direct contracts with DOE. All subcontracts are awarded under a competitive process and are at least 50 percent cost-shared by developers. The FY 2011 activity will continue emphasis on accelerating the development of batteries for PHEVs. Batteries in the PHEV application must support both fully electric drive and power-assist (as in a typical HEV). The need for extended all-electric range motivates the search for materials with higher energy density, while the need for HEV operation maintains the need for good high power performance. Also, as the battery becomes larger, abuse-tolerance becomes more of a concern, requiring higher stability between the electrodes and the electrolyte, and enhanced thermal management at the system level. The focus of the remaining high-power USABC subcontracts is cost reduction, as high-power Li-ion systems appear able to meet many critical performance requirements.

This activity will also continue to validate requirements and refine standardized testing procedures to evaluate performance and life of PHEV batteries, as well as identify areas requiring additional R&D.

In FY 2011, VTP will continue to support the development of a Li-ion materials supply base in order to strengthen the U.S. based manufacturing of Li-ion batteries and to ensure success of battery manufacturing facility awards made under the Recovery Act. Studies of recycling and reuse of lithium batteries will continue. In addition, these funds will be used to support peer reviews; data collection and dissemination; and technical, market, economic, and other analyses.

Ultracapacitors (Ucaps), hybrid ultracapacitors (in which one electrode may be an activated carbon and the other an intercalation compound as in a Li-ion battery) and advanced lead acid batteries offer the possibility of significantly lower system cost with moderate reductions in certain performance characteristics. These and other non-traditional technologies are being tested in the laboratory, evaluated in vehicle simulations, and researched using advanced diagnostics to understand the ability to enable higher mileage automobiles. Ucaps have relatively low specific energy (less than three watt-hours per kilogram, which limits their capacity to serve as the main energy-storage devices in hybrid vehicles. However, Ucaps offer the possibility of improved vehicle performance in a battery-plus-ultra-capacitor hybrid configuration and a 10 to 20 percent fuel economy improvement in city driving if used in a start/stop application. The battery/Ucap configuration will be evaluated and optimized for lower cost and improved durability in a PHEV platform when the Ucap is sized for power assist and the battery is sized for energy. Ucap R&D focuses on the use of low-cost, high-capacity carbon electrodes and improved electrolytes, which will allow the capacitors to operate at a higher voltage to improve their specific energy.

Since high-power Li-ion batteries are poised to enter the HEV market, the emphasis in FY 2011 will continue to be on PHEV systems in the applied and exploratory programs. In addition to new high-capacity electrode materials and high-voltage electrolytes, research efforts will be devoted to the development of additives to prevent overcharging, additives that form a good interface between the electrode and the electrolyte for improved life and fast charge capability, and electrolyte formulations and additives for low-temperature operation. These programs will also investigate and support the development of innovative energy storage devices, such as Ucaps, asymmetric Ucaps, and advanced lead acid batteries. Testing and analysis will continue to evaluate the applicability of these technologies, with R&D activities being undertaken based on those results. Currently, VTP is testing several asymmetric Ucaps, two advanced lead acid batteries, and is involved in a joint research program with Advanced Lead Acid Battery Consortium (ALABC) to investigate the operation of advanced lead acid batteries.

In coordination with BES and OE, the VTP Battery/Energy Storage activity will participate in integrated activities to support development of nanoscale materials and architectures for electrical energy storage. Nanomaterials can exhibit superior performance over conventional battery materials in terms of high pulse discharge and recharge power, and improved performance at low temperatures. However, the behavior of these materials is not well understood and is thought to be more than just a length-scale effect. New diagnostic tools and techniques could be required to investigate these materials. VTP activities will develop high energy and/or high power electric drive vehicle (EDV) battery cells that significantly exceed existing technologies in terms of performance and/or cost. Specifically, VTP will: (1) expand work on next generation energy storage; (2) develop low cost packaging and thermal management technologies; (3) develop battery computer aided engineering design tools; and (4) investigate revolutionary battery reuse and recycling technology. Each of these areas has the potential to improve performance and/or reduce the cost of the resulting system.

VTP will expand work in the area of extremely high energy couples for use in EVs and PHEVs and into high power systems for HEVs. Higher energy (for EVs and PHEVs) and higher power (for HEVs) couples promise to significantly lower system cost as fewer cells should be needed in the entire system. One focus of this work will be on new materials and couples that offer a minimum of two times improvement in either energy or power over today's technologies. Some specific technologies which are of interest include, but are not limited to, the design and development of robust EDV battery cells that contain high voltage (5V) and/or high capacity (>300mAh/g) cathodes; alloy or Lithium metal anodes; Lithium/air and Lithium/S systems; high voltage and solid polymer composite electrolytes. In addition, VTP will expand work on cells and/or systems that offer significant cost reductions. The focus of this work will be on robust EDV battery cells or systems that contain new materials and couples that offer a minimum of two times reduction in cost over existing technologies. Some specific technologies which are of interest include, but are not limited to: asymmetric ultracapacitors; high power lead acid systems, including those that incorporate carbon-based electrodes; and organic or other novel high power electrodes. Recovery Act investments to develop manufacturing capacity for batteries and electric drive components will allow more rapid commercialization of advanced electrochemical couples developed under this activity.

In FY 2011, research will be conducted to expedite the development of more efficient designs and design processes for high-volume production of large format, HEV and PHEV, Li-ion batteries. Areas of interest include the development of revolutionary packaging approaches and thermal management technologies. Currently, the "non active" components of a battery (~70 percent by weight of the battery) increase the volume, weight, and cost of the finished product. Approaches to reduce the inactive components in the cell and battery will be pursued. Sample areas include developing much thicker electrodes, bi-polar technologies, and solid electrolytes. In addition, today's thermal management technologies add weight, cost, and complexity to the system which all could be reduced through the use of novel thermal management technology. Research will be conducted to both manage batteries' temperature and potentially to reduce their overall cost. Approaches that significantly extend the operating temperature range of the system at either lower or higher ends will also be investigated.

Testing new materials is extremely time-consuming and expensive. Computer aided engineering (CAE) tools have been widely used throughout the aerospace and automotive industry to speed up the product development cycle. In contrast, the battery industry still relies heavily on the building and testing of prototypes in the design cycles. A virtual design toolset could identify an optimal design in days or weeks, compared to months or years for a hardware-based process. The development of battery CAE tools will accelerate design cycles, reduce the number of prototypes to be tested, reduce battery cost and provide a competitive advantage to US OEMs, suppliers, and battery manufacturers.

Recent analyses show that recycling of EDV Li-ion batteries can significantly mitigate possible material supply issues and reduce the cost of the finished product. In 2011, VTP will identify specific recycling research topics to pursue and begin preliminary work. Some possible topics include improving the efficiency and cost effectiveness of current recycling processes, enhancing recycling processes to recover more materials, and restoring or refurbishing partially spent batteries to near new performance levels.

In FY 2011, VTP will refine the goals and objectives of a draft secondary use program document that was created in 2009. In addition, VTP will collect information on battery end-of-life performance, obtain industry input, evaluate second use applications, and conduct testing to assess the suitability of used batteries for secondary use.

In conjunction with SuperTruck activities initiated in 2010, energy storage technologies and systems specific to heavy vehicle applications will optimize maturing battery technologies for the long-haul truck application.

Advanced Power Electronics and Electric Motors R&D	**17,358**	**22,295**	**23,267**

The Advanced Power Electronics and Electric Motors activity supports long-term R&D of power electronics, electric motors and other electric propulsion components, as well as the thermal control subsystems necessary for the development and ultimate adoption of PHEVs, HEVs, and pure EVs. Supporting R&D on capacitors, magnets and wide band-gap materials (such as silicon carbide [SiC] and gallium nitride [GaN]) for advanced power electronics technologies also enables the higher operating temperatures that are necessary to reduce 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 (such as a battery) to the electric motor. This module also provides functionality that enables lower-cost and more efficient motors, while protecting them from harmful voltage and current conditions, and helps to reduce the overall size of the battery. R&D efforts focus on developing advanced, low cost technologies compatible with the high-volume manufacturing of motors, inverters, and DC/DC converters for electric drive vehicles.

In FY 2011, the industry R&D efforts from the FY 2010 solicitation will continue to develop power electronics and electric motors associated with increased vehicle electrification. Electrification of light-duty vehicles has great potential to reduce dependence on oil imports, and advanced power electronics and electric motors are critical components for the successful deployment of advanced vehicles. These activities will enable substantial reductions in cost, weight, and volume, while ensuring a domestic supply chain. Emphasis will be placed on R&D for advanced packaging, enhanced reliability, and improved manufacturability. Efforts will also accelerate 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/GaN components, low-cost permanent magnet materials, high-temperature capacitors, advanced thermal systems, and motor control systems to meet future passenger vehicle hybrid systems requirements. Existing work in these areas will address the performance requirements for PHEVs, including utilizing power electronics to provide plug-in capability by integrating the battery charging function into the traction drive, thereby reducing electric propulsion system cost. Activities focusing on advanced materials will enable the production of prototype devices to accelerate the process of transferring research results to device manufacturers. Joint efforts with other programs and agencies in wide bandgap materials will be emphasized to enable earlier use of advanced devices and components.

The power electronics and electric motors activity coordinates with other DOE programs with relevant work in advanced technologies to maximize the return on DOE's technology investments in this area. Interagency coordination on advanced power electronics and motors development is conducted through the government-sponsored Interagency Advanced Power Group (IAPG). The synergies of technologies for advanced vehicles, including PHEVs, HEVs, and EVs, will be achieved by maintaining close

(dollars in thousands)

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 in advanced 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 2009	FY 2010	FY 2011
SBIR/STTR	**0**	**2,839**	**3,378**

In FY 2009, on a comparable basis, $2,419,575 and $290,349 were transferred to the SBIR and STTR programs respectively. The FY 2010 and 2011 amounts shown are estimated requirements for the continuation of the SBIR and STTR program.

Total, Batteries and Electric Drive Technology	**101,572**	**101,405**	**120,637**

Explanation of Funding Changes

	FY 2011 vs. FY 2010 ($000)
Vehicle and Systems Simulation and Testing In FY 2011 this activity is proposed as the new Vehicle and Systems Simulation and Testing subprogram. The comparable reduction to the Batteries and Electric Drive Technology subprogram is a decrease of $44,328	0
Technology Validation No change.	0
Battery/Energy Storage R&D Relative to the comparable FY 2010 appropriation, the FY 2011 request includes an increase of $17,721. Additional funding will support work to develop high energy or high power EDV battery cells and systems that significantly exceed existing technologies in terms of performance and/or cost. Specifically, VTP will: (1) expand work on next generation energy storage electrochemistries, (2) develop low cost packaging and thermal management technologies, (3) develop battery computer aided engineering design tools, and (4) investigate revolutionary battery reuse and recycling technology. Each of these areas has the potential to improve performance and/or reduce the cost of the resulting system.	+17,721
Advanced Power Electronics and Electric Motors R&D Based on past progress and results anticipated in FY 2010, funding for FY 2011 is increased to build the focus on efforts and activities showing the most promise in meeting programmatic goals and objectives. Efforts in materials R&D for capacitors, magnets, wide bandgap devices, as well as packaging and reliability will be accelerated to advance the state of electric drive technology.	+972
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.	+539
Total Funding Change, Batteries and Electric Drive Technology	**+19,232**

Vehicle and Systems Simulation and Testing
Funding Schedule by Activity
(Comparable Structure to the FY 2011 Request)

(dollars in thousands)

	FY 2009	FY 2010	FY 2011
Vehicle and Systems Simulation and Testing[a]			
Vehicle and Systems Simulation and Testing	21,126	43,732	43,732
SBIR/STTR	0[b]	596	596
Total, Vehicle and Systems Simulation and Testing	21,126	44,328	44,328

Description

In FY 2011, VTP is elevating the Vehicle and Systems Simulation and Testing (VSST) activity from the former Hybrid and Electric Systems subprogram (renamed as the Batteries and Electric Drive Technologies subprogram) to a subprogram in order to make budget line items more transparent and meaningful. VSST includes a number of crosscutting activities that are not specifically tied to battery and electric or hybrid drive technologies; rather, they tie all of the VTP hardware R&D together. The VSST activity is comprised of work in five areas: 1) modeling and simulation; 2) component and systems evaluations; 3) laboratory and field vehicle evaluations; 4) electric drive vehicle codes and standards; and 5) heavy vehicle systems optimization. This subprogram includes all of VTP's efforts directly related to the planning and modeling, development, and evaluation of advanced hybrid, electric, and plug-in hybrid drive systems for passenger and commercial vehicles. 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 21CTP and the FreedomCAR and Fuel Partnership.

System-level simulations help specify the necessary performance characteristics of the hardware to establish goals and predict the overall vehicle efficiency and performance for a given configuration. Both simulation and testing activities are 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.

Dynamometer, 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. These evaluations are also used to identify component, vehicle, and testing codes and standards that need to be updated for new vehicle technologies, and to develop and validate new codes and standards in partnership with government and industry stakeholders. In addition, the VSST activities include R&D to reduce auxiliary vehicle loads and parasitic loses, many of which are also applicable to passenger vehicles.

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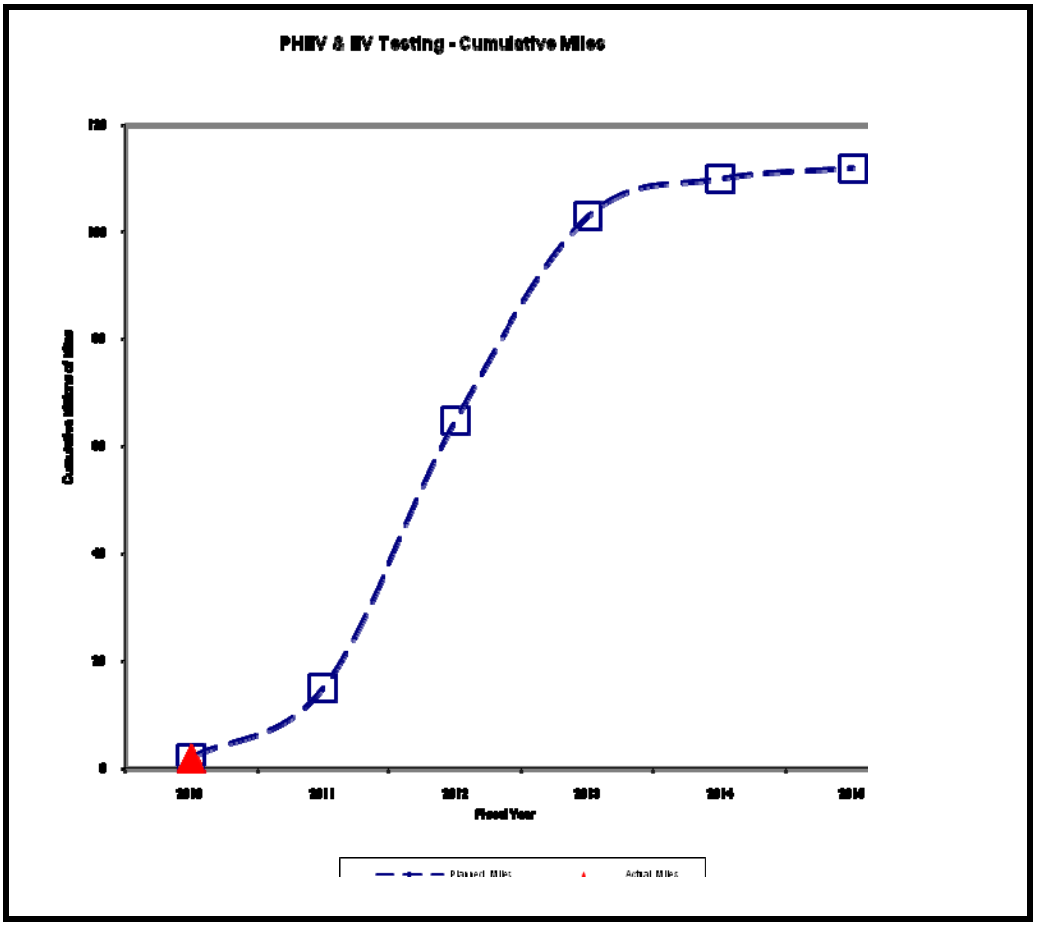
[a] Vehicle and Systems Simulation and Testing was formally a key activity under the Hybrid Electric Systems Subprogram.
[b] On a comparable basis, $267,825 was transferred to the SBIR program and $32,139 to the STTR program in FY 2009.

Benefits

The VSST subprogram supports VTP goals by addressing the utilization of electric energy storage, electric drives, and energy recovery in new, more efficient vehicle designs.

VSST contributes to meeting national energy security, environmental, and economic objectives by striving to demonstrate market readiness of PHEV technologies by 2015. Market readiness will be determined from accumulated test data from over 100 million test miles of electric propulsion vehicles as indicated in the progress indicator figure below.



Detailed Justification

(dollars in thousands)

	FY 2009	FY 2010	FY 2011
Vehicle and Systems Simulation and Testing	**21,126**	**43,732**	**43,732**

VSST integrates the modeling, systems analysis, and testing efforts that support VTP. Funding for FY 2011 will support vehicle and systems modeling of advanced electric drive vehicles for passenger and commercial vehicles. It will also support baseline testing and evaluation of both commercial and passenger electric drive vehicles evaluated in cooperation with manufacturers, utilities and other industry partners. A portion of the funds will also be used to continue 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 uses a systems approach to define technical targets and requirements, guide technology development, and validate performance of VTP-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, BEVs 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 VTP-wide research.

This subprogram will also research heavy vehicle systems to develop 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, accessory loads, and tire efficiency.

In FY 2011, the subprogram will continue simulation studies of advanced control strategies and components for PHEVs and other electric drive vehicles, 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. 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 complete the integration of turbulence and other computational fluid dynamics (CFD) models. The program will also 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 VTP subprograms.

VSST will utilize the Mobile Automotive Technology Testbed (MATT) and hardware-in-the-loop techniques that operate selected pieces of hardware linked to a real-time simulation of the rest of the vehicle, to emulate vehicle systems to determine systems interactions (e.g., energy storage requirements for different cumulative electric range control strategies and power electronics components and configurations). In FY 2011, VSST will continue hardware in the loop (HIL) evaluations of advanced energy storage systems and dual battery systems, advanced combustion technologies developed by other VTP R&D subprograms, and the use of engine emission models for analyzing the impact of emission control equipment on the fuel economy of all vehicle classes. VSST will validate, in a systems environment, performance targets for deliverables from power electronics and energy storage technology R&D activities, and examine overall vehicle impacts associated with integration of other advanced vehicle technologies.

The subprogram will conduct evaluations of advanced original equipment manufacturer (OEM) PHEVs and electric drive vehicles, and complete tests of vehicles retrofitted with components developed through VTP R&D activities. Evaluations will include testing on laboratory dynamometers, closed tracks, and real-world monitored fleets. Test results will help identify component and system performance and reliability weaknesses to be addressed through future R&D activities. Data from these tests will expand the currently limited PHEV knowledge base and help accelerate market introduction of these fuel saving vehicles.

The Recovery Act provided substantial new resources for EERE to expand the impact of base activities. The Transportation Electrification is allowing the purchase, deployment, and evaluation of thousands of plug-in hybrid and all-electric vehicles for test demonstrations in several locations across the U.S., as well as electric charging infrastructure, education and training to support these activities. The data from the Recovery Act Transportation Electrification advanced electric drive vehicle demonstrations will also be analyzed to identify technology needs and improvements to be addressed through VTP R&D activities to accelerate the market introduction of electric drive vehicles. Efforts focus on infrastructure/vehicle interface evaluations and potential impacts on the electricity grid. VSST will work with OE to demonstrate the potential benefit of PHEV commercialization coupled with smart grid technologies to both improve the value proposition of PHEVs while improving grid reliability and utilization.

VSST will continue its government/industry cooperative efforts to identify and resolve component, vehicle, and testing codes and standards that need to be updated for new vehicle technologies. Specific activities will include on-vehicle testing of components integrating new standards to ensure the revised standards are appropriate to ensure vehicle performance, reliability, efficiency, and safety. Work will be initiated to develop and validate additional codes and standards identified as deficient through partnership with government and industry stakeholders.

In FY 2011, additional vehicle testing data will be collected through VSST activities, as well as other independent testing sources, and will be utilized to validate medium duty vocations in the heavy vehicle model. In FY 2011, VSST will complete the final year of a three year effort focused on on-road and wind tunnel evaluations 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. 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 2009	FY 2010	FY 2011
SBIR/STTR	**0**	**596**	**596**

In FY 2009, on a comparable basis, $267,825 and $32,139 were transferred to the SBIR and STTR programs respectively. The FY 2010 and 2011 amounts shown are estimated requirements for the continuation of the SBIR and STTR program.

	FY 2009	FY 2010	FY 2011
Total, Vehicle and Systems Simulation and Testing	**21,126**	**44,328**	**44,328**

Explanation of Funding Changes

	FY 2011 vs. FY 2011 ($000)
Vehicle and Systems Simulation and Testing (VSST)	
Relative to the FY 2010 appropriation, there is no funding change. This a new subprogram proposed for FY 2011 as a comparable increase of $43,732. However, this is the same activity funded in FY 2010 as part of the former Hybrid and Electric Systems subprogram.	0
SBIR/STTR	
Relative to FY 2010 appropriation, there is no funding change. However, this is a comparable increase of $596.	0
Total Funding Change, Vehicle and Systems Simulation and Testing	**0**

Advanced Combustion Engine R&D
Funding Schedule by Activity

	(dollars in thousands)		
	FY 2009	FY 2010	FY 2011
Advanced Combustion Engine R&D			
Combustion and Emission Control	35,089	47,239	47,239
Solid State Energy Conversion	4,568	8,748	8,748
SBIR/STTR	0 [a]	1,613	1,613
Total, Advanced Combustion Engine R&D	39,657	57,600	57,600

Description

The Advanced Combustion Engine R&D subprogram focuses on removing critical technical barriers to commercializing higher efficiency, advanced internal combustion engines for passenger and commercial vehicles. The goals are to develop engine technologies to dramatically increase the fuel economy of passenger vehicles by 25 to 40 percent and commercial vehicles by 20 percent while meeting cost, durability, and emissions constraints, and allowing earlier market introduction. 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.

Increasing the efficiency of internal combustion engines is likely the most cost effective approach to reducing the petroleum consumption of the Nation's fleet of vehicles in the near- to mid-term. Using these advanced engines in HEVs and PHEVs will enable even greater fuel savings benefits. Improvements in engine efficiency alone have the potential for dramatically increasing vehicle fuel economy and reducing GHG emissions. Accelerated research on advanced combustion regimes, including homogeneous charge compression ignition (HCCI) and other modes of low-temperature combustion and lean-burn gasoline operation, is aimed at realizing this potential.

Benefits

The Advanced Combustion Engine R&D subprogram contributes to VTP 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: After successfully meeting the engine thermal efficiency goal of 45 percent for passenger vehicles, the goal will emphasize the use of these engines to improve the vehicle fuel economy over a real-world driving cycle:
- Increase the efficiency of internal combustion engines resulting in fuel economy improvements of 25 percent for gasoline vehicles and 40 percent for diesel vehicles by 2015.

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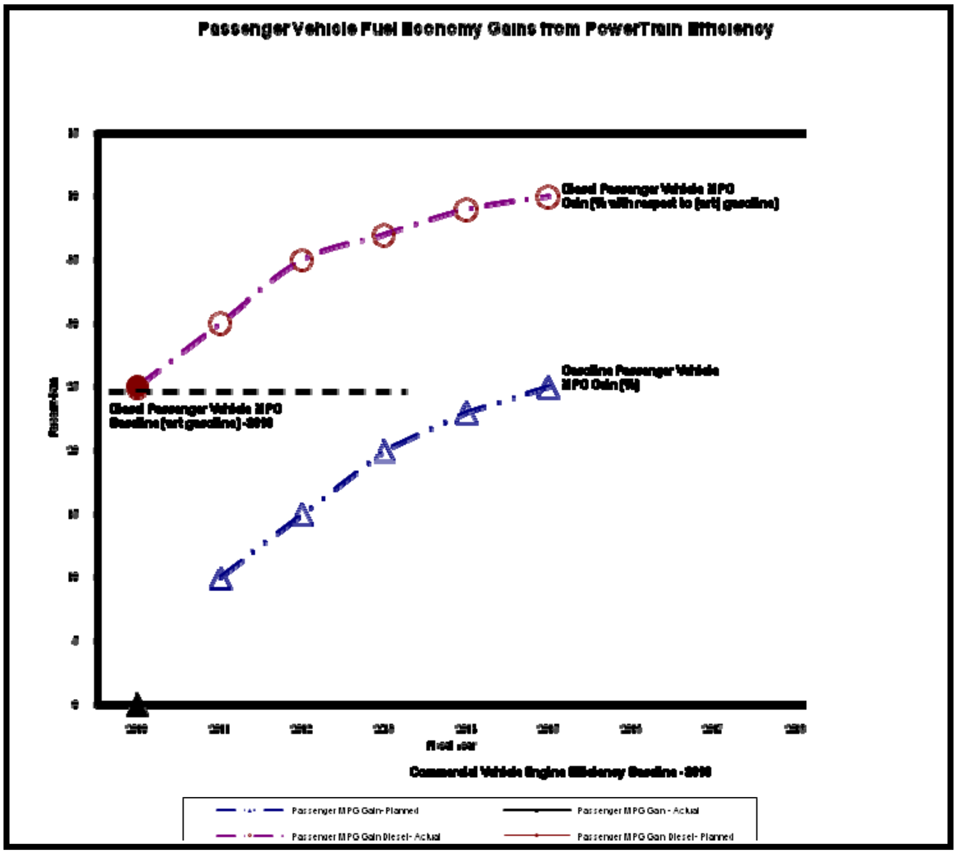
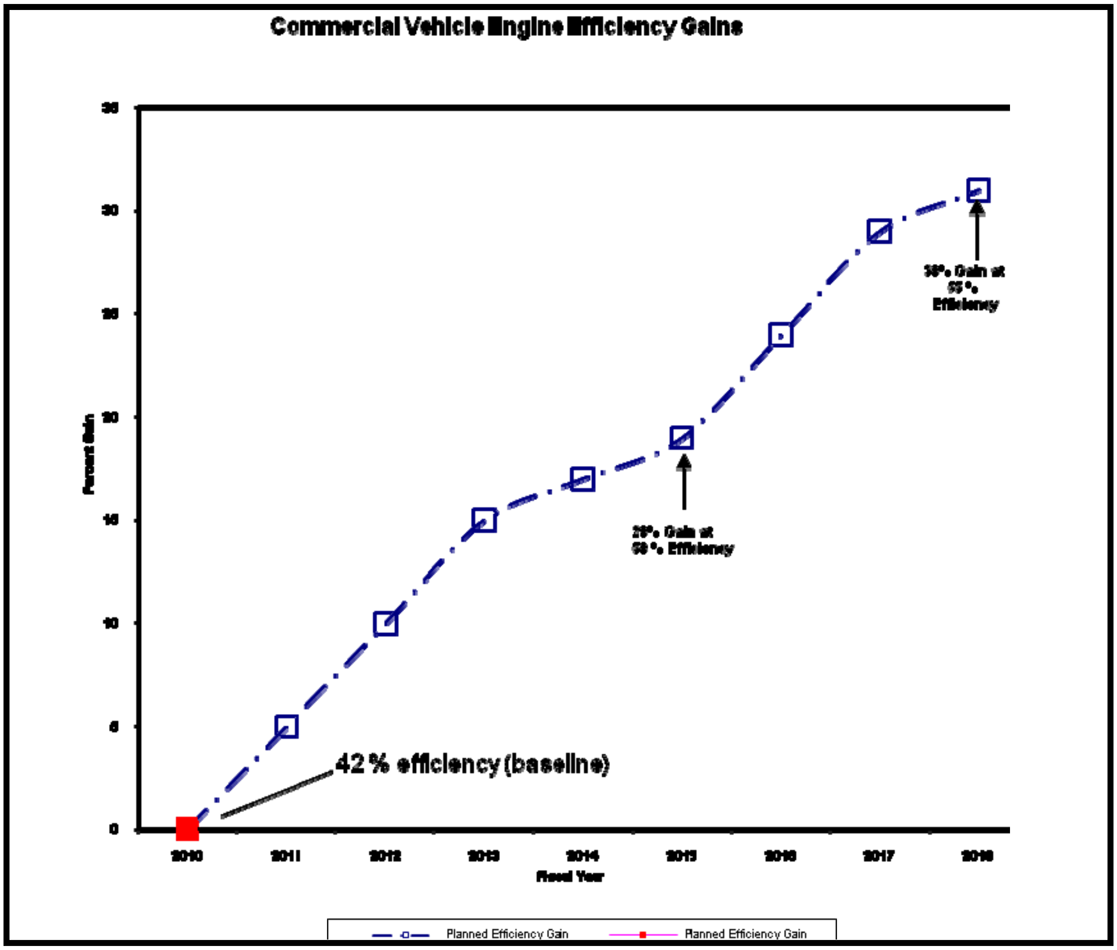
[a] In FY 2009, $1,020,000 was transferred to the SBIR program and $122,400 to the STTR program.

- Commercial vehicles: Increase the efficiency of internal combustion engines from 42 percent (2010 baseline) to 50 percent (20 percent improvement) by 2015, and further improve engine efficiency to 55 percent by 2018 with demonstrations on commercial vehicle platforms. The passenger and commercial vehicle goals will be met while utilizing advanced fuel formulations that incorporate a non-petroleum based blending agent to reduce petroleum dependence and enhance combustion efficiency.
- Solid State Energy Conversion: Increase the efficiency of thermoelectric generators to convert waste heat to electricity from eight percent to greater than 15 percent by 2015.

Progress is indicated by efficiency of passenger and commercial vehicle internal combustion engines and is shown graphically below.





Note: Efficiency gain in percent relative to FY 2010 baseline of 42 percent efficiency.

Detailed Justification

(dollars in thousands)

	FY 2009	FY 2010	FY 2011
Combustion and Emission Control	**35,089**	**47,239**	**47,239**

Combustion and Emission Control research supports the VTP goal of enabling energy-efficient, clean vehicles powered by advanced internal combustion engines using clean, petroleum- and non-petroleum-based fuels and hydrogen. This activity develops technologies for advanced engines with the goal of improving thermal efficiency by optimizing combustion, fuel injection, air handling, emission control, and waste heat recovery systems, along with reducing friction and pumping losses, while ensuring that no new toxic air emissions are generated. The activity will be closely coordinated with VTP's Fuels Technology subprogram as different fuel characteristics and reduced property variability may be needed to meet the goals.

This activity focuses on developing cost-competitive technologies for passenger and commercial vehicle engines operating in advanced combustion regimes, including HCCI and other modes of low-temperature combustion (LTC), which will increase efficiency beyond current advanced diesel levels and further reduce engine-out emissions of NO_x and particulate matter (PM) to near-zero levels. After successfully meeting the engine thermal efficiency goal of 45 percent for passenger vehicles in FY 2010, the goal for 2015 will emphasize increasing the efficiency of internal combustion engines resulting in fuel economy improvements over real-world driving cycles.

Meeting anticipated future emission standards will be challenging for high efficiency diesel and lean-burn gasoline engines. To address this issue, research on innovative emission control strategies will be pursued through National Laboratory 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 2011, the Combustion and Emission Control activity will continue emphasis on R&D of advanced combustion engines that can achieve VTP's fuel economy 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 2010 for passenger vehicle advanced power-train systems targeting a 25 to 40 percent improvement in vehicle fuel economy by 2015. The activity will continue to fund awards from the FY 2010 solicitation to work in partnership with the commercial vehicle industry to incorporate advanced engine technologies capable of demonstrating 50 percent thermal efficiency and a 20 percent fuel economy improvement in a Class 8 truck by 2015. The Recovery Act provided approximately $80 million to integrate and demonstrate these advanced technologies in Class 8 long-haul trucks. These Recovery Act projects promise to expedite the commercialization of advanced heavy duty vehicle technology. 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, 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.

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 (IC) engine research focused on overcoming barriers to the development of high-efficiency, hydrogen-fueled IC engine technology in coordination with EERE's Hydrogen and 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 2010 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.

In FY 2011, the final year of the Advanced Collaborative Emissions Study (ACES) contract, VTP will continue to support the generation and characterization of 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 emissions samples for ACES. These characterized engine emissions have been routed to expose animals (rats and mice) beginning in FY 2009 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	**4,568**	**8,748**	**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 and provide cooling/heating for vehicle interiors. Thermoelectric generators can directly convert a nominal 1kW of electric power from engine waste heat for passenger vehicles and up to 5kW for commercial vehicles.

In FY 2011, the activity will continue to fund cost-shared cooperative agreements (typically three to five years in duration) awarded to industry and academia in FY 2009 and FY 2010 to develop and fabricate high-efficiency thermoelectric generators to produce electricity from waste heat and thermoelectric air conditioner/heaters to replace current R134-a gas air conditioners in passenger and commercial vehicles. These awards will fund research for advanced thermoelectric materials including segmented or nano-modified bulk materials and other high-efficiency materials that have shown potential for greater than 20 percent efficiency in laboratory evaluations. The activity will also investigate scaling up production of thermoelectric modules for demonstration in vehicle applications with the potential to improve vehicle fuel economy by up to 10 percent.

The activity will continue research on advanced thermoelectric materials and scale-up for demonstration in 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**	**1,613**	**1,613**

In FY 2009, $1,020,000 was transferred to the SBIR program and $122,400 was transferred to the STTR program. The FY 2010 and 2011 amounts shown are estimated requirements for the continuation of the SBIR and STTR programs.

Total, Advanced Combustion Engine R&D	**39,657**	**57,600**	**57,600**

Explanation of Funding Changes

	FY 2011 vs. FY 2010 ($000)
Combustion and Emission Control	
No change.	0
Solid-State Energy Conversion	
No change.	0
SBIR/STTR	
No change.	0
Total Funding Change, Advanced Combustion Engine R&D	**0**

Materials Technology
Funding Schedule by Activity

(dollars in thousands)

	FY 2009	FY 2010	FY 2011
Materials Technology			
Propulsion Materials Technology	10,742	12,989	12,989
Lightweight Materials Technology	22,374	30,652	30,652
High Temperature Materials Laboratory	5,670	5,662	5,662
SBIR/STTR	0 [a]	1,420	1,420
Total, Materials Technology	38,786	50,723	50,723

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 all of the efficiency goals (PHEV, combustion etc.) undertaken by VTP. 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 VTP goals 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. For a mid-sized or larger vehicle, every 10 percent reduction in a vehicle's weight could result in a six to eight percent increase in vehicle fuel economy.[b]

The following goal of the Materials Technology subprogram can contribute to meeting national energy security, environmental, and economic objectives:

- By 2015, validate (to within 10 percent uncertainty) the cost-effective reduction of the weight of passenger vehicle body and chassis systems by 50 percent with safety, performance, and recyclability comparable to 2002 vehicles.

This is a broader goal than the previous subprogram goals of reducing the projected mass-production price of carbon-fiber materials to $3 per pound or simply reducing vehicle weight without simultaneously demonstrating cost, safety and performance. 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.

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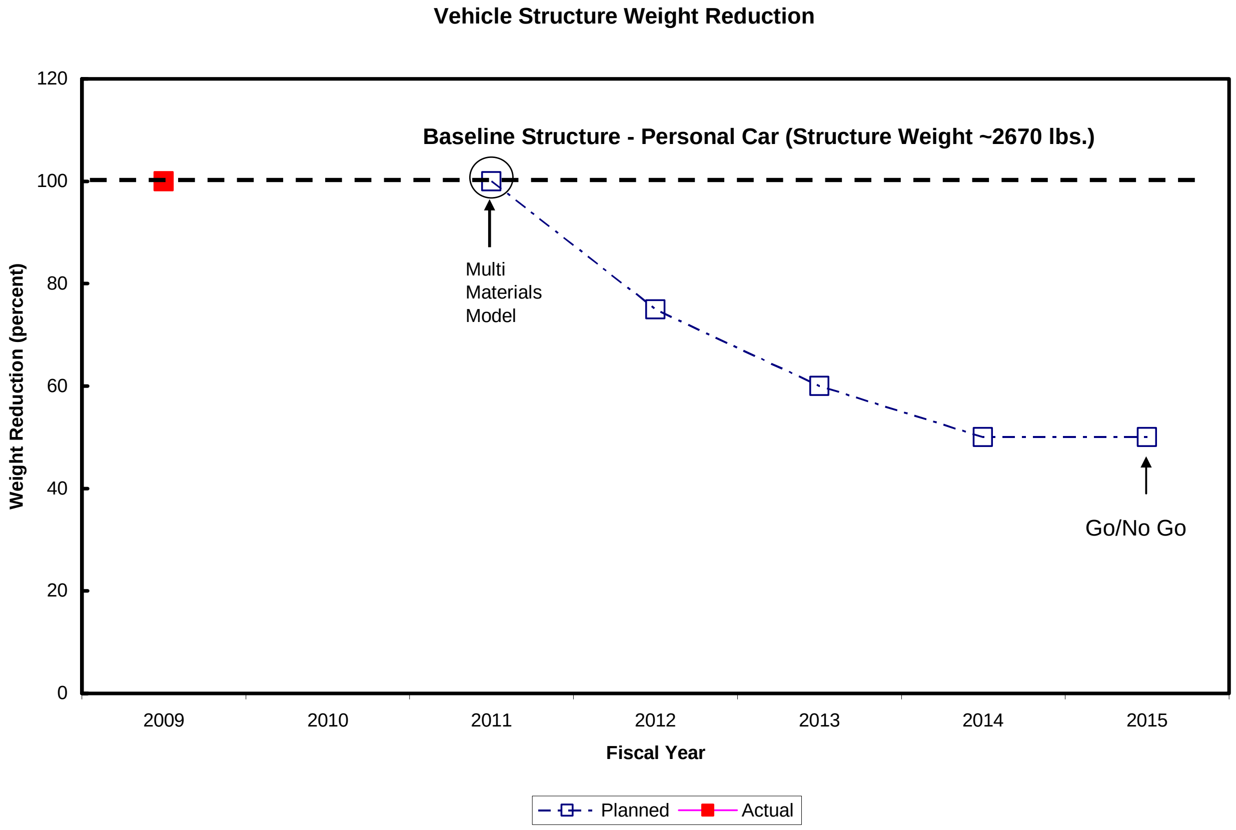
[a] In FY 2009, $997,575 was transferred to the SBIR program and $119,709 to the STTR program.

[b] Argonne National Laboratory PSAT analysis, 2008.



Note: 2009 value is baseline

Detailed Justification

(dollars in thousands)

	FY 2009	FY 2010	FY 2011
Propulsion Materials Technology	**10,742**	**12,989**	**12,989**

The Propulsion Materials Technology key activity will conduct R&D on improved materials that will enable the development of highly efficient propulsion systems for advanced passenger cars and commercial vehicles operating on a combination of conventional and non-petroleum fuels and electricity. Improved propulsion materials are critical for the performance and cost targets of advanced technologies being developed by VTP.

In FY 2011, research efforts will support three VTP teams: 1) Advanced Combustion Engines; 2) Fuels; and 3) Hybrid Electric Systems to achieve energy efficiency improvements and petroleum displacement goals. Researchers 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 in support of advanced combustion engine efforts. In cooperation with the VTP fuels team, researchers will identify and mitigate interaction issues between new fuel formulations and engine component materials. Materials will be developed to improve the performance of energy recovery systems such as turbo-compounding and solid state thermoelectric devices. Efforts to develop materials for hybrid-and electric-drive components will target domestic magnetic materials for drive motors, high-temperature power electronics, and life cycle improvements to advanced batteries through the development of materials recycling and recovery techniques. All activities include technology transfer components to communicate results to industry, accelerating deployment of beneficial technologies.

Lightweight Materials Technology **22,374** **30,652** **30,652**

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 R&D and validation of materials needed to meet the goal of 50 percent body and chassis weight reduction, as well as designing and manufacturing components and structures from these materials. The objective is to lower the potential costs and cost uncertainties of advanced materials to achieve the FY 2015 goal of cost neutrality.

In FY 2011, funding will continue to 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. One focus will be on completion of a detailed design and cost model for a multi-materials vehicle (MMV) to be used for validation assessments in FY 2012-2014.

High Temperature Materials Laboratory (HTML) **5,670** **5,662** **5,662**

FY 2011 funding continues support of the HTML and the HTML user program, focused 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 maintains 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, and academia for use in solving complex materials problems, at nominal or no cost, especially small businesses. Activities include the investigation and determination of the composition, structure, physical and chemical properties and performance characteristics of metals, alloys, ceramics, composites, and novel nano-phase materials under development for vehicle applications. Recently added new analytical capabilities at the HTML include: instruments to characterize the properties and performance of new high efficiency thermoelectric materials (e.g., Seebeck Coefficient), deployment of an intense neutron flux diffractometer 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.

	(dollars in thousands)		
	FY 2009	FY 2010	FY 2011
SBIR/STTR	**0**	**1,420**	**1,420**

In FY 2009, $997,575 was transferred to the SBIR program and $119,709 was transferred to the STTR program. The FY 2010 and 2011 amounts shown are estimated requirements for the continuation of the SBIR and STTR programs.

Total, Materials Technology	**38,786**	**50,723**	**50,723**

Explanation of Funding Changes

	FY 2011 vs. FY 2010 ($000)
Propulsion Materials Technology	
No change.	0
Lightweight Materials Technology	
No change.	0
High Temperature Materials Laboratory (HTML)	
No change.	0
SBIR/STTR	
No change.	0
Total Funding Change, Materials Technology	**0**

Fuels Technology
Funding Schedule by Activity

	(dollars in thousands)		
	FY 2009	FY 2010	FY 2011
Fuels Technology			
Advanced Petroleum Based Fuels (APBF)	5,808	6,780	0
Non-Petroleum Based Fuels and Lubricants (NPBFL)	13,752	16,641	10,692
SBIR/STTR	0 [a]	674	308
Total, Fuels Technology	19,560	24,095	11,000

Description

Fuels and lubricants are complex mixtures of thousands of chemical compounds. Because modern engines and emissions-control systems are precisely tuned for high performance and low emissions, they are much more sensitive to variations in fuel and lubricant constituents than older engines. In addition, nonconventional fuels often burn differently than their conventional counterparts, which can affect the performance and longevity of the engine or emissions-control systems.

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 are likely to accentuate the problem of increased sensitivity to fuel composition in the future. Already, different fuels meeting the same specifications can have a widely varying impact on engine performance and emissions. For future advanced technology engines such as those being developed in the Advanced Combustion Engine subprogram, fuel composition determines whether engines will operate in the desired regimes, and also strongly influences the combustion rate, combustion control, cycle-to-cycle consistency, and emissions. Thus, fuel formulation has a substantial impact on the ability to fully exploit and implement these regimes in emerging engine technologies. Future refinery feedstocks are likely to be increasingly derived from non-conventional sources such as 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 VTP to develop more energy-efficient and environmentally friendly highway transportation vehicles that enable the U.S. to use less petroleum. It enables advanced combustion regime engines and emission control systems to operate efficiently while meeting future emission standards. Non-petroleum fuels also reduce reliance on petroleum through direct fuel substitution.

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[a] In FY 2009, $503,650 was transferred to the SBIR program and $59,278 to the STTR program.

Detailed Justification

(dollars in thousands)

	FY 2009	FY 2010	FY 2011
Advanced Petroleum Based Fuels (APBF)	**5,808**	**6,780**	**0**

In FY 2011, APBF will discontinue studies on the impact of lubricants on emissions from conventional vehicles; studies on the influence of petroleum-based fuels and fuel composition on advanced combustion regimes; and will cease development of computer models for the chemical kinetics of fuels that supported computer aided engine design. These conventional fuels-related activities are being discontinued to focus on higher priority technologies for transportation electrification, including advanced batteries, power electronics, and electric motors for hybrid and plug-in hybrid vehicles, as well as deployment activities to develop infrastructure for increased use of these technologies. Future requirements will be assessed and included as appropriate.

Non-Petroleum Based Fuels and Lubricants (NPBFL)	**13,752**	**16,641**	**10,692**

The NPBFL activity formulates and evaluates non-petroleum-based fuels and lubricants that can be used as neat (pure) alternative fuels or as primary constituents of transportation fuels. Biomass-based renewable fuels and bio-synthetic fuels are emphasized. Specific areas being investigated include fuel quality and stability; detailed chemical composition and its relationship to fuel bulk properties; the effect of physical and chemical properties on engine performance and emissions; and safety associated with storage, handling, and toxicity.

In FY 2011, 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. These activities are undertaken in close coordination with the Advanced Combustion Engine R&D subprogram.

SBIR/STTR	**0**	**674**	**308**

In FY 2009, $503,650 was transferred to the SBIR program and $59,278 was transferred to the STTR program. The FY 2010 and 2011 amounts shown are estimated requirements for the continuation of the SBIR and STTR programs.

Total, Fuels Technology	**19,560**	**24,095**	**11,000**

Explanation of Funding Changes

	FY 2011 vs. FY 2010 ($000)
Advanced Petroleum Based Fuels (APBF)	
In FY 2011, activities related to conventional fuels will be discontinued due to a shift in emphasis to higher priority transportation technologies, including transportation electrification.	-6,780
Non-Petroleum Based Fuels (NPBF)	
Testing of intermediate ethanol blended fuels is expected to be completed in FY 2010, and no further evaluations are anticipated. E-85 optimized engine activities are also expected to conclude in FY 2010. FY 2011 efforts will continue studies of the effects of synthetic and renewable fuels on the performance and emissions of advanced combustion engines.	-5,949
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.	-366
Total Funding Change, Fuels Technology	**-13,095**

Outreach, Deployment & Analysis
(Formerly Technology Integration)
Funding Schedule by Activity

(dollars in thousands)

	FY 2009	FY 2010	FY 2011
Outreach, Deployment & Analysis (Formerly Technology Integration)			
Graduate Automotive Technology Education (GATE)	950	1,000	1,000
Advanced Vehicle Competitions	1,750	2,000	2,000
Education	4,200[a]	0 [b]	0
Safety and Code and Standards	12,238[a]	0 [b]	0
Legislative and Rulemaking	1,804	2,004	2,004
Vehicle Technologies Deployment	25,000	25,510	35,510
Biennial Peer Reviews	500	2,700	500
SBIR/STTR	0 [c]	0	0
Total, Outreach, Deployment & Analysis (Formerly Technology Integration)	46,442	33,214	41,014

Description

EERE proposes to rename the Technology Integration subprogram to Outreach, Deployment & Analysis, which better reflects the nature of the subprogram's activities.

The Outreach, Deployment & Analysis 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 VTP 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. VTP works with public/private partnerships between DOE and local coalitions of key stakeholders across the country (such as Clean Cities) to implement strategies and projects that displace petroleum. In addition, the annual DOE/EPA Fuel Economy Guide publication and related data dissemination efforts (required by law) are produced, along with the website www.fueleconomy.gov.

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[a] In FY 2009, the Education and Safety and Codes & Standards activities were transferred from the HFCT Program to VTP.

[b] In FY 2010, the Education and Safety and Codes & Standards activities were transferred from VTP back to the HFCT Program as part of a reprioritization of hydrogen and fuel cell related R&D.

[c] In FY 2009, $234,375 was transferred to the SBIR program and $28,125 to the STTR program.

Activities such as the Advanced Vehicle Competitions and Graduate Automotive Technology Education (GATE) encourage the interest of university student engineers and engage their participation in advanced technology development. This helps address the need for more highly trained engineers in hybrid and fuel cell technologies to overcome barriers in the marketplace. GATE also supports a pipeline into the auto industry of new engineers familiar with the most advanced technologies.

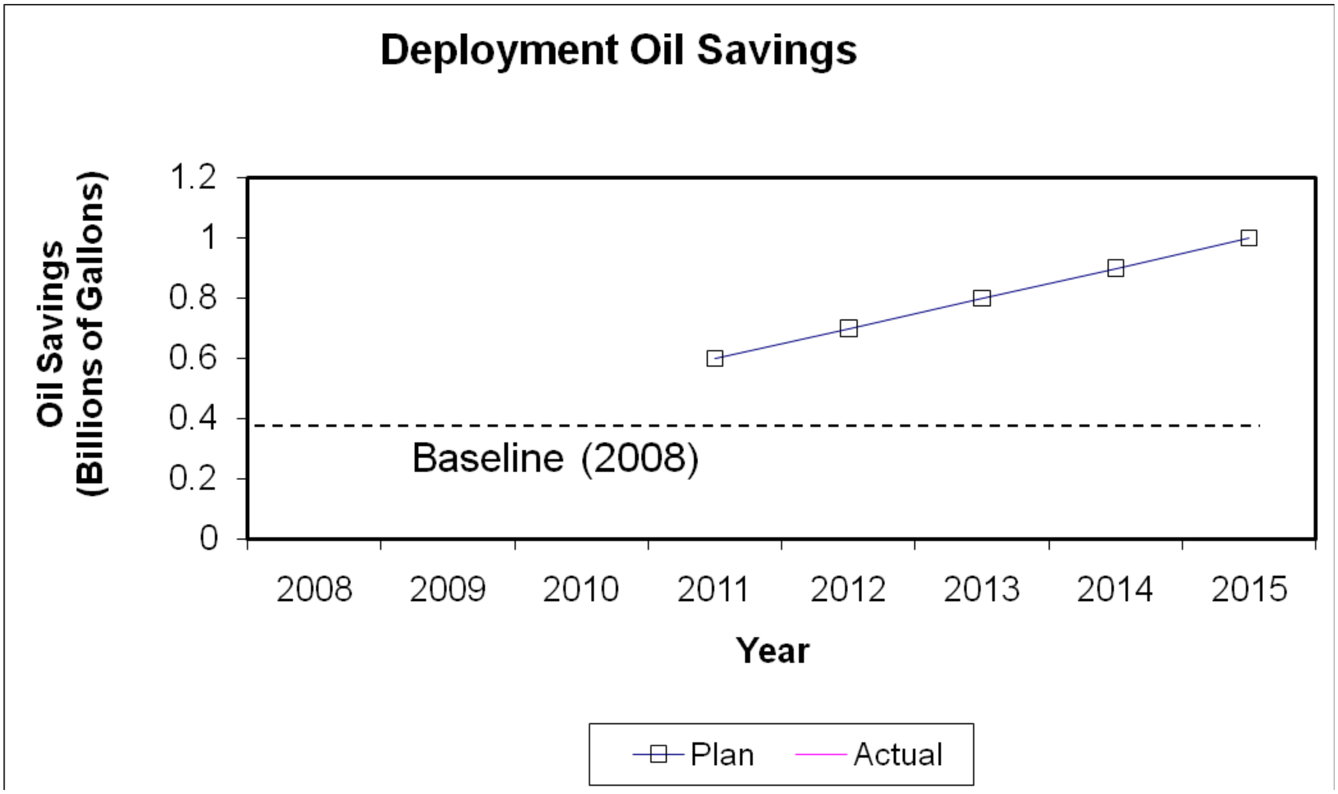
The Legislative and Rulemaking activity implements a variety of statutory responsibilities placed on DOE by EPAct 2005 and other legislation. The main responsibilities include oversight and regulation of the requirements for States and alternative-fuel providers to operate AFV vehicle fleets.

Benefits

The Outreach, Deployment & Analysis subprogram contributes directly to VTP'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. A key goal of the subprogram is to:

- Achieve a petroleum reduction of 2.5 billion gallons per year by 2020 through the adoption of alternative fuel vehicles and infrastructure.

The progress indicator for this goal is shown below.



Applied R&D benefits are not parsed to individual subprograms because of the interdependency of the R&D and technologies within the program. VTP continually assesses and draws from feedback, new information and advances among science, research, technologies and key market elements to accelerate the benefits of technology development and adoption.

Detailed Justification

	(dollars in thousands)		
	FY 2009	FY 2010	FY 2011
Graduate Automotive Technology Education (GATE)	**950**	**1,000**	**1,000**

In FY 2011, this activity will fund competitively selected GATE Centers of Excellence to develop new curricula and provide research fellowships for approximately 30 students for research in advanced automotive technologies, and release a solicitation to compete the selection of the next round of GATE Centers of Excellence. This activity will be coordinated with RE-ENERGYSE. 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	**1,750**	**2,000**	**2,000**

In FY 2011, the Advanced Vehicle Competitions activity will conduct the third year of the EcoCAR: the NeXt Challenge Student Competition Series. 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 2011 the program will also continue planning and select the participating schools 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**	**0**	**0**

In FY 2010, the Education activity transferred from VTP to the Hydrogen and Fuel Cell Technologies Program as part of a reprioritization of fuel cell and hydrogen-related work.

Safety and Codes & Standards	**12,238**	**0**	**0**

In FY 2010 the Safety and Codes & Standards activity was transferred from VTP to the Hydrogen and Fuel Cell Technologies Program as part of a reprioritization of fuel cell and hydrogen-related work.

Legislative and Rulemaking	**1,804**	**2,004**	**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 impacts of other regulatory and pending legislative activities, and the implementation of legislative changes to the EPAct fleet activities as they occur. The fleet programs require selected covered fleets to procure passenger AFVs annually. DOE reviews and processes petitions to designate new alternative fuels under EPAct. In addition, these funds may be used to support efforts such as peer reviews; data collection and dissemination; and technical, market, economic, and other analyses.

(dollars in thousands)

	FY 2009	FY 2010	FY 2011
Vehicle Technologies Deployment	**25,000**	**25,510**	**35,510**

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 will also continue efforts to provide technical assistance for early adopters of technologies, and provide training and workshops to coalitions, public safety officials, and stakeholders related to infrastructure development and targeted niche market opportunities that include: transit, refuse trucks, school bus, delivery trucks, and municipal fleets.

Section 405 of EPAct 1992 and Sections 721, 1001, and 1004 of EPAct 2005 direct DOE to:

- Expand consumer education,
- Promote technology transfer, and
- Address implementation barriers.

VTP will identify and support opportunities to showcase the technology focus areas and continue to build national and regional alliances to promote petroleum reduction strategies and will support further expansion of 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 website (www.fueleconomy.gov) 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.

The Recovery Act provided more than $298 million for Clean Cities projects to speed the transformation of the Nation’s vehicle fleet through a range of energy efficient and advanced vehicle technologies, as well as refueling infrastructure for various alternative fuel vehicles, and public education and training initiatives.

FY 2011 funding includes $20 million for support of transportation electrification-related infrastructure activities. These efforts include market analysis that will identify communities and regions where aggressive infrastructure deployment efforts will have the greatest chances for success and determine which technologies and vehicle charging systems are market ready, practical, and safe for widespread introduction. Technical and financial assistance programs will be developed to accelerate the introduction of these technologies, and targeted consumer education and outreach efforts will focus on helping drivers and fleet operators choose electric-drive vehicles and charging systems that best suit their needs while also training the support-service providers that will be needed to install, maintain, and repair these systems. Activities supporting codes and standards that facilitate the introduction of

	(dollars in thousands)		
	FY 2009	FY 2010	FY 2011

electric drive vehicles and infrastructure will also be conducted.

Biennial Peer Reviews	**500**	**2,700**	**500**

Funding is used to conduct reviews of the government/industry partnerships by an independent third party, such as the NAS/National Academy of Engineering, to evaluate the progress and direction of the program. Reviews will include evaluation of progress toward achieving the technical and program goals supporting each partnership, as well as an assessment of the appropriateness of Federal investment in each of the activities. Based on evaluations, resource availability, and other factors, the partners will consider new opportunities, make adjustments to technology specific targets, and set goals as appropriate.

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

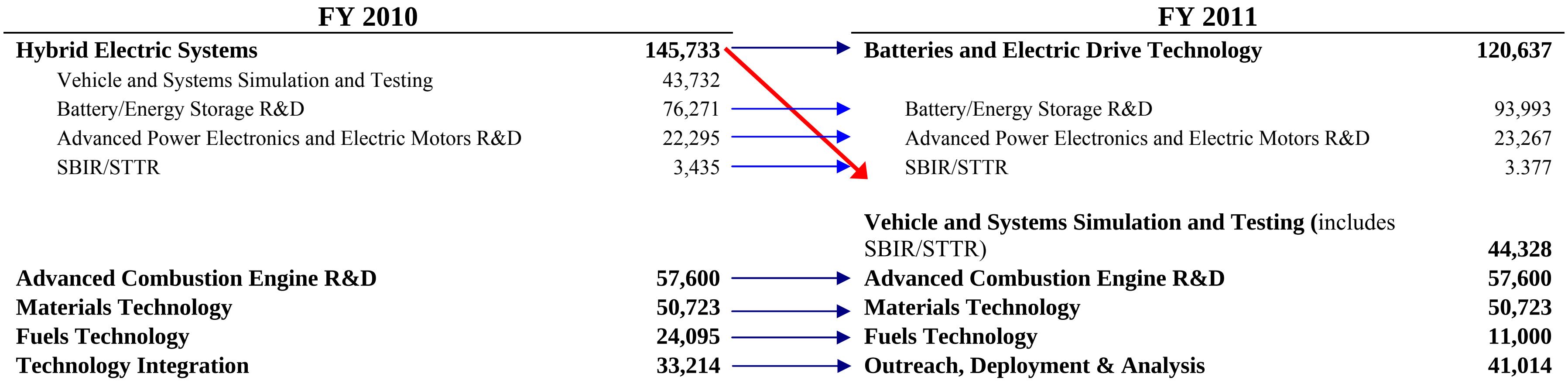
In FY 2009, $234,375 was transferred to the SBIR program and $28,125 was transferred to the STTR program (from the Safety and Codes & Standards activity). In FY 2010 and FY 2011, no funding is expected to be transferred to the SBIR and STTR programs.

Total, Outreach, Deployment & Analysis (formerly Technology Integration)	**46,442**	**33,214**	**41,014**

Explanation of Funding Changes

	FY 2011 vs. FY 2010 ($000)
Graduate Automotive Technology Education (GATE)	
No change.	0
Advanced Vehicle Competitions	
No change.	0
Education	
No change.	0
Safety and Codes & Standards	
No change.	0
Legislative and Rulemaking	
No change.	0
Vehicle Technology Deployment	
Increased funding will provide additional support for transportation electrification-related infrastructure deployment activities, including determining which technologies and vehicle charging systems are market-ready, practical, and safe for widespread introduction. These efforts will include market analysis, technical and financial assistance, codes and standards development, and targeted consumer education and outreach activities.	+10,000
Biennial Peer Reviews	
FY 2010 funding was provided for a one-time comprehensive analysis of energy use within the light duty vehicle transportation sector, thus no funds are requested. Funds requested for regularly scheduled peer reviews remain level with previous years.	-2,200
SBIR/STTR	
No change.	0
Total Funding Change, Outreach, Deployment & Analysis (Formerly Technology Integration)	**+7,800**

Vehicle Technologies FY 2010 - FY 2011 Crosswalk



FY 2010		FY 2011	
Hybrid Electric Systems	**145,733**	**Batteries and Electric Drive Technology**	**120,637**
Vehicle and Systems Simulation and Testing	43,732		
Battery/Energy Storage R&D	76,271	Battery/Energy Storage R&D	93,993
Advanced Power Electronics and Electric Motors R&D	22,295	Advanced Power Electronics and Electric Motors R&D	23,267
SBIR/STTR	3,435	SBIR/STTR	3.377
		Vehicle and Systems Simulation and Testing (includes SBIR/STTR)	**44,328**
Advanced Combustion Engine R&D	**57,600**	**Advanced Combustion Engine R&D**	**57,600**
Materials Technology	**50,723**	**Materials Technology**	**50,723**
Fuels Technology	**24,095**	**Fuels Technology**	**11,000**
Technology Integration	**33,214**	**Outreach, Deployment & Analysis**	**41,014**

Building Technologies
Funding Profile by Subprogram

(dollars in thousands)

	FY 2009 Current Appropriation[a]	FY 2009 Current Recovery Act Appropriation	FY 2010 Current Appropriation	FY 2011 Request
Building Technologies				
Residential Buildings Integration	21,900	68,052	40,000	39,000
Commercial Buildings Integration	32,057	85,552	39,000	39,000
Emerging Technologies	42,896	121,522	86,000	92,698
Technology Validation and Market Introduction	21,260	29,313	22,000	20,000
Equipment Standards and Analysis	20,000	14,747	35,000	40,000
Total, Building Technologies	138,113	319,186	222,000[b]	230,698

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 of 1992"
P.L. 109-58, "Energy Policy Act of 2005"
P.L. 110-140, "Energy Independence and Security Act of 2007"

Mission

The mission of the Building Technologies Program (BTP) is to change the landscape of energy demand in homes and buildings through energy productivity and increased use of clean, secure energy, which will lower greenhouse gas (GHG) emissions, foster economic prosperity and increase National energy security. BTP 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.

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[a] SBIR/STTR funding transferred in FY 2009 was $1,685,000 for the SBIR program and $202,000 for the STTR program.

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

Benefits

Buildings account for more than 70 percent of the electric energy consumed in the U.S.[a] BTP 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 both new and existing residential and commercial buildings. BTP strives to make buildings net zero energy buildings (ZEB), a building that can generate an equal or greater amount of energy than it consumes from the grid through a combination of on site renewable energy and increased efficiency. ZEB can be achieved by taking a whole buildings approach through the systems integration of state-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 based upon technology and product advances that frequently include technology R&D. TVMI activities catalyze the introduction of new advanced technologies and the widespread use of highly efficient technologies already in the market.

In addition, BTP's progress depends upon the coordination of other EERE program efforts including: the Solar Buildings Initiative, which will accelerate the R&D and large scale commercialization of distributed photovoltaic (PV) technology for buildings to achieve ZEB; the Weatherization and Intergovernmental Program (WIP), which will provide consumers and other decision makers with information on cost, performance, and financing of energy efficiency projects; and the Federal Energy Management Program (FEMP), which 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 emissions.[b] BTP 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 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 1.5 gigatons of CO_2 by 2030 and more than 7 gigatons of CO_2 by 2050.

Energy Security

Advanced efficiency technologies can reduce oil use, making the Nation less vulnerable to oil supply disruptions or price spikes. R&D activities in advanced envelope and windows technologies 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.[c] By reducing

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[a] U.S. DOE Energy Efficiency and Renewable Energy, *2009 Buildings Energy Databook.* November 2009: http://buildingsdatabook.eren.doe.gov/Default.aspx.

[b] Ibid.

[c] Ibid.

heating load, reducing demand through efficiency, and replacing petroleum with renewables as the source of space heat, BTP reduces domestic dependence on petroleum. Achievement of the program's goals is expected to displace 0.26 million barrels of imported oil in 2030 (see Primary Metrics for FY 2011 table below). This will in turn, lower GHG, provide clean, secure energy, and stimulate economic prosperity.

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 BTP 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 provide benefits to electricity consumers. Savings experienced by power companies might also be used to modernize the electric grid and on other needed energy infrastructure investments.

BTP projects accelerate deployment of energy efficient retrofits by improving the technology available to retrofit existing buildings, helping Americans save money on their electric bills and lowering GHG emissions. Achieving BTP's goals of reducing the cost of advanced building technologies and homeowner energy bills will permit consumers to use these saved dollars elsewhere, stimulating other parts of the economy, and could result in cumulative net consumer savings of nearly $300 billion by 2030 and $1.2 trillion by 2050. In addition, cumulative savings to the electric power industry are expected to be near $200 billion by 2030 and almost $600 billion by 2050 (see Primary Metrics for FY 2011 table below).

The proposed FY 2011 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 existing buildings. The Recovery Act Projects will accelerate the development of technologies, techniques, and tools that will make buildings more energy efficient and affordable. Specifically, it supports the current BTP goals of creating technologies and design approaches that lead to marketable ZEH by 2020, zero energy commercial buildings by 2025, and will make America's existing housing stock more efficient through application of new retrofit technologies.

Recovery Act projects allow for continued advancement of R&D to bolster the efficiency of new homes, which acts as a barrier to market penetration of efficient technologies. In addition, Recovery funds will allow BTP to expand its network of "Commercial Building Partners", which are companies or organizations that design, build, own, manage, or operate large fleets of buildings. These Commercial Building Partners commit to achieving exemplary energy performance in selected projects for both new buildings and in selected existing buildings and set standards within their industries for efficient commercial buildings. The Recovery Act also supports State implementation and adoption of building energy codes.

FY 2011 activities will build upon historic clean energy investments in the Recovery Act to further the Nation's energy goals through sustained technology innovation and continued investments in enabling infrastructure. This integrated targeted performance builds on both Recovery and RD&D will enable the realization of Administration's goals and commitments to energy, the economy and climate. 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 BTP's goals. These benefits are achieved by targeted Federal investments in technology R&D 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 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 BTP goals. The benefits are generated by modeling both the program goal and baseline cases[a] within two energy-economy models: NEMS-GPRA11 for benefits through 2030, and MARKAL-GPRA11 for benefits through 2050. The following tables display the full list of modeled benefits.

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[a] Baseline cases utilize data from the updated *Annual Energy Outlook 2009* Reference Case Service Report, April 2009.

FY 2011 Primary Metrics

	Metric	Model	Year			
			2015	2020	2030	2050
Energy Security	Oil Imports Reduction, cumulative (Bil bbl)	NEMS	ns	0.09	0.26	N/A
		MARKAL	ns	ns	ns	ns
	Natural Gas Imports Reduction, cumulative (Tcf)	NEMS	ns	0.40	2.38	N/A
		MARKAL	ns	0.60	7.64	29.0
Environmental Impacts	CO_2 Emissions Reduction, cumulative (Mil mtCO_2)	NEMS	ns	296	1481	N/A
		MARKAL	199	660	2174	7746
	SO_2 Allowance Price Reduction ($/ton)	NEMS	ns	ns	ns	N/A
		MARKAL	N/A	N/A	N/A	N/A
	NO_x Allowance Price Reduction ($/ton)	NEMS	ns	ns	ns	N/A
		MARKAL	N/A	N/A	N/A	N/A
Economic Impacts	Primary Energy Savings, cumulative (quads)	NEMS	1.3	6.4	26	N/A
		MARKAL	ns	10.6	36	126
	Oil Savings, cumulative (Bil bbl)	NEMS	ns	0.1	0.5	N/A
		MARKAL	0.01	0.06	0.22	0.45
	Consumer Savings, cumulative (Bil $)	NEMS	13	70	272	N/A
		MARKAL	52	158	422	1190
	Electric Power Industry Savings, cumulative (Bil $)	NEMS	24	70	231	N/A
		MARKAL	20	66	188	597
	Household Energy Expenditures Reduction ($/household/yr)	NEMS	30	90	180	N/A
		MARKAL	92	176	237	397

- “Reductions” and “savings” are calculated as the difference between results from the baseline case (i.e. no future DOE funding for this technology) and the program case (i.e. requested DOE funding for this technology is received and is successful).
- Oil impacts are shown as two metrics. "Oil Imports Reduction" refers only to reductions in oil imports; "Oil Savings" refers to savings (reduction) in total oil consumption.
- All cumulative metrics are based on results beginning in 2011.
- All monetary metrics are in 2007$.
- Cumulative monetary metrics are in 2007$ that are discounted to 2011 using a 3% discount rate.

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

FY 2011 Secondary Metrics

	Metric	Model	Year			
			2015	2020	2030	2050
Energy Security	Oil Imports Reduction, annual (Mbpd)	NEMS	ns	0.03	0.06	N/A
		MARKAL	ns	ns	ns	ns
	Natural Gas Imports Reduction, annual (Tcf)	NEMS	0.01	0.15	0.16	N/A
		MARKAL	ns	0.24	0.91	1.78
	MPG Improvement (%)	NEMS	ns	ns	ns	N/A
		MARKAL	ns	ns	ns	ns
Environmental Impacts	CO2 Emissions Reduction, annual (Mil mtCO2/yr)	NEMS	ns	76.2	155	N/A
		MARKAL	71	113	174	361
	CO_2 Intensity Reduction of US Economy (Kg CO2/$GDP)	NEMS	ns	ns	0.01	N/A
		MARKAL	0.01	0.01	0.01	0.01
	CO_2 Intensity Reduction of US Power Sector (Kg CO2/kWh)	NEMS	ns	ns	ns	N/A
		MARKAL	ns	ns	ns	ns
	CO_2 Intensity Reduction of US Transportation Sector (Kg CO2/mile)	NEMS	ns	ns	ns	N/A
		MARKAL	ns	ns	ns	ns
Economic Impacts	Primary Energy Savings, annual (quads/yr)	NEMS	0.50	1.31	2.70	N/A
		MARKAL	ns	1.9	3.1	5.6
	Oil Savings, annual (Mbpd)	NEMS	ns	0.04	0.16	N/A
		MARKAL	0.01	0.04	0.09	0.02
	Consumer Savings, annual (Bil $)	NEMS	6.8	21	42	N/A
		MARKAL	19	32	55	107
	Electric Power Industry Savings, annual (Bil $)	NEMS	7.9	15	34	N/A
		MARKAL	8.4	13	24	59
	Energy Intensity of US Economy (energy/$GDP)	NEMS	0.07	0.11	0.16	N/A
		MARKAL	ns	0.13	0.17	0.20
	Net Energy System Cost Reduction, cumulative (Bil $)	NEMS	N/A	N/A	N/A	N/A
		MARKAL	47	178	570	1585

- "Reductions" and "savings" are calculated as the difference between results from the baseline case (i.e. no future DOE funding for this technology) and the program case (i.e. requested DOE funding for this technology is received and is successful).

- Oil impacts are shown as two metrics. "Oil Imports Reduction" refers only to reductions in oil imports; "Oil Savings" refers to savings (reduction) in total oil consumption.
- All cumulative metrics are based on results beginning in 2011.
- All monetary metrics are in 2007$.
- Cumulative monetary metrics are in 2007$ that are discounted to 2011 using a 3% discount rate.

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

Contribution to the Secretary’s Goals and GPRA Unit Program Goal

BTP contributes to the Secretary’s goals focusing on clean, secure energy by changing the landscape of energy demand and stimulating energy efficiency to decrease energy use in homes and buildings. By bringing together science, discovery, and innovation, U.S. buildings will be significantly more efficient, productive, and affordable.

Energy: Build a competitive, low-carbon economy and secure America’s energy future

BTP utilizes research on ventilation, controls, and lighting to reduce energy consumption in homes and commercial buildings to reduce energy demand. In addition, BTP improves existing buildings through energy efficiency upgrades by investing in building component R&D to address the unrealized efficiency gains in America’s stock of existing homes and buildings. BTP will contribute to the development of the green workforce by training builders, home auditors, architects, engineers and others around the country to help retrofit homes.

BTP 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, BTP creates vehicles for novel government/university and industrial collaborations; intellectual property models for development, commercialization; and deployment of efficient energy-using technologies and systems through ZEB R&D. BTP works to change behavior to “waste not, want not” via outreach efforts, marketing campaigns, and green branding through the ENERGY STAR campaigns such as the “Change a Light, Change the World,” and BTP’s work mobilizing a greening effort in the U.S. military through “Operation Change Out.”

Contribution to GPRA Unit Program Goal 20 (Building Technologies)

The BTP 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 ZEH by 2020, and when adapted to existing homes results in a significant reduction in their energy use. By 2014, develop, document and disseminate five cost effective technology packages that achieve an average of 50 percent reduction in whole house energy use.
- Commercial Buildings Integration R&D Activities: By 2014, collaborate with industry to develop, document and disseminate a complete set of 16 technology packages and 70 case studies that provide builders energy efficient options to meet their complex performance demands. They will enable the achievement of a 30 or 50 percent reduction in purchased energy use in new, small to medium-sized commercial buildings and existing 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 BTP 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 (TVMI): Accelerate the adoption of clean and efficient domestic energy technologies through activities, such as ENERGY STAR and Building Energy Codes. Achieve market penetration target for ENERGY STAR appliances of 37 percent, 17 percent for CFLs and 25 percent for windows. Building Energy Code activities will support the development and adaptation of improved building energy codes that are 30 percent more efficient than earlier 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 the end of 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.

Annual Performance Results and Targets

BTP performance contributes directly to two of the Secretary's goals: Innovation – Lead the world in science, technology, and engineering and Energy – Build a competitive, low-carbon economy and secure America's energy future. The performance measures also align to the BTP goal of developing 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.

BTP 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, BTP 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 BTP R&D activities.

BTP is working to produce development and deployment pathways that will provide technologies that reduce energy consumption in the U.S., enabling the U.S. to set a high standard on global environmental issues and lead by example. BTP partners globally by providing technical R&D support to the International Energy Agency (IEA) and by coordinating U.S. industry support, while also building research networks across departments, government, nations and the globe. In addition, BTP supports developing world clean energy by reducing energy consumption in the U.S. through RD&D of energy efficient technologies in buildings that are shared through international activities, providing a source of clean, secure energy.

A major economic factor which creates significant challenges for BTP performance goals is the current state of the housing market. With new home starts down, efforts to demonstrate new technologies and design packages are significantly more challenging. The impacts of these challenges are currently being assessed and have the potential to require BTP to reconfigure annual performance metrics to reflect the longer timeline needed to achieve ZEB goals. Recovery Act emphasis on home retrofits could also impact future BTP metrics in the outyears as the program shifts from a focus solely on ZEB R&D to a more balanced portfolio between ZEB and retrofit R&D. FY 2012 metrics will reflect the increased emphasis on retrofit R&D.

<table>
<tr><td colspan="10">Annual Performance Targets and Results
Secretarial Goal: Goal 1: Innovation: Lead the world in science, technology, and engineering
Goal 2: Energy: Build a competitive, low-carbon economy and secure America’s energy future
GPRA Unit Program Goal: 20 Building Technologies
Subprogram: Residential Buildings Integration</td></tr>
<tr><th>FY 2006</th><th>FY 2007</th><th>FY 2008</th><th>FY 2009</th><th>FY 2010</th><th>FY 2011</th><th>FY 2012</th><th>FY 2013</th><th>FY 2014</th><th>FY 2015</th></tr>
<tr><td colspan="10">Performance Measure: Complete design technology packages (at 50% greater efficiency for FY 2011-2014 and 70% greater efficiency in FY 2015) for new residential buildings[a] at net zero financed cost to the homeowner for one climate zone. (number of design packages)</td></tr>
<tr><td>T: NA
A: NA</td><td>T: NA
A: NA</td><td>T: NA
A: NA</td><td>T: NA
A: NA</td><td>T: NA
A: NA</td><td>T: 1
A:</td><td>T: 1
A:</td><td>T: 2
A:</td><td>T: 1
A:</td><td>T: 1
A:</td></tr>
<tr><td colspan="10">Performance Measure: The FY 2011 performance measure was created in transition from reporting qualitative milestones to quantitative performance measures. Previous year performance measures for this subprogram are not direct predecessor measures to the FY 2011 performance measure. These measures included below enabled the progress necessary to support the new FY 2011 Performance Measure.
FY 2006: 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.
FY 2007: 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.
FY 2008: Complete 1 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.
FY 2009: Complete 1 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.
FY 2010: Complete 2 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.</td></tr>
<tr><td>T: Qualitative
A: MET</td><td>T: Qualitative
A: MET</td><td>T: 1
A: MET</td><td>T: 1
A: MET</td><td>T: 2
A:</td><td>T: RETIRED
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A: NA</td><td>T: NA
A: NA</td><td>T: NA
A: NA</td><td>T: NA
A: NA</td></tr>
</table>

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[a] Whole house energy savings for all residential end uses are measured relative to the Building America Benchmark (Hendron, R., NREL: *Building America Research Benchmark Definition.* December 2008).

<table>
<tr><td colspan="10">Annual Performance Targets and Results

Secretarial Goal: Goal 1: Innovation: Lead the world in science, technology, and engineering
Goal 2: Energy: Build a competitive, low-carbon economy and secure America’s energy future
GPRA Unit Program Goal: 20 Building Technologies
Subprogram: Commercial Buildings Integration</td></tr>
<tr><th>FY 2006</th><th>FY 2007</th><th>FY 2008</th><th>FY 2009</th><th>FY 2010</th><th>FY 2011</th><th>FY 2012</th><th>FY 2013</th><th>FY 2014</th><th>FY 2015</th></tr>
<tr><td colspan="10">Performance Measure: Complete Retrofit and New Commercial Buildings Case Studies (that achieve at least 30 and 50 percent increase, respectively, in energy efficiency relative to the ASHRAE 90.1-2004 benchmark) with five year or less payback. Annual targets are for an individual year, not cumulative. (retrofit case study/new commercial case study)</td></tr>
<tr><td>T: NA
A: NA</td><td>T: NA
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A: NA</td><td>T: NA
A: NA</td><td>T: NA
A: NA</td><td>T: 5/5
A:</td><td>T: 10/10
A:</td><td>T: 10/10
A:</td><td>T: 10/10
A:</td><td>T: 10/10
A:</td></tr>
<tr><td colspan="10">Performance Measure: The FY 2011 performance measure was created in transition from reporting qualitative milestones to quantitative performance measures. Previous year performance measures for this subprogram are not direct predecessor measures to the FY 2011 performance measure. These measures included below enabled the progress necessary to support the new FY 2011 Performance Measure.

FY 2006: Complete the development of 1 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.

FY 2007: Complete the development of 2 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.

FY 2008: Complete 4 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.

FY 2009: Complete 4 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.

FY 2010: Complete 4 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.</td></tr>
<tr><td>T: 1
A: MET</td><td>T: 2
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A: NA</td><td>T: NA
A: NA</td></tr>
</table>

Annual Performance Targets and Results

Secretarial Goal: Goal 1: Innovation: Lead the world in science, technology, and engineering

Goal 2: Energy: Build a competitive, low-carbon economy and secure America's energy future

GPRA Unit Program Goal: 20 Building Technologies

Subprogram: Emerging Technologies

FY 2006	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
Performance Measure: Increase efficacy (measured in lumens per Watt (lm/W)) of "white light" SSL in a lab device.[a] (lm/w)									
T: NA A: NA	T: NA A: NA	T: NA A: NA	T: NA A: NA	T: NA A: NA	T: 123 lm/W A:	T: 126 lm/W A:	T: 129 lm/W A:	T: 130 lm/W A:	T: 133 lm/W A:
Performance Measure: The FY 2011 performance measure was created in transition from reporting qualitative milestones to quantitative performance measures. Previous year performance measures for this subprogram are not direct predecessor measures to the FY 2011 performance measure. These measures included below enabled the progress necessary to support the new FY 2011 Performance Measure. FY 2006: 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. FY 2007: 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. FY 2008: Achieve efficiency of "white light" solid state lighting in a lab device, of at least 101 lumens per Watt. FY 2009: Achieve efficiency of "white light" solid state lighting in a lab device, of at least 110 lumens per Watt. FY 2010: Achieve efficiency of "white light" solid state lighting in a lab device, of at least 113 lumens per Watt.									
T: 65 A: MET	T: 86 A: MET	T: 101 A: MET	T: 110 A: MET	T: 113 A:	T: RETIRED A: NA	T: NA A: NA	T: NA A: NA	T: NA A: NA	T: NA A: NA

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[a] In FY 2010 BTP issued a solicitation to SSL manufacturers through the Recovery Act for cost shared R&D focused on lowering the cost of producing SSLs. Currently no contracts are awarded through the DOE Solid-State Manufacturing R&D Initiative, preventing the inclusion of a modeled cost metric in FY 2011. However, such a metric will be included in the FY 2012 performance tables.

<table>
<tr><td colspan="10">Annual Performance Targets and Results

Secretarial Goal: Goal 1: Innovation: Lead the world in science, technology, and engineering
Goal 2: Energy: Build a competitive, low-carbon economy and secure America’s energy future
GPRA Unit Program Goal: 20 Building Technologies
Subprogram: Technology Validation and Market Introduction/ENERGY STAR</td></tr>
<tr><th>FY 2006</th><th>FY 2007</th><th>FY 2008</th><th>FY 2009</th><th>FY 2010</th><th>FY 2011</th><th>FY 2012</th><th>FY 2013</th><th>FY 2014</th><th>FY 2015</th></tr>
<tr><td colspan="10">Performance Measure: The FY 2011 performance measure was created in transition from reporting qualitative milestones to quantitative performance measures. Previous year performance measures for this subprogram are not direct predecessor measures to the FY 2011 performance measure. These measures included below enabled the progress necessary to support the new FY 2011 Performance Measure.[a]

FY 2006: 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.

FY 2007: Increase market penetration of appliances to 30 to 32 percent (baseline 30 percent calendar year 2003), to 2.5 to 4 percent for CFLs (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.

FY 2008: 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).

FY 2009: 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.</td></tr>
<tr><td>T: Qualitative
A: MET</td><td>T: Qualitative
A: MET</td><td>T: Qualitative
A: MET</td><td>T: Qualitative
A: MET</td><td>T: RETIRED
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A: NA</td><td>T: NA
A: NA</td><td>T: NA
A: NA</td><td>T: NA
A: NA</td></tr>
</table>

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[a] Due to the signing of a memorandum of understanding (MOU) between DOE and EPA in FY 2010, the scope of ENERGY STAR’s activities changed. In FY 2011 ENERGY STAR will not have a new metric because of this transition in scope.

Annual Performance Targets and Results

Secretarial Goal: Goal 1: Innovation: Lead the world in science, technology, and engineering
Goal 2: Energy: Build a competitive, low-carbon economy and secure America’s energy future
GPRA Unit Program Goal: 20 Building Technologies
Subprogram: Equipment Standards and Analysis

FY 2006	**FY 2007**	**FY 2008**	**FY 2009**	**FY 2010**	**FY 2011**	**FY 2012**	**FY 2013**	**FY 2014**	**FY 2015**
Performance Measure: Complete proposals (includes unique product inclusions in NOPRS and Final Rules) to update appliance standards and test procedures and publish in the Federal Register.[a] (proposals/final rules)									
T: NA A: NA	T: NA A: NA	T: NA A: NA	T: NA A: NA	T: NA A: NA	T: 13/11 [b] A:	T: 13/13 A:	T: 10/10 A:	T: 9/10 A:	T: 10/8 A:
Performance Measure: The FY 2011 performance measure was created in transition from reporting qualitative milestones to quantitative performance measures. Previous year performance measures for this subprogram are not direct predecessor measures to the FY 2011 performance measure. These measures included below enabled the progress necessary to support the new FY 2011 Performance Measure. FY 2006: 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. FY 2007: 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. FY 2008: Complete 11-13 proposals[c] to update appliance standards and test procedures to publish in the Federal Register. Final rules will be issued for 1-2 product categories, consistent with law, to amend appliance standards and test procedures that are economically justified and will result in significant energy savings. FY 2009: Complete 14-16 proposals[d] to update appliance standards and test procedures to publish in the Federal Register. Final rules will be issued for 4-6 product categories, consistent with law, to amend appliance standards and test procedures that are economically justified and will result in significant energy savings. FY 2010: Complete 14-17 proposals[e] to update appliance standards and test procedures to publish in the Federal Register. Final rules will be issued for 10 product categories, consistent with law, to amend appliance standards and test procedures that are economically justified and will result in significant energy savings.									
T: Qualitative A: MET	T: Qualitative A: MET	T: Qualitative A: MET	T: Qualitative A: MET	T: Qualitative A:	T: RETIRED A: NA	T: NA A: NA	T: NA A: NA	T: NA A: NA	T: NA A: NA

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[a] Final Rules to be issued for the product categories, consistent with law, to amend appliance standards and test procedures that are economically justified and will result in significant energy savings.

[b] Target numbers shown as proposals/final rules. Annual targets are for an individual year, not cumulative. FY 2012 through FY 2015 Performance targets will be updated upon completion of a multi-year planning activity that is planned for FY 2010.

[c] For this measure “proposal” includes 11-13 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.

[d] For this measure “proposal” includes 14-16 unique product inclusions as above.

[e] For this measure “proposal” includes 14-17 unique product inclusions as above.

Means and Strategies

BTP 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.

BTP will implement the following means:

- Residential Buildings Integration: Focus on improving the efficiency of the approximately 1.1 million new homes built each year and 113 million existing homes.[a] 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;
- Commercial Buildings Integration: Address energy savings opportunities in new and existing commercial buildings. 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;
- Emerging Technologies: Conduct 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;
- TVMI: Accelerate the adoption of clean, efficient, and domestic energy technologies through two major activities, ENERGY STAR and Building Energy Codes. ENERGY STAR is a joint DOE/EPA activity designed to identify and promote energy efficient products. 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 EPCA Section 304. It also promulgates standards for manufactured housing as required by Section 413 of the Energy Independence and Security Act of 2007 (EISA); and
- Equipment Standards and Analysis: Work to improve 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.

BTP'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, BTP will implement the following strategies:

- Focus the R&D portfolios to ensure that the most promising and revolutionary technologies and techniques are being explored for existing and new buildings; align the Residential and Commercial

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[a] 2009 Buildings Energy Data Book.

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;
- Invest in collaborative research with the Solar Energy Program to reduce barriers to the installation and operation of PV technology on ZEH and ZEB;
- 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. BTP 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. BTP 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.

The following external factors could affect BTP’s ability to achieve its strategic goal:

- Fragmented construction market: Several factors 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 R&D 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 could slow down research on ZEH. The last phase of research is having a builder construct a subdivision using technologies developed by BTP in order to prove them in a real world setting. If fewer subdivisions are being constructed by more risk-adverse contractors, it could slow BTP’s research considerably; and

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[a] Scott Hassell, Anny Wong, Ari Houser, Debra Knopman, Mark Bernstein, RAND Corporation: *Building Better Homes: Government Strategies for* Promoting Innovation in Housing. 2003: http://www.rand.org/pubs/monograph_reports/MR1658/MR1658.pdf

- Unit price of renewable energy: ZEB goals are contingent upon the development of cost effective small scale renewable energy systems.

In carrying out the program's mission, BTP 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. DOE coordinates its R&D, regulatory activities, and technology demonstrations with EPA's marketplace activities (http://www.energystar.gov/). Through these activities with EPA, BTP contributes to the Administration's objective of reducing GHG emissions;
- In support of EISA, BTP is implementing a Commercial Buildings Initiative (CBI) which collaborates with National Laboratories, the private sector, other Federal agencies, and non-governmental organizations (NGOs) to advance high-performance commercial green buildings and produce market-ready commercial ZEB 2025. In support of CBI, BTP has launched programs and initiatives that will produce quick-hitting, practical results, including:
  - Commercial Building Energy Partnerships (including retailers, commercial real estate owners, and institutions);
  - National Laboratory Collaborative on Building Technologies; and
  - Commercial Building Partners.
- 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. BTP 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 DOE's Office of Science in basic research on SSL technology;
- BTP'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
- BTP interacts regularly with industry to ensure relevance of research, including R&D workshops (e.g., biennial reviews in SSL and windows research) and peer reviews.

Validation and Verification

To validate and verify program performance, BTP will conduct various internal and external reviews and audits. These programmatic activities are subject to continuing review by Congress, the General Accountability Office, DOE’s Inspector General, EPA, and State environmental agencies. The table below summarizes validation and verification activities.

Data Sources:

- “Annual Energy Review 2008,” Department of Energy/Energy Information Administration, DOE/EIA-0384(2008), June 26, 2009;
- 2003 Commercial Building Energy Consumption Survey (CBECS), Department of Energy/Energy Information Administration, http://www.eia.doe.gov/emeu/cbecs/contents.html ;
- 2005 Residential Energy Consumption Survey (RECS), Department of Energy/Energy Information Administration, http://www.eia.doe.gov/emeu/recs/contents.html;
- 2009 Building Energy Data Book (BED), Department of Energy/Building Technologies Program, http://buildingsdatabook.eren.doe.gov/Default.aspx;
- “Annual Energy Outlook (AEO) 2009,” Department of Energy/Energy Information Administration, DOE/EIA-0383(2009), March, 2009;
- ISTAR (ENERGY STAR database);
- “Current Industrial Reports (CIR)” U.S. Census Bureau, http://www.census.gov/manufacturing/cir/index.html;

Baselines: The following are key baselines used in the BTP program:

- New Residential Buildings: Energy use varies by climate region, based on the Building America Benchmark.[a] The program will focus on creating design technology packages to reduce energy consumption from the Building America Benchmark. In 2003, zero 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[b]). The program will focus on creating design technology packages to reduce energy consumption by 30 and 50 percent for small commercial buildings (baseline one technology package for 30 percent and zero technology option sets for 50 percent in 2005).
- SSL (2002): 25 lumens/Watt (lm/W) efficacy (SSL 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

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[a] Hendron, R., NREL: *Building America Research Benchmark Definition.* December 2008: http://www.nrel.gov/docs/fy08osti/42662.pdf

[b] ANSI/ASHRAE/IESNA Standard 90.1-2004, *Energy Standard for Buildings except Low-Rise Residential Buildings.* 2004: http://www.ashrae.org/

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 BTP outputs will be undertaken annually.

Evaluation: In carrying out its mission, BTP 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 the Performance Measurement Manager (PMM);
- 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 GPRA; and
- Continuing 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. BTP 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.

Residential Buildings Integration

Funding Schedule by Activity

	(dollars in thousands)		
	FY 2009	FY 2010	FY 2011
Residential Buildings Integration	21,900	39,194	38,126
SBIR/STTR	0	806	874
Residential Buildings Integration	21,900	40,000	39,000

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 the 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 with its reduced energy needs and renewable energy systems a ZEH can give back as much energy to the utility as it takes over the course of a year. This ZEH also has a cost component goal of net zero financial cost to the homeowner. The annual energy savings in utility bills will offset the annual financing cost of ZEH energy efficiency upgrades. In addition, BTP will conduct research in multi-family housing, Builders Challenge deployment activities, and R&D for energy efficient improvements in existing homes.

Benefits

RBI R&D activities will provide the energy technologies and solutions that will catalyze a 70 percent reduction in energy use of new 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 energy use. These activities and outputs lead directly to decreased energy use in homes and reduced homeowner energy bills. BTP 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.

Detailed Justification

	(dollars in thousands)		
	FY 2009	FY 2010	FY 2011
Residential Buildings Integration	**21,900**	**39,194**	**38,126**

In order to achieve the technical capability for ZEH[a] by 2020, BTP 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[b]), and provide energy for the remaining 30 percent through the use of integrated onsite power systems. Building America demonstrates strategies to achieve ZEH 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 2015 and 70 percent by 2020 (compared to the Building America Benchmark).[c]

To ensure meeting the performance goals, Building America specified the following interim performance targets for completion of technology package research reports for new homes in 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[c])	Marine	Hot-humid	Hot/Mixed Dry	Mixed Humid	Cold
30%	2006	2007	2005	2006	2005
40%	2008	2010	2007	2010	2009[d]
50%	2012	2013	2011	2013	2014
70%	2017	2016	2015	2017	2018
ZEH[e]	2020	2020	2019	2020	2020

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[a] ZEHs integrate energy efficiency gains with onsite renewable power solutions at net zero financial cost to the homeowner to achieve the final goal of an annual net ZEH.

[b] 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, NREL: www.buildingamerica.gov)

[c] 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.

[c] Whole house energy savings for all residential end uses are measured relative to the Building America Benchmark (Hendron, R., NREL: *Building America Research Benchmark Definition.* December 2008).

[d] Current projection is for five cold climate case studies to be completed in 2009. However, due to the economic slowdown and reduction in single family and multifamily new housing starts, completion of one or more cold climate case studies will be completed in 2010.

[e] 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) are needed to provide the remaining 30 percent through the integration of onsite renewable energy systems.

Research at the 40 percent efficiency level for all climates was completed in FY 2010. In FY 2011, BTP will complete research at the 50 percent efficiency level for the hot/mixed dry climate. A major economic factor that might impede BTP from reaching its performance goals is the current state of the housing market. New home starts are down, slowing deployment of new technologies since the final stage of BTP's deployment efforts involve finding builders willing to construct a cluster of houses using the efficient design packages. Without new home construction, dissemination of finalized real-world tested design suites will be hindered. Specific climate zone targets may be adjusted due to market conditions and the degree of technical complexity involved in developing solutions for each climate.

In addition to the Building America activities, the National Builder's Challenge is designed to support America's homebuilding industry in its efforts to design, build, and sell 220,000 high performance homes by FY 2012. In FY 2011, BTP will increase research and deployment of 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). BTP will also work with retailers to promote energy efficient home remodeling and retrofits through innovative financing. Outreach and educational efforts will be expanded by developing guidance for energy audits at the time of home resale, including appropriate training materials for real estate agents and lenders. The RBI subprogram performs an additional integral function within BTP by evaluating R&D in light of the market to further guide effective decision making within a shifting market context.

Additionally, BTP will invest in collaborative research with the Solar Energy Program to reduce barriers to the installation, integration, and operation of solar systems on homes and buildings. BTP efforts will focus 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, RBI 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.

	FY 2009	FY 2010	FY 2011
SBIR/STTR	**0**	**806**	**874**

In FY 2009 and FY 2010, no funding was transferred to the SBIR and STTR programs. The FY 2011 amount shown is the estimated requirement for the continuation of the SBIR and STTR program.

	FY 2009	FY 2010	FY 2011
Total, Residential Buildings Integration	**21,900**	**40,000**	**39,000**

Explanation of Funding Changes

	FY 2011 vs. FY 2010 ($000)
Residential Buildings Integration	
The reduction in funding is due to a down-select of ZEB R&D projects to focus on only the most promising efficient technologies and processes in new building construction. This change allows for an increasing emphasis in the outyears on retrofit R&D to address the existing housing stock.	-1,068
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. RBI related SBIR/STTR funding increases from $806 in FY 2010.	+68
Total Funding Change, Residential Buildings Integration	**-1,000**

Commercial Buildings Integration

Funding Schedule by Activity

	(dollars in thousands)		
	FY 2009	FY 2010	FY 2011
Commercial Buildings Integration	32,057	38,290	38,290
SBIR/STTR	0 [a]	710	710
Total, Commercial Buildings Integration	32,057	39,000	39,000

Description

Sections 421 and 422 of EISA 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 of developing and disseminating 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 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 cost-effective on a lifecycle basis; and

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[a] SBIR/STTR funding transferred in FY 2009 includes a reduction of $842,500 for the SBIR program and $101,000 for the STTR program.

[b] EISA, Section 422(c)

- Development of improved means of measurement and verification of energy savings and performance for public dissemination.[a]

Benefits

By the end of FY 2011, 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 (four packages) reduction in the purchased energy use in new, small to medium-sized commercial buildings relative to ASHRAE 90.1-2004. Commercial Buildings Integration will also complete five retrofit and five new commercial buildings case studies (that achieve at least 30 and 50 percent increase, respectively, in energy efficiency relative to the ASHRAE 90.1-2004 benchmark) with five year or less payback. 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 2009	FY 2010	FY 2011
Commercial Buildings Integration	**32,057**	**38,290**	**38,290**

The CBI subprogram is an integral part of the BTP program which evaluates research in the context of the buildings market. The organization of the CBI involves significant engagement of private sector companies, public, non-government and trade organizations through Commercial Building Energy Partnerships, formally recognized green building partnership consortia, and a competitively selected CBI supporting consortium. As directed by EISA, BTP consults with the supporting partnership consortium and others to establish priorities and plans for the CBI. Based on those plans, BTP is executing a program of high-value RD&D and technology deployment, and also engages 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 Partnerships for Retailers, Commercial Real Estate (owned and leased, hospitality), and Institutions (higher education, State, and local government) are vehicles for peer assistance, technology procurements, and sharing of technology assessments and best practices. In FY 2011, BTP proposes to transfer the existing Rebuild America activity and combine it with efforts conducted under Commercial Buildings Integration. This effort would continue to focus on EnergySmart Hospitals.

BTP is also providing cost-shared research and technical assistance on a competitive basis to Commercial Building Partners. Commercial Building Partners are comprised of business entities with building portfolios of significant square-footage that regularly engage in new construction, and also implement retrofit of existing buildings on a regular basis. Commercial Building Partners have

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[a] EISA, Section 422(d)

committed to a building retrofit that reduces energy use by 30 percent, and the design of a prototype new building at 50 percent reduced energy use, relative to ASHRAE 90.1-2004. Building Partners activities enable the development of an in-depth understanding of the technical challenges and gaps, market factors and barriers, and business cases and obstacles associated with achieving CBI goals. As 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 Commercial Building Partner activities, BTP is engaging the full spectrum of research performers (i.e. National Laboratories, universities, and private sector companies) in cost-shared research needed to develop technologies, tools and practices required to meet the long-term CBI goals.

Commercial Building Design Technology Packages Performance Targets

(fiscal year)

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

In FY 2011, BTP will continue work on the development of retrofit and new buildings case studies that will help drive a net cost-effective increase (50 to 70 percent) in commercial building energy efficiency over ASHRAE 90.1-2004. The Commercial Building Design Team will develop a case study final report documenting all findings to include energy savings, redesign costs, and payback period for each building constructed or retrofitted. These reports will be of laboratory technical quality and peer-reviewed for public distribution. FY 2011 represents the first year of production of the case studies, with 10 expected completions (five retrofit and five 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.

SBIR/STTR	**0**	**710**	**710**

In FY 2009, $487,000 and $59,000 were transferred to the SBIR and STTR programs respectively. The FY 2010 and 2011 amounts shown are estimated requirements for the continuation of the SBIR

	FY 2009	FY 2010	FY 2011
	(dollars in thousands)		
and STTR program.			
Total, Commercial Buildings Integration	**32,057**	**39,000**	**39,000**

Explanation of Funding Changes

	FY 2011 vs. FY 2010 ($000)
Commercial Buildings Integration	
No change.	0
SBIR/STTR	
No change.	0
Total Funding Change, Commercial Buildings Integration	**0**

Emerging Technologies

Funding Schedule by Activity

(dollars in thousands)

	FY 2009	FY 2010	FY 2011
Emerging Technologies			
Lighting R&D	24,056	25,652	26,809
Space Conditioning and Refrigeration R&D	3,329	9,000	8,773
Building Envelope R&D	8,652	16,000	18,521
Analysis Tools	3,149	5,500	5,557
Solar Heating and Cooling[a]	3,710	6,500	7,311
Energy Innovation Hub: Energy Efficient Building Systems Design[b]	0	22,000	24,300
SBIR/STTR[c]	0	1,348	1,427
Total, Emerging Technologies	42,896	86,000	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 focuses on developing technologies to support the residential and commercial building goal of reducing total energy use in buildings by up to 70 percent. BTP is actively analyzing technology advancement in areas that will be required to reach ZEB goals and using this analysis to inform the continued direction of the program and corresponding funding needs. When coupled with research to integrate onsite renewable energy supply systems into commercial and residential buildings, the improvement in component and system energy efficiency, will establish the technologies from which to package marketable net zero energy designs.

The Emerging Technologies subprogram focuses on:

- Lighting R&D: Solid State Lighting (SSL) with long term efficiencies with the technical potential to approach 200 lm/W, compared to most conventional technologies with maximum efficiencies in the 85 to 115 lm/W range;
- Space Conditioning and Refrigeration R&D: Heating and cooling systems with the technical potential to reduce annual heating, ventilation, and cooling (HVAC), dehumidification and water heating energy consumption by 80 percent aligned with advanced technology performance requirements of the Residential Buildings Integration subprogram;

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[a] Transferred from the EERE Solar Energy Program in FY 2009.

[b] In FY 2010 the Secretary exercised the option provided in H.R.3183 to fund two Energy Hubs for a total of $44M using funds appropriated for Facilities and Infrastructure construction and infrastructure projects. As per conditions of this exercising option, a commensurate amount of Recovery Act resources was transferred to the Facilities and Infrastructure line to support the critical construction and infrastructure requirements at NREL.

[c] SBIR/STTR funding transferred in FY 2009 includes a reduction of $842,500 for the SBIR program and $101,000 for the STTR program.

- Building Envelope R&D: 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;
- Analysis Tool: Rating and simulation tools, such as EnergyPlus, with full capabilities to model whole-building integration of emerging energy-efficiency technologies and renewable energy systems into building design and operation;
- Solar Heating and Cooling: 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; and
- Energy Innovation Hub - Energy Efficient Building Systems Design: 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.

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 activities support the BTP goals through R&D of advanced lighting, building envelope, windows, space conditioning, water heating and appliance technologies and analysis tools. Without advanced components and subsystems, such as the SSL technologies developed in the Emerging Technologies activities, the goal of ZEB will not be met. A more detailed synopsis of specific benefits arising out of the individual technologies within the Emerging Technology subprogram can be found in a particular technology's detailed justification section.

Detailed Justification

(dollars in thousands)

	FY 2009	FY 2010	FY 2011
Lighting R&D	**24,056**	**25,652**	**26,809**

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 SSL 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 126 lm/W projected for laboratory devices by 2012.[b] White light is the standard of measure for a successful LED and OLED prototype because when creating

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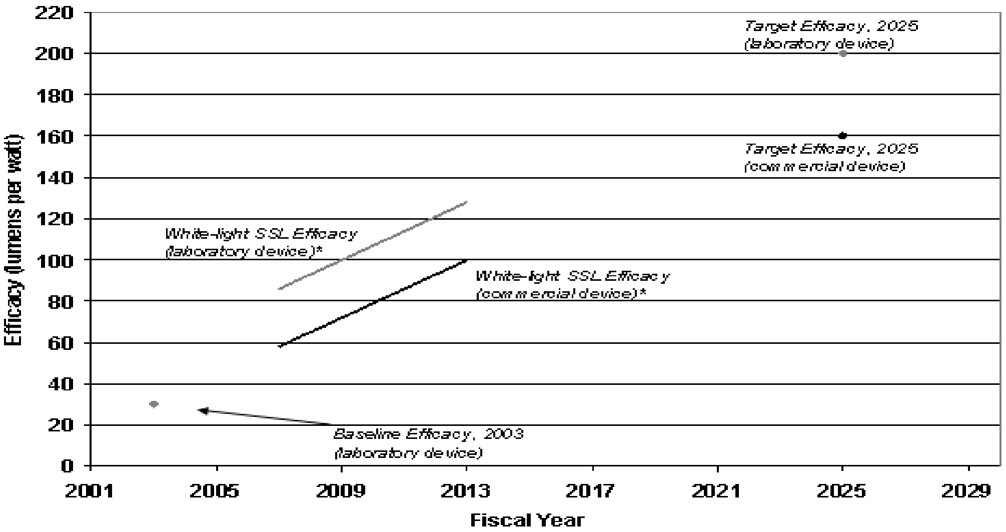
[a] Linear fluorescent lamps offer efficacies as high as 80 lm/W. Compact fluorescent lamps, a derivative of this technology, are less efficient (approximately 60 lm/W); however still offer a four-fold improvement over traditional incandescent bulbs.

[b] For SSL technologies, the performance target is focused on the energy efficiency rating "efficacy," of the device measured in lm/W of energy consumed. Several lighting products, including fluorescent lamps and incandescent reflector lamps, are regulated using an efficacy target. The efficacy projections for SSL are generated for laboratory devices because the Lighting R&D portfolio does not have direct influence over commercially offered products.

lighting for general purposes, it is important to create light that spans the entire spectrum, which white light does. 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.

Point Values of Efficacy Projections for White-Light SSL Laboratory Devices

(fiscal year)

Characteristics	Units	2003 (baseline)	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
SSL Performance Targets	Lm/W	30	65	79	95	101	110	120	123	126	129	130
Actual		48	65	79	95	107	117	–	–	–	–	–

The R&D agenda of the SSL activities is established through an annual consultative process with general lighting industry, compound semi-conductor industry, universities, research institutions, National Laboratories, trade organizations, other industry consortia, and the Next Generation Lighting Industry Alliance (DOE's competitively selected SSL Partnership). A majority of the tasks are competitively bid and awarded to entities with proposals that meet these priorities and the SSL portfolio's stated objectives. The SSL activity classifies projects into three R&D classes: LED Core Technology, Product Development, and Manufacturing Improvements.

The SSL portfolio currently funds nine core priority R&D topics and eleven Product Development priority R&D topics.[a] In addition, the first round of the Manufacturing R&D has been released. Each year, R&D topics are reviewed for progress, completion of topical areas, new topics to start, and advice from the Alliance and the research community. The R&D topics are reprioritized for each annual solicitation.

FY 2011 focuses include:

- Core Technology Research: Applied research for technology development, with particular emphasis on meeting efficiency, performance, and cost targets;
- Product Development: Using the knowledge gained from basic or applied research to develop or improve commercially viable materials, devices, or systems; and
- Manufacturing Improvement: Accelerating SSL technology adoption through manufacturing improvements that reduce costs and enhance quality.

In FY 2011, the program will continue the SSL R&D projects that have demonstrated progress and completed a peer review. These project topical areas are identified in the table below

SSL R&D Topics

Topic	**LEDs**		**OLEDs**	
	Current R&D	Future R&D	Current R&D	Future R&D
Core:	• Phosphors • Semiconductor materials • Defect Physics • Light extraction	• Substrates, buffers and wafers • Alternative Structures • Encapsulating and packaging • Fabrication of component prototypes	• Novel Materials • New architectures • Light extraction • Improved charge injection • Transparent electrodes	• Encapsulating materials • Material/structures evaluation • Substrate materials • Down conversion materials • Modeling of material principles • Electrodes and interconnects • Fabrication and patterning techniques

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[a] For further information on the SSL R&D Pathways, as discussed at the SSL Workshop by the research community and documented in the Multi-Year Program Plan FY 2009 – FY 2014, see the SSL website: (www.ssl.energy.gov)

Product Development:	• Luminaire life and performance • Optical coupling and modeling • Packaging • Manufactured materials • Thermal design • Materials in devices • Light extraction from devices	• Electronic development • Fabrication and manufacturing challenges • Device architectures • Mechanical design	• Application of materials in fabrication • Applied light extraction • Manufacturing process optimization • Device encapsulation and packaging	• Surface modification techniques • Demonstration architectures • Simulation tools for devices • Power spreading and driver electronics • Luminaire design • Synthesis manufacturing scale-up • Tools for manufacturing
Manufacturing:		• Epitaxial growth tools and processes • LED chip manufacturing • Automated LED packaging • LED luminaire manufacturing		• Production of OLED lighting prototypes • Paths to high volume manufacturing of OLED devices

Activities will continue to analyze and address barriers to enable market introduction and commercialization of technologies resulting from these research projects. Included in this is activity is the Bright Tomorrow Lighting Prize (L Prize), the first government-sponsored technology competition designed to spur lighting manufacturers to develop high-quality, high-efficiency SSL products to replace the common light bulb.

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

Space Conditioning and Refrigeration R&D 3,329 9,000 8,773

Space conditioning systems, which have transformed the 20th Century by enabling building users to become more productive and comfortable, will continue to play a critical role in achieving BTP's ZEB goal. Space conditioning equipment for residential and commercial buildings consumes approximately 32.5 percent of the total energy used in buildings and is the most important contributor to summer peak electricity demand.[a]

Although the energy efficiency of HVAC equipment has increased substantially in recent years, new approaches and technologies are needed to continue this trend. The dramatic reductions in HVAC energy consumption necessary to support ZEB goals require a systems-oriented approach. This approach

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[a] 2009 Buildings Energy Data Book, U.S. Department of Energy, November 2009.

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 ZEBs, the Space Conditioning R&D activity will reduce the energy consumption of commercial HVAC and residential water heating equipment by 80 percent over baseline levels by 2020.

Space Conditioning System Performance Goals

Characteristics	2004 Status	2007 Target	2010 Target	2020 Target
Annual Residential HVAC, Water Heating and Dehumidification Energy Consumption Reduction vs. Building America benchmark (demonstrated product)	Baseline	25%	50%	–
Annual Residential Water Heating Energy Consumption Reduction vs. Building America benchmark	Baseline	–	–	80%
Annual Commercial HVAC Energy Consumption Reduction vs. 2004 Baseline	Baseline	–	–	80%

In FY 2011, BTP will continue the development of an air-to-air integrated heat pump system that can meet the air heating, cooling, dehumidifying, ventilating, and water heating requirements of a tight-envelope mechanically ventilated near-ZEH, and the development of a ground-source integrated heat pump (GS-IHP). 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 FY 2011, BTP will start looking into affordable advanced materials, components, refrigeration cycles and systems that improve system energy consumption (including CO_2 systems), as well as non-vapor compression technologies with humidity control to reduce the energy consumption of HVAC, dehumidification and water heating equipment by 50 to 80 percent over baseline levels. In addition, BTP will work on retrofit technologies, application of nanotechnology to AC component design, development of zero-global warming potential refrigerants, development of next-generation residential water heaters at a cost effective price premium with multi-functional capabilities, development of integrated end-use appliances, and identification of the most promising target technologies and components in miscellaneous electric loads to reduce energy consumption by 30 percent.

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

(dollars in thousands)

	FY 2009	FY 2010	FY 2011
Building Envelope R&D	**8,652**	**16,000**	**18,521**

Window Technologies

Window performance will also be vital to reaching residential and commercial buildings goals. Development of cost effective, highly efficient and dynamic glazing and fenestration systems for all building types throughout the U.S. will require a portfolio of technologies matched to those types and climatic conditions. The table below lists the performance measurement targets for the windows 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.

In FY 2011, BTP will continue competitive fundamental science research to develop the second generation of materials, chemical engineering applications, and advanced manufacturing processes that can offer “leap frog” reductions in the cost of dynamic windows while maintaining a high level of reliability and durability with a broad range of optical properties. The second generation of dynamic windows is targeted to enter the market between 2011 and 2015 with substantially lower consumer prices. These initial second generation product offerings will not meet DOE long term price goals for ZEBs by 2020 and 2025 unless this research is conducted. The program will also work on cost effective R10 (U value of 0.10) highly insulating windows. These products are needed for colder climates with high solar heat gain which may be most viable in a vacuum glazing product.

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.

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.

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, BTP 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. Completions 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 were 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 and completed in FY 2011. Dynamic roof surfaces will be refined and further analyzed in FY 2011, providing cool roofs in summer and harvesting passive heating in winter.

The table below lists the performance goals for Thermal Insulation activities. All performance measurements are relative to historical baselines that were set as the Building America regional baseline for new construction. Achieving cost-effectiveness and durability are critical aspects of these targets. Research will be conducted to develop an accelerated performance rating for cool roofs from the current requirement of three years to six months, allowing for faster introduction of new innovative products in the marketplace. The "aged" performance rating is critical because all roofs get soiled, which reduces their energy performance over time and ratings provide realistic energy savings potential. Cool roof materials reflect more heat than standard materials, and thus lower thermal conduction into buildings, decreasing air conditioning requirements and providing additional benefits of urban heat island mitigation in hot climates.

Thermal Insulation and Materials Performance Goals

Characteristics	2004 Status (units: R-Value*)	2007 Target (units: R-Value*)	2010 Target (units: R-Value*)	2015 Target (units: R-Value*)
Advanced attic/roof system	30	35	Dynamic annual performance equal to conventional R-45	Improved dynamic annual performance at no extra cost
Wall insulation	10	Dynamic annual performance equal to conventional R-20[a]	Dynamic annual performance equal to conventional R-25[b]	Improved dynamic annual performance at no extra cost

***** R-value measures the resistance to heat flow for a material. The higher the R-value, the better walls and roof will resist the transfer of heat

BTP is developing advanced envelope materials in response to needs identified in the Residential Buildings and Commercial Integration activities. In FY 2011, dynamic membranes will be further analyzed and evaluated in cooperation with private industry as a result of prior fundamental material science research and partnerships. 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. In FY 2011, large scale whole house side by side evaluations will continue to be conducted in multiple climate zones. Fundamental research on basements for both existing and new

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[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.

construction begun in FY 2010 will also be continued.

Analytical studies on cool roofs report very large carbon mitigation potential through the direct rejection of heat from urban surfaces. However, these claims have not yet been validated. In FY 2010, BTP began working with an international scientific panel on a comprehensive research plan. In FY 2011, increased funding will allow this research plan to be initiated along with policy analysis for carbon mitigation from applications which are uneconomic for the property owner (roofs, roadways, and parking areas).

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.

Analysis Tools	**3,149**	**5,500**	**5,557**

Similar technologies and design approaches will be applied to improve the performance of existing buildings to accompany ZEB goals related to new construction. The ZEB goals cannot be met through research alone to significantly improve the performance of components (e.g., windows, appliances, heating and cooling equipment, and lighting).

Meeting the goals also requires a revolutionary approach to building design and operation that can achieve up to 70 percent reductions in load, coupled with careful integration with onsite renewable energy supplies as well as thermal and electrical storage. Building energy performance, 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 dimming controls on the electric lights with daylighting includes reductions in lighting electricity use and heat gain from lights. Lower heat from lights reduces cooling use (amount depends on cooling equipment efficiency) and in the winter can significantly increase the heating energy. Thus, the annual impact of daylighting on energy use requires detailed calculations that consider these interactions.[a] This in turn requires powerful simulation tools that support evaluation of new ZEB demand-reduction and energy-supply technologies throughout building design, operation, and retrofit.

In FY 2011, BTP 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. BTP 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. BTP 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 BTP 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

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[a] In a series of field evaluation case study reports, NREL found that simulation tools were one of the essential elements for tuning the building design as well as the operating building performance [Paul A. Torcellini, Ron Judkoff, and Drury B. Crawley, “Lessons Learned: High-Performance Buildings,” ASHRAE Journal, September. 2004].

systems, and renewable energy technologies such as solar and wind, as well as assist 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) 3,710 6,500 7,311

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.[a] 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.

Activities for Solar Heating & Cooling (SH&C) in FY 2011 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 PV/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 the prototype house evaluation process of the Building America program will accelerate deployment of solar thermal technologies into the marketplace. SH&C will also leverage research activities with similar R&D conducted through the IEA SH&C Program, including the development of advanced solar thermal testing and internationally harmonized and accepted certification procedures for solar collectors and systems.

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.

Energy Innovation Hub: Energy Efficient Building Systems Design 0 22,000 24,300

DOE initiated the establishment of a multi-disciplinary Energy Innovation Hub (Hub) to address the basic science, technology, economic, and policy issues hindering the ability to become energy secure and economically strong, while addressing climate change and reducing GHG emissions. The main focus of this 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 is 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 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

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[a] Warm climates had a baseline of $0.12 to 0.14/kWh in 1999 and cold climates, on which research has just begun, have a baseline of $0.18 to 0.20/kWh with a base year of 2009.

10 years. Any funding after 10 years would be predicated on "raising the bar" above that needed for simple renewal.

In FY 2011, BTP will continue developing 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.

SBIR/STTR	**0**	**1,348**	**1,427**

In FY 2009, $849,500 and $101,000 were transferred to the SBIR and STTR programs respectively. The FY 2010 and 2011 amounts shown are estimated requirements for the continuation of the SBIR and STTR program.

Total, Emerging Technologies	**42,896**	**86,000**	**92,698**

Explanation of Funding Changes

	FY 2011 vs. FY 2010 ($000)
Lighting R&D	
Increased funding in FY 2011 will focus on the most promising topic areas in progress as the next generation of projects. 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.	+1,157
Space Conditioning and Refrigeration R&D	
No significant change.	-227

Building Envelope R&D Cool roofs have the greatest cost effective energy saving potential in very hot climates with low levels of installed insulation. Thus, the areas with the greatest potential are outside of the U.S. Working with partners in countries and regions such as India, the Middle East, ASEAN, Africa, Australia, and Brazil, the program will provide technical support to help develop product rating and building code requirements to allow for greater potential for U.S. manufacturer investment.	+2,521
Analysis Tools The funding increase will support a number of new features implemented in EnergyPlus, as well as the implementation of least five additional new features.	+57
Solar Heating and Cooling Systems (SH&C) Additional funding will focus on combined solar heating, cooling, and water heating systems for ZEH, solar electric/solar thermal pathways to ZEH and improved manufacturing processes of enhanced, building-integrated SH&C products that are cost-effective and easy to install. Commercialization activities will be implemented that promote market transformation assistance for SH&C products and create community-based solar installation workforce training programs across the U.S. to broaden the Nation's ability to provide quality solar installations, create new jobs and promote the expanded use of solar energy for a clean and reliable energy future.	+811
Energy Innovation Hub: Energy Efficient Building Systems Design The change in this line item reflects a continuation and ramp-up of efforts in the Hub's second year of operation.	+2,300
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.	+79
Total Funding Change, Emerging Technologies	**+6,698**

Technology Validation and Market Introduction
Funding Schedule by Activity

	(dollars in thousands)		
	FY 2009	FY 2010	FY 2011
Technology Validation and Market Introduction			
Rebuild America	5,000	1,000	0
ENERGY STAR	7,484	7,000	10,000
Building Energy Codes	5,376	9,000	10,000
Solar Decathlon[a]	3,400	5,000	0
Total, Technology Validation and Market Introduction	21,260	22,000	20,000

Description

Technology Validation and Market Introduction (TVMI) accelerates the adoption of clean and efficient domestic energy technologies, including ENERGY STAR and Building Energy Codes. ENERGY STAR is a joint DOE/EPA activity designed to identify and promote energy efficient products and buildings. 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 Building Energy Codes activities support upgrading building industry model energy codes and standards, and their adoption, implementation and enforcement by State and local jurisdictions.

The Rebuild America Program activity is proposed to be aligned with BTP Commercial Buildings Integration R&D activities to accelerate the adoption of advances in building integrated design, software tools, practices and advanced controls, equipment, and lighting. BTP will continue implementation of EnergySmart Hospitals and EnergySmart Schools.

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. Building Energy Codes submits code proposals, supports the upgrading of model building energy codes, and provides technical and financial assistance to States to update, implement, and enforce their energy codes to meet or exceed model codes in support of Section 304 of ECPA. It also promulgates standards for manufactured housing as required by Section 413 of EISA. These activities and outputs increase the energy performance of newly constructed homes and commercial buildings, targets consumers and assist them in reducing energy bills, and contribute to job creation in the construction industry.

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[a] Transferred to the EERE RE-ENERGYSE Program in FY 2011.

Detailed Justification

(dollars in thousands)

	FY 2009	FY 2010	FY 2011
Rebuild America	**5,000**	**1,000**	**0**

The Rebuild America activities, e.g. EnergySmart Schools and EnergySmart Hospitals, will be realigned with the Commercial Buildings Integration activities in FY 2011.

ENERGY STAR	**7,484**	**7,000**	**10,000**

DOE will continue to raise the efficiency targets of ENERGY STAR products and support program enhancements as stated in the Memorandum of Understanding between DOE and EPA signed September 30, 2009. The DOE ENERGY STAR team will work with EPA to help promote currently labeled products. A two-pronged strategy will be deployed in FY 2011 to support the portfolio of existing technologies: 1) developing and updating efficiency criteria including ENERGY STAR test procedures for products to keep the label relevant and meaningful in the market; and 2) working with EPA and participating manufacturers, retailers, and energy efficiency program sponsors on certification and product testing.

The National Buildings Rating Program (NBRP) will provide guidance for energy retrofits of existing buildings based on state-of-the-art cost and performance data. It will also establish a comprehensive energy efficiency rating system for both residential and commercial buildings on a national scale. DOE will develop, validate, and update software tools for both asset and benchmark ratings in consultation with EPA. These tools provide information to owners on whole-building comparative energy use, while also providing decision assistance about retrofits. DOE will maintain all relevant databases used by the software tools and create data sharing mechanisms with EPA. EPA will establish ENERGY STAR criteria for buildings based on technical input from the DOE and the NBRP.

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 Energy Codes	**5,376**	**9,000**	**10,000**

In FY 2011, BTP will initiate analyses; support upgrading the next generation of ASHRAE 90.1 codes and set substantial new efficiency targets. Upgrades will include performance criteria based on size, internal functions, and envelope characteristics (beyond the current prescriptive criteria) permitting the next substantial increase in code stringency. 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)].

Efforts to improve the ASHRAE and IECC Codes must align with the existing cycles used by the two bodies to update their respective codes. The cycles include periods for new technical proposals, review, comment, and revision, and generally take three years. In previous revision cycles, both the ASHRAE and IECC codes have been improved incrementally at the rate of one to two percent per cycle. With increased emphasis on building energy codes, the current goal is to increase both ASHRAE and IECC codes by 30 percent over baseline in the ongoing revision cycle. Significant progress has been made towards these goals, with estimated increases of 10 to 11 percent for ASHRAE and 15 percent for

IECC. These ongoing improvements contribute to reaching DOE's goal of ZEB.

DOE will also conduct analyses and publish determinations in the Federal Register as to whether each new edition of the baseline model codes will improve the energy efficiency of buildings. Determinations are to be issued within one year of the publication of the model codes. DOE will improve energy code compliance tools, integrating them with the design process and non-energy code enforcement. Technical assistance will be provided to States to adopt, update, implement, and enforce their energy codes to meet the 2009 IECC and Standard 90.1-2010.

DOE will also propose standards for energy efficiency in manufactured housing that will meet or exceed the 2009 IECC. Manufactured housing codes will be updated within one year of each IECC code revision.

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

Solar Decathlon	**3,400**	**5,000**	**0**

The Solar Decathlon 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 fosters innovation and encourages incorporation of new building technologies and design practices into engineering and architecture university curricula. As a result, the Solar Decathlon continues to be a successful workforce development program for thousands of college graduates. In FY 2011 the 20 selected universities will continue to refine their designs. The highly energy efficient buildings will be constructed and judged in 2012.

Beginning in FY 2011, the Solar Decathlon is proposed to be transferred to the RE-ENERGYSE Program, within which $5.0 million is included.

Total, Technology Validation and Market Introduction	**21,260**	**22,000**	**20,000**

Explanation of Funding Changes

	FY 2011 vs. FY 2010 ($000)
Rebuild America	
The Rebuild America activities will be realigned with the Commercial Buildings Integration	-1,000
ENERGY STAR	
The increase in funds will be used to accelerate the development of test procedures for an increased range of products. In addition, the development of verification procedures will be accelerated to ensure the reliability of the ENERGY STAR label in the eyes of consumers. Developing test procedures and verification methods is a intensive process, but necessary as DOE begins doing more in-house testing and verification.	+3,000
Building Energy Codes	
The increase in funds will be directed to providing technical assistance to States required by Section 410 of the 2009 Recovery Act to adopt building energy codes.	+1,000
Solar Decathlon	
No funds are requested because the Solar Decathlon Program is proposed to be transferred from the Building Technologies Program to the RE-ENERGYSE Program in FY 2011. The focus within RE-ENERGYSE on educating future leaders to help develop affordable, abundant and clean energy is aligned with the Solar Decathlon's goal of fostering innovation and encouraging incorporation of new technologies and design practices into university curricula. RE-ENERGYSE proposes to fund the Solar Decathlon at $5.0 million.	-5,000
Total Funding Change, Technology Validation and Market Introduction	**-2,000**

Equipment Standards and Analysis

Funding Schedule by Activity

(dollars in thousands)

	FY 2009	FY 2010	FY 2011
Equipment Standards and Analysis	20,000	35,000	40,000
Total, Equipment Standards and Analysis	20,000	35,000	40,000

Description

The goal of the Equipment Standards and Analysis subprogram is to develop minimum energy efficiency standards that are technologically feasible and economically justified. In FY 2011, 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.

Benefits

Equipment Standards and Analysis activities lead to improved efficiency of appliances and equipment by conducting analyses and developing standards that are technologically feasible and economically justified. In 2011, BTP will issue 13 proposals and final rules for 11 product categories. Test procedures and energy conservation standards developed by this subprogram correlate directly to energy policy objectives such as increasing energy savings, reducing peak electricity demand, and reducing carbon emissions. According to a study by ACEEE, “peak capacity reduction from existing standards is expected to reach 72 GW in 2010, or about 7 percent of the projected U.S. generating capacity.”[a]

Detailed Justification

(dollars in thousands)

	FY 2009	FY 2010	FY 2011
Equipment Standards and Analysis	**20,000**	**35,000**	**40,000**

In FY 2011, DOE will continue to take all necessary steps, consistent with the consent decree, EPAct 2005, and EISA, to finalize legally required efficiency standards consistent with all applicable judicial and statutory deadlines.

The subprogram will continue ongoing rule-makings or begin rulemakings for the following product categories in FY 2011:

- 1-500 hp Electric Motors

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[a] Neubauer, Max, et al., “Ka-BOOM! The Power of Appliance Standards.” Report Number ASAP-7/ACEEE-A091. July 2009, p. 9. http://www.standardsasap.org/documents/Ka-BOOM!%20Executive%20Summary.pdf

- 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
- Elliptical Reflector (ER)/Bulged Reflector (BR)/Reflector (R) Lamps
- Metal Halide Lamp Fixtures
- Microwave Ovens
- Commercial Refrigeration Equipment
- Furnace Fans
- High Intensity Discharge Lamps
- Automatic Ice Makers
- Distribution Transformers
- Furnaces and Boilers

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 and 2010, DOE initiated six energy conservation standards rulemakings (ER/BR/R lamps, walk-in coolers and freezers, metal halide lamp fixtures, residential clothes washers, furnaces and boilers, and distribution transformers) and test procedure rulemakings for six products (battery chargers, external power supplies, clothes washers, fluorescent ballasts, central air-conditioners, and 1-500 hp electric motors).

In accordance with EISA, 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 significantly alters the scope of certain rulemakings by authorizing DOE to consider regional standards for certain space conditioning products. The central air conditioning and the furnaces and boilers rulemakings 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 2011 will also include responses to waiver requests from manufacturers and requests for input and recommendations to the DOE Office of Hearings and Appeals. Resource planning is critical to minimize delays and availability conflicts of DOE staff and contractor support.

DOE will also initiate an energy conservation standard rulemaking on automatic ice-makers. Funds may also be used to prepare for challenges such as new technologies utilized in appliances including

(dollars in thousands)

	FY 2009	FY 2010	FY 2011
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	**20,000**	**35,000**	**40,000**

Explanation of Funding Changes

	FY 2011 vs. FY 2010 ($000)
Equipment Standards and Analysis	
The funding increase in 2011 will allow DOE to develop energy conservation standards and test procedures for new products on schedule and to increase the scope of coverage for existing standards. In FY 2011, DOE will also examine its procedures for certification and enforcement, including updates to existing certification and reporting requirements for manufacturers. DOE will also evaluate performance and conduct testing on select products to verify compliance.	+5,000
Total Funding Change, Equipment Standards and Analysis	**+5,000**

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

(dollars in thousands)

	FY 2009 Current Appropriation[a]	FY 2009 Current Recovery Act Appropriation	FY 2010 Current Appropriation	FY 2011 Request
Industrial Technologies				
Industries of the Future (Specific)	15,160	0	12,121	2,627
Industries of the Future (Crosscutting)	73,036	212,854	83,879	87,373
Manufacturing Energy Systems	0	0	0	10,000
Efficiency of Information and Communications Technology and Standards	0	48,647	0	0
Total, Industrial Technologies	88,196	261,501	96,000	100,000

Funding Profile by Subprogram
(Comparable Structure to the FY 2011 Request)

(dollars in thousands)

	FY 2009 Current Appropriation[a]	FY 2009 Current Recovery Act Appropriation	FY 2010 Current Appropriation	FY 2011 Request
Industrial Technologies				
Industries of the Future (Specific)	15,160	0	12,121	2,627
Industries of the Future (Crosscutting)	53,469	202,904	53,005	55,213
Industrial Technical Assistance	*19,567*	*9,950*	*30,874*	*32,160*
Manufacturing Energy Systems	0	0	0	10,000
Efficiency of Information and Communications Technology and Standards	0	48,647	0	0
Total, Industrial Technologies	88,196	261,501	96,000	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” (ECP A) (1976)
P.L. 95-91, “Department of Energy Organization Act” (1977)
P.L. 95-619, “National Energy Supply Policy Act” (NECPA) (1978)
P.L. 95-620, “Powerplants and Industrial Fuel Use Act” (1978)
P.L. 96-294, “Energy Security Act” (1980)
P.L. 101-218, “Renewable Energy and Energy Efficiency Technology Competitiveness Act” (1989)
P.L. 102-486, “Energy Policy Act of 1992”

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[a] SBIR/STTR funding transferred in FY 2009 includes a reduction of $1,611,000 for the SBIR program, and $193,000 for the STTR program.

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

Mission

The mission of 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.[a] 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 private-sector partnerships. The program's activities help the Nation's industries advance their global competitiveness, creating and preserving jobs in America and reducing reliance on carbon based fuels 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).[a] Cumulative tracked energy savings over that period are estimated to be over 5.6 Quads. In 2006, the most recent year for which complete data are available, the program directly contributed to industrial energy savings of almost 500 trillion Btu worth about $5.5 billion.[bc] 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 2017.

The FY 2011 investments complement Recovery Act funds that are accelerating achievement of program goals. Recovery Act funding within ITP has helped to stimulate the economy and create and retain jobs through Combined Heat and Power (CHP), District Energy Systems, Waste Heat Recovery, Efficient Industrial Equipment, Information Technology Equipment Efficiency, and Pre-commercial Technology Demonstration for Information and Communication Technology Systems projects.
FY 2011 activities will build upon historic clean energy investments in the Recovery Act to further the Nation's energy goals through sustained technology innovation and continued investments in enabling infrastructure. This integrated targeted performance builds on both Recovery and RD&D will enable the realization of administration's goals and commitments to energy, the economy and climate. 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 a set of integrated activities proposed in this budget that are designed to increase the use of energy efficiency technologies and domestic renewable resources. It is expected that these improvements will continue to provide concomitant economic, environmental and security benefits. The most significant growth benefits are anticipated from innovative crosscutting technologies

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[a] Emissions of Greenhouse Gases in the United States 2007 report, December, 2008 http://www.eia.doe.gov/oiaf/1605/ggrpt

[b] See 2008 Impacts report at http://www1.eere.energy.gov/industry/about/pdfs/impacts2006_intro.pdf.

[c] 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).

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 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 strong industrial and National Laboratories partnerships to transform the way industry uses energy, thereby reducing reliance on carbon based fuels and cutting GHG emissions. As shown in the table below, EERE's GPRA models currently predict a cumulative reduction by 2030 of more than 1.5 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 ITP's domestic partners with a competitive edge in the green industrial revolution underway and planned for the future. As shown in the modeling data displayed below, it is projected that a cumulative reduction of more than 2.2 trillion cubic feet (Tcf) in natural gas and at least 200 million barrels in oil imports will result from ITP efforts by 2030, ten times that by 2050.

Economic Impact

As shown in the benefits tables below, ITP activities are projected to approach $200 billion dollars in cumulative consumer savings and a cumulative savings in the electric power industry of at least $80 billion.

The metrics tables that follow show the estimated benefits from 2015 through 2050 that would result from realization of ITP's goals. These benefits will be realized through targeted Federal investments in technology R&D through industrial partnerships with major energy-consuming sectors such as chemicals and cement, 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 tables also reflect 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 ITP'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 ITP, and is identical for all DOE applied energy R&D programs, 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 is 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 ITP'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 ITP'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 ITP.

The benefits are generated by modeling both the program goal and baseline cases[a] within two energy-economy models: NEMS-GPRA11 for benefits through 2030, and MARKAL-GPRA11 for benefits through 2050. The following tables display the full list of modeled benefits.

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[a] Baseline cases utilize data from the updated *Annual Energy Outlook 2009* Reference Case Service Report, April 2009

FY 2011 Primary Metrics

	Metric	Model	Year			
			2015	2020	2030	2050
Energy Security	Oil Imports Reduction, cumulative (Bil bbl)	NEMS	ns	ns	0.20	N/A
		MARKAL	0.17	0.39	0.74	1.9
	Natural Gas Imports Reduction, cumulative (Tcf)	NEMS	0.03	0.45	2.2	N/A
		MARKAL	ns	0.66	4.38	13.8
Environmental Impacts	CO_2 Emissions Reduction, cumulative (Mil mtCO_2)	NEMS	82	350	1504	N/A
		MARKAL	82	391	1934	5509
	SO_2 Allowance Price Reduction ($/ton)	NEMS	ns	ns	ns	N/A
		MARKAL	N/A	N/A	N/A	N/A
	NO_x Allowance Price Reduction ($/ton)	NEMS	ns	ns	ns	N/A
		MARKAL	N/A	N/A	N/A	N/A
Economic Impacts	Primary Energy Savings, cumulative (quads)	NEMS	1.4	5.5	23	N/A
		MARKAL	1.5	6.2	28	85
	Oil Savings, cumulative (Bil bbl)	NEMS	0.01	0.06	0.50	N/A
		MARKAL	0.18	0.43	1.1	2.7
	Consumer Savings, cumulative (Bil $)	NEMS	15	49	171	N/A
		MARKAL	23	64	275	654
	Electric Power Industry Savings, cumulative (Bil $)	NEMS	11	32	95	N/A
		MARKAL	6	18	80	206
	Household Energy Expenditures Reduction ($/household/yr)	NEMS	10	30	40	N/A
		MARKAL	ns	ns	ns	ns

- "Reductions" and "savings" are calculated as the difference between results from the baseline case (i.e. no future DOE funding for this technology) and the program case (i.e. requested DOE funding for this technology is received and is successful).
- Oil impacts are shown as two metrics. "Oil Imports Reduction" refers only to reductions in oil imports; "Oil Savings" refers to savings (reduction) in total oil consumption.
- All cumulative metrics are based on results beginning in 2011.
- All monetary metrics are in 2007$.
- Cumulative monetary metrics are in 2007$ that are discounted to 2011 using a 3% discount rate.

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

FY 2011 Secondary Metrics

	Metric	Model	Year			
			2015	2020	2030	2050
Energy Security	Oil Imports Reduction, annual (Mbpd)	NEMS	ns	0.03	ns	N/A
		MARKAL	0.12	0.12	0.11	0.13
	Natural Gas Imports Reduction, annual (Tcf)	NEMS	ns	0.13	0.12	N/A
		MARKAL	ns	0.26	0.33	0.5
	MPG Improvement (%)	NEMS	ns	ns	ns	N/A
		MARKAL	ns	ns	ns	ns
Environmental Impacts	CO2 Emissions Reduction, annual (Mil mtCO2/yr)	NEMS	23	70	147	N/A
		MARKAL	29	94	166	198
	CO2 Intensity Reduction of US Economy (Kg CO2/$GDP)	NEMS	ns	ns	0.01	N/A
		MARKAL	ns	0.01	0.01	0.01
	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 (Kg CO2/mile)	NEMS	ns	ns	ns	N/A
		MARKAL	ns	ns	ns	ns
Economic Impacts	Primary Energy Savings, annual (quads/yr)	NEMS	ns	1.04	2.2	N/A
		MARKAL	0.48	1.38	2.6	3.1
	Oil Savings, annual (Mbpd)	NEMS	0.01	0.04	0.2	N/A
		MARKAL	0.13	0.14	0.19	0.22
	Consumer Savings, annual (Bil $)	NEMS	3.2	12	21	N/A
		MARKAL	8.3	11	48	39
	Electric Power Industry Savings, annual (Bil $)	NEMS	3.8	6.6	13	N/A
		MARKAL	ns	3.5	14	18
	Energy Intensity of US Economy (energy/$GDP)	NEMS	0.04	0.08	0.1	N/A
		MARKAL	ns	ns	0.1	0.1
	Net Energy System Cost Reduction, cumulative (Bil $)	NEMS	N/A	N/A	N/A	N/A
		MARKAL	22	65	214	519

- “Reductions” and “savings” are calculated as the difference between results from the baseline case (i.e. no future DOE funding for this technology) and the program case (i.e. requested DOE funding for this technology is received and is successful).
- Oil impacts are shown as two metrics. "Oil Imports Reduction" refers only to reductions in oil imports; "Oil Savings" refers to savings (reduction) in total oil consumption.
- All cumulative metrics are based on results beginning in 2011.
- All monetary metrics are in 2007$.
- Cumulative monetary metrics are in 2007$ that are discounted to 2011 using a 3% discount rate.

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

Contribution to the Secretary's Goals and GPRA Unit Program Goals

ITP contributes to the Secretary's goals as enumerated below.

Innovation: Lead the world in science, technology, and engineering

ITP advances cutting edge, next generation energy technology innovation in areas such as nanomanufacturing, waste heat recovery and reuse, novel chemical process 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 technology solutions (chemical synthesis, nanomanufacturing, etc.) find application in the market. 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. National Laboratory teams maximize the synergy inherent in cooperative projects with industry and academia, while ITP also leverages competitive awards and cost-sharing to magnify its impact. Through the forging of strong industry partnerships, ITP ensures the relevance of cost-effective technology solutions for direct real-world industrial application (in CHP, nanomanufacturing, and other specific industrial processes), critical for accelerating technology commercialization.

ITP builds research networks across departments, agencies and nations, 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 gaps between mission-oriented science and real-world industrial use.

ITP proposes to develop a Manufacturing Energy Systems Program anchored at two premier U.S. universities to serve as knowledge development and dissemination centers organized around distinct manufacturing areas with critical technical needs. These centers will convene a consortium of leaders from academia, industry, the National Laboratories, and NGOs to set boundaries on known manufacturing platforms and define specifications for new products and processes necessary to reduce U.S. carbon emissions and enhance national energy security. Additionally, ITP continues to train the next-generation of energy engineers through the university-based Industrial Assessment Centers (IACs).

Energy: Build a competitive, low-carbon economy and secure America's energy future

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 fossil fuels. Industrial energy savings stimulate economic activity and reduce carbon impacts on the climate now, 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 energy-intensive industries result in tangible improvements demonstrating the power of such innovation. ITP is currently developing highly energy efficient technologies that result in tangible carbon emission reductions. 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 supports 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 expand the green workforce of the future. The program also conducts training of plant staff and others to become "qualified experts" in performing energy assessments. In addition, ITP is working to develop an ANSI/ISO standard that would independently certify the energy efficiency performance of industrial facilities.

To help reduce industrial energy use and carbon emissions globally, ITP is working with a range of countries to support international training initiatives, and 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 supporting targeted training exercises in developing nations such as India and China that focus on energy savings. 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).

Between 2002 and 2015, ITP activities will contribute to a 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 (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.[a]

ITP develops real-world energy solutions throughout the manufacturing value chain and helps American manufacturers uncover affordable energy savings and carbon reducing opportunities. For example, ITP's Save Energy Now (SEN) effort conducted 2, 421 assessments from 2006 through November 2009 that identified potential energy and cost savings for all types of manufacturers. The 2, 260 plants with completed reports identified more than $1.3 billion in potential cost savings per year, with $231 million per year already implemented and $437 million per year underway or scheduled.[b]

ITP continues to reduce energy use through efficiency improvements and concurrent activities supported by ITP. The program's goal reflects the increasing adoption of technologies by industry from the program's RD&D portfolio over time as program goals are met.

Annual Performance Results and Targets

ITP's performance contributes directly to two of the Secretary's goals. ITP's performance targets quantify the program's key contribution to achieving a clean, secure energy future through improving energy efficiency, saving TBtus, and directly reducing the demand for oil and other fossil 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. 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.

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[a] See 2008 Impacts report at http://www1.eere.energy.gov/industry/about/pdfs/impacts2006_intro.pdf

[b] ITP Save Energy Now: Results available at http://apps1.eere.energy.gov/industry/saveenergynow/partners/results.cfm

Annual Performance Targets and Results

Secretarial Goal: Goal 1: Innovation: Lead the world in science, technology, and engineering
Goal 2: Energy: Build a competitive, low-carbon economy and secure America's energy future

GPRA Unit Program Goal: 19: Industrial Technologies

Subprogram Name: Industrial Technologies

FY 2006	**FY 2007**	**FY 2008**	**FY 2009**	**FY 2010**	**FY 2011**	**FY 2012**	**FY 2013**	**FY 2014**	**FY 2015**
Performance Measure: Commercialize 2 new industrial technologies in partnership with the most energy-intensive industries that improve energy efficiency of an industrial process or product by at least 10 percent.									
T: 3 A: 7	T: 3 A: 3	T: 3 A: 3	T: 3 A: 3	T: 2 A:	T: 2 A:	T: 2 A:	T: 1 A:	T: 1 A:	T: 1 A:
Performance Measure: Achieve an estimated 100 trillion Btus energy savings from applying EERE technologies (trillion Btu).									
T: 100 A: NA	T: 100 A: NA	T:100 A: MET	T: 100 A: MET	T:100 A:	T:100 A:	T:100 A:	T:100 A:	T:100 A:	T:100 A:
Performance Measure: Achieve an estimated 100 trillion Btus energy savings from applying EERE technologies (trillion Btu). Annually impact 600 energy-intensive plants.[a] (TBtus/number of energy intensive plants)									
T: 100/200 A: MET	T: 100/1,000 A: MET	T: 100/400 A: MET	T: 100/600 A: MET	T: RETIRED A: NA	T: NA A: NA	T: NA A: NA	T: NA A: NA	T: NA A: NA	T: NA A: NA
Performance Measure: The FY 2011 performance measure was created in transition from reporting qualitative milestones to quantitative performance measures. Previous year performance measures for this subprogram are not direct predecessor measures to the FY 2011 performance measure. This measure included below enable the progress necessary to support the new FY 2011 Performance Measure. FY 2006: 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.									
T: 200/20% A: MET	T: RETIRED A: NA	T: NA A: NA	T: NA A: NA	T: NA A: NA	T: NA A: NA	T: NA A: NA	T: NA A: NA	T: NA A: NA	T: NA A: NA

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[a] "Impacted" refers to the number of unique plants receiving EERE energy 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 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.

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.

In addition, ITP will also implement 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 routes to achieve much lower energy use than current processes; and
- Conduct market transformation activities to accelerate the adoption of CHP and other clean energy technologies.

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.

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

- ITP's RD&D activities heavily leverage the intellectual property and knowledge of 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, Solar Energy, and Vehicle Technologies;
- 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;
- Leverages its partnerships with NIST, EPA, and utilities in the implementation of its Save Energy Now LEADER initiative;
- Coalitions between regional groups and ITP result in a series of industrial energy efficiency summits with associated industries, utilities, States, and other stakeholders; establish the foundations for a commitment to reduce industrial energy intensity and carbon emissions; and engage utilities, regional trade associations and local political influence;
- Partners with States and regional entities, providing a State Incentives and Resources Database, Energy Saving Assessments, Industrial Assessment Center assessments, and events and training;
- As part of the development of the international energy management standard ISO 50001, ITP is working with industry and American National Standards Institute (ANSI) to develop standards for facility level comprehensive energy management, system level management, and measurement and verification;
- The Energy-Efficient Data Centers initiative is the result of collaboration among ITP, DOE-FEMP, and the EPA ENERGY STAR program;
- Works with several utility trade groups to establish a program which will utilize energy efficiency options to slow electric and gas demand; and
- Provides for new technology demonstrations, plant assessment and other projects in steel, cement and other industries; collaborates with China (MOU) to assist Chinese industry in meeting China's 2010 energy and carbon intensity reduction goal; collaborates with India in areas of improved energy efficiency in manufacturing; and, Industrial Energy Technologies and Systems Implementing Agreement & District Heating/CHP activities with the International Energy Agency (IEA).

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 continuous 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 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, the Performance Measurement Manager (PMM).

Data Sources:

- Energy intensity is calculated from the Energy Information Administration's (EIA's) Annual Energy Outlook, the Manufacturing Energy Consumption Survey (MECS), and Department of Commerce (DOC) data.[a,b]
- The number of technologies and their energy savings are ascertained through interviews with technology developers and suppliers.
- Commercially available products developed through ITP sponsorship are recorded in the IMPACTS document.[c]
- Energy savings for the technical assistance programs are estimated based upon past reported participant data.
- Plant energy assessment results are available in online ITP databases.[d]

Evaluation: In carrying out the program's mission, ITP 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 external experts of the program and subprogram portfolios;
- Annual internal Technical Program Review of ITP;
- Continue to conduct the transparent oversight and performance management initiated by Congress and the Administration;
- 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 PMM; 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.

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

[b] EIA Manufacturing Energy Consumption Survey, available at http://www.eia.doe.gov/emeu/mecs/

[c] IMPACTS: Industrial Technologies Program: Summary of Program Results for CY 2006, September 2008 http://www1.eere.energy.gov/industry/about/pdfs/impacts2006_full_report.pdf

[d] Save Energy Now: Energy Assessments, available http://www1.eere.energy.gov/industry/saveenergynow/assessments.html, Industrial Assessment Center Database, available at http://iac.rutgers.edu/database/

Frequency:

- EIA/MECS collects energy intensity data once every four years, and ITP makes annual estimates based upon data from annual DOC 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, available 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 the 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.

Industries of the Future (Specific)
Funding Schedule by Activity

	(dollars in thousands)		
	FY 2009	FY 2010	FY 2011
Industries of the Future (Specific)			
Chemicals Industry	4,273	4,407	2,070
Cement Industry	0	0	487
Forest and Paper Products Industry	1,449	1,390	0
Steel Industry	4,380	4,205	0
Aluminum Industry	2,139	1,796	0
Metal Casting Industry	1,946	0	0
Glass Industry	973	0	0
SBIR/STTR	0 [a]	323	70
Total, Industries of the Future (Specific)	15,160	12,121	2,627

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 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.

In FY 2011, new work will be initiated with the chemicals and cement industries, while existing efforts in the Forest and Paper Products Industry, the Steel Industry, and the Aluminum Industry will continue to completion, as ITP continues to shift to greater support of crosscutting technologies that provide significant savings across multiple energy intensive industries using investments more productively. With the chemicals industry, ITP will develop technologies and innovations that produce dramatic efficiency improvements such as industrial process equipment improvements, adopting alternative chemical feedstocks, and applying new scientific understanding of chemistry to chemical processing applications. A new exploratory initiative with the cement industry will also be commenced, targeting energy efficiency improvements and reduced GHG emissions.

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[b] based on the technical significance, uniqueness and usefulness of projects and technologies from across industry, government, and academia. The IOF Specific subprogram will also continue its excellent track record of moving innovative energy-efficient technologies from R&D through demonstration and eventual introduction to their respective markets.

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[a] SBIR/STTR funding transferred in FY 2009 was $370,000 for the SBIR program and $45,000 for the STTR program.

[b] R&D 100 Awards, R&D Magazine, available at http://www.rdmag.com/Awards/RD-100-Awards/R-D-100-Awards/

Benefits

ITP’s IOF Specific RD&D reduces the energy intensity and carbon emissions of some of the most energy-intensive processes in the Nation’s major industries. Energy, environmental, and productivity improvements resulting from IOF Specific RD&D will enhance the competitive position of the Nation’s critical industries, and preserve jobs while significantly contributing to mitigating global climate change. 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 IOF, including Chemicals Industry activities.

In FY 2011, commercialization of two new technologies in partnership with the most energy-intensive industries will improve energy efficiency of an industrial process or product by at least 10 percent. This will also strengthen partnerships with organizations developing ITP-supported technologies.

Detailed Justification

(dollars in thousands)

	FY 2009	FY 2010	FY 2011
Chemicals Industry	**4,273**	**4,407**	**2,070**

In FY 2011, this activity will involve projects addressing alternative processes for chemical production, oxidation reactions, hybrid distillation processes, and micro-reactors. 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.

	FY 2009	FY 2010	FY 2011
Cement Industry	**0**	**0**	**487**

In FY 2011, this new activity will study and identify a variety of next-generation cement technologies. Improvements in cement manufacturing represent a sizable opportunity to reduce CO_2 production emissions and reduce energy intensities. Potential transformational technologies to explore include replacement materials (e.g. geopolymer cements), low-energy intensive cements that absorb CO_2 during the curing process, and nanotechnologies for optimizing cement manufacturing.

	FY 2009	FY 2010	FY 2011
Forest and Paper Products Industry	**1,449**	**1,390**	**0**

Ongoing multi-year activities initiated in prior years will continue to completion, involving: high efficiency pulping technologies; other cost-shared industry specific RD&D; and process innovations.

	FY 2009	FY 2010	FY 2011
Steel Industry	**4,380**	**4,205**	**0**

Ongoing multi-year activities initiated in prior years will continue to completion, including: developing cokeless iron making technologies; blast furnace optimization; and other cost-shared industry specific RD&D and process innovations.

	FY 2009	FY 2010	FY 2011
Aluminum Industry	**2,139**	**1,796**	**0**

Ongoing multi-year activities initiated in prior years, involving a focus on the areas of efficient melting and forming, will continue to completion.

	(dollars in thousands)		
	FY 2009	FY 2010	FY 2011
Metal Casting Industry	**1,946**	**0**	**0**

Ongoing work from projects initiated in prior years was completed in FY 2010. Work with this industry is now being conducted through the Energy Intensive Process R&D key activity within the Industries of the Future (crosscutting) subprogram.

Glass Industry	**973**	**0**	**0**

Ongoing work from projects initiated in prior years was completed in FY 2010. Work with this industry is now being conducted through the Energy Intensive Process R&D key activity within the Industries of the Future (crosscutting) subprogram.

SBIR/STTR	**0**	**323**	**70**

In FY 2009, $370,000 and $45,000 were transferred to the SBIR and STTR programs respectively. The FY 2010 and FY 2011 amounts shown are estimated requirements for the continuation of the SBIR and STTR program.

Total, Industries of the Future (Specific)	**15,160**	**12,121**	**2,627**

Explanation of Funding Changes

	FY 2011 vs. FY 2010 ($000)
Chemicals Industry	
This decrease reflects a more streamlined overall FY 2011 program, emphasizing crosscutting technologies that provide significant savings across multiple energy intensive industries.	-2,337
Cement Industry	
This increase reflects the establishment of an explorative study to identify the pathways for significant carbon emission reduction to meet long term GHG goals.	+487
Forest and Paper Products Industry	
This decrease reflects a prioritized overall FY 2011 program, emphasizing crosscutting technologies that provide significant savings across multiple energy intensive industries. Existing projects will run until completion.	-1,390
Steel Industry	
This decrease reflects a prioritized overall FY 2011 program, emphasizing crosscutting technologies that provide significant savings across multiple energy intensive industries.	-4,205

Aluminum Industry	
This decrease reflects a more streamlined overall FY 2011 program, emphasizing crosscutting technologies that provide significant savings across multiple energy intensive industries. Existing projects will run until completion.	-1,796
Metal Casting Industry	
No change.	0
Glass Industry	
No change.	0
SBIR/STTR	
Changes in the SBIR/STTR funding are a direct result of changes in the funding of program activities.	-253
Total Funding Change, Industries of the Future (Specific)	**-9,494**

Industries of the Future (Crosscutting)
Funding Schedule by Activity
(Non-Comparable, or as Appropriated, Structure)

(dollars in thousands)

	FY 2009	FY 2010	FY 2011
Industries of the Future (Crosscutting)			
Industrial Materials of the Future	4,653	4,468	4,167
Combustion	814	0 [a]	0
Industrial Technical Assistance			
Industrial Assessment Centers	4,035	3,874	4,035
Best Practices	15,532	27,000	28,125
Total, Industrial Technical Assistance	19,567	30,874	32,160
Energy-Intensive Process R&D	14,847	14,252	14,847
Fuel and Feedstock Flexibility	3,889	3,633	3,786
Nanomanufacturing and Other Interagency Manufacturing R&D	4,861	4,543	4,732
Industrial Distributed Energy	24,405	24,698	25,727
Desalination	0	0	488
SBIR/STTR	0 [b]	1,411	1,466
Total, Industries of the Future (Crosscutting)	73,036	83,879	87,373

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[a] Prior to FY 2010, Combustion was funded as a key activity under Industries of the Future (Crosscutting). Work under this activity was transferred to the crosscutting Energy-Intensive Process R&D activity in FY 2010.

[b] SBIR/STTR funding transferred in FY 2009 was $1,241,000 for the SBIR program and $148,000 for the STTR program.

Industries of the Future (Crosscutting)
Funding Schedule by Activity
(Comparable Structure to the FY 2011 Request)

(dollars in thousands)

	FY 2009	FY 2010	FY 2011
Industries of the Future (Crosscutting)			
Industrial Materials of the Future	4,653	4,468	4,167
Combustion	814	0 [a]	0
Energy-Intensive Process R&D	14,847	14,252	14,847
Fuel and Feedstock Flexibility	3,889	3,633	3,786
Nanomanufacturing	*4,861*	*4,543*	*4,732*
Combined Heat and Power Generation	*24,405*	*24,698*	*25,727*
Desalination	*0*	*0*	*488*
SBIR/STTR	0 [b]	1,411	1,466
Total, Industries of the Future (Crosscutting)	53,469	53,005	55,213

Description

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 five years, crosscutting technologies developed by ITP have won seven 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.

ITP projects that received Recovery Act funds focus on Combined Heat and Power (CHP), District Energy Systems, Waste Energy Recovery, and Efficient Industrial Equipment. These projects build upon ITP's existing Combined Heat and Power projects and focus on increased efficiency. CHP and District Energy Systems projects will co-generate electrical and useful thermal energy with a minimum efficiency of 60 percent; Waste Energy Recovery systems projects will have a minimum efficiency of 30 percent; and, Efficient Industrial Equipment projects will have be a minimum of 25 percent more efficient than the equipment being replaced.

The Recovery Act funding also provided an opportunity to begin R&D to develop new technologies to dramatically improve energy efficiency in Information and Communication Technology an the emphasis on new technologies that can be commercialized within the next three to five years, and to demonstrate through field testing highly energy efficient, emerging technologies that are ready for or are in the initial stage of commercial introduction. The activities proposed here serve to complement and build upon

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[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 transferred in FY 2009 was $1,241,000 for the SBIR program and $148,000 for the STTR program.

these targeted investments in industrial energy efficiency.

In FY 2011, the IOF Crosscutting subprogram will:

- Accelerate R&D and adoption of CHP in industrial and commercial markets, a technology that can improve energy efficiency, simultaneously create green jobs, reduce GHG emissions, and improve the efficiency of U.S. industry;
- Support cutting-edge R&D in the Energy Intensive Processes (EIP) portfolio to develop transformational technologies with applications across a broad spectrum of markets;
- Continue Industrial Materials of the Future RD&D;
- Focus Nanomanufacturing activities on enabling processes for building on scientific discoveries from the National Laboratories and DOE's Office of Science 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 carbon based fuel; and
- Commence a new Desalination initiative to reduce process energy consumption.

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 nanotechnology field; and
- The combined 2025 energy savings for IOF Crosscutting is estimated at 990 trillion Btus. Carbon savings for that same year are estimated at 28.77 MMTCO$_2$.

Detailed Justification

(dollars in thousands)

	FY 2009	FY 2010	FY 2011
Industrial Materials of the Future	**4,653**	**4,468**	**4,167**

In FY 2011, 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 44 trillion Btus and carbon savings of 0.79 MMTCO$_2$.

(dollars in thousands)

	FY 2009	FY 2010	FY 2011
Combustion	**814**	**0**	**0**

Work in this activity to develop and demonstrate an ultra-high efficiency industrial boiler system was transferred to and continues within the crosscutting Energy-Intensive Process R&D activity in FY 2010.

Energy-Intensive Process (EIP) R&D	**14,847**	**14,252**	**14,847**

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 work was previously 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-excitation 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 and beverage, computer and electronic, and fabricated metal products), in three to 10 years. Estimated annual energy savings in 2025 are 288 trillion Btus and carbon savings of 4.50 $MMTCO_2$.

Fuel and Feedstock Flexibility	**3,889**	**3,633**	**3,786**

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 involve: assisting industry in integrating alternative fuels into manufacturing processes; improving fuel flexibility to reduce the damaging effects of fossil fuel price hikes; facilitating the manufacturing, 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. Estimated annual energy savings in 2025 are 49 trillion Btus and carbon savings of 0.75 $MMTCO_2$.

(dollars in thousands)

	FY 2009	FY 2010	FY 2011
Nanomanfacturing	**4,861**	**4,543**	**4,732**

ITP is helping lead the charge to transform nanotechnology science into real-world energy solutions. 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 efforts positions this new program activity as a crucial link between the National Laboratories, research universities and a market eager to lay a new foundation for national prosperity.

Recent work focuses on the development of new technologies and techniques to manufacture novel nano-catalysts, nano-lubricants, nano-coatings, and nano-composites; and, nano-enabled processes for PV material production and energy storage applications. Estimated annual energy savings in 2025 are 76 trillion Btus and carbon savings of 1.13 $MMTCO_2$.

Combined Heat and Power Generation	**24,405**	**24,698**	**25,727**

In FY 2008, Congress re-established a distributed energy (DE) activity within ITP, including CHP.

The Recovery Act funds build upon the program’s existing Combined Heat and Power projects and focus on increased efficiency. In FY 2011, 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 NO_x 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 533 trillion Btus of displaced energy and 21.6 $MMTCO_2$ in carbon savings per year by 2025.

	(dollars in thousands)		
	FY 2009	FY 2010	FY 2011
Desalination	**0**	**0**	**488**

In 2011 ITP will focus on the issues surrounding water resources related to industrial processes. Specifically, ITP will investigate the current and state-of-the-art desalination technologies utilized for both potable and industrial applications. Focus areas will include the evaluation of the current drivers related to water usage including the current industry required capacity, water supply and quality evaluations, R&D projects, and an evaluation of emerging technologies as they pertain to industry. In addition, ITP will evaluate the current challenges associated with the desalination of both ocean and brackish surface water and its disposal including the potential to reduce energy intensity, environmental degradation and economic impacts linked with the increased use of this resource. It is anticipated that workshops will be held with industry experts, academia, government agencies and others in an attempt to gain a more thorough understanding of the barriers associated with the advancement of desalination technology and policy.

SBIR/STTR	**0**	**1,411**	**1,466**

In FY 2009, $1,241,000 and $148,000 were transferred to the SBIR and STTR programs respectively. The FY 2010 and FY 2011 amounts shown are estimated requirements for the continuation of the SBIR and STTR program.

Total, Industries of the Future (Crosscutting)	**53,469**	**53,005**	**55,213**

Explanation of Funding Changes

	FY 2011 vs. FY 2010 ($000)
Industrial Materials of the Future	
This decrease reflects the reprioritization of funding to support the new desalination activity.	-301
Combustion	
No change.	0
Energy Intensive Process R&D	
No significant change.	+595
Fuel and Feedstock Flexibility	
No significant change.	+153
Nanomanufacturing	
This new activity reflects activities transferred from Nanomanufacturing and Other	+189

	FY 2011 vs. FY 2010 ($000)
Interagency Manufacturing R&D. No significant change.	
Combined Heat and Power Generation	
This new activity includes work transferred from Industrial Distributed Energy.	+1,029
Desalination	
This increase reflects the establishment of the new activity.	+488
SBIR/STTR	
Changes in the SBIR/STTR funding are a direct result of changes in the funding of program activities.	+55
Total Funding Change, Industries of the Future (Crosscutting)	**+2,208**

Manufacturing Energy Systems
Funding Schedule by Activity

(dollars in thousands)

	FY 2009	FY 2010	FY 2011
Manufacturing Energy Systems	0	0	9,733
SBIR/STTR	0	0	267
Total, Manufacturing Energy Systems	0	0	10,000

Description

The Manufacturing Energy Systems (MES) subprogram is focused on enhancing the competitiveness of America’s manufacturers through the rapid innovation of new products and processes to significantly reduce manufacturing energy intensity and carbon emissions.

Anchored at two premier U.S. universities, the Manufacturing Energy Systems Program (MES) will serve as knowledge development and dissemination centers organized around distinct manufacturing areas with critical technical needs. These centers will convene a consortium of leaders from academia, industry, the National Laboratories, and NGOs to set boundaries on known manufacturing platforms and define specifications for new products and processes necessary to reduce U.S. carbon emissions and enhance national energy security.

Once defined, these boundaries will effectively serve as a market “push” by providing the real-world manufacturing framework that can focus scientific research on those activities with the greatest commercial promise. Designing basic research with cost and manufacturing feasibility in mind will reduce the time necessary to translate innovation into commercial product and avoid the “valley of death” risk that too often dooms fledgling technologies. With access to all academic departments at the MES institutions, the centers can address economic issues and other barriers. MES prominence will also likely spawn nearby start-up firms, private research organizations, suppliers, and other complementary groups and businesses that will facilitate technology development and adoption.

Benefits

The manufacturing framework, programmatic emphasis on low or near-zero carbon processes and technologies, and cross-disciplinary approach will accelerate translation of scientific knowledge toward those applications with the greatest commercial promise. MES prominence will also help catalyze private efforts to build a clean energy future while supporting the Administration's carbon reduction and green job creation goals.

ITP’s MES support the President’s goal to strengthen the economy through sustainable job creation in the clean energy economy by:

- Setting conceptual technology boundaries organized around distinct areas of critical manufacturing products and processes that enable or support carbon reductions.
- Defining known manufacturing process limits will pinpoint specific research needs, enabling rapid translation of laboratory innovation into commercial products.
- Helping build the knowledge base and deploy the human capital necessary to address energy and climate change challenges.
- Contributing to the targeted development of technologies to significantly reduce carbon emissions.

- Enhancing the competitiveness of America's manufacturers and leading to the creation of jobs both in manufacturing and other domestic industries through the rapid innovation of new products and processes.

Detailed Justification

	(dollars in thousands)		
	FY 2009	FY 2010	FY 2011
Manufacturing Energy Systems	**0**	**0**	**9,733**

The Manufacturing Energy Systems will serve as knowledge development and dissemination centers organized around distinct manufacturing areas with critical technical needs. In FY 2011, ITP will initiate subprogram activities by selecting critical areas to be funded, competitively solicit for Manufacturing Energy Systems, and initiate activities.

	FY 2009	FY 2010	FY 2011
SBIR/STTR	**0**	**0**	**267**

No funds were transferred to SBIR/STTR in FY 2009 as this is a new subprogram. The FY 2011 amount shown is an estimated requirement for the continuation of the SBIR and STTR program.

	FY 2009	FY 2010	FY 2011
Total, Manufacturing Energy Systems	**0**	**0**	**10,000**

Explanation of Funding Changes

	FY 2011 vs. FY 2010 ($000)
Manufacturing Energy Systems	
This increase reflects the establishment of the MES subprogram	+9,733
SBIR/STTR	
Changes in the SBIR/STTR funding are a direct result of changes in the funding of program activities.	+267
Total Funding Change, Manufacturing Energy Systems	**+10,000**

Industrial Technical Assistance
Funding Schedule by Activity

	(dollars in thousands)		
	FY 2009	FY 2010	FY 2011
Industrial Technical Assistance			
Energy Services Development	4,035	3,874	4,055
Save Energy Now Leaders Partnerships	15,532	27,000	28,105
Total, Industries Technical Assistance	19,567	30,874	32,160

Description

Modifications are proposed to the budget structure to better reflect ITP's technical assistance activities in FY 2011. Previously titled Industrial Assessment Centers and Best Practices, technical delivery activities are now represented as Industrial Technical Assistance, including the sub-categories Energy Services Development and Save Energy Now (SEN) Leaders Partnership.

In FY 2011, ITP will:

- Provide energy assessments and audits through Energy Services Development and SEN Leaders Partnership; and
- Partner with leading industrial companies, plants, and supply chains to implement energy-saving and carbon-reducing technology solutions in the SEN Leaders Partnership.

ITP will also continue to promote the use of energy-efficient technologies and practices throughout industry. Deployment efforts such as Energy Services Development through university-based assessment centers and the SEN Leaders Partnership 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 Energy Services Development assessment centers 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 for 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 Industrial Technical Assistance activities achieve energy savings and carbon reductions by:

- Disseminating energy assessments, tools, information, and training to state, utility, and local partners;
- Identifying plant-wide opportunities for energy savings and process efficiency;
- Training and engaging engineering students and manufacturing plant staff in conducting technology delivery activities that help plants access and apply today's most efficient technologies and energy management practices, thus building a green workforce for the future;
- Promoting a corporate culture of energy efficiency and carbon management throughout industry. In FY 2011, achieving an estimated 100 trillion Btus energy savings from applying EERE technologies will lead to lower GHG emissions and increased energy cost savings for industry.

Between SEN's inception in 2006 and November 2009, the initiative has conducted 2,421 assessments at the Nation's most energy-intensive industrial facilities. For the 2,260 assessments where reporting is available, opportunities were identified that could save more than 122 trillion Btus of natural gas, the amount used by nearly 1.7 million average U.S. homes. If fully implemented, the improvements could save nearly $1.4 billion dollars per year and reduce carbon dioxide emissions by 11.7 $MMTCO_2$ annually.[a]

Detailed Justification

(dollars in thousands)

	FY 2009	FY 2010	FY 2011
Energy Services Development	**4,035**	**3,874**	**4,055**

The Energy Services Development activity funds a network of universities that deploy undergraduate and graduate engineering students to conduct free energy audits of small and medium-sized manufacturers. The audits identify a range of efficiency improvements, including no-cost and low-cost recommendations, providing assistance to U.S. manufacturers struggling to cope with high energy prices. This activity also supports the President's goal of training more engineers and scientists in the energy field.[b] 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.

This activity is expected to yield annual energy savings of 180 trillion Btus in 2025 and a carbon savings of 2.67 $MMTCO_2$.

Save Energy Now Leaders Partnership	**15,532**	**27,000**	**28,105**

Through the SEN Leaders Partnership, 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 Section 106 of EPAct 2005. 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 800 completed Energy Savings Assessments (ESAs), which have identified $1.3 billion per year in potential energy cost savings since 2006. In FY 2011, ITP will expand its partnership with leading corporations in energy management and pilot a new voluntary ANSI-accredited[c] 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. SEN Leaders Partnership activities are estimated to result in energy savings in 2025 of 1,651 trillion Btus and a carbon savings of 24.5 $MMTCO_2$.

Total, Industrial Technical Assistance	**19,567**	**30,874**	**32,160**

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[a] ITP Save Energy Now: Results available at http://apps1.eere.energy.gov/industry/saveenergynow/partners/results.cfm

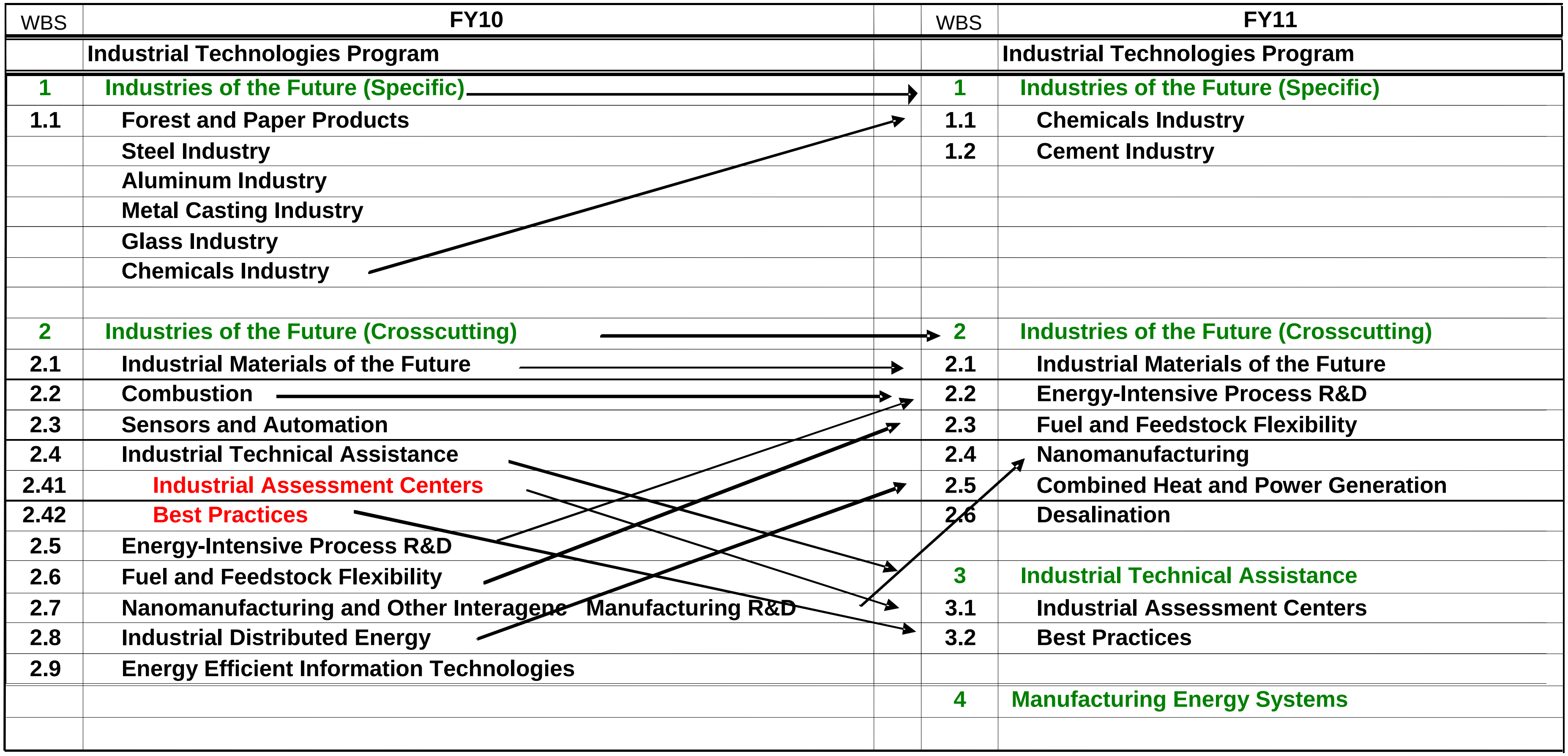
[b] White House Press Office http://www.whitehouse.gov/the_press_office/Remarks-by-the-President-at-the-National-Academy-of-Sciences-Annual-Meeting/

[c] ANSI refers to the American National Standards Institute

Explanation of Funding Changes

	FY 2011 vs. FY 2010 ($000)
Industrial Technical Assistance	
Energy Services Development	
Activities were transferred from Industrial Assessment Centers. No significant change.	+181
Save Energy Now Leaders Partnerships	
Activities were transferred from Best Practices. Increase will be used to expand partnerships and pilot a new voluntary manufacturing facility energy efficiency certification standard.	+1,105
Total Funding Change, Industrial Technical Assistance	**+1,286**

Industrial Technologies Program FY 2010 – FY 2011 Crosswalk



WBS	FY10		WBS	FY11
	Industrial Technologies Program			**Industrial Technologies Program**
1	Industries of the Future (Specific)		1	Industries of the Future (Specific)
1.1	Forest and Paper Products		1.1	Chemicals Industry
	Steel Industry		1.2	Cement Industry
	Aluminum Industry			
	Metal Casting Industry			
	Glass Industry			
	Chemicals Industry			
2	Industries of the Future (Crosscutting)		2	Industries of the Future (Crosscutting)
2.1	Industrial Materials of the Future		2.1	Industrial Materials of the Future
2.2	Combustion		2.2	Energy-Intensive Process R&D
2.3	Sensors and Automation		2.3	Fuel and Feedstock Flexibility
2.4	Industrial Technical Assistance		2.4	Nanomanufacturing
2.41	Industrial Assessment Centers		2.5	Combined Heat and Power Generation
2.42	Best Practices		2.6	Desalination
2.5	Energy-Intensive Process R&D			
2.6	Fuel and Feedstock Flexibility		3	Industrial Technical Assistance
2.7	Nanomanufacturing and Other Interagency Manufacturing R&D		3.1	Industrial Assessment Centers
2.8	Industrial Distributed Energy		3.2	Best Practices
2.9	Energy Efficient Information Technologies			
			4	Manufacturing Energy Systems

Federal Energy Management Program
Funding Profile by Subprogram

(dollars in thousands)

	FY 2009 Current Appropriation	FY 2009 Current Recovery Act Appropriation	FY 2010 Current Appropriation	FY 2011 Request
Federal Energy Management Program				
Project Financing	8,000	7,888	11,800	12,072
Technical Guidance and Assistance	4,000	11,000	8,000	10,000
Planning, Reporting and Evaluation	2,000	3,500	3,000	5,000
Federal Fleet	2,000	0	3,000	3,000
DOE Specific Investments	6,000	0	6,200	12,200
Total, Federal Energy Management Program	22,000	22,388	32,000	42,272

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 of 1992”
P.L. 109-58, “Energy Policy Act of 2005”
P.L 110-140, “Energy Independence and Security Act of 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

As proposed, FEMP program activities in support of Federal agencies 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 renewable energy technologies 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 ESPCs and 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, federal fleets, renewable electric power and agency compliance with relevant public law and Executive Order (E.O.) requirements. For DOE, FEMP promotes internal energy management policies and planning efforts following DOE Order 430.2b[a] and E.O. 13514 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 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; including the Federal Interagency Energy Management Task Force, Interagency Sustainable Working Group, and the Federal Utility Partners Working Group.

By providing 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 climate change, energy security and positive economic impacts.

Steady progress is being made on FEMP’s two Recovery Act projects. The Enhance & Accelerate FEMP Service Functions to the Federal Government project is enhancing technical assistance, communications, outreach and training to assist agencies with a great increase in activity and investments in energy efficiency and renewable energy, water and green building projects occurring across the Federal Government. The Energy, Water & Emissions Reporting and Tracking System project is developing comprehensive GHG tools and resources that provide the necessary services to Federal agencies and assist other Federal agencies as they make energy and water investment decisions. FY 2011 activities will build upon historic clean energy investments in the Recovery Act to further the Nation’s energy goals through sustained technology innovation and continued investments in enabling infrastructure. 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.

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[a] DOE Order 430.2b “Departmental Energy, Renewable Energy and Transportation Management” can be found at: http://www.directives.doe.gov/pdfs/doe/doetext/neword/430/o4302b.html.

Climate Change

FEMP provides support to Federal Agencies to meet their greenhouse gas reduction goals which were established according to the requirements of Executive Order 13514. FEMP also assists agencies in tracking their greenhouse gases by providing guidelines and GHG tools and resources.

Energy Security

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. Private sector development of alternative fuel stations at Federal sites will be supported to demonstrate opportunities for petroleum displacement.

Economic Impact

FEMP-facilitated investments in energy efficiency and renewable energy also increase the Nation's energy productivity and increase green jobs. Estimated economic benefits show the potential to reduce cumulative net consumer expenditures by more than $20 billion by 2030.[a]

The benefit tables on the following pages show the preliminary strategic estimated benefits from 2015 through 2050 and related metrics that would result from realization of FEMP's goals.[b] 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.

FEMP's goal case is modeled along with a "baseline" case in which no DOE R&D or deployment programs exist. 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 is 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 FEMP's goal case, and the resulting economic, environmental and security benefits attributed to FEMP'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 FEMP'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 FEMP.

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[a] Detailed economic impact benefit can be found in the NEMS-GPRA11 tables.

[b] Additional information on EERE's impact analysis methodology and assumptions, as well as the final FY 2011 budget impact estimates, can be found at http://www1.eere.energy.gov/ba/pba/program_benefits.html.

The benefits are generated by modeling both the program goal and baseline cases[a] within two energy-economy models: NEMS-GPRA11 for benefits through 2030, and MARKAL-GPRA11 for benefits through 2050. The following tables display the full list of modeled benefits.

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[a] Baseline cases utilize data from the updated *Annual Energy Outlook 2009* Reference Case Service Report, April 2009

FY 2011 Primary Metrics

	Metric	Model	Year			
			2015	2020	2030	2050
Energy Security	Oil Imports Reduction, cumulative (Bil bbl)	NEMS	ns	ns	ns	N/A
		MARKAL	ns	ns	ns	ns
	Natural Gas Imports Reduction, cumulative (Tcf)	NEMS	ns	ns	0.11	N/A
		MARKAL	ns	0.18	1.00	2.32
Environmental Impacts	CO_2 Emissions Reduction, cumulative (Mil mtCO_2)	NEMS	ns	29.9	91.5	N/A
		MARKAL	15	38	87	165
	SO_2 Allowance Price Reduction ($/ton)	NEMS	NA	NA	NA	N/A
		MARKAL	N/A	N/A	N/A	N/A
	NO_x Allowance Price Reduction ($/ton)	NEMS	NA	NA	NA	N/A
		MARKAL	N/A	N/A	N/A	N/A
Economic Impacts	Primary Energy Savings, cumulative (quads)	NEMS	ns	ns	ns	N/A
		MARKAL	ns	ns	0.74	2.70
	Oil Savings, cumulative (Bil bbl)	NEMS	ns	ns	ns	N/A
		MARKAL	ns	0.01	0.01	ns
	Consumer Savings, cumulative (Bil $)	NEMS	ns	7.43	23.23	N/A
		MARKAL	ns	ns	ns	ns
	Electric Power Industry Savings, cumulative (Bil $)	NEMS	ns	3.3	9.1	N/A
		MARKAL	1.6	3.8	12.3	19.1
	Household Energy Expenditures Reduction ($/household/yr)	NEMS	ns	ns	ns	N/A
		MARKAL	9.0	4.9	14.1	ns

- “Reductions” and “savings” are calculated as the difference between results from the baseline case (i.e. no future DOE funding for this technology) and the program case (i.e. requested DOE funding for this technology is received and is successful).

- Oil impacts are shown as two metrics. "Oil Imports Reduction" refers only to reductions in oil imports; "Oil Savings" refers to savings (reduction) in total oil consumption.

- All cumulative metrics are based on results beginning in 2011.
- All monetary metrics are in 2007$.
- Cumulative monetary metrics are in 2007$ that are discounted to 2011 using a 3% discount rate.

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

FY 2011 Secondary Metrics

	Metric	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	ns	0.07	0.09	ns
	MPG Improvement (%)	NEMS	ns	ns	ns	N/A
		MARKAL	ns	ns	ns	ns
Environmental Impacts	CO2 Emissions Reduction, annual (Mil mtCO2/yr)	NEMS	ns	3.9	8.5	N/A
		MARKAL	5.5	3.7	4.8	1.0
	CO2 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 (Kg CO2/mile)	NEMS	NA	NA	NA	N/A
		MARKAL	ns	ns	ns	ns
Economic Impacts	Primary Energy Savings, annual (quads/yr)	NEMS	ns	ns	ns	N/A
		MARKAL	ns	0.06	0.10	0.05
	Oil Savings, annual (Mbpd)	NEMS	ns	ns	ns	N/A
		MARKAL	ns	ns	ns	ns
	Consumer Savings, annual (Bil $)	NEMS	ns	1.48	1.93	N/A
		MARKAL	ns	ns	ns	ns
	Electric Power Industry Savings, annual (Bil $)	NEMS	ns	0.64	0.92	N/A
		MARKAL	0.68	0.45	1.88	0.79
	Energy Intensity of US Economy (energy/$GDP)	NEMS	NA	NA	NA	N/A
		MARKAL	ns	ns	ns	ns
	Net Energy System Cost Reduction, cumulative (NPV, Bil $)	NEMS	N/A	N/A	N/A	N/A
		MARKAL	6.3	19.1	50.4	94.2

- "Reductions" and "savings" are calculated as the difference between results from the baseline case (i.e. no future DOE funding for this technology) and the program case (i.e. requested DOE funding for this technology is received and is successful).
- Oil impacts are shown as two metrics. "Oil Imports Reduction" refers only to reductions in oil imports; "Oil Savings" refers to savings (reduction) in total oil consumption.
- All cumulative metrics are based on results beginning in 2011.
- All monetary metrics are in 2007$.
- Cumulative monetary metrics are in 2007$ that are discounted to 2011 using a 3% discount rate.

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

Contribution to the Secretary's Goals and GPRA Unit Program Goals

FEMP contributes to several of the Secretary's goals as described below, principally.

Energy: Build a competitive, low-carbon economy and secure America's energy future.

FEMP's priorities reduce 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.

FEMP activities provide 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 that will reduce energy demand and deploy low-carbon energy technologies. For example, FEMP's facilitation of Energy Savings Performance Contracts (ESPCs) and Utility Energy Service Contracts (UESCs) provides third party financing for the installation of energy efficient technologies or of renewable energy generating technologies in Federal facilities.

FEMP facilitates deployment pathways for clean energy through its activities across the Federal Government that helps institute energy efficient and low GHG emission technologies. FEMP also provides assistance in planning and instituting ESPC-UESC program support, energy conservation measures (ECM), and training. FEMP-facilitated investments in energy efficiency and renewable energy technologies increase the Nation's energy productivity and increase green jobs.

Contributions to GPRA Unit Program Goal 7 (Federal Energy Management Program)

FEMP activities contribute 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 EPAct 2005, E.O. 13423, EISA 2007, and E.O. 13514. Current government-wide goals include:

- Improve energy efficiency and reduce GHG emissions of the agency, through reduction of energy intensity by three percent annually or 30 percent by the end of FY 2015, relative to the baseline of the agency's energy use in FY 2003;
- Ensure that at least five percent of Federal electricity consumption is generated from renewable sources in 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 two percent annually or 16 percent by the end of the FY 2015 as compared to the FY 2007 base year; and
- For agencies operating a fleet of at least 20 motor vehicles, ensure these agencies, relative to their respective baselines for FY 2005: (1) reduce the fleet's total consumption of petroleum products by two percent annually through the end of FY 2015; (2) increase the total fuel consumption that is non-petroleum-based by 10 percent annually; and (3) use 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.

Annual Performance Results and Targets

The FY 2011 performance measures align closely with the Secretary's goal to build a competitive, low-carbon economy and secure America's energy future. FEMP measures how its broad range activities contribute to lifecycle Btu savings at Federal agencies. These activities include project financing services and technical assistance services to all Federal agencies and direct capital funding to DOE. These activities contribute to a low-carbon economy through Federal investments in energy efficiency and renewable energy technologies. These technologies are often the least costly option, providing a competitive energy future that is secure.

Other factors will affect the program's milestones. For example, technology developments and industry growth in energy efficiency and renewable technologies will drive the cost of these technologies down, which will make these technologies more cost-effective for Federal agencies. In addition, Federal agencies will each develop a new GHG emissions reduction target as required by E.O. 13514, which requires additional effort on the part of agencies to incorporate energy efficiency and renewable technologies. These factors have been incorporated into the Program targets.

Annual Performance Targets and Results

Secretarial Goal: Goal 2: Energy: Build a competitive, low-carbon economy and secure America's energy future.
GPRA Unit Program Goal: 07 Federal Energy Management Program
Subprogram: Federal Energy Management Program

<table>
<tr><th>FY 2006</th><th>FY 2007</th><th>FY 2008</th><th>FY 2009</th><th>FY 2010</th><th>FY 2011</th><th>FY 2012</th><th>FY 2013</th><th>FY 2014</th><th>FY 2015</th></tr>
<tr><td colspan="10">Performance Measure: Enable the additional lifecycle savings of 54 trillion Btus (TBtus) in Federal facility energy use through alternative financing, technical assistance or direct funding of new capital projects[a]. (British Thermal Units)</td></tr>
<tr><td>T: NA
A: NA</td><td>T: NA
A: NA</td><td>T: NA
A: NA</td><td>T: NA
A: NA</td><td>T: NA
A: NA</td><td>T: 54
A:</td><td>T: 54
A:</td><td>T: 54
A:</td><td>T: 54
A:</td><td>T: 54
A:</td></tr>
<tr><td colspan="10">Performance Measure: The FY 2011 performance measure was created in transition from reporting qualitative milestones to quantitative performance measures. Previous year performance measures for this subprogram are not direct predecessor measures to the FY 2011 performance measure. These measures included below enabled the progress necessary to support the new FY 2011 Performance Measure.

FY 2007: 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.

FY 2008: 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.

FY 2009: 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

FY 2010: 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.</td></tr>
<tr><td>T: NA
A: NA</td><td>T: 17.1
A: MET</td><td>T: 20.2
A: MET</td><td>T: 34.4
A: MET</td><td>T: 50.0
A: MET</td><td>T: RETIRED
A: NA</td><td>T: NA
A: NA</td><td>T: NA
A: NA</td><td>T: NA
A: NA</td><td>T: NA
A: NA</td></tr>
</table>

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[a] The FY 2011 performance measure, similar to prior year's performance measures (FY 2007-FY 2010) is achieved through alternative financing and technical assistance, demonstrating the combined performance of various FEMP activities. These savings should result in about a 0.75 percent annual reduction in energy intensity.

Annual Performance Targets and Results

Secretarial Goal: Goal 2: Energy: Build a competitive, low-carbon economy and secure America's energy future.

GPRA Unit Program Goal: 07 Federal Energy Management Program
Subprogram: Project Financing

FY 2006	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
Performance Measure: Enable the additional lifecycle savings of 54 trillion Btus (TBtus) in Federal facility energy use through alternative financing, technical assistance or direct financing of new capital projects. (British Thermal Units)									
T: 80-120 A: NA	T: RETIRED A: NA	T: NA A: NA	T: NA A: NA	T: NA A: NA	T: NA A: NA	T: NA A: NA	T: NA A: NA	T: NA A: NA	T: NA A: NA
Performance Measure: The FY 2011 performance measure was created in transition from reporting qualitative milestones to quantitative performance measures. Previous year performance measures for this subprogram are not direct predecessor measures to the FY 2011 performance measure. These measures included below enabled the progress necessary to support the new FY 2011 Performance Measure. FY 2006: 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.									
T: $199M A: MET	T: RETIRED A: NA	T: NA A: NA	T: NA A: NA	T: NA A: NA	T: NA A: NA	T: NA A: NA	T: NA A: NA	T: NA A: NA	T: NA A: NA

Annual Performance Targets and Results

Secretarial Goal: Goal 2: Energy: Build a competitive, low-carbon economy and secure America’s energy future
GPRA Unit Program Goal: 07 Federal Energy Management Program
Subprogram: Technical Guidance and Assistance

FY 2006	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
Performance Measure: Enable the additional lifecycle savings of 54 trillion Btus (TBtus) in Federal facility energy use through alternative financing, technical assistance or direct financing of new capital projects. (British Thermal Units)									
T: 27 A: NA	T: RETIRED A: NA	T: NA A: NA	T: NA A: NA	T: NA A: NA	T: NA A: NA	T: NA A: NA	T: NA A: NA	T: NA A: NA	T: NA A: NA
Performance Measure: The FY 2011 performance measure was created in transition from reporting qualitative milestones to quantitative performance measures. Previous year performance measures for this subprogram are not direct predecessor measures to the FY 2011 performance measure. These measures included below enabled the progress necessary to support the new FY 2011 Performance Measure. FY 2006: 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.									
T: 56 A: MET	T: RETIRED A: NA	T: NA A: NA	T: NA A: NA	T: NA A: NA	T: NA A: NA	T: NA A: NA	T: NA A: NA	T: NA A: NA	T: NA A: NA

Annual Performance Targets and Results

Secretarial Goal: Goal 2: Energy: Build a competitive, low-carbon economy and secure America’s energy future

GPRA Unit Program Goal: 07 Federal Energy Management Program
Subprogram: Departmental Energy Management

FY 2006	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
Performance Measure: Enable the additional lifecycle savings of 54 trillion Btus (TBtus) in Federal facility energy use through alternative financing or technical assistance activities or direct financing of new capital projects. (British Thermal Units)									
T: 3 A: NA	T: RETIRED A: NA	T: NA A: NA	T: NA A: NA	T: NA A: NA	T: NA A: NA	T: NA A: NA	T: NA A: NA	T: NA A: NA	T: NA A: NA
Performance Measure: The FY 2011 performance measure was created in transition from reporting qualitative milestones to quantitative performance measures. Previous year performance measures for this subprogram are not direct predecessor measures to the FY 2011 performance measure. These measures included below enabled the progress necessary to support the new FY 2011 Performance Measure. FY 2006: Complete the selection for funding of three energy retrofit projects that will provide the required dollar savings to achieve a 20% return on the investment of the DEMP funding. These projects will save over 12 billion Btus per year.									
T: 3 A: 4	T: RETIRED A: NA	T: NA A: NA	T: NA A: NA	T: NA A: NA	T: NA A: NA	T: NA A: NA	T: NA A: NA	T: NA A: NA	T: NA A: NA

Means and Strategies

FEMP 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 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.

The following external factors could affect FEMP's ability to achieve its strategic goal:

- Mission changes at Federal sites that could change building usage;
- Availability of energy management personnel at Federal sites; and
- Significant changes in energy price will affect the focus on energy conservation.

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 toward reaching their respective 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. 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. The most current report can be found at: http://www1.eere.energy.gov/femp/pdfs/annrep06.pdf.

Baselines: The baseline for the energy efficiency goal for Federal facilities of EPAct 2005, the E.O. 13423 and DOE Order 430.2B 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 is the amount of Federal petroleum usage in 2005 – 420 million gallons of gasoline equivalent.

Frequency: Annual.

Evaluation: In carrying out its 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 the Performance Measurement Manager (PMM, the DOE quarterly performance progress review of budget targets); and
- Annual review of methods, and recomputation of potential benefits for GPRA.

Data Storage: FEMP maintains a database of reported information. Agencies maintain their own, detailed data.

Verification: External audits are conducted each year. Reporting anomalies are identified and resolved during the annual reporting cycle.

Project Financing
Funding Schedule by Activity

(dollars in thousands)

	FY 2009	FY 2010	FY 2011
Project Financing	8,000	11,800	12,072
Total, Project Financing	8,000	11,800	12,072

Description

FEMP facilitates Federal agencies' access to private sector financing to fund energy efficiency improvements through Energy Savings Performance Contracts (ESPCs), public benefit funds, and Utility Energy Service Contracts (UESCs) program support. FEMP 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 energy efficiency and renewable energy projects improve the energy efficiency of Federal facilities. Projects save energy at Federal facilities and are implemented with little or no upfront cost to the government. By providing a means for Federal agencies to utilize renewable energy and energy efficiency technologies, these programs help reduce GHG emissions associated with power usage at Federal facilities and promote the use of clean, secure alternatives to conventional technologies.

FEMP's goal is to facilitate new energy investments through the ESPC and UESC programs that result in an estimated lifecycle savings of 30 trillion Btus in FY 2011. The energy savings from Project Financing activities are estimated to be 56 percent of FEMP's annual target to reduce a total of 54 TBtus in FY 2011, equivalent to displacing the energy use of about 22,000 households over the lifetime of the investment.

Detailed Justification

(dollars in thousands)

	FY 2009	FY 2010	FY 2011
Project Financing	**8,000**	**11,800**	**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 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. Project facilitators will continue to provide ESPC and UESC assistance, including identifying and screening projects and evaluating proposals. Facilitators will also provide technical

(dollars in thousands)

	FY 2009	FY 2010	FY 2011

and contracting expertise for issues such as interest rates, competitive financing, and utility rates to support the negotiation process.

Analytical activities will continue in support of reporting requirements for project metrics, milestones and program plans to implement improvements in the ESPC and UESC activities. Activities supporting the use of state-provided public benefit funds for Federal facilities and the use of power purchase agreements will continue.

Total, Project Financing	**8,000**	**11,800**	**12,072**

Explanation of Funding Changes

	FY 2011 vs. FY 2010 ($000)
Project Financing	
No significant change.	+272
Total Funding Change, Project Financing	**+272**

Technical Guidance and Assistance
Funding Schedule by Activity

(dollars in thousands)

	FY 2009	FY 2010	FY 2011
Technical Guidance and Assistance	4,000	8,000	10,000
Total, Technical Guidance and Assistance	4,000	8,000	10,000

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).

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 result in an estimated lifecycle savings of 14 trillion Btus in FY 2011. The energy savings from Technical Guidance and Assistance are estimated to be 26 percent of FEMP's annual target to reduce a total of 54 Tbtus, equivalent to displacing the energy use of about 10,000 households over the lifetime of the investment.

Detailed Justification

(dollars in thousands)

	FY 2009	FY 2010	FY 2011
Technical Guidance and Assistance	**4,000**	**8,000**	**10,000**

FEMP's broad range of assistance includes analytical support to Federal agencies from its laboratories, new technology deployment, development of Federal agency efficiency standards, specification of products for agency procurement, energy assessments and assistance to help other agencies develop comprehensive planning and internal processes to reduce their energy use and to achieve Federal water consumption goals.

Technology areas include lighting, renewable energy and Combined Heat and Power (CHP) technologies. EPAct 2005 and EISA 2007 establish FEMP's responsibility for carrying out a number of activities, including developing product specifications and issuing guidance on metering, new

	(dollars in thousands)		
	FY 2009	FY 2010	FY 2011

construction, and other energy-related building topics. FEMP will continue to update its specifications for highly energy efficient products. These specifications will be provided to the General Services Administration and Defense Logistics Agency as required by the Federal purchase requirement set forth in EPAct 2005. Technical Guidance and Assistance also provides program-specific technical training and information.

FEMP will expanding its efforts in two areas: (1) "continuous commissioning" to ensure that existing investments in energy efficiency and building control systems are kept at peak operating efficiency; and (2) an expansion of FEMP's interagency technical support and assistance which often takes the form of design and analysis of new energy efficiency or renewable energy projects. There is a great deal of unmet demand at agencies, as demonstrated by the response to a call for technical assistance projects funded by the Recovery Act.

Total, Technical Guidance and Assistance	**4,000**	**8,000**	**10,000**

Explanation of Funding Changes

	FY 2011 vs. FY 2010 ($000)
Technical Guidance and Assistance	
Increased funding will support: (1) an increase in continuous commissioning for Federal agencies to keep their investments at peak operating efficiency; and (2) expansion of FEMP's interagency technical support and assistance.	+2,000
Total Funding Change, Technical Guidance and Assistance	**+2,000**

Planning, Reporting and Evaluation
Funding Schedule by Activity

	(dollars in thousands)		
	FY 2009	FY 2010	FY 2011
Planning, Reporting and Evaluation	2,000	3,000	5,000
Total, Total, Planning, Reporting and Evaluation	2,000	3,000	5,000

Description

National Energy Conservation Policy Act (as amended by EISA 2007) requires DOE to collect, verify and report on progress by Federal agencies (including 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. These best practices are not only used by FEMP to improve its performance, but also shared throughout the Federal Government to support collaboration in meeting energy savings goals and deployment of energy efficiency technologies. Information is shared through means such as the FEMP website, interaction with personnel from other agencies on the various interagency panels hosted by FEMP, and multiple training activities. FEMP's collaboration with other Federal agencies to co-sponsor the annual GovEnergy meeting also provides information to thousands of Federal and non-Federal stakeholders on new technologies, processes, and procedures to increase energy efficiency and to increase generation of renewable energy in the Federal Government.

Detailed Justification

	(dollars in thousands)		
	FY 2009	FY 2010	FY 2011
Planning, Reporting and Evaluation	**2,000**	**3,000**	**5,000**

Data collection, verification and reporting continue to be centralized for the Federal agencies at FEMP with the assistance of technical experts for preparing analysis and verification of data. This also includes maintaining DOE 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.

	(dollars in thousands)		
	FY 2009	FY 2010	FY 2011

Activities include strategic communications and marketing, improved analysis of investments and financing, training for FEMP personnel and 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 legislative and E.O. goals, as well as recognizing progress through the Presidential and Federal awards programs. Activities will include GHG accounting, reporting and guidance development required by E.O. 13514.

Total, Planning, Reporting and Evaluation	**2,000**	**3,000**	**5,000**

Explanation of Funding Changes

	FY 2011 vs. FY 2010 ($000)
Planning, Reporting and Evaluation	
Increased funding will support an increased effort in GHG accounting, reporting and guidance development as required by E.O. 13514. Per E.O. 13514, FEMP is responsible for developing, maintaining, and analyzing data collection on GHG emission reductions from all Federal agencies.	+2,000
Total Funding Change, Planning, Reporting and Evaluation	**+2,000**

Federal Fleet
Funding Schedule by Activity

(dollars in thousands)

	FY 2009	FY 2010	FY 2011
Federal Fleet	2,000	3,000	3,000
Total, Federal Fleet	2,000	3,000	3,000

Description

Federal vehicle fleet activities include the tracking and reporting activities for the Federal fleet required by Federal law. Additional activities include the promotion of the increased use of alternative fuel for Federal Agency sites and 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, the Federal Fleet activity decreases the 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. FEMP provides technical assistance and support to agencies to reduce their petroleum consumption by 20 percent between 2005 to 2015 and to increase alternative fuel consumption by 10 percent per year over the same time. These activities will support private sector development of alternative fuel stations at Federal sites and demonstrate opportunities for petroleum displacement to increase alternative fuel use and its fueling infrastructure.

Detailed Justification

(dollars in thousands)

	FY 2009	FY 2010	FY 2011
Federal Fleet	**2,000**	**3,000**	**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 and issues specifically related to use of renewable electricity generation, utility integration, time-of-day charging, and potential impacts on Federal facilities.

FEMP will continue to report on and conduct analysis of Federal vehicle fleet activities and to implement compliance measures in each agency's fleet activity. 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.

	FY 2009	FY 2010	FY 2011
Total, Federal Fleet	**2,000**	**3,000**	**3,000**

Explanation of Funding Changes

	FY 2011 vs. FY 2010 ($000)
Federal Fleet	
No change.	0
Total Funding Change, Federal Fleet	**0**

DOE Specific Investments
Funding Schedule by Activity

	(dollars in thousands)		
	FY 2009	FY 2010	FY 2011
DOE Specific Investments	6,000	6,200	12,200
Total, DOE Specific Investments	6,000	6,200	12,200

Description

DOE Specific Investments includes activities designed to implement Federal environmental, energy, and transportation management goals at DOE sites. FEMP provides technical assistance, project transaction services and a coordination role for other DOE program offices making capital investments. These activities support DOE's efforts to meet goals set by EISA 2007, E.O. 13423, internal DOE Order 430.2b and E.O. 13514, helping DOE to be in the forefront of implementing Federal best practice in the areas of environmental, energy, and transportation management.

EISA Section 432 requires that all DOE facilities conduct comprehensive energy assessments and install advanced metering with some exceptions. To meet this requirement, FEMP will provide funding for comprehensive energy assessments and support for advanced metering to accelerate ongoing efforts taking place at DOE facilities. Beginning in FY 2011, DOE Specific Investments will include direct funding for capital projects at DOE sites. Candidate projects include funding for advanced metering hardware, retrocommissioning retrofits and continuous commissioning retrofits. Other projects may include hardware for capturing fugitive GHG emissions and renewable pilot projects with solar, biomass and alternative vehicle fueling stations technology.

Benefits

These activities further DOE's strategic goal of energy security by increasing energy productivity and energy diversity, and reducing the GHG emissions from energy use at the Department while enhancing DOE's ability to lead by example. For facilities, the goals from EISA 2007 are: 30 percent reduction in energy intensity from FY 2003 through FY 2015; 16 percent reduction in water use intensity from FY 2007 through FY 2015; 7.5 percent of electricity must be from renewable sources from FY 2013. In support of these goals, FEMP provides assistance to specific investments that result in an estimated lifecycle Btu savings of 10 trillion in FY 2011. The activities further 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.

Detailed Justification

(dollars in thousands)

	FY 2009	FY 2010	FY 2011
DOE Specific Investments	**6,000**	**6,200**	**12,200**

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.

An increased effort for comprehensive energy assessments of "covered" DOE facilities will be undertaken to achieve compliance with EISA 2007 by retro-commissioning where deemed appropriate through: the assessment process; selection of retrofit projects as needed to support retro-commissioning efforts; and advanced metering planning support and hardware acquisition. These projects may be some of the most cost effective measures available to reduce energy and save money. FEMP will support agency-wide real-time energy monitoring and continuous commissioning, placement of Resource Efficiency Managers (REMs) and provide energy manager and building operator training. Administrative and technical support will be provided for the Program Energy Manager Officials group (PEMO), the Energy Efficiency Working Group (EEWG) and the Energy Facilities Contractor Group (EFCOG).

Beginning in FY 2011, DOE Specific Investments will include direct funding for capital projects at DOE sites. Capital projects may include advanced metering hardware, retrocommissioning retrofits, continuous commissioning retrofits, hardware for capturing fugitive GHG emissions and projects with solar, biomass and alternative vehicle fueling stations technology.

Total, DOE Specific Investments	**6,000**	**6,200**	**12,200**

Explanation of Funding Changes

	FY 2011 vs. FY 2010 ($000)
DOE Specific Investments	
Increase in funding will support DOE efforts to meet goals established by EISA 2007, E.O. 13423 and E.O. 13514. Efforts will focus on the following areas at DOE sites: (1) comprehensive energy assessments and support for advanced metering; (2) retro-commissioning and continuous commissioning and capital projects associated with these efforts; (3) hardware for capturing of fugitive emissions; and (4) pilot renewable projects in such areas as solar, biomass and alternative fueling stations.	+6,000
Total Funding Change, DOE Specific Investments	**+6,000**

RE-ENERGYSE (Regaining our Energy Science and Engineering Edge)
Funding Profile by Subprogram

(dollars in thousands)

	FY 2009 Current Appropriation	FY 2009 Current Recovery Act Appropriation	FY 2010 Current Appropriation	FY 2011 Request
RE-ENERGYSE				
Higher Education	0	0	0	35,000
Technical Training, Education and Outreach	0	0	0	15,000
Total, RE-ENERGYSE	0	0	0	50,000

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”

Mission

The mission of RE-ENERGYSE (Regaining our Energy Science and Engineering Edge) is to provide the education and training necessary to build a highly skilled U.S. clean energy workforce dedicated to solving the world’s greatest energy challenges.[a]

Benefits

The U.S. is on the cusp of transformational changes in how energy is produced and used. Major investments are being made by the Federal government and private industry in clean energy technologies that will help create entirely new growth industries, expand markets for solar, wind, and other clean energy sources, and support the productivity gains inherent in energy efficiency. These efforts, if coupled with a well-educated and skilled clean energy workforce, will ensure that the U.S. remains highly competitive in global markets, while meeting the President’s goal of reducing greenhouse gas (GHG) emissions by 83 percent by 2050.

However, challenges exist. Statistics show that the U.S. currently lags behind other nations in the race to produce and bring to market new clean energy systems. European countries, for example, currently control 80 percent of the wind technology market, and China is projected to become the world’s largest supporter of solar energy by 2011.[b] A recent study by the World

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[a] RE-ENERGYSE activities funded within the Office of Energy Efficiency and Renewable Energy (EERE) will be coordinated with the Office of Nuclear Energy (NE) ($5 million requested). Funds are requested in separate accounts to be consistent with appropriated intent; RE-ENERGYSE funds requested within NE will only support nuclear technology education, and funds requested in EERE will support other clean energy technologies. RE-ENERGYSE activities will also be coordinated closely with the National Science Foundation (NSF).

[b] United Nations Environment Programme. *“Green Jobs: Towards Decent Work in a Sustainable, Low-Carbon World”* Published by Worldwatch Institute. September 2008: http://www.ilo.org/wcmsp5/groups/public/---dgreports/---dcomm/documents/publication/wcms_098503.pdf

Wildlife Fund showed that the U.S. is ranked 19th in relative global clean energy technology product sales, weighted by GDP; behind France, Germany, Japan, and others outside of the G8.[a]

The U.S. ranks behind other major nations in making the transitions required to educate students for emerging energy trades, research efforts, and other professions to support the future energy technology mix. Having a high competency level in science, technology development, engineering, and mathematics (STEM) subjects is critical to knowledge creation, technology, and innovation. However, the U.S. ranks 20th out of the 30 Organisation of Economic Cooperation and Development (OECD) nations in the percentage of students which performed at the top level of science.[b] According to a study of the National Assessment of Educational Progress, only 18 percent of U.S. 12th grade students performed at or above the proficient level in math and science, while only two percent excelled. These numbers are not sufficient to create the leaders and innovators of a new clean energy workforce or even resupply the current energy workforce, which could see a 40 to 60 percent retirement rate within the next five years.

In order to make the leap in global energy technology leadership, the U.S. must also make the leap in energy education. However, the current energy education infrastructure is severely under developed. According to the Association of American Universities, there are no post-doctorate fellowships at U.S. universities related to renewable energy, and not one of the 149 U.S. professional science masters degree programs offered currently at 84 American universities focuses on interdisciplinary energy studies.[c] At the community college level, 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.[d] According to the Interstate Renewable Energy Council's training catalog, only 106 institutions are currently offering courses in energy efficiency and renewable energy technologies, of which only 24 are universities.[e] This is significant, as there are 6,519 post-secondary institutions in the U.S.[f]

Meeting the challenge of creating the new clean energy economy will require research and development of new energy technologies and the application of science to understand the impact of these technologies on a sustainable environment. As such, DOE will partner with the National Science Foundation (NSF) to collaborate closely on the administration, management and impact measurement of RE-ENERGYSE education programs. This partnership will build on the scientific and engineering expertise of both agencies in the energy field, and benefit from NSF's successful track record of integrating research with education in programs it has developed and administered over the past two decades.

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[a] "Clean Economy, Living Planet: Building Strong Clean Energy Technology Industries." World Wildlife Fund. Amsterdam, The Netherlands. November 2009. p. 13: http://assets.panda.org/downloads/rapport_wwf_cleaneconomy_international_def.pdf

[b] "Education at a Glance 2009: OECD Indicators." Organization for Economic Co-operation and Development. September 2009. p. 78: http://www.oecd.org/dataoecd/41/25/43636332.pdf

[c] Professional Science Master's (PSM), PSM Locations Map, http://www.sciencemasters.com/Default.aspx?tabid=58 (January 11, 2010).

[d] American Association of Community Colleges, 2009: http://www.aacc.nche.edu/Pages/default.aspx

[e] "2009 Updates and Trends." Interstate Renewable Energy Council. October 2009. Anaheim, CA. p. 4: http://irecusa.org/wp-content/uploads/2009/10/IREC-2009-Annual-ReportFinal.pdf

[f] As specified by Title IV of the Higher Education Act

Contribution to the Secretary's Goals

RE-ENERGYSE contributes to the following Secretarial goals.

Innovation: Lead the world in science, technology, and engineering

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 complement existing Federal efforts, and provide the U.S. research community with a major influx of highly specialized technical expertise that can bring new technologies to the marketplace.

Energy: Build a competitive, low-carbon economy and secure America's energy future

Given the need to reduce the environmental impact of the U.S. energy sector, there is a need for a well-trained workforce for a transformed energy sector. 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.

RE-ENERGYSE will educate and train Americans to adapt green technology to their existing industry/trade, to enter thousands of green jobs and increase U.S. competitiveness. This effort will help universities and community colleges develop cutting 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 National Laboratories.

RE-ENERGYSE will develop leading edge undergraduate and graduate programs; help between 3,000 and 6,000 highly educated scientists, engineers, and other professionals enter the clean energy field by 2016; and approximately 7,000 to 13,000 professionals by 2021. By 2016, efforts will result in the development of approximately 75 community college and other training programs to equip thousands of technically skilled workers for clean energy jobs. By 2016, thousands of U.S. residents and students will be educated about clean energy technologies leading reduced energy consumption and cost saving benefits.

Annual Performance Results and Targets

The RE-ENERGYSE Program activities support the Secretary's Strategic Priority goal of Innovation by coordinating education efforts within DOE, working collaboratively with NSF, and other federal agencies to build a pipeline to create a resource of highly educated scientists and engineers. This pipeline will further accelerate the burgeoning clean technology industry in the U.S., positioning the country to lead in science, technology, engineering and energy by educating students through universities, community colleges, and K-12 programs. These programs, which will not only prepare students to pursue careers in developing and deploying the clean energy solutions of the future, will also increase awareness of the issues surrounding energy efficiency and sustainability.

RE-ENERGYSE will help make the U.S. significantly more technologically competitive globally, while contributing to creating a grassroots foundation of a low-carbon economy here at home. In response to international climate agreements, CO_2 reduction goals,[a] and investments in

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[a] 2009 G-8 Summit, Declaration of the Leaders on Energy and Climate committed to limit average global temperatures from exceeding 2 degrees Celsius above pre-industrial levels. This figure corresponds with the 450 ppm scenario and CO_2 reduction targets. http://www.g8italia2009.it/G8/Home/Summit/G8-G8_Layout_locale-1199882116809_Atti.htm

clean energy technologies,[a] the clean energy market is poised as the next great industry. Through the 2009 Recovery Act, the U.S. government made considerable investments in the advancement of clean energy technologies and energy infrastructure which could accelerate development of clean technologies. Pending legislation may have additional incentives for the development and deployment of these technologies into the marketplace.

Despite the current financial climate, the clean energy market is expected to grow between 5 and 15 percent per year for the foreseeable future,[b] resulting in a concurrent growth in workforce demand. RE-ENERGYSE will offer fellowships, multi-disciplinary masters programs, technical training, and K-12 education and outreach programs. The programs supported by RE-ENERGYSE respond to the very real challenge that the U.S. suffers a shortage of skilled workers available to enter energy professions.[c]

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[a] The Recovery Act provided DOE with substantial funding to support clean energy and environmental clean up projects, creating hundreds of thousands of jobs and providing a meaningful down payment on the nation's energy and environmental future.

[b] "Clean Economy, Living Planet: Building Strong Clean Energy Technology Industries." World Wildlife Fund. Amsterdam, The Netherlands. November 2009. http://assets.panda.org/downloads/rapport_wwf_cleaneconomy_international_def.pdf

[c] 40 to 60 percent of energy utilities' skilled workers and engineers could retire by 2012. Center for Energy Workforce Demand 2007 Report: Gaps in the Energy Workforce Pipeline: http://www.cewd.org/documents/CEWD_08Results.pdf

Annual Performance Targets and Results

Secretarial Goal: Goal 1: Innovation: Lead the world in science, technology, and engineering,
Goal 2: Energy: Build a competitive, low-carbon economy and secure America's energy future

GPRA Unit Program Goal: RE-ENERGYSE

Subprogram Name: Higher Education

FY 2006	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
Performance Measure: Number of post-secondary students awarded competitive STEM education research fellowships and internships.[a]									
T: NA A: NA	T: NA A: NA	T: NA A: NA	T: NA A: NA	T: NA A: NA	T: 1130 A:	T: 1130 A:	T: 1130 A:	T: 1130 A:	T: 1130 A:

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[a] The FY 2011 performance measures are based on similar education and training programs in other Federal agencies, for example the National Science Foundation. Previous years of educational activities conducted by EERE further informed the creation of this new performance measure for RE-ENERGYSE. Performance monitoring for the Higher Education subprogram activities are intended to support future impact evaluations to assess potential effects on public awareness, attitude and behavior.

Annual Performance Targets and Results

Secretarial Goal: Goal 1: Innovation: Lead the world in science, technology, and engineering,

Goal 2: Energy: Build a competitive, low-carbon economy and secure America’s energy future

GPRA Unit Program Goal: RE-ENERGYSE

Subprogram Name: Technical Training, Education and Outreach

FY 2006	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
Performance Measure: Number of students participating (directly or indirectly) in a technical training, K-12 education and/or outreach program sponsored by RE-ENERGYSE.[a]									
T: NA A: NA	T: NA A: NA	T: NA A: NA	T: NA A: NA	T: NA A: NA	T: 250,000 A:	T: 350,000 A:	T: 450,000 A:	T: 550,000 A:	T: 600,000 A:

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[a] The FY 2011 performance measures are based on similar education and training programs in other Federal agencies, for example the National Science Foundation. Previous years of educational activities conducted by EERE further informed the creation of this new performance measure for RE-ENERGYSE. Performance monitoring for the Technical Training, Education and Outreach subprogram activities are intended to support future impact evaluations to assess potential effects on public awareness, attitude and behavior

Means and Strategies

RE-ENERGYSE will use the following means and strategies:

- Strategically plan and implement activities by coordinating with experts in education, DOE's Office of Science, the Department of Labor (DOL), the Department of Education, the NSF, 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, educational foundations, NSF, 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;
- Develop the outreach infrastructure necessary to communicate and disseminate curricula and other programs materials, and importantly enable collaboration and feedback;
- 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 for metric driven program evaluation activities and peer reviews;
- Create energy-specific materials at the K-12 level, to engage, excite, and educate;
- Provide direct channels feeding energy-accredited and up-to-date materials into K-12 schools and communities; and
- Attract qualified candidates to competitive higher education programs.

RE-ENERGYSE provides a much needed collaborative model of innovation in the Federal government, by performing the following activities:

- Works with NSF, DOL, Department of Education, the American Association of Community Colleges, and other leading scientific and academic organizations to create teacher professional development opportunities nationwide, and ensure strategic and non-duplicative investment in science education at all levels;
- Works with leading researchers in the public, private, and academic sectors to provide cutting-edge research opportunities that can attract highly qualified undergraduate, graduate, and post-doctoral students into the clean energy field;
- Works with the NSF to compile and evaluate existing K-12 resources for teaching, as well as creating innovative ways to communicate the challenges and promises of clean energy at all grade levels; develop and assess the effectiveness of different educational communication strategies and innovate ways to scale-up the most effective ones into general practice; and
- Rewarding student success and fostering innovation and collaboration is an important element of engaging youth. Incentive competitions will complement the academic effort through public, private and academic organizations.

Validation and Verification

To validate and verify the impact of each program, RE-ENERGYSE will:

- Assemble an expert panel from the science, education and government sectors to review and accredit educational materials, competition guidelines, and other outreach materials;
- Conduct rigorous reviews of individual performance, program effectiveness, and overall programmatic accomplishment of goals, and impact on student achievement;
- Undertake comprehensive impact and process evaluations for training and outreach elements, as supported by the OMB Voluntary Evaluation Initiative (OMB October 7, 2009). These evaluations will expand on initial program design and be conducted by third-party independent evaluators;
- Use randomized controlled trials when possible;
- Use effective evaluation processes including pre- and post-program testing of participants, longitudinal workforce studies to determine program effectiveness, and external reviews conducted by experts in education and training; and
- 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.

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, and National Science Teachers Association) will be consulted to provide data for the development of program priorities.
- Existing studies that can guide efforts include:
  - *Rising Above the Gathering Storm (2007)* http://sciencedems.house.gov/Media/File/Reports/natacad_compete_exsum_6feb06.pdf;
  - *Graduate Education: The Backbone of American Competitiveness and Innovation (2007)* http://www.cgsnet.org/portals/0/pdf/GR_GradEdAmComp_0407_EMB.pdf; and
  - *Losing the Competitive Advantage: The Challenge for Science and Technology in the United States (2005)* http://www.aeanet.org/publications/IDJJ_AeA_Competitiveness.asp.
- Data collected from grant recipients and other sources as needed, such as pre- and post-program surveys, to verify the accomplishment of specified goals and milestones.

Baselines:

- Number of post-secondary students awarded competitive STEM education research fellowships and internships: 0 in 2010; and
- Number of students participating (directly or indirectly) in a technical training, K-12 education and/or outreach program sponsored by RE-ENERGYSE: 0 in 2010.

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 third-party evaluators;
- Specialized program field metrics and impact and process evaluation studies, including metrics, preparing a multi-year comprehensive Evaluation Plan, and implementing the Plan to gather baseline data;
- Quarterly and annual assessment of program and management results based performance; and
- Annual review of methods.

Data Storage: EERE Benefits website, the EERE Corporate Planning System, and other computer-based data systems.

Verification: Peer reviews and program evaluations.

Higher Education
Funding Schedule by Activity

(dollars in thousands)

	FY 2009	FY 2010	FY 2011
Higher Education	0	0	35,000
Total, Higher Education	0	0	35,000

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 support:

- Up to 60, three-year fellowships for graduate students in engineering and other relevant fields;
- Up to 70 post-doctoral opportunities that will allow exceptional students to apply their skills in a laboratory setting devoted to clean energy topics;
- 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;
- The development of two interdisciplinary masters programs in clean energy;
- Up to 3,000 students involved in the high-profile Solar Decathlon competition, which is proposed to be included within RE-ENERGYSE in FY 2011; and
- Implementation, from the ground up, of rigorous evaluation methods to assess the impact and process for RE-ENERGYSE activities on the clean energy workforce using various metrics including number of students, cost-effectiveness, career choices upon completion on activities, etc.[a]

Benefits

Higher Education efforts will result in hundreds of highly qualified candidates each year entering 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 at least 500 U.S. citizens per year who will contribute to the invention and commercialization of advanced clean energy technologies, such as net zero energy buildings, nanotechnology-based solar cells, energy storage for advanced electric cars, smart grid technologies, and other areas. Higher education programs focused on clean energy, along with funded research opportunities, will encourage students to pursue careers in clean energy research and practice in industry, academia, and government.

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[a] Best-practices for evaluating the impact of higher education programs were elucidated, for example, in the Report of the Academic Competitiveness Council in 2007 – http://www.ed.gov/about/inits/ed/competitiveness/acc-mathscience/report.pdf

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] These 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.

Detailed Justification

(dollars in thousands)

	FY 2009	FY 2010	FY 2011
Higher Education	**0**	**0**	**35,000**

The Higher Education subprogram is dedicated to the development of scientists, engineers, and other professionals with the skills needed to enter the clean energy field. Widespread outreach will be conducted at U.S. universities, scientific professional societies, and other organizations with relevant student populations within each subprogram activity. 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 programs, undergraduate research internships, and a high profile university competition.

The Post-Doctoral Fellowships (approximate funding $8 million) will support approximately 70 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 opportunity will 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[b] found that of the 1,718 postdoctoral students working at DOE National Laboratories; only 39 percent (664) were U.S. citizens. This supports recent reports by the National Academies of Science[c] that U.S. citizens are not pursuing STEM careers in numbers equal to other nations.

The Graduate Research Fellowships will support approximately 60 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 students' 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

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[a] "Survey of Graduate Students in Post-Doctorate in Science and Engineering." National Science Foundation, Division of Science, Resources and Statistics. 2007. Table 1.

[b] "Survey of Postdoctorates at Federally Funded Research and Development Centers." National Science Foundation. November 2008.

[c] "Rising Above the Gathering Storm: Energizing and Employing America for a Brighter Future." National Academies of Science. 2007.

evaluation of each application against established criteria, such as the student's academic performance and demonstrated interest and experience in clean energy research. (Approximate funding $10 million)

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 development of at least two 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. 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, business, and economics, specialized study in energy engineering or a related energy field, and a part-time or summer student internship at a DOE National Laboratory, a private sector research firm, or other laboratory. Given the high and growing industry demand for professionals with cross-cutting energy training, these graduates will be particularly valuable. (Approximate funding $6 million)

The Undergraduate Internships will support up to 1,000 research appointments for undergraduate students through competitive awards to students to participate in individually mentored research in the clean energy field. Internships can be carried out at universities, in industry, and at 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 each student's field of interest. Participants will spend an intensive 10 to 16 weeks working under the individual mentorship of resident scientists, and will produce an abstract and research paper, with a goal of publishing results in a peer-reviewed journal. Participants will attend seminars that broaden their view of energy science careers and help them understand how to become members of the energy research community. 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. (Approximate funding $6 million)

Beginning in FY 2011, the Solar Decathlon is proposed to be transferred from the Buildings Technology Program and included within the RE-ENERGYSE Program. Solar Decathlon is a high-profile university competition held in Washington, D.C., that promotes public awareness of highly efficient building technologies and Zero Energy Homes (ZEH) using solar energy. The competition also fosters innovation and encourages incorporation of new building technologies and design practices into engineering and architecture university curricula. This event is held in September/October every other year. New teams for the 2011 Solar Decathlon will be recruited through a request for proposals issued in October 2009 to all universities throughout the country. The proposals will be reviewed and ranked, and the top 20 universities will be selected and each awarded grants to support their projects. New participants will be announced in January 2010. Activities 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

(dollars in thousands)

	FY 2009	FY 2010	FY 2011

dissemination; and technical, market, economic, and other analyses. (Approximate funding $5 million) In addition, up to 10 percent of funds will be used for administration and evaluation.

	FY 2009	FY 2010	FY 2011
Total, Higher Education	**0**	**0**	**35,000**

Explanation of Funding Changes

	FY 2011 vs. FY 2010 ($000)
Higher Education	
The increase reflects the start of a new activity and the transfer of the Solar Decathlon from the Buildings Technology Program.	+35,000
Total Funding Change, Higher Education	**+35,000**

Technical Training, Education and Outreach
Funding Schedule by Activity

	(dollars in thousands)		
	FY 2009	FY 2010	FY 2011
Technical Training, Education and Outreach	0	0	15,000
Total, Technical Training, Education and Outreach	0	0	15,000

Description

The Technical Training, Education and Outreach 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, parents, and educators to help meet the Nation's energy and environment challenges. This subprogram will include a national communication campaign to create an energy-literate population and develop high-value, targeted public service advertisements and strategic media relations to create broad public awareness. The subprogram will also support K-12 energy literacy by working closely with schools and educational programs to enhance STEM education and support the future workforce needs. These efforts will include ongoing evaluations and semi-annual reporting to inform program implementation, execution and content as well as measure effectiveness.

Benefits

According to the Interstate Renewable Energy Council's training catalog, only 106 institutions are offering courses in energy efficiency and renewable energy technologies, of which only 24 are universities.[a] There are 6,519 post-secondary institutions in the U.S.[b] 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."[c] Colleges 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 the U.S. 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. DOE will conduct a comprehensive study in FY 2010 that defines the current and projected needs at the community college level for energy-related fields, and work to establish what DOE can do to fill the gaps required to meet these workforce and educational needs.

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[a] "2009 Updates and Trends." Interstate Renewable Energy Council. October 2009. Anaheim, CA. p. 4: http://irecusa.org/wp-content/uploads/2009/10/IREC-2009-Annual-ReportFinal.pdf

[b] As specified by Title IV of the Higher Education Act

[c] American Association of Community College's CC STATS home page: http://www2.aacc.nche.edu/research/index.htm

This subprogram will ensure excellence in technical training for workers interested in entering clean energy trades. Approximately seven technical training programs will be established each year with the capacity to train up to 400 highly skilled technicians each year to enter the clean energy field.

This subprogram will also reach thousands of K-12 students and educators with campaigns, curricula, competitions, and other efforts aimed at educating, engaging, and inspiring students to pursue clean energy careers and adopt sustainable energy practices that are necessary to mitigate climate change.

Efforts will also help tap into the potential for increased energy efficiency in the U.S., conveying simple messages that can remind Americans that energy savings are important. Just as recycling has become a standard operating practice recognized widely by all Americans as an integral part of their lives, smarter, more efficient use of energy can become much more widely integrated. A national, strategic communication campaign can help launch such a transformation.

Detailed Justification

	(dollars in thousands)		
	FY 2009	FY 2010	FY 2011
Technical Training, Education and Outreach	**0**	**0**	**15,000**

Technical training grants will be awarded through competitive and peer reviewed processes. This subprogram will offer competitive grants to community colleges and other training institutions to develop certificate programs to train approximately 400 U.S. technicians and faculty per year in STEM subjects focusing on clean energy technologies, processes, and applications. Selected institutions will develop appropriate curriculum, equip laboratories, and 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 addition to the technical grants, this effort will include the development of an online, state-of-the-art, educational system to train teachers and workers on a variety of skills needed in clean energy fields. The training system will be modeled in part on the effective online learning systems used by the Department of Defense that includes training through simulation. In addition, the system will be designed to allow for continuous improvement as new methods, technologies, and information becomes available. This effort will complement the direct grants to community colleges and create an avenue for information sharing among grant recipients and others involved in clean energy training and education. (Approximate funding $6 million)

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 and energy savings in their daily lives and choices. (Approximate funding $9 million)

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. 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.

In FY 2011, DOE will implement activities that are viewed as most effective in getting K-12 students excited about how they can become a part of developing solutions to important problems associated with energy use such as climate change. This effort will include developing innovative approaches to engage the Nation's K-12 students and teachers, such as new online training offering interactive games and lessons that use the latest graphics, simulation, and technologies designed to appeal to youth.

In addition, DOE will collaborate with NSF on a national outreach effort to communicate the benefits of energy efficiency, as well as the actions that U.S. citizens can take to realize those benefits. The campaign will stress practical, cost-effective measures consumers can use to reduce consumption. The campaign will tailor messages to most effectively appeal to specific audiences. Depending on the targeted audience, messages may stress the cost benefits of energy efficiency; the link between affordable domestic energy and job growth; or, the connection between energy conservation, climate change and other environmental issues; as well as a variety of other themes. The campaign will take advantage of multimedia and modern communication technologies that have become widely used particularly among younger audiences (e.g., text messaging, Twitter, You-tube, video games, etc.). As with messaging, the method for communication will be tailored to the appropriate audience. This effort will include ongoing evaluations and semi-annual reporting to inform program implementation, execution and content as well as measure effectiveness.

In addition, up to 10 percent of funds will be used for administration and evaluation.

	FY 2009	FY 2010	FY 2011
Total, Technical Training and K-12 Education	**0**	**0**	**15,000**

Explanation of Funding Changes

	FY 2011 vs. FY 2010 ($000)
Technical Training, Education and Outreach	
The increase reflects the start of a new activity.	+15,000
Total Funding Change, Technical Training, Education and Outreach	**+15,000**

Facilities and Infrastructure
Funding Profile by Subprogram

(dollars in thousands)

	FY 2009 Current Appropriation	FY 2009 Current Recovery Act Appropriation	FY 2010 Current Appropriation	FY 2011 Request
Facilities and Infrastructure				
National Renewable Energy Lab.				
General Plant Projects	7,000	0	10,000	10,000
Upgrade East Access to STM	0	0	4,000	0
General Purpose Equipment	3,000	0	5,000	5,000
Scientific Computing at Sandia National Laboratory	12,000	0	0	0
Maintenance and Repair	0	0	0	3,000
Subtotal, Operations and Maintenance	22,000	0	19,000	18,000
Construction	54,000	144,197	0	39,500
National Wind Test Center	0	9,950	0	0
F&I Lab Call[a]	0	104,773	0	0
Total, Facilities and Infrastructure	76,000	258,920	19,000[b]	57,500

Public Law Authorizations:

P.L. 95-91, "Department of Energy Organization Act" (1977)
P.L. 109-58, "Energy Policy Act of 2005"
P.L. 110-140, "Energy Independence and Security Act of 2007"

Mission

The National Renewable Energy Laboratory (NREL) is 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 DOE's Offices of Electricity Delivery and Energy Reliability, Science, and Nuclear Energy, the Nuclear Security and Safety Administration.

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[a] The Lab Call is a one-time competitive solicitation for multiple projects awarded to multiple National Laboratories. Most of the funding under the Lab Call was awarded to National Laboratories other than NREL.

[b] Per P.L. 111-85, DOE exercised the option to fund the $44.0 million NREL Ingress/Egress project with Recovery Act funds. These funds are shown in the Construction line of the FY 2009 Current Recovery Act Appropriation in the table.

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 portfolio's 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 investments support and enable the Administration's energy efficiency and renewable energy priorities, EERE mission needs, DOE Directives, and the safe and efficient operation of EERE's National Laboratory implementers. These investments also fulfill EERE's stewardship responsibility for NREL. Funding ensures the readiness of EERE's Laboratory network to conduct renewable energy research in the energy efficiency and renewable energy arenas.

Detailed Justification

(dollars in thousands)

	FY 2009	FY 2010	FY 2011
Operation and Maintenance (NREL Specific)	**22,000**	**19,000**	**18,000**
▪ **General Plant Projects**	**7,000**	**10,000**	**10,000**

The Plant Projects request supports a portion of the annual investment used to upgrade and provide new capabilities to EERE's existing real property and related infrastructure at NREL. These projects apply to both the South Table Mountain (STM) and National Wind Technology Center (NWTC) locations in Golden, CO. These projects include: safety and security improvements; replacement of building systems and components; replacement and upgrades to building and site utilities; site-wide energy efficiency improvements; reconfiguration of existing buildings to accommodate changes or growth in RDD&D programs or research support needs; and other site improvements to maintain the viability of EERE's capital investments at NREL.

▪ **Upgrade East Access to STM**	**0**	**4,000**	**0**

Upgrades and reconfigures the east access interchange (the original site access point) to increase safety and efficiency due to current and future site growth. This project will improve traffic flow through the east access by adding turning lanes and improved signals. These changes will improve the safety of NREL employees and the community during peak arrival and departure times, as well as for emergency access and evacuation purposes. The western-most portion of the original interchange was designed and constructed thirty years ago. FY 2010 funding will complete this project.

▪ **General Purpose Equipment**	**3,000**	**5,000**	**5,000**

The General Purpose Equipment request maintains EERE’s general scientific and administrative equipment value through replacement of expired equipment and the addition of new equipment. This portfolio includes: general scientific equipment with multiple users across NREL; information technology; safety and security equipment; administrative equipment; communications equipment; and other categories of general equipment.

▪ **Scientific Computing at Sandia National Laboratory**	**12,000**	**0**	**0**

FY 2009 appropriations provided funding to NREL to acquire additional high performance computing capability at SNL to ensure NREL priority access to critical computational science resources in support of NREL R&D.

▪ **Maintenance and Repair**	**0**	**0**	**3,000**

Direct funded maintenance and repair allows for the predictive, preventive, and corrective maintenance of real property that is required to sustain property in a condition suitable for its intended designated purpose. Maintenance of real property equipment, systems, and facilities is required to maintain their intended functions or design conditions to ensure availability of equipment and facilities for research activities. Maintenance and Repair funding is needed to fund recurring day-to-day work required to maintain and preserve plant and capital equipment in a condition suitable for its intended purpose, and not for betterments which are funded through GPP and GPE.

Construction	**54,000**	**0**	**39,500**
▪ **South Table Mountain Infrastructure, Zone II**	**13,000**	**0**	**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 and storm water; natural gas, heating and cooling water distribution; roads and walkways; and renewable energy technologies. This project was fully funded in FY 2009.

▪ **Energy Systems Integration Facility**	**41,000**	**0**	**39,500**

The Energy Systems Integration Facility (ESIF) creates a unique national capability to simulate, model, and create cost-effective renewable electricity generation, storage, and distribution components and systems to reduce the financial, technical, and market risk of wide-scale deployment and commercialization within the Nation’s existing grid and emerging distributed energy infrastructure. The facility will integrate the effort of multiple EERE technology programs. The ESIF relies on advanced computational science capability to design, model, simulate, test, and improve solar, wind, fuel cell, buildings systems, and integrated energy systems, including electricity storage systems to meet requirements for integration into specific utility systems. ESIF enables the development of new approaches to integrate renewables into existing energy systems to accelerate the deployment of renewable energy technologies. This facility will provide a world class research environment for renewable energy development and deployment.

Total, National Renewable Energy Laboratory	**76,000**	**19,000**	**57,500**

Explanation of Funding Changes

	FY 2011 vs. FY 2010 ($000)
Operation and Maintenance	
▪ **General Plant Projects**	
Activity decreases due to full funding requirement met for the upgrade East access to STM during FY 2010. Balance of funding for GPP remains the same for FY 2011.	-4,000
▪ **Maintenance and Repair**	
Increased Maintenance and Repair funding is needed to fund recurring day-to-day work required to maintain and preserve plant and capital equipment in a condition suitable for its intended purpose. This funding (previously funded within GPP and GCE) is being broken out separately beginning in FY 2011 to improve transparency.	+3,000
Total, Operation and Maintenance	-1,000
Construction	
▪ **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 was deferred to FY 2011. Increase reflects the funding required to complete the facility and to purchase/install essential research equipment.	+39,500
Total, Construction	+39,500
Total Funding Change, National Renewable Energy Laboratory	**+38,500**

Capital Operating Expenses and Construction Summary

Capital Operating Expenses

(dollars in thousands)

	FY 2009	FY 2010	FY 2011
General Plant Projects	7,000	10,000	10,000
GPP – Upgrade East Access to STM	0	4,000	0
General Purpose Equipment	15,000	5,000	5,000
Maintenance and Repair	0	0	3,000
Total, Capital Operating Expenses	22,000	19,000	18,000

Construction Projects

(dollars in thousands)

	Total Estimated Cost (TEC)	Prior-Year Appropriation	FY 2009	FY 2010	FY 2011	Unappropriated Balance
Energy Systems Integration Facility	135,000	95,500	41,000	0	39,500	39,500
Total, Construction Projects	135,000	95,500	41,000	0	39,500	39,500

Major Items of Equipment

(dollars in thousands)

	Total Project Cost (TPC)	Total Estimated Cost (TEC)	Prior-Year Appropriations	FY 2009	FY 2010	FY 2011	Completion Date
Scientific Computing at Sandia National Laboratory	12,000	12,000	12,000	12,000	0	0	FY 2009
Total, Major Items of Equipment	12,000	12,000	12,000	12,000	0	0	FY 2009

08-EE-01, Energy Systems Integration Facility, National Renewable Energy Laboratory, Golden, Colorado
Project Data Sheet is for PED/Construction

1. Significant Changes

The most recent DOE O 413.3A approved Critical Decision (CD) is CD-0 that was approved on August 9, 2007 for the Energy Systems Integration Facility (ESIF) project for a Total Project Cost (TPC) of $98.3 million. Planning and development activities, including a stakeholder workshop and updated cost estimate and conceptual design, have determined that the current working estimate is $132.7 million TPC for completion.[a] The current total preliminary estimated cost range is $115 to $135 million.

A Federal Project Director (FPD) has been assigned to this project with Level II certification. The FPD has completed all coursework and is expected to attain Level III certification.

This Project Data Sheet (PDS) is an update of the FY 2009 PDS. Congress included $55,000,000 [less a 0.91% across-the-board rescission] in FY 2008 appropriations to begin design/construction for this project. The Total Estimated Cost (TEC) project funding profile is $54.5M in FY 2008, $41.0M in FY 2009 and $39.5M in FY 2011. Construction funds will be executed only upon CD-2/3 approval.

2. Design, Construction, and D&D Schedule[b]

(fiscal quarter or date)

	CD-0	CD-1	PED Complete	CD-2	CD-3	CD-4	D&D Start	D&D Complete
FY2009	8/9/2007	2QFY2010	4QFY2010	--	--	--	---	--
FY2011	8/9/2007	2QFY2010	4QFY2010	3QFY2011	3QFY2011	3QFY2012	---	--

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

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[a] Final cost will be baselined at CD-2/3.

[b] Project does not have CD-2/3 approval. Schedules are to be determined upon completion of a validated Performance Baseline. Preliminary schedule for CD-4 is approximately 3QFY2012.

3. Baseline and Validation Status[a,b]

(dollars in thousands)

	TEC, PED	TEC, Construction	TEC, Total	OPC Except D&D	OPC, D&D	OPC, Total	TPC
FY2009	NA	TBD	TBD	TBD	TBD	TBD	TBD
FY2010	NA	TBD	TBD	TBD	TBD	TBD	TBD
FY2011	TBD	TBD	TBD	TBD	TBD	TBD	TBD

4. Project Description, Justification, and Scope

The Energy Information Administration forecasts that energy consumption in the U.S. will increase by 34% by 2030.[c] The current energy infrastructure and total energy demand cannot be replaced by a single production source. Renewable energy sources including solar, wind, and hydrogen (a carrier) need to be a significant part of the energy supply to accommodate the increased demand. In the U.S., solar and wind resources offer a major opportunity to supply energy for production of electricity and hydrogen; however, their variability, decentralization, and intermittency can make them challenging to integrate into energy production and delivery systems while continuing to ensure low cost and high system reliability. Developing integrated energy systems and testing technologies that include energy generation, storage, distribution, and utilization are critical to maximize the potential benefits of renewable technologies.

The U.S. Department of Energy (DOE) recognizes the need to develop an integrated energy systems approach that will result in large scale adoption of renewable energy. Inherent variability in power quality and intermittency of renewable generation systems requires full characterization to lower economic and technical risk for maximum deployment acceleration of these carbon-free power systems. The scope defined is technology improvements on the generator systems equipment (Renewable Energy generator plant, inverters, transformers, power conditioning/controls systems, etc) side of the interconnection point. Activities, therefore, need to include efforts to:

- Develop foundation of advanced renewable resource evaluation and forecasting tools for adoption of renewable technologies at scale;
- Develop and characterize renewable generator performance and power quality (voltage variability, harmonics, etc.);
- Combine renewable resource assessments data with renewable generation project performance data for model validation;
- Test and validate optimized renewable energy generators and associated equipment (e.g., electricity storage for PV systems, etc.) to reduce operability and reliability risks;
- Model, simulate, and evaluate increased market penetration of renewable generation to optimize RE generation portfolios for specific regions, and to identify and mitigate issues related to intermittency and variability;
- Build common platforms for renewable systems integration hardware testing to enable evaluation of many different, novel generator/controller/load scenarios quickly and cheaply;

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[a] Costs are to be determined upon completion of a validated Performance Baseline. Preliminary cost estimate range for the project is $115 to $135 million TPC. Baseline validation following an External Independent Review is planned for Spring 2010.

[b] No construction funds (excluding approved long lead procurement and preliminary design) will be used until the project performance baseline has been validated and CD-2/3 has been approved.

[c] Annual Energy Outlook 2006; Energy Information Administration

- Explore a variety of end-user-level systems configurations in a controlled environment allowing for the understanding of fundamental integration and interconnection issues;
- Enable the ability to explore systems configuration optimization at a scale that is cheaply and quickly configured and reconfigured; and
- Fully incorporate technical, economic, and financial analyses with technical validation efforts.

Energy Efficiency and Renewable Energy (EERE) programs support the R&D needed to bring critical new technologies to a point where industry is able to commercialize renewable energy-based energy systems, hydrogen infrastructure, and plug-in hybrid vehicles. To meet programmatic milestones, EERE requires an effective research facility, with appropriate testing, modeling and data management capabilities, to reduce R&D time and enable quicker deployment of cost-effective technologies to the marketplace.

DOE must increase its ability to characterize and test pre-commercial-scale integrated renewable energy systems to maximize the benefit of individual program funding. The ability to test and evaluate integrated systems will help maximize the benefit to each technology program to accomplish the EERE mission in support of the Department's Strategic Goals. This scale of testing can be done more quickly at less cost than commercial-scale demonstrations, and will allow industry to try a variety of new and advanced component and system combinations before deciding on which paths forward make the best economic sense to commercial deployment with the lowest technological and financial risks.

The capability must be designed for industry collaboration through cost-shared partnerships. A user-oriented facility must be located where it can easily be accessed by researchers and by energy stakeholders from the utility, buildings, hydrogen, electricity, and other key sectors. It will allow industry partners to test their individual technologies and systems in a controlled integrated energy system platform, and optimize the technologies for earlier market penetration. Experience has shown that validating and correcting problems in a laboratory environment enables technologies to go from concept to production more quickly, reduces overall cost, improves reliability, and reduces risks. This, in turn, makes early-stage projects more easily financed at better terms. Establishing this capability will foster information exchanges to help grow these emerging industries.

The Energy Systems Integration Facility (ESIF) supports the development and deployment of energy efficiency and renewable technologies expressed in the Energy Policy Act (EPAct) of 2005. DOE builds on the EPAct goals in its Strategic Plan (Fall 2006), which established goals for achieving national energy security that include:

- Increase U.S. energy diversity thus reducing vulnerability to disruption and increasing the flexibility of the market;
- Improve the quality of the environment by reducing greenhouse gas emissions and environmental impacts from energy production and use; and,
- Create a more flexible, more reliable, and higher capacity U.S. energy infrastructure.

The ESIF research capability will:
- Contain computational support for characterization of solar, wind, hydrogen, buildings systems, and integrated energy systems, including electricity storage is required that can effectively design, engineer, test, and verify technologies for commercial deployment.

- Test technology systems will ensure that the technical and financial risks faced by U.S. industry are fewer, making technology readiness less difficult, less costly, and take significantly less time.

- Enable U.S. industry to compete more readily with foreign companies in Europe and Asia, and will help determine technology readiness, allowing the U.S. to overcome vulnerabilities inherent in dependence on foreign oil, and achieving the objectives of energy security in an accelerated way.

DOE's visionary initiatives and programs are designed to accelerate the development of technologies to meet milestones for each individual technology. Developing a new electric and fuel infrastructure for the nation is a complex task requiring a systems-level approach, and many paths can lead to a successful electric and hydrogen future. Today, scientists and engineers are developing more efficient and lower-cost fuel cells; advanced vehicle designs; new methods to produce hydrogen from solar, wind, and biomass resources; gasoline and diesel alternatives from biomass.

To fully realize the benefits of EERE's technology programs and improve the market impact of renewable energy, DOE also needs to strengthen its engineering, design, modeling, simulation, and testing capabilities. Currently, the DOE research, development, and demonstration environment has little capability to accomplish the following critical activities:

- Integrate components into optimized systems from power generation through end use at a building-scale, community-scale, or utility-scale system.
- Test systems using flexible platforms for mixing and matching power generation and use.
- Provide technical and economic data/analyses to foster successful business opportunities.

EERE needs to increase the ability to characterize and test pre-commercial-scale integrated renewable energy and hydrogen systems to maximize the benefit of individual program funding, which is directed at individual technology development. The ability to test and evaluate integrated systems will help maximize the benefit to each technology program to accomplish the EERE mission in support of the Department's Energy Strategic Goals. This scale of testing can be done quicker and for less cost than commercial-scale demonstrations and will allow industry to try a variety of new and advanced component and system combinations quickly before deciding on which paths forward make the best economic sense to commercialize (Figure 2.3.1).

The Federal system currently lacks a facility for designing and testing engineering optimized systems, testing integrated energy technologies, and simulating and or emulating new infrastructure scenarios under the control of DOE and available to all of DOE industry partners. The lack of such a facility represents a key barrier to being able to meet DOE's solar, wind, and hydrogen goals. A new facility would allow DOE to optimize these technologies as part of a total energy system collecting both technical and economic data for business analysis will encourage their integration into energy production and delivery systems at minimum cost and high system reliability.

In addition to supporting EERE Program requirements for the Solar; Wind; Hydrogen, Fuel Cells, and Infrastructure; FreedomCAR and Vehicle Technologies; and Building Technologies, the capabilities of a new facility would also support the interconnection requirements of the Office of Electricity program for distributed power from renewable energy technologies and the integration of EERE technologies into the electrical grid.

Industry partnership is vital to the success of new energy and transportation technologies. U.S. utilities and private sector companies are interested in partnering with DOE to achieve a successful electric and hydrogen future. However, there is currently no facility in the country that supports cooperative public-private, laboratory-controlled research at the pre-commercial engineering scale, including testing and verification of a wide variety of concepts for advanced hydrogen technologies and integrated energy systems. Also, private facilities are not equally available to all researchers involved in a national effort.

One of the goals of NREL, for which EERE is the principal secretarial office, is to manage the interface between applied R&D and the commercial marketplace to encourage the market penetration of renewable and energy efficiency technologies. Many of the existing individual engineering and testing activities supporting the goals of the Solar, Wind, Hydrogen, Buildings and FreedomCAR programs described above are conducted at NREL. Hydrogen systems development and advanced fuels technology development activities are effectively leveraged to take advantage of NREL's core expertise and capabilities in integrating clean energy technologies such as solar, wind, and biofuels. These activities at NREL, however, have no dedicated facility.

Creating a facility to test the integrated renewable technology systems concept (energy system technology and system design, testing and performance optimization in the context of the larger energy supply, delivery, and end use systems for deployment) forms the center of DOE's energy efficiency renewable energy capability. The Energy Systems Integration Facility (ESIF) will enable DOE and its industrial partners to assess the potential of solar, wind, and hydrogen technology options for buildings, transportation, community, and utility utilization and develop a validated engineering-scale collection and analysis of performance data for the most promising technologies and integrated energy systems. The ESIF will allow U.S. industry members to insert their individual technologies into a controlled integrated energy system platform to test and optimize the technologies for earlier market penetration. It will also help to enable the success of the Hydrogen, Fuel Cell & Infrastructure Technologies Program effort to meet the technology readiness milestones.

The ESIF is envisioned to be a new facility specially designed to accommodate the critical engineering, testing, optimization, and verification research needed for integrated engineering systems development for EERE programs. It is proposed as a "first of its kind" integrated test and validation facility for new technologies being developed by the EERE programs and industry research partners nationwide, including engineering performance and testing of renewable hydrogen systems. The facility will provide support space for researchers and support staff, effectively consolidating activities currently in several different locations at NREL, some of which is currently in leased facilities. In addition, outdoor pads will be available for testing larger equipment and systems up to the multi-megawatt scale. The facility itself will be designed to merit at least a "Gold" rating from the U.S. Green Building Council, in support of EERE's goal to demonstrate energy efficient buildings with a lower impact on the environment.

The project will be conducted in accordance with the project management requirements in DOE Order 413.3A, Program and Project Management for the Acquisition of Capital Assets, and all appropriate project management requirements will be met.

A conceptual for the project has been completed. The project has been submitted for CD-1 approval to enable start of preliminary design and development of the cost, scope, and schedule baselines for validation. The project is expected to attain a combined CD2/3 in the Summer of 2010.

5. Financial Schedule

	(dollars in thousands)		
	Appropriations[a]	Obligations	Costs
Total Estimated Cost (TEC)			
PED			
FY2008	7,900	7,900	0
FY2009	0	0	2,000
FY2010	0	0	5,900
Total, PED	7,900	7,900	7,900
Construction			
FY2008	45,100	45,100	0
FY2009	40,500	40,500	0
FY2010	0	0	39,000
FY2011	39,280	39,280	75,000
FY2012	0	0	10,880
Total, Construction	124,880	124,880	124,880
TEC			
FY2008	53,000	53,000	0
FY2009	40,500	40,500	2,000
FY2010	0	0	44,900
FY2011	39,280	39,280	75,000
FY2012	0	0	10,880
Total, TEC	132,780	132,780	132,780
Other Project Cost (OPC)			
OPC except D&D			
FY2008	1,500	1,500	159
FY2009	500	500	1,100
FY2010	0	0	270
FY2011	220	220	0
FY2012	0	0	691
Total, OPC except D&D	2,220	2,220	2,220
D&D[b]			
FY	TBD	TBD	TBD
Total, D&D	TBD	TBD	TBD
OPC			
FY2008	1,500	1,500	159
FY2009	500	500	1,100
FY2010	0	0	270
FY2011	220	220	0
FY2012	0	0	691
Total, OPC	2,220	2,220	2,220

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[a] Congress directed funding to EERE for this project in FY 2008 and FY 2009.

[b] The DOE Golden Field Office will work with the HQ Program Office (EERE) and other DOE sites to identify square footage offsets that NREL can use to comply with the "one for one" requirement. No D&D costs are expected.

	(dollars in thousands)		
	Appropriations[a]	Obligations	Costs
Total Project Cost (TPC)			
FY2008	54,500	54,000	159
FY2009	41,000	41,000	3,100
FY2010	0	0	45,170
FY2011	39,500	39,500	75,000
FY2012	0	0	11,571
Total, TPC	135,000	135,000	135,000

6. Details of Project Cost Estimate

	(dollars in thousands)			
	Current Preliminary Cost Range		Previous Total Estimate	Original Validated Baseline[a]
	Low	High		
Total Estimated Cost (TEC)				
Design (PED)[b]				
Design	6,800	7,200	7,000	TBD
Contingency	600	700	0	
Total, PED	7,400	7,900	7,000	TBD
Construction				
Site Preparation	3,200	3,550	5,088	TBD
Equipment	31,500	35,000	34,000	TBD
Other Construction	59,515	75,330	35,912	TBD
Contingency	10,000	11,000	11,000	TBD
Total, Construction	104,215	124,880	86,000	TBD
Total, TEC	111,615	132,780	93,000	TBD
Contingency, TEC	10,600	11,700	11,000	TBD
Other Project Cost (OPC)				
OPC except D&D				
Conceptual Planning/Design	1,300	1,525	1,500	TBD
Other Project-Related costs	90	95	200	TBD
Start-Up	350	400	2,000	TBD
Contingency	160	200	200	TBD
Total, OPC except D&D	1,900	2,220	3,900	TBD
D&D				
D&D		0	0	0
Contingency		0	0	0
Total, D&D		0	0	0

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[a] Project does not have CD-2/3 approval. Costs are to be determined upon completion of a validated Performance Baseline. Preliminary approximate cost estimate range for the project is $115 to $135 million TPC.

[b] No specific PED funs 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 Preliminary Cost Range		Previous Total Estimate	Original Validated Baseline[a]
Total, OPC	1,900	2,220	3,900	TBD
Contingency, OPC	160	200	200	TBD
Total, TPC	115,000	135,000	96,900	TBD
Total, Contingency	10,760	11,900	11,200	TBD

7. Funding Profile History[a]

($K)

		Prior Years	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	Outyears	Total
FY 2009	TEC	58,500	34,500	0	0	0	0	0	0	93,000
	OPC	1,900	1,300	500	200	0	0	0	0	3,900
	TPC	60,400	35,800	500	200	0	0	0	0	96,900
FY 2011	TEC	93,500	0	39,280	0	0	0	0	0	132,780
	OPC	2,000	0	220	0	0	0	0	0	2,220
	TPC	95,500	0	39,500	0	0	0	0	0	135,000

8. Related Operations and Maintenance Funding Requirements

Start of Operation or Beneficial Occupancy (fiscal quarter or date)	3QFY2012
Expected Useful Life (number of years)	50
Expected Future Start of D&D of this capital asset (fiscal quarter)	3QFY2062

(Related Funding requirements)

(dollars in thousands)

	Annual Costs		Life Cycle Costs	
	Current Total Estimate	Previous Total Estimate	Current Total Estimate	Previous Total Estimate
Operations	1,371	1,371	68,550	68,550
Maintenance	876	876	43,800	43,800
Total, Operations & Maintenance[b]	2,247	2,247	112,350	112,350

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[a] Project does not have CD-2/3 approval; therefore, a performance baseline has not yet been established.

[b] Estimated costs do not include building utilities i.e. electric, natural gas, sewer or water.

9. Required D&D Information

Area	Square Feet
Area of new construction	TBD
Area of existing facility(s) being replaced	TBD
Area of additional D&D space to meet the “one-for-one” requirement	TBD

The new construction is not replacing an existing DOE owned facility. EERE has secured offset space through the Office of Engineering and Construction Management to comply with the "one-for-one" requirement.

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 EERE recommended Acquisition Strategy is progressive design/build. This strategy will reduce project performance risk and will deliver the best value to the government.[a]

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.

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[a] The Acquisition Executive must approve the recommended Acquisition Strategy at CD-1 which scheduled for early February 2010.

Weatherization and Intergovernmental Activities
Funding Profile by Subprogram

(dollars in thousands)

	FY 2009 Current Appropriation[a]	FY 2009 Current Recovery Act Appropriation	FY 2010 Current Appropriation	FY 2011 Request
Weatherization and Intergovernmental Activities				
Weatherization Assistance Grants	450,000	4,977,500	210,000	300,000
State Energy Program	50,000	3,084,500	50,000	75,000
International Renewable Energy Program	5,000	0	0	0
Tribal Energy Activities	6,000	0	10,000	10,000
Renewable Energy Production Incentive	5,000	0	0	0
Energy Efficiency and Conservation Block Grants	0	3,184,000	0	0
Energy Efficient Appliance Rebate Program	0	298,500	0	0
Total, Weatherization and Intergovernmental Activities	516,000	11,544,500	270,000	385,000

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”
P.L. 109-58, “Energy Policy Act of 2005”
P.L. 110-140, “Energy Independence and Security Act of 2007”
P.L. 111-5, “American Recovery and Reinvestment Act of 2009”

Mission

The mission of the Weatherization and Intergovernmental Activities Program (WIP) is to accelerate the deployment of energy efficiency, renewable energy, and oil displacement technologies and practices by a wide range of government and business stakeholders.

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[a] Includes $250,000,000 million in emergency funding for the Weatherization Assistance Grants program provided by P.L. 111-6, “The Continuing Appropriations Resolution, 2009.”

Benefits

The program addresses both the supply and demand sides of the DOE clean energy security goal. WIP facilitates energy investments that reduce energy consumption and increase renewable energy capacity and the availability and affordability of domestic fuels.

WIP provides a combination of competitive and formula grants and technical assistance to state and local, U.S. territories, and tribal governments. Grantees utilize these resources to implement a variety of energy projects, including the weatherization of homes, renewable energy planning, emergency energy management, and sustainable energy integration.

The program produces benefits on multiple levels. Specifically, Weatherization Assistance Grants reduce national energy consumption while concurrently reducing energy costs for low-income families. In partnership with tribal governments, Tribal Energy Activities 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 2011 budget investments complement Recovery Act objectives through weatherizing thousands of low-income residences; training state, local and weatherization workforces for green careers; and supporting energy efficiency. The Energy Efficiency and Conservation Block Grants (EECBG) support the goals of the multi-year “Recovery Through Retrofit” initiative. Through the "Retrofit Ramp-Up" portion of the competitive EECBG, DOE will award up to $390 million for innovative programs that are structured to provide whole-neighborhood building energy retrofits.

FY 2011 activities will build upon historic clean energy investments in the Recovery Act to further the Nation’s energy goals through sustained technology innovation and continued investments in enabling infrastructure. This integrated targeted performance builds on both Recovery and Research, Development, Demonstration and Deployment (RDD&D) will enable the realization of Administration’s goals and commitments to energy, the economy and climate. WIP manages approximately 30 percent (about $11.5B) of DOE’s appropriation from 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.

WIP achieves substantial climate change benefits through the deployment of clean energy technologies and sustainable energy policies. Specific contributions include:

Climate Change

WIP activities will create carbon savings of over 150 million metric tons of CO_2 by 2020 and more than 400 million metric tons of CO_2 by 2030.

Economic Impact

The cumulative consumer and power company savings nearing $45 billion by 2020 (about one-third of that savings to the electric power industry) could more than double by 2030.

The following metrics tables of benefits display the estimates of primary strategic and supporting secondary benefits from 2015 through 2050 that would result from the realization of WIP'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 WIP'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 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 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[a] within two energy-economy models: NEMS-GPRA11 for benefits through 2030, and MARKAL-GPRA11 for benefits through 2050[b]. The following tables display the full list of modeled benefits.

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[a] Baseline cases utilize data from the updated *Annual Energy Outlook 2009* Reference Case Service Report, April 2009

[b] 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, 2010. GPRA modeling and analysis documentation for prior budget years can be found at http://www1.eere.energy.gov/ba/pba/program_benefits.html.

FY 2011 Primary Metrics

	Metric	Model	Year			
			2015	2020	2030	2050
Energy Security	Oil Imports Reduction, cumulative (Bil bbl)	NEMS	ns	0.07	0.38	N/A
		MARKAL	ns	ns	0.05	0.18
	Natural Gas Imports Reduction, cumulative (Tcf)	NEMS	0.05	0.18	0.41	N/A
		MARKAL	ns	0.66	3.58	8.38
Environmental Impacts	CO_2 Emissions Reduction, cumulative (Mil mtCO_2)	NEMS	63.38	160.23	427.50	N/A
		MARKAL	71	204	516	899
	SO_2 Allowance Price Reduction ($/ton)	NEMS	N/A	N/A	N/A	N/A
		MARKAL	N/A	N/A	N/A	N/A
	NO_x Allowance Price Reduction ($/ton)	NEMS	N/A	N/A	N/A	N/A
		MARKAL	N/A	N/A	N/A	N/A
Economic Impacts	Primary Energy Savings, cumulative (quads)	NEMS	0.93	2.34	5.33	N/A
		MARKAL	ns	1.1	5.9	14.3
	Oil Savings, cumulative (Bil bbl)	NEMS	0	0.08	0.41	N/A
		MARKAL	0.01	0.04	0.13	0.28
	Consumer Savings, cumulative (Bil $)	NEMS	13.8	40	109	N/A
		MARKAL	30	70	163	347
	Electric Power Industry Savings, cumulative (Bil $)	NEMS	6.1	15	34	N/A
		MARKAL	10	24	57	104
	Household Energy Expenditures Reduction ($/household/yr)	NEMS	20	20	20	N/A
		MARKAL	5.2	1.9	10	ns

- "Reductions" and "savings" are calculated as the difference between results from the baseline case (i.e. no future DOE funding for this technology) and the program case (i.e. requested DOE funding for this technology is received and is successful).

- Oil impacts are shown as two metrics. "Oil Imports Reduction" refers only to reductions in oil imports; "Oil Savings" refers to savings (reduction) in total oil consumption.

- All cumulative metrics are based on results beginning in 2011.
- All monetary metrics are in 2007$.
- Cumulative monetary metrics are in 2007$ that are discounted to 2011 using a 3% discount rate.

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

FY 2011 Secondary Metrics

	Metric	Model	Year			
			2015	2020	2030	2050
Energy Security	Oil Imports Reduction, annual (Mbpd)	NEMS	ns	ns	0.10	N/A
		MARKAL	ns	ns	ns	0.01
	Natural Gas Imports Reduction, annual (Tcf)	NEMS	ns	ns	ns	N/A
		MARKAL	ns	0.26	0.32	ns
	MPG Improvement (%)	NEMS	ns	ns	22.6%	N/A
		MARKAL	ns	ns	ns	ns
Environmental Impacts	CO2 Emissions Reduction, annual (Mil mtCO2/yr)	NEMS	20.3	21.1	39.7	N/A
		MARKAL	25.5	27.3	19.4	15.6
	CO2 Intensity Reduction of US Economy (Kg CO2/$GDP)	NEMS	N/A	N/A	N/A	N/A
		MARKAL	ns	ns	ns	ns
	CO_2 Intensity Reduction of US Power Sector (Kg CO2/kWh)	NEMS	N/A	N/A	N/A	N/A
		MARKAL	ns	ns	ns	ns
	CO_2 Intensity Reduction of US Transportation Sector (Kg CO2/mile)	NEMS	N/A	N/A	N/A	N/A
		MARKAL	ns	ns	ns	ns
Economic Impacts	Primary Energy Savings, annual (quads/yr)	NEMS	0.29	0.30	0.42	N/A
		MARKAL	ns	0.43	0.58	0.1
	Oil Savings, annual (Mbpd)	NEMS	ns	ns	0.13	N/A
		MARKAL	0.02	ns	0.02	ns
	Consumer Savings, annual (Bil $)	NEMS	5.3	8.0	9.0	N/A
		MARKAL	11	9.2	18	19
	Electric Power Industry Savings, annual (Bil $)	NEMS	2.2	3.0	3.5	N/A
		MARKAL	3.5	3.7	5.9	5.5
	Energy Intensity of US Economy (energy/$GDP)	NEMS	N/A	N/A	N/A	N/A
		MARKAL	ns	0.03	0.03	0.01
	Net Energy System Cost Reduction, cumulative (Bil $)	NEMS	N/A	N/A	N/A	N/A
		MARKAL	39	110	273	494

- "Reductions" and "savings" are calculated as the difference between results from the baseline case (i.e. no future DOE funding for this technology) and the program case (i.e. requested DOE funding for this technology is received and is successful).

- Oil impacts are shown as two metrics. "Oil Imports Reduction" refers only to reductions in oil imports; "Oil Savings" refers to savings (reduction) in total oil consumption.
- All cumulative metrics are based on results beginning in 2011.
- All monetary metrics are in 2007$.
- Cumulative monetary metrics are in 2007$ that are discounted to 2011 using a 3% discount rate.
ns - Not significant   NA - Not yet available   N/A - Not applicable

Contribution to the Secretary's Goals and GPRA Unit Program Goal

WIP's objectives complement and support the following Secretarial goal.

Energy: Build a competitive, low-carbon economy and secure America's energy future

WIP efforts enhance economic prosperity and competitiveness. WIP expands a green workforce by preparing thousands of workers for careers in residential energy retrofits and other energy-related fields.

WIP reduces energy demand by implementing energy efficiency programs in the buildings, industry, transportation, and utility sectors. Examples include: shifting electric utility emphasis towards energy efficiency; sponsoring near term residential energy retrofits for low-income residents; leading an effort to increase Energy Savings Performance Contracting (ESPC) in state and local buildings; and developing and sharing effective energy technology assessment and planning tools.

WIP expands energy supply through the deployment of clean, safe, low carbon renewable energy technologies (e.g., wind, solar, geothermal). Activities include: facilitating the standardization of renewable energy certificate trading programs; expanding the infrastructure for alternative fuels; and sponsoring feasibility studies on sustainable energy options and implementation plans for renewable energy facilities.

Contribution to GPRA Unit Program Goal 21 (Weatherization Assistance Grants)

Weatherization Assistance Grants contribute to providing cost-effective energy efficiency improvements to low-income homes.

Contribution to GPRA Unit Program Goal 22 (State Energy Program)

The State Energy Program contributes to facilitating the deployment of energy efficiency and renewable energy technologies and sustainable energy policies.

Contribution to GPRA Unit Program Goals from Additional Intergovernmental Activities

Intergovernmental activities managed by Weatherization contribute encouraging energy efficiency and renewable energy investments through grants, incentives, and technical assistance.

Annual Performance Results and Targets

Both WIP performance measures align with the Program's technology deployment mission and the Secretary's goal to build a competitive, low-carbon economy and secure America's energy future. The Weatherization Assistance Program (WAP) metric represents residential energy efficiency deployment and is the key component in generating estimated energy benefits. The State Energy Program (SEP) performance measure directly estimates the energy impact from the deployment of clean energy technologies and policies. Grantee reporting, monitoring, and validation systems developed for Recovery Act programs also benefit regular program activities. Specifically, the Grant Reporting and Analysis Software System quantitatively measures progress for all WIP grantees.

Annual Performance Targets and Results

Secretarial Goal: Goal 2: Energy: Build a competitive, low-carbon economy and secure America's energy future

GPRA Unit Program 21 Weatherization Assistance Grants

Subprogram: Weatherization Assistance

FY 2006	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
Performance Measure: Weatherize homes using DOE funds[a]									
T: 97,300 A: 104,283	T: 70,051 A: 101,667	T: 75,848 A: 94,487	T: 52,360 A: 95,821	T: 22,168 A:	T: 33,484 A:	T: 33,484 A:	T: 33,484 A:	T: 33,484 A:	T: 33,484 A:

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[a] In FY 2011, up to 86,000 low-income homes will be weatherized when DOE funds are combined with other funding sources. The 33,484 home energy retrofits funded through the formula weatherization program are expected to be matched by an equal number of home energy retrofits supported by non-Federal funding. Innovation in Weatherization funding will directly support the weatherization of 5,000 homes. Partnership with other non-Federal funds are expected to result in an additional 15,000 home energy retrofits.

Annual Performance Targets and Results

Secretarial Goal: Goal 2: Energy: Build a competitive, low-carbon economy and secure America's energy future

GPRA Unit Program 21 22 State Energy Program

Subprogram: Weatherization Assistance

FY 2006	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
Performance Measure: Achieve an average annual energy savings (in trillions of Btus) from DOE funded projects									
T: 8-10 A: 10.6	T: 12-14 A: 12.2	T: 10-12 A: 14.3	T: 6-7 A: 8.8	T: 6-7 A:	T: 9-10 A:	T: 9-10 A:	T: 9-10 A:	T: 9-10 A:	T: 9-10 A:

Means and Strategies

WIP will use various means and strategies to achieve its GPRA Unit Program goals as described below. However, various external factors, as listed below, may impact the ability to achieve these goals. The program also performs collaborative activities to help meet its goals.

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 energy efficiency and renewable energy projects;
- Use formula grants to support core capabilities of States and weatherization offices;
- Assist with feasibility studies and implementation planning on specific energy efficiency and renewable energy projects and policies; 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 focusing 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;
- Develop new innovative models to leverage Federal weatherization resources;
- 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 in the residential energy retrofit process.

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.

In carrying out the program’s mission, WIP collaborates with several groups on its key activities including:

- Weatherization Assistance and the State Energy Program work closely with all 50 States, the District of Columbia, U.S. Territories, and national stakeholder groups; and
- Tribal Energy coordinates activities with the 562 federally recognized Tribes and collaborates 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, WIP 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; Commercial Building Energy Consumption Survey (CBECS); Residential Energy Consumption Survey (RECS); DOE Laboratory reports; and information collected directly from WIP performers or partners.

Baseline:

- The SEP baseline of 1990 state energy consumption was established in EPAct 2005 as part of an overall goal for a 25 percent increase in energy efficiency by 2012. This baseline will be updated as part of the findings from a major national evaluation to be completed in FY 2012.
- The Tribal Energy baseline is renewable energy capacity on tribal lands.

Frequency: Annual; Complete revalidation of assumptions and results take place every three to four 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 the Performance Measurement Manager (PMM, 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 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 DOE information systems and 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 and market surveys. 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. The most recent peer review was completed in 2006. The next review is scheduled for 2010.

EIA data undergo regular verification reviews.

Weatherization Assistance Grants
Funding Schedule by Activity

(dollars in thousands)

	FY 2009	FY 2010	FY 2011
Weatherization Assistance Grants			
Weatherization Assistance	436,770	176,700	262,500
Training and Technical Assistance	13,230	3,300	7,500
Innovations in Weatherization	0	30,000	30,000
Weatherization Assistance Grants	450,000	210,000	300,000

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 support includes managerial and hands-on technical training, State-level energy saving evaluations, and updates to health, safety, and client education protocols. In collaboration with program stakeholders, DOE conducts regional and national training and technical assistance activities that benefit all States. Additionally, the Recovery Act provided an 8-fold increase over the average annual appropriation. These funds will result in over 500,000 energy retrofits in homes occupied by low-income families. Recovery Act activities will expand the capacity of the weatherization network, increase training programs, create demand for additional products (work trucks, insulation, weather stripping, blower doors) and expand the workforce. The program’s size creates opportunities to standardize key items, such as energy audits, training programs and methods to measure energy savings.

Recent legislative changes include:

- Increasing the allowable state average 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 updated in June of each year. The following table displays current information:

Weatherization Assistance Funding

(whole dollars)

State/Territory	Source of Non-Federal Funds	FY 2010 Federal DOE Funds	FY 2008 Non-Federal Funds[a]
Alabama	Alabama Power-Centsable Energy Program	1,882,352	225,000
Alaska	Alaska Housing Finance Corp (State)	1,329,537	200,000,000
Arizona	Utility funds	1,058,086	4,200,000
Arkansas	N/A	1,622,103	1,629,724
California	N/A	4,917,928	0
Colorado	Utilities- Excel Energy	4,307,729	2,391,000
Connecticut	Utilities: WRAP, UI, SCG	1,972,276	7,800,000
Delaware	Utility funds	460,428	367,000
Dist. Columbia	N/A	519,060	4,653,600
Florida	N/A	1,484,081	0
Georgia	GA Power Company & Atlanta Gas Light Resources	2,282,504	2,350,000
Hawaii	N/A	169,266	0
Idaho	Utility funds, landlord contributions, BPA funds	1,558,041	2,204,605
Illinois	Utility Customer Charge	10,844,851	10,000,000
Indiana	Utility company projects either with IHCDA or alone	5,137,920	2,400,000
Iowa	N/A	3,918,674	4,859,495
Kansas	N/A	1,988,468	0
Kentucky	N/A	3,547,808	0
Louisiana	N/A	1,340,633	0
Maine	N/A	2,415,842	0
Maryland	N/A	2,083,502	0
Massachusetts	Utility funds	5,137,610	21,000,000
Michigan	N/A	11,910,904	8,500,000
Minnesota	Utility funds, plus approximately $114,000 HUD/CDBG funds	7,739,554	2,000,000
Mississippi	N/A	1,290,592	0
Missouri	Ameren Electric, Ameren gas, Atmos Gas, Laclede Gas	4,703,704	2,167,245
Montana	State, Utility, BPA	1,987,207	3,359,682
Nebraska	N/A	1,964,240	0
Nevada	Universal Energy Charge	662,859	3,648,815

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[a] FY 2009 non-Federal funding data not available until June, 2010

(whole dollars)

State/Territory	Source of Non-Federal Funds	FY 2010 Federal DOE Funds	FY 2008 Non-Federal Funds[a]
New Hampshire	Electric Utility Efficiency Program	1,193,071	2,922,542
New Jersey	N/A	3,999,259	0
New Mexico	Utility Funds	1,506,127	1,772,928
New York	Owner investments in larger multifamily buildings	15,786,616	10,000,000
North Carolina	N/A	3,249,190	0
North Dakota	N/A	1,969,451	0
Ohio	N/A	10,762,015	20,000,000
Oklahoma	Oklahoma Energy Resources Board	2,029,472	250,000
Oregon	N/A	2,222,843	6,890,500
Pennsylvania	N/A	11,519,998	0
Rhode Island	National Grid	916,134	1,753,250
South Carolina	Utility - SC Electric and Gas	1,388,815	50,000
South Dakota	N/A	1,513,071	0
Tennessee	N/A	3,278,362	0
Texas	N/A	4,294,261	901,531
Utah	State Electric Utility, Gas Utility	1,638,680	1,188,836
Vermont	VT Weatherization Trust Fund	1,012,458	7,886,609
Virginia	N/A	3,148,212	0
Washington	Energy Matchmakers Program and Matching Dollars	3,570,881	9,000,000
West Virginia	Utility funds	2,525,991	1,417,250
Wisconsin	N/A	6,726,647	46,310,037
Wyoming	N/A	932,139	1,768,277
American Samoa	N/A	154,860	0
Guam	N/A	158,948	0
Puerto Rico	N/A	647,129	0
Northern Mariana Islands	N/A	155,635	0
Virgin Islands	N/A	161,976	0
Weatherization Innovation	N/A	30,000,000	0
Headquarters T&TA	N/A	3,300,000	0
Total, Weatherization Assistance Funding		210,000,000	395,867,926

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[a] FY 2009 non-Federal funding data not available until June, 2010

Benefits

The Weatherization Assistance Program (WAP) contributes to the Secretarial goals of reducing energy demand and creating a green workforce. Since 1976, the program has helped 6.25 million American families, resulting in an estimated average energy savings of $350 for 2009 and increasing the comfort and safety of their homes. Weatherization returns $1.67[a] (1.65 in 2008 and 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 2009	FY 2010	FY 2011
Weatherization Assistance	**436,770**	**176,700**	**262,500**

WAP 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, the District of Columbia, and Native American tribal governments to increase the energy efficiency of homes occupied by low-income families. These agencies, in turn, contract with almost 900 local governmental or nonprofit agencies to deliver weatherization services to low-income clients in their areas.

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 2011 target is to weatherize 33,484 low-income homes. The majority of WAP 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.

Training and Technical Assistance	**13,230**	**3,300**	**7,500**

DOE directed weatherization training and technical assistance activities improve the effectiveness and efficiency of WAP. These resources support strategic planning and analysis; program performance measurement and documentation; and facilitation of (e.g., through pilot programs, publications, training programs, workshops and peer exchange) advanced techniques and collaborative strategies. An ongoing national evaluation is assessing the overall energy savings and cost-effectiveness of the program.

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[a] Assuming $5,505 savings, with 20 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: http://weatherization.ornl.gov/pdf/CON-493FINAL10-10-05.pdf

(dollars in thousands)

	FY 2009	FY 2010	FY 2011
Innovation in Weatherization	**0**	**30,000**	**30,000**

The objectives of the Innovation in Weatherization activity is to demonstrate new ways to increase the number of low-income homes weatherized and lower the Federal per home cost for residential energy retrofits, while also establishing a stable funding base. DOE will form partnerships with non-traditional weatherization providers such as foundations and other non-profits, labor unions, churches, private contractors, large companies, and other groups. These organizations will provide leadership in leveraging financial resources and managing the home energy retrofit process. Innovation in Weatherization contributes directly to priorities for the expansion of a green workforce and the energy retrofit of one million homes per year. A key component will be the ability of grantees to obtain $3 in non-Federal contributions for every $1 investment from DOE. This activity will build upon lessons learned from the Weatherization Innovation pilot funded in the previous fiscal year.

	FY 2009	FY 2010	FY 2011
Total, Weatherization Assistance Grants	**450,000**	**210,000**	**300,000**

Explanation of Funding Changes

	FY 2011 vs. FY 2010 ($000)
Weatherization Assistance	
Additional funding will support the President's goal to increase the number of low-income homes weatherized.	+85,800
Technical and Training Assistance	
The increase will support the completion of the national program evaluation.	+4,200
Total, Weatherization Assistance Program	**+90,000**

State Energy Program
Funding Schedule by Activity

(dollars in thousands)

	FY 2009	FY 2010	FY 2011
State Energy Program			
State Energy Program Formula Grant	25,000	25,000	37,500
State Energy Program Special Projects	25,000	25,000	37,500
Total, State Energy Program	50,000	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. SEP special 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 improve the comfort and quality of life for millions of Americans by lessening transmission grid congestion and overall energy demand. The substantial resources provided for SEP in the Recovery Act is allowing States to accelerate implementation of transformational and self-sustaining energy practices and policies.

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 energy retrofits in state and local government buildings, schools, universities and hospitals.

Detailed Justification

(dollars in thousands)

	FY 2009	FY 2010	FY 2011
State Energy Program Formula Grant	**25,000**	**25,000**	**37,500**

Formula-based grants allow 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 support the development and maintenance of energy emergency planning at state and local levels, a critical security benefit and maintain the viability of the State energy office network.

State Energy Program Special Projects	**25,000**	**25,000**	**37,500**

SEP competitive Special Projects focus on specific high impact market transformation and crosscutting solutions, and also provides valuable training and technical assistance to States. The most recent solicitation cycle (FY 2008) 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. Future areas of interest include encouraging: 1) States and utilities to improve energy efficiency and renewable energy deployment; and 2) optimization of state energy planning and protocols.

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; 3) development of web-based reporting and monitoring systems; and 4) broader planning, analysis, and evaluation activities. The program is conducting a national evaluation, scheduled for completion in FY 2012, to improve measurement of energy and non-energy benefits.

Total, State Energy Program	**50,000**	**50,000**	**75,000**

Explanation of Funding Changes

	FY 2011 vs. FY 2010 ($000)
State Energy Program Formula Grant	
The increase will support the expansion of State capabilities to: 1) deploy energy efficiency and renewable energy technology to local governments, businesses, and consumers; and 2) facilitate the transition to lower-carbon clean energy technologies and sustainable energy policies.	+12,500
State Energy Program Special Projects	
Competitive grants have a significant energy impact through addressing "policy" and "financial" components of the technology deployment process. The increase will support additional high-impact state energy projects, expanded training and technical assistance to States, and continued development of web-based reporting and monitoring systems.	+12,500
Total, State Energy Program	**+25,000**

International Renewable Energy Program
Funding Schedule by Activity

	(dollars in thousands)		
	FY 2009	FY 2010	FY 2011
International Renewable Energy Program	5,000	0	0
Total, International Renewable Energy Program	5,000	0	0

Description

The International Renewable Energy Program (IREP) increases 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.

International energy activities are continuing and expanding. Due to their importance, these efforts are now managed at the EERE corporate level to better serve, coordinate, and integrate international activities across the EERE portfolio. Additional information can be found in the Program Support section of the FY 2011 Budget Request.

Benefits

EERE international energy activities are located in the Program Support line item.

Detailed Justification

	(dollars in thousands)		
	FY 2009	FY 2010	FY 2011
International Renewable Energy Program	**5,000**	**0**	**0**

EERE international energy activities are located in the Program Support line item.

Explanation of Funding Changes

	FY 2011 vs. FY 2010 ($000)
International Renewable Energy Program	
No change.	0
Total, International Renewable Energy Program	**0**

Tribal Energy Activities

Funding Schedule by Activity

(dollars in thousands)

	FY 2009	FY 2010	FY 2011
Tribal Energy Activities	6,000	10,000	10,000
Total, Tribal Energy Activities	6,000	10,000	10,000

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 program contributes to the Secretarial goal of building a competitive, low-carbon economy and securing America's energy future. Tribal Energy Activities, collaboratively with the Department of Interior and the Department of Housing and Urban Development, help tribes implement their energy objectives. Sustainable energy projects address concerns of tribal governments for energy sufficiency and economic development.

For example, the Augustine Band of Cahuilla Mission Indians received a financial grant to explore their energy options. DOE funding led to the adoption of a five-year development plan, and installation and operation of a 1 MW solar electric system on tribal lands in 2009.

Detailed Justification

(dollars in thousands)

	FY 2009	FY 2010	FY 2011
Tribal Energy Activities	**6,000**	**10,000**	**10,000**

Tribal Energy Activities are particularly valuable in advancing sustainable clean energy development and deployment on tribal lands. The program utilizes technical and financial assistance to support the assessment of sustainable energy options, and the planning for renewable energy installations and cost effective energy efficiency projects on tribal lands. Between FY 2002 and FY 2008, 93 tribal energy projects totaling $16.5 million were awarded on a competitive basis. These projects were leveraged by $6.4 million cost-shared by the tribes.

(dollars in thousands)

	FY 2009	FY 2010	FY 2011

A key area of emphasis is 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 2011 the program will continue to distribute these tools using EERE website and training sessions.

Total, Tribal Energy Activities	**6,000**	**10,000**	**10,000**

Explanation of Funding Changes

	FY 2011 vs. FY 2010 ($000)
Tribal Energy Activities	
No change.	0
Total, Tribal Energy Activities	**0**

Renewable Energy Production Incentive (REPI)
Funding Schedule by Activity

(dollars in thousands)

	FY 2009	FY 2010	FY 2011
Renewable Energy Production Incentive	5,000	0	0
Total, Renewable Energy Production Incentive	5,000	0	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 generated. This, coupled with the uncertainty about future funding, limits the impact of the program.

Detailed Justification

(dollars in thousands)

	FY 2009	FY 2010	FY 2011
Renewable Energy Production Incentive	**5,000**	**0**	**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.

DOE proposed to eliminate this subprogram in FY 2010, recognizing that the incentive value of REPI to stimulate deployment has significantly diminished over time as renewable energy technologies become more competitive. Additionally, the steadily growing pool of applicants resulted in increasingly smaller resources available for individual payouts, given the limited availability of funds to distribute.

	FY 2009	FY 2010	FY 2011
Total, Renewable Energy Production Incentive	**5,000**	**0**	**0**

Explanation of Funding Changes

	FY 2011 vs. FY 2010 ($000)
Renewable Energy Production Incentive	
No change.	0
Total, Renewable Energy Production Incentive	**0**

Program Direction
Funding Profile by Category

(dollars in thousands)

	FY 2009 Current Appropriation	FY 2009 Current Recovery Act Appropriation	FY 2010 Current Appropriation	FY 2011 Request
Headquarters (HQ)				
Salaries and Benefits	40,677	11,450	58,209	76,628
Travel	2,437	1,269	2,626	2,315
Support Services	23,336	20,172	20,441	21,446
Other Related Expenses	15,302	4,705	14,117	16,646
Total, Headquarters	81,752	37,596	95,393	117,035
HQ Full Time Equivalents	294	79	401	518
Golden Field Office (GO)				
Salaries and Benefits	18,399	15,548	19,134	44,771
Travel	687	514	697	653
Support Services	7,435	6,897	5,424	5,426
Other Related Expenses	4,630	2,518	3,818	3,562
Total, Golden Field Office	31,151	25,477	29,073	54,412
GO Full Time Equivalents	129	121	148	334
National Energy Technology Laboratory (NETL)				
Salaries and Benefits	6,186	9,702	7,176	17,886
Travel	189	142	374	180
Support Services	7,458	3,444	6,990	8,828
Other Related Expenses	884	3,639	994	1,667
Total, NETL	14,717	16,927	15,534	28,561
NETL Reimbursable FTE [a]	57	86	64	153
Total Program Direction				
Salaries and Benefits	65,262	36,700	84,519	139,285
Travel	3,313	1,925	3,697	3,148
Support Services	38,229	30,513	32,855	35,700
Other Related Expenses	20,816	10,862	18,929	21,875
Total, Program Direction	127,620	80,000[b]	140,000	200,008
Total, EERE Full Time Equivalents	423	200	549	852

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[a] Fossil Energy Employees
[b] Excludes $4.0 million transferred to Departmental Administration

(dollars in thousands)

	FY 2009 Current Appropriation	FY 2009 Current Recovery Act Appropriation	FY 2010 Current Appropriation	FY 2011 Request
Total, NETL Reimbursable FTE	57	86	64	153
Total FTE	480	286	613	1,005

Mission

Program Direction provides funding for Federal employees, contractor staffing, and operational costs required for the overall implementation 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

(dollars in thousands)

	FY 2009	FY 2010	FY 2011
Salaries and Benefits	**65,262**	**84,519**	**139,285**

EERE plans to ramp up its Federal workforce to execute, monitor, and evaluate more than 7,000 active contracts, grants and agreements valued in excess of $4 billion. Due, in part, to residual Recovery Act follow-up, reporting and transparency requirements, risk-management, and accountability work, the number of transactions is expected to double between FY 2009 and FY 2011. This funding supports a base of 613 full time equivalent (FTE) employees, plus an increase of 392 FTE. This amount includes: Headquarters (+117); Golden Field Office (+186); and (+89) reimbursable Fossil Energy employees located at NETL, totaling 1,005 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. Funding includes an OMB annual baseline salary increase factor of 1.014, which covers cost-of-living allowances, promotions, within-grade-increases and relocation allowances for current and new employees.

Travel	**3,313**	**3,697**	**3,148**

Provides necessary travel for proper management and oversight of Federally-funded projects, including additional audits and on-site monitoring of new and expanding technology programs, Recovery Act formula grants, and weatherization assistance. Conduct frequent, geographically-dispersed reviews of Weatherization Assistance and State Energy Program grants. Travel also supports expanding international activities necessary to address global climate change and supports a number of key bilateral and multilateral initiatives that further DOE's research, demonstration, and deployment goals. This request supports continued work on-site with member countries to develop the International Partnership for Energy Efficiency Cooperation and lead the Energy Development for the Island Nations initiative. Funding reflects a 5 percent reduction below FY 2009 travel costs.

(dollars in thousands)

	FY 2009	FY 2010	FY 2011
Support Services	**38,229**	**32,855**	**35,700**

This funding supports information technology (IT), communications, and network systems, including connectivity to separate office building locations, as well as the purchase and installation of desktop systems to ensure rapid response capabilities, and accurate reports and analyses, critical for decision-making. This funding also supports training, education, safety and health support, facility safeguards and security, and computer hardware and software installation, configuration, and maintenance.

Additionally, this request provides for a 67 percent indirect overhead charge for reimbursable work provided by Fossil Energy employees at NETL, which includes business administration (budget and financial management, human resources, procurement, etc); administrative assistance to project managers; facilities and space management; IT and local-area network operations.

This funding also supports Reports and Analysis, Management and General Administrative Services for project planning, analysis, management, oversight and reporting. These requirements, characterized by the increase in accountability and transparency envisioned 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 requirements for corporate level planning, evaluation, reporting, analysis and administrative services.

Other Related Expenses	**20,816**	**18,929**	**21,875**

This request provides for the acquisition of additional office space at Headquarters and the Project Management Center for 392 new Federal employees. 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. Includes funding for GSA rent for the Golden Field Office, as well as supplies and materials for both Golden Field Office and NETL, such as computer equipment, hardware, software, licenses, and support, utilities, postage, printing, graphics, administrative expenses, and security, plus workers compensation, publications, conferences, and reimbursable expenses at NETL.

Total, Program Direction	**127,620**	**140,000**	**200,008**

Explanation of Funding Changes

	FY 2011 vs. FY 2010 ($000)
Salaries and Benefits	
The increase funds 392 additional Federal employees required to advance the Presidential and Secretarial priorities for research, development and deployment of EERE programs; business administration; and increased project management, evaluation, risk management, accountability, monitoring and oversight. This request includes annual baseline salary increase factor of 1.014, cost-of-living, promotions, within-grade-increases, and relocation allowances for new employees.	+54,766
Travel	
The decrease reflects a 5 percent reduction below the FY 2009 travel costs.	-549
Support Services	
This increase is a result of additional contract staff and related indirect and overhead costs included in the FY 2010 Appropriation. 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. Includes OMB annual baseline support services increase factor of 1.014.	+2,845
Other Related Expenses	
The increase is due to planning for more workspace in FY 2011 and the corresponding support systems required for contractor staff, both at Headquarters and at the Project Management Centers than provided for in the FY 2010 Appropriation. It also includes the OMB annual baseline other related expenses increase factor of 1.014.	+2,946
Total Funding Change, Program Direction	**+60,008**

Support Services by Category

	FY 2009	FY 2010	FY 2011
	(dollars in thousands)		
Technical Support			
Feasibility of Design Considerations	1,925	1,655	1,798
Development of Specifications	2,887	2,481	2,694
System Definition	1,925	1,655	1,798
System Review and Reliability Analyses	1,444	1,241	1,349
Trade-off Analyses	1,237	1,063	1,155
Economic and Environmental Analyses	825	709	770
Surveys or Reviews of Technical Operations	1,925	1,655	1,798
Total, Technical Support	12,168	10,459	11,362
Management Support			
Analyses of Workload and Work Flow	756	649	706
Directives/Management Studies	344	295	321
Automated Data Processing	11,687	10,044	10,914
NETL Reimbursable Overhead Services	6,673	5,735	6,232
Preparation of Program Plans	482	414	450
Training and Education	1,103	948	1,030
Analyses of DOE Management Processes	413	355	386
Reports and Analyses, Mgt & Gen Admin Services	4,603	3,956	4,299
Total, Management Support	26,061	22,396	24,338
Total, Support Services	38,229	32,855	35,700

Other Related Expenses by Category

	(dollars in thousands)		
	FY 2009	FY 2010	FY 2011
Other Related Expenses			
Rent to GSA	1,554	1,414	1,522
Rent to Others	0	0	0
Communications, Utilities, Miscellaneous	874	795	855
Printing and Reproduction	575	522	563
Other Services	548	499	537
Purchases from Govt Accounts	408	371	399
Operation and Maintenance of Equipment	573	521	561
Supplies and Materials	3,019	2,745	2,956
Equipment	517	470	506
Working Capital Fund	12,748	11,592	13,976
Total, Other Related Expenses	20,816	18,929	21,875

Annual Performance Targets and Results

Secretarial Goal: Goal 1: Innovation: Lead the world in science, technology, and engineering
Goal 2: Energy: Build a competitive, low-carbon economy and secure America's energy future
GPRA Unit Program Goal: Program Direction
Subprogram: Program Direction

FY 2006	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
Performance Measure: Complete pilot test of the EERE Operational Efficiency Index[a]									
T: NA A: NA	T: NA A: NA	T: NA A: NA	T: NA A: NA	T: NA A: NA	T: BASELINE A:	T: A:	T: A:	T: A:	T: A:
Performance Measure: FY 2006: 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. FY 2007: 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. FY 2008: Maintain administrative costs as a percent of total program costs less than 12 percent. FY 2009: Maintain administration costs at less than 12 percent of total program costs FY 2010: Maintain administration costs at less than 12 percent of total program costs									
T: 12% A: 9.6%	T: 12% A: 7.8%	T: 12% A: 6.6%	T: 12% A: 6.8	T: 12% A:	T: RETIRED A: NA	T: NA A: NA	T: NA A: NA	T: NA A: NA	T: NA A: NA

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[a] EERE will complete a one year pilot of the new Operational Efficiency Measure. This new measure is an index which aggregates information from EERE management activities to produce a baseline score. Once a baseline is determined from a full year of pilot testing, future performance targets will be created. Description of the methodology and further details will be posted on the web by October 1, 2010 in preparation for pilot testing.

Program Support
Funding Profile by Subprogram

(dollars in thousands)

	FY 2009 Current Appropriation	FY 2009 Current Recovery Act Appropriation	FY 2010 Current Appropriation	FY 2011 Request
Program Support				
Planning, Analysis and Evaluation	10,078	0	11,000	12,094
Technology Advancement and Outreach	8,079	0	11,000	13,000
Strategic Priorities and Impact Analysis	0	21,890	6,000	27,000
Commercialization	0	0	7,000	10,213
International	0	0	10,000	25,000
Total, Program Support	18,157	21,890	45,000	87,307

Public Law Authorizations:

P.L. 95-91, “Department of Energy Organization Act” (1977)
P.L. 109-58, “Energy Policy Act of 2005”
P.L. 110-140, “Energy Independence and Security Act of 2007”

Mission

The mission of the Program Support function is to enable the Office of Energy Efficiency and Renewable Energy (EERE) to effectively and efficiently achieve program goals (efficient energy use, increased energy diversity and security, and greenhouse gas (GHG) reductions through technological advances) while supporting DOE’s programs as they fulfill Presidential and Congressional mandates and objectives. This is done by providing both forward looking and current, integrated information and multidisciplinary analysis to inform decisions for portfolio choices, levels of investment and increased market adoption of innovative EERE based processes, individual technologies, and energy systems that will result in large scale national adoption at a significantly accelerated pace.

Benefits

The Program Support function advances Presidential and Congressional objectives in clean and secure energy, economic prosperity, GHG mitigation, and science and discovery. EERE implements a diverse portfolio of programs with a significant array of distinct purposes and requirements. Providing decision-makers, the private sector and the public with quality integrated independent analysis informs strategic investment and supports portfolio investments that allow EERE to effectively partner and leverage to achieve goals and meet external requirements at the scale and pace needed to achieve Presidential and Congressional energy related goals. Program Support activities provide best-in-class, strategic, performance-based management processes, outreach and products. These processes and products allow both internal and external EERE stakeholders to maintain awareness of, and make informed decisions based on, analysis and information about issues affecting EERE goals, operations, planning and program progress. EERE will continue to coordinate, consolidate and fund corporate-level activities via this line item to improve their integration, functionality, productivity, management, and transparency.

Planning, Analysis and Evaluation
Funding Schedule by Activity

	(dollars in thousands)		
	FY 2009	FY 2010	FY 2011
Planning, Analysis and Evaluation	10,078	11,000	12,094
Total, Planning, Analysis and Evaluation	10,078	11,000	12,094

Description

Planning, Analysis, and Evaluation (PAE) provides DOE and EERE senior and program management with timely, high quality, and program independent analyses that is guided, managed and integrated to inform portfolio, 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), legislation and other departmental and external Administration authorities that demand coordination or integration. PAE develops corporate approaches, capacity and technical resources for planning, analysis, and evaluation that inform and improve the EERE portfolio and enable effective collaboration and implementation of strategic management at the Federal and Departmental level (e.g. EPA, HUD, CFO, PI, and SC) which enables EERE to most productively advance DOE’s goals.

Benefits

PAE supports science, discovery, innovation and clean energy by providing credible, reliable and independent insight and feedback necessary to develop, direct, defend and manage EERE’s budget portfolio to those goals at all decision making levels. PAE, in concert with the Strategic Priorities and Impact Analysis (SPIA) and the Commercialization subprograms, plans, 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 and management, and funds activities that provide technical, economic, and policy analyses and support for strategic and multi-year planning, performance and budget integration, GPRA benefit estimation, and scenario analysis for all DOE Energy Efficiency (EE) and Renewable Energy (RE) programs. 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.

Detailed Justification

	(dollars in thousands)		
	FY 2009	FY 2010	FY 2011
Planning, Analysis and Evaluation	**10,078**	**11,000**	**12,094**

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 analyses. A key component of PAE's efforts is to work with the programs to develop multi-year plans linking DOE's Strategic Plan to a program's performance management, Joule and activity targets. PAE's planning and analysis activities seek to improve the understanding, methodology, treatment, representation and application of benefits, risk, and uncertainty, and to help advance Planning Budget-Performance Integration.

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 continuing to work 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 investments 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, answer senior management questions, better account for technical risk and uncertainty, and 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	**10,078**	**11,000**	**12,094**

Explanation of Funding Changes

	FY 2011 vs. FY 2010 ($000)
Planning, Analysis and Evaluation	
Increase will be used to expand and more effectively integrate program analysis into decision making processes to ensure more informed decisions based on increased program evaluation, economic analyses and strategic planning.	+1,094
Total Funding Change, Planning, Analysis and Evaluation	**+1,094**

Technology Advancement and Outreach
Funding Schedule by Activity

(dollars in thousands)

	FY 2009	FY 2010	FY 2011
Technology Advancement and Outreach	8,079	11,000	13,000
Total, Technology Advancement and Outreach	8,079	11,000	13,000

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 corporate and programmatic product development technical assistance contributes both to the EERE programs' deployment goals and to E-government initiatives to make government more transparent and accessible to the public.

Benefits

TAO provides strategic communications and outreach support for EERE's scientific and technology achievements. TAO manages and creates public engagement tools and products that keep 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. By educating the public about clean energy TAO helps raise awareness, overcome technology barriers, and speed adoption of new technologies. 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 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 provides timely and relevant information to help 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.

Detailed Justification

	(dollars in thousands)		
	FY 2009	FY 2010	FY 2011
Technology Advancement and Outreach	**8,079**	**11,000**	**13,000**

TAO will manage and continually update the EERE website and expand mechanisms for electronic outreach. In the ever-changing world of web-based communications, TAO will work to deploy the latest effective approaches to proactively promote energy efficiency and renewable energy. This effort will require new technology methods and ongoing upgrades of content and server technology. EERE may coordinate parts of its outreach efforts with other government agencies, such as NSF, and share assets and tools as appropriate to promote energy efficiency and renewable energy.

TAO maintains a catalogue of all EERE information products, including publications, CDs, and analytic tools, and makes that information available online. 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 online to educate consumers in the use of these technologies.

TAO will support the dissemination of information on energy efficiency and renewable energy technologies, by seeking additional partnerships with corporations, trade associations, other government agencies and NGOs to promote EERE technologies and leverage resources to deploy those technologies.

TAO supports public information efforts focused on improving awareness of energy efficiency. TAO will seek out high-impact events and opportunities to educate the general public on renewable energy and efficiency technologies, both online and in person. By engaging the public through exhibitions, community associations, and stakeholder events, TAO will help to foster an energy literate population through such mechanisms as streaming video, and user friendly capabilities.

TAO operates the EERE Information Center, a “one-stop,” centralized information center that provides information to the general public and other stakeholders through web-based and toll-free telephone services. The Information Center currently handles approximately 27,000 phone inquiries annually, and mails and distributes more than 370,000 publications per year. With continued demand growth for these services, TAO will continue to produce and disseminate documents in both English and Spanish to educate homeowners on energy savings techniques and technologies.

Total, Technology Advancement and Outreach	**8,079**	**11,000**	**13,000**

Explanation of Funding Changes

	FY 2011 vs. FY 2010 ($000)
Technology Advancement and Outreach	
Additional funding will improve web-integration, upgrade equipment, and correspondence, information dissemination, and public outreach capabilities to keep up with the rising interest in energy efficiency and renewable energy technologies and deployment activities.	+2,000
Total Funding Change, Technology Advancement and Outreach	**+2,000**

Strategic Priorities and Impact Analysis
Funding Schedule by Activity

	(dollars in thousands)		
	FY 2009	FY 2010	FY 2011
Strategic Priorities and Impact Analysis	0	6,000	27,000
Total, Strategic Priorities and Impact Analysis	0	6,000	27,000

Description

FY 2011 funding will support existing and new priority cross-cutting analysis tasks, promote innovative strategies for market adoption, and demonstrate the benefits of integrated application of clean energy technologies and policies to maximize energy savings and GHG emission reductions. The subprogram distils key conclusions from analysis on clean energy technologies, provides quality control, and meets emerging Administration analytical priorities. Following DOE-wide direction, these activities draw input and expertise from the National Laboratories, EERE programs, and other quality independent sources and refine the material into integrated products that complement technology-specific analyses completed by EERE programs. The results of the work are communicated to DOE and EERE management to guide decisions, to the EERE programs to directly inform technology decision-makers, and to external stakeholders to enable them to advance DOE's strategic priorities. Technical staff coordinates regularly with relevant EERE programs. Efforts are carried out consistent with an office-wide methodology and are coordinated with the EERE Planning, Analysis, and Evaluation group, the Department's Office of Policy and International, Office of Science, Chief Financial Office, and the National Laboratories.

Benefits

The Strategic Priorities and Impact Analysis (SPIA) subprogram conducts analyses to provide a clear picture of how the sum of EERE's parts, practices and policies can contribute to solutions as a whole. Analytical products inform development of pathways to meeting the Nation's clean energy and GHG reduction goals and technology deployment at a scale never before achieved. This subprogram enables better understanding of how science and technology supported by EERE can drive economic recovery and growth, improve energy security, and reduce harmful emissions. Work is conducted at a cross-cutting level by analyzing the work of all EERE programs within an integrated, credible and independent forum. This approach directly applies to solving the problems identified in EERE's core mission goals: climate, sustainability, energy security, and economic prosperity. A variety of independent, analytical products are developed each year to address these highly interrelated issues, which inform the alternative pathways to achieve the national and international potential of all EERE's RDD&D projects. The nature of the energy challenges facing the U.S. requires close DOE and SPIA collaboration with programs across the Federal, State, local, and international governments and with academia, industry, and NGOs. The same foundation of unbiased, quality information created and used by EERE to make decisions is made available to external stakeholders to inform policy decisions at all levels of government, as well as to facilitate private investment to promote the rapid adoption of clean energy technologies in the marketplace.

Detailed Justification

	(dollars in thousands)		
	FY 2009	FY 2010	FY 2011
Strategic Priorities and Impact Analysis	**0**	**6,000**	**27,000**

Strategic Priorities and Impact Analysis activities include but are not limited to the following areas:

Climate and carbon analysis supports DOE and EERE analysis in understanding the interactions between carbon mitigation objectives and EE and RE technologies, as well as provides technical support. A more informed analytic basis for impacts of EERE technologies relative to their contribution to climate mitigation strategies at the national level informs DOE's approach to evaluating near and longer term objectives for low carbon initiatives that may incorporate multiple EERE technologies. Activities use existing tools to conduct assessment of the carbon mitigation potential of EE and RE technologies under alternative policy scenarios to support the global climate change dialogue, including scenario analysis with integrated assessment models. Analysis is coordinated with DOE to address the impact of proposed climate change policies and legislation on the RD&D and commercialization of RE and EE technologies, including understanding the interaction of carbon-specific instruments with existing incentives. The climate change analytic activities and technical support for FY 2011 will expand upon the efforts of FY 2010 to reflect the requirements of proposed U.S. legislation and increased international engagement.

Market and financial analyses improve the understanding of implications of supporting markets, industries, and critical materials for EE and RE technology deployment. Market analysis addresses up-to-date market data relevant to EERE's technologies and makes this information available to DOE and EERE senior management for use in speeches, testimony, briefings and presentations. Work includes analysis of EE and RE technology financing structures, assessment of project financing tools and assumptions, identification of supply chain bottlenecks, and implementation of a renewable financing web portal. A systematic methodology, data and tools for analyzing target market conditions and developing near-term technology deployment projections for EE and RE technologies is 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 is compiled and easily accessible.

Energy policy analysis analyzes and reports on EE and RE policy and legislative proposals. 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 to characterize the associated outcome. This task area continues to develop new and strengthen existing models to support near term policy analyses. This area also includes developing an understanding of the implementation and impacts of R&D based tax credits.

Energy systems analysis provides understanding of the decision process and basic motivations of various energy market participants to broaden the characterization of EE and RE technologies and markets within energy models beyond technology cost and performance. Analytic products, tools, and methodologies to support EERE's integrated approach to energy systems will continue to be refined 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. In order to enable widespread deployment of renewable electricity, efficiency, and transportation technologies, this task includes analysis of different options for surmounting known barriers to the development of physical infrastructure and consideration of different concepts of the Federal role and regulatory regimes with respect to energy related infrastructure.

Data and analysis foundation and dissemination focuses on strengthening the value of EERE's cross-cutting 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 developing peer-reviewed data 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 The approach is based on best practices from all industry and laboratory sources. For major analysis products, 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.

Leveraging its analytical and strategic planning expertise, the subprogram will support Departmental efforts to help emerging economies develop a portfolio of clean energy technologies and establish a low-carbon growth plan. This initiative is integral to positioning the U.S. as a global leader in the development and deployment of clean energy technologies needed for a sustainable energy economy.

The effort will have a special focus on a systems approach for electrification that is clean, efficient, secure, reliable and resilient. DOE will develop portfolio planning and analytical tools that help emerging economies plan for expanded electrification and introduce clean energy technologies into growing markets. These plans will provide opportunities for U.S based companies to offer the goods and services needed by emerging economies to meet their clean energy needs. DOE experience with technology adoption in emerging economies indicates that successful efforts come from technical assistance and the provision of tools built from DOE and National Laboratory expertise. DOE will also leverage academic expertise by supporting university partnerships and virtual centers of excellence for clean energy technology RD&D, commercialization, and policy development. Prior examples include the Low-Carbon Communities of the Americas Initiative, announced by Secretary Chu in June, 2009.

Specific efforts will include: completing state of the art resource assessment, including inventories of population, grid, and buildings; engaging with international "community of practice" to complete comprehensive technical characterization of technology options and pathways; engaging and helping build systems analysis capabilities using global best practices; engaging and building expertise in efficiency, renewable energy, clean energy markets, financing and policy through expert exchanges; and providing key technical assistance and access to financial information to help spur project development. The subprogram will use existing partnerships and organizations, such as the International Partnership for Energy Efficiency Cooperation and the International Energy Agency, as much as possible to leverage existing expertise.

	FY 2009	FY 2010	FY 2011
Total, Strategic Priorities and Impact Analysis	**0**	**6,000**	**27,000**

Explanation of Funding Changes

	FY 2011 vs. FY 2010 ($000)
Strategic Priorities and Impact Analysis	
The increase supports Presidential and Secretary priorities and ensures that decision-making necessary to meet those priorities is thoroughly informed by unbiased analysis. The increased focus on EE and RE technologies as a solution to climate change requires a proportionate increase in analytical preparation. Cross-cutting projects previously supported by all EERE programs are incorporated within this subprogram, providing enhanced coordination and value. The increase also incorporates the Low-carbon Energy Systems project, directly leveraging EERE and SPIA's analytical expertise to help meet climate goals set out at Copenhagen.	+21,000
Total Funding Change, Strategic Priorities and Impact Analysis	**+21,000**

Commercialization
Funding Schedule by Activity

(dollars in thousands)

	FY 2009	FY 2010	FY 2011
Commercialization	0	7,000	10,213
Total, Commercialization	0	7,000	10,213

Description

The mission of the Commercialization subprogram is to increase the speed and scale of the market penetration by EE and RE technologies borne out of EERE's investments in its National Laboratories. This funding will support new and existing priority corporate needs that were previously supported through multi-program collaborations. The consolidation at the corporate level enhances overall efficacy and more readily enables economies of scale and scope to enhance the return on research investment in promising clean energy technologies.

Benefits

The Commercialization subprogram is working to bring the benefits of taxpayers' investment in R&D, particularly from National Laboratories to the market. 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. This activity will accelerate public benefit of EERE-funded intellectual property and realize public value for the American taxpayer investment. Involving the large scale private sector investment bridges gaps which speeds and broadens the application of the EERE portfolio.

The subprogram focuses on the gap between the time and money needed to go from the initial technology invention to product market penetration i.e. "the valley of death." This time lag and revenue need impedes commercialization of many EERE energy technology and system innovations. Commercialization activities develop and manage initiatives to 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 and new jobs. These activities serve 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 in their direct commercialization activities. Through this linkage, work on commercialization provides an enhanced opportunity for all EERE technologies to address DOE's strategic priorities. Movement from RD&D to commercialization makes the realization of technology benefits possible.

Detailed Justification

	(dollars in thousands)		
	FY 2009	FY 2010	FY 2011
Commercialization	**0**	**7,000**	**10,213**

Commercialization entails both accelerating National Laboratory technologies into the marketplace as well as growing American markets generally for efficiency and renewable technologies. The individual initiatives seek to increase the flow through the product pipeline to the market by enhancing the awareness of market relevance earlier in the Laboratory development process. Commercialization thus enhances both market the supply side and the demand side of high-impact innovation. All efforts carry the added benefits of maximizing energy savings, reducing carbon emissions, and enhancing national security through the primary focus of interfacing with the capital markets.

Commercialization will create substantive links that create measurable economic value among the scientific and financial communities. Several initiatives are designed to specially draw out individual technologies from the National Laboratories, including: Entrepreneur in Residence (EIR), Technology Commercialization Showcase (TCS), and the Technology Commercialization Fund (TCF).

EIR allows individual venture capital firms to competitively bid for a one year slot at one of the National Laboratories selected by the Secretary. Each firm is given one year to mine the technology available for licensing in that Laboratory, with firm constraints driven by existing CRADAs, Federal work, and Homeland Security access restrictions. The firms then name an individual to spend one year at the Laboratory to identify promising technologies for market readiness and build the associated business case.

TCS, held at least annually at DOE headquarters in Washington, D.C., asks representatives from across EERE Programs and National Laboratory Technology Transfer Offices to present to a broad and diverse representation of the financial community for their technologies that may have market interest.

TCF funds are competitively awarded to National Laboratory Technology Transfer Offices in order to forge cost-sharing relationships to mature individual technologies. The TCF poises DOE as the limited partner of a venture capital firm. TCF is competitively awarded to National Laboratory Technology Transfer Offices with the express purpose to undergo a stage-gated process to select technologies for licensing with a 50/50 cost-share with industry. The TCF will enable the launch of an estimated 10 new commercial licenses by 2012.

Commercialization activities will also leverage resources already dedicated in National Laboratories and within EERE programs’ industry partners to lay out pathways for market launch and growth. This will entail writing technology summaries and business plans, evaluating technologies for stage-gate review, and connecting manufacturers with private capital and National Laboratory resources. In addition, a pilot program will be initiated to incentivize National Laboratories to secure more licensing agreements with industry. Metrics to demonstrate results and additional capital leveraged such as the number of licenses granted will be established, monitored, and reported.

Total, Commercialization	**0**	**7,000**	**10,213**

Explanation of Funding Changes

	FY 2011 vs. FY 2010 ($000)
Commercialization	
The FY 2011 increase in Commercialization funding will expand FY 2010 activities consistent with Administration priorities. The focus will be on necessary improvements and upgrades to the National Laboratory technology portal, increasing the usefulness and relevance for government and external stakeholders.	+3,213
Total Funding Change, Commercialization	**+3,213**

International

Funding Schedule by Activity

	(dollars in thousands)		
	FY 2009	FY 2010	FY 2011
International	0	10,000	25,000
Total, International	0	10,000	25,000

Description

The International subprogram coordinates a variety of international initiatives, partnerships, and events that promote greater understanding and utilization of renewable energy (RE) and energy efficiency (EE) technologies worldwide. The goals of the International subprogram are to advance EERE's mission globally by promoting U.S. energy security, economic goals and work against global climate change; to accelerate clean energy innovation and cost reductions; and to transformer and EE markets in key developing countries. Making use of public-private partnerships wherever possible, EERE aims to advance these goals through cooperative RD&D, market transformation, and assessments of global clean energy potential. EERE implements these activities through cooperative agreements (such as MOUs) with other countries on bi- and multi- lateral bases, and through partnerships with key international institutions. The subprogram leverages DOE's technical expertise, activities, and relationships to make a significant and sustainable impact in addressing climate change, enhancing U.S. energy security and economic vitality, and building product infrastructure knowledge necessary for the domestic economy.

The subprogram also addresses climate change through three approaches:

- Leveraging U.S. investments through bilateral and multilateral R&D partnerships to accelerate RE and EE technology innovation;
- Assisting key countries (China, India, Brazil and regional efforts) in strengthening policies, standards and programs that lay the groundwork for accelerated deployment of RE and EE technologies; and
- 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), 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.

In close coordination with the DOE Office of Policy and International Affairs (PI), EERE will continue to partner with other DOE offices, other U.S. agencies, and the private sector to implement market transformation partnerships, R&D partnerships, and to conduct analyses relating to RE and EE potential, costs, and lifecycle emissions.

Benefits

EERE's International Subprogram seeks to achieve three objectives:

- Advance U.S. global climate change, energy security and economic goals: A primary driver for international clean energy cooperation is to accelerate reductions in global GHG emissions and effectively engage developing countries in meaningful climate change programs in support of the UNFCCC. Partnerships with developing countries advance deployment of clean energy technologies and achieve substantial, measurable environmental impacts on GHG emissions and related sustainability factors. Commercialization of these technologies leads to diversification of U.S. energy supplies, thereby improving energy security. Providing access to clean energy in the developing world enhances local and regional stability through improved living standards. 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.[a]
- Accelerate clean energy innovation and cost reductions: Through partnerships with other countries at the cutting edge of clean energy R&D, EERE will leverage DOE resources to accelerate development and cost reductions for EE and RE technologies. These partnerships can serve as a force multiplier in more rapidly achieving EERE's RD&D technical and cost goals.
- 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.

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[a] "Strengthening U.S. Leadership of International Clean Energy Cooperation: Proceedings of Stakeholder Consultations." NREL. Report Number: NREL/TP-6A0-44261. December 2008:   http://www.nrel.gov/docs/fy09osti/44261.pdf

Detailed Justification

(dollars in thousands)

	FY 2009	FY 2010	FY 2011
International	**0**	**10,000**	**25,000**

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; implement demonstration and deployment projects; and attract investment and business partnerships. EERE will also play a lead role in key multilateral initiatives to accelerate market penetration of EE and RE technologies, such as the Major Economies Forum, the Energy and Climate Partnership of the Americas, and the International Partnership for Energy Efficiency Cooperation. EERE may also support regional programs to advance EE and RE use in Africa, the Middle East, and the newly independent states such as those of the former Soviet Union 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 will also work to expand efforts to deploy clean energy technologies on islands through the Energy Development in Island Nations initiative.

Research, Development, and Demonstration Cooperation: EERE will continue partnering with other countries that play a lead role in RD&D of advanced EE and RE technologies and systems to leverage resources and expertise to accelerate the progress of R&D. This will include multilateral cooperation through the International Energy Agency and other bodies and bilateral partnerships with key Organization for Economic Cooperation and Development countries, Israel, and major emerging economies (e.g. China, India, Brazil). Cooperation will focus on non-competitive topics where international partnerships can serve as force multipliers to more rapidly achieve EERE's technology RD&D goals.

Specific examples of EERE bilateral relationships include:

- China: Work conducted under the Strategic and Economic Dialogue (S&ED), the Energy Efficiency Action Plan, and the U.S.-China Renewable Energy Partnership includes cooperation on building and industrial efficiency, electric vehicles, biofuels, wind, and solar energy, as well as joint R&D through the U.S.-China Clean Energy Research Center;
- Brazil: Focuses on the development of advanced biofuel technologies and methodologies for conducting economic and sustainability analyses and new cooperation on energy efficiency and renewable energy;
- India: Collaboration through the U.S.-India Energy Dialogue as well as through the new Indo-U.S. Clean Energy Research and Deployment Initiative (CERDI)
- Canada: Cooperation continues through the U.S.-Canada Clean Energy Dialogue; work includes collaboration on energy efficiency, biomass, and clean vehicles R&D; and
- Israel: Collaborative research includes solar energy, electric vehicle and plug-in electric vehicle battery technologies, and biofuel production and use.
- Russia: Activities in support of the MOU between the DOE and the Russian Ministry of Energy.

(dollars in thousands)

	FY 2009	FY 2010	FY 2011

Global Energy Assessment. On a strategic basis, EERE will continue 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 are conducted in partnership with the Intergovernmental Panel on Climate Change, the IEA, U.N. Agencies, and other countries. EERE will also continue to support broad use of EE and RE energy analysis and decision tools that can inform government and industry policy and investment decisions. The subprogram also supports the application of these tools to support design and implementation of low carbon clean energy growth strategies in developing countries.

Total, International	**0**	**10,000**	**25,000**

Explanation of Funding Changes

International	FY 2011 vs. FY 2010 ($000)
Increased funding will support new Presidential and Secretarial initiatives focused on global technology deployment and climate change mitigation. Examples of new activities include the China and India Clean Energy Research Centers and programs launched under the Major Economies Forum (MEF). In addition, expanded funding will provide EERE with resources to support increased activity through a variety of regional partnerships, such as the Asia-Pacific Economic Cooperation (APEC), the Energy and Climate Partnership of the Americas (ECPA), Energy Development in Island Nations (EDIN), and a regional energy platform for Africa. Additional funding will support a greatly increased level of effort under bilateral partnerships with countries such as China, India, Russia, Brazil, Canada, and Argentina that will continue to advance EE and RE technology RDD&D throughout the world.	+15,000
Total Funding Change, International	**+15,000**

Congressionally Directed Projects

Funding Profile by Subprogram

(dollars in thousands)

	FY 2009	FY 2010	FY 2011
Congressionally Directed Projects	228,803	292,135	0

Description

The Energy and Water Development and Related Agencies Appropriation Act, 2010 included 295 congressionally directed projects 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 2009	FY 2010	FY 2011
Congressionally Directed Projects			
▪ 21st Century Renewable Fuels, Energy, and Materials Initiative (MI)	0	1,250	0
▪ A123 Systems Large Format Nanophosphate Batteries for Solar Energy Storage (MI)	0	1,000	0
▪ Alternate Fuel Cell Membranes for Energy Independence at the University of Southern Mississippi (MS)	952	0	0
▪ Adaptive Liquid Crystal Windows (OH)	952	0	0
▪ Advanced Automotive Fuels Research, Development, & Commercialization Cluster (OH)	0	1,000	0
▪ Advanced Battery Manufacturing (VA)	0	200	0
▪ Advanced Engineered Rapidly Deployable Manufacturing Methods and Materials for Environmentally Benign and Energy Efficient Housing (VA)	476	0	0
▪ Advanced Power Batteries for Renewable Energy Applications (PA)	351	0	0
▪ Advanced Power Cube for Wind Power and Grid Regulation Services (PA)	0	500	0
▪ Agri-business Energy Independence Demonstration (NY)	0	80	0
▪ Alabama Institute for Deaf and Blind Biodiesel Project Green (AL)	0	300	0
▪ Algae Biofuels Research (WA)	0	2,000	0
▪ Algae to Ethanol Research and Evaluation (NJ)	0	750	0
▪ Algal-based Renewable Energy for Nevada (NV)	714	800	0
▪ Alternative and Unconventional Energy Research and Development	0	10,000	0

(dollars in thousands)

	FY 2009	FY 2010	FY 2011
(UT)			
▪ Alternative Crops and Biofuels Production (OK)	285	0	0
▪ Alternative Energies Workforce Applications Education and Training Program (OH)	952	0	0
▪ Alternative Energy Engineering Technology (VA)	95	0	0
▪ Alternative Energy for Higher Education (NE)	1,142	0	0
▪ Alternative Energy School of the Future (NV)	1,189	1,200	0
▪ Alternative Energy Training Institute (CA)	0	500	0
▪ Alternative Fuel Bus Project, Schaghticoke, NY (NY)	0	300	0
▪ Anaerobic Digester and Combined Heat Power Project (MO)	571	0	0
▪ Anchorage Regional Landfill (AK)	714	0	0
▪ Ann Arbor Wind Generator for Water Treatment Plant (MI)	952	0	0
▪ Anti-idling Lithium Ion Battery Program (CA)	952	0	0
▪ Atlanta International Terminal LEED Certification (GA)	476	0	0
▪ Auburn University Bioenergy and Bioproducts Laboratory (NY)	951	0	0
▪ Auburn University, Biomass to Liquid Fuels and Electric Power Research (AL)	0	1,500	0
▪ Bayview Gas to Energy Project (UT)	0	1,000	0
▪ Ben Franklin Technology Partners - Clean Technology Commercialization Initiative (PA)	951	500	0
▪ Bexar County Solar Collection Farm and Distribution System (TX)	476	1,000	0
▪ Bio Energy Initiative for Connecticut (CT)	0	1,500	0
▪ Biodiesel Blending (WI)	0	600	0
▪ Bio-diesel Cellulosic Ethanol Research Facility (FL)	951	0	0
▪ Biodiesel Feedstock Development Initiative (MO)	0	1,000	0
▪ Biodiesel Production from Grease Waste (CA)	0	250	0
▪ Bioeconomy Initiative at MBI International (MI)	476	0	0
▪ Bioenergy Demonstration Project: Value-Added Products from Renewable Fuels (NE)	1,903	0	0
▪ Bioenergy/Bionanotechnology Projects (LA)	0	500	0
▪ Biofuel Micro-refineries for Local Sustainability (TN)	0	500	0
▪ Biofuels Campus for Accelerated Development (NC)	0	500	0
▪ Biofuels Development at Texas A&M (TX)	951	0	0
▪ Biofuels Research and Development Infrastructure (WA)	476	0	0
▪ Biofuels Research Laboratory (KT)	0	1,000	0
▪ Biofuels, Biopower and Biomaterials Initiative (GA)	0	1,250	0
▪ Biogas Center of Excellence (MI)	951	0	0
▪ Biomass Energy Generation Project (IA)	285	0	0
▪ Biomass Energy Resources Center (VT)	1,427	1,000	0
▪ Biomass Fuel Cell Systems (CO)	1,665	0	0

(dollars in thousands)

	FY 2009	FY 2010	FY 2011
▪ Biomass Gasification Research and Development Project (WA)	951	0	0
▪ Bioprocesses Research and Development, Michigan Biotechnology Institute, Lansing, MI (MI)	0	500	0
▪ Biorefinery Demonstration Project, UGA, Athens (GA)	1,189	0	0
▪ Biorefinery for Ethanol, Chemicals, Animal Feed and Biomaterials from Sugarcane Bagasse (LA)	951	0	0
▪ Biorefining for Energy Security Project, OU-Lancaster (OH)	951	0	0
▪ Black Hills State Heating and Cooling Plant (SD)	0	1,000	0
▪ Boulder SmartGridCity - Plug-In Electric Hybrid Vehicles (CO)	0	500	0
▪ Bridge Hydro-Turbine Study (OR)	0	150	0
▪ Brookston Wind Turbines Study, Brookston, IN (IN)	0	75	0
▪ California Polytechnic State University Center for Renewable Energy and Alternative Electric Transportation Technologies Equipment Acquisition (CA)	0	250	0
▪ Carbon Neutral Green Campus (NV)	381	0	0
▪ Cayuga County Regional Digester Facility (NY)	476	0	0
▪ Cellulosic Diesel Biorefinery (NJ)	0	1,000	0
▪ Center for Applied Alternative Energy, Sustainable & Practices (FL)	0	500	0
▪ Center for Biomass Utilization (ND)	2,000	7,000	0
▪ Center for Clean Fuels and Power Generation at the University of Houston (TX)	476	0	0
▪ Center for Efficiency in Sustainable Energy Systems (OH)	1,903	0	0
▪ Center for Energy Storage Research (TX)	0	1,000	0
▪ Center for Environmental and Energy Research (NY)	0	250	0
▪ Center for International Intelligent Transportation Research (TX)	523	0	0
▪ Center for Nanoscale Energy (ND)	4,757	5,000	0
▪ Center for Ocean Renewable Energy (NH)	0	750	0
▪ Center for Renewable Energy, Science and Technology (TX)	1,403	0	0
▪ Center of Excellence in Ocean Energy Research and Development, Florida Atlantic University (FL)	1,189	0	0
▪ Central Corridor Energy District Integration Study (MN)	0	500	0
▪ Central Piedmont Community College (NC)	0	525	0
▪ Central Vermont Recovered Biomass Facility (VT)	951	500	0
▪ Chariton Valley Densification - Phase II (IA)	951	0	0
▪ Christmas Valley Renewable Energy Development (OR)	381	410	0
▪ City Hall Leadership in Energy and Environmental Design (LEED) Certification (FL)	0	500	0
▪ City of Boise Geothermal Expansion to Boise State University (ID)	1,427	1,000	0
▪ City of Grand Rapids Solar Roof Demonstration Project (MI)	142	250	0
▪ City of Las Vegas Plug-In Hybrid Vehicle Demonstration Program	142	0	0

(dollars in thousands)

	FY 2009	FY 2010	FY 2011
(NV)			
▪ City of Louisville Energy Conservation Initiative (KY)	142	0	0
▪ City of Markham Community Center (IL)	238	0	0
▪ City of Miami Green Initiative (FL)	951	0	0
▪ City of Norco Waste-to-Energy Facility (CA)	0	750	0
▪ City of Oakdale Energy Efficiency Upgrades (MN)	0	400	0
▪ City of Redlands Facilities Upgrades to Improve Energy Efficiency (CA)	0	900	0
▪ City of Tallahassee Innovative Energy Initiatives (FL)	571	250	0
▪ City of Winter Garden Weatherization Demonstration Project (FL)	0	200	0
▪ Clean and Efficient Diesel Engine (PA)	1,189	0	0
▪ Clean Power Energy Research Consortium (CPERC) (LA)	1,903	1,000	0
▪ Clean Technology Evaluation Program (MA)	476	0	0
▪ Clemson University Cellulosic Biofuel Pilot Plant (SC)	476	1,000	0
▪ Clemson University Cellulosic Biofuel Pilot Plant in Charleston (SC)	951	0	0
▪ Closed Loop Woody Biomass Project (NY)	476	0	0
▪ Cloud County Community College Renewable Energy Center of Excellence (KS)	0	750	0
▪ Coastal Ohio Wind Project: Removing Barriers to Great Lakes Offshore Wind Energy Development (OH)	952	1,000	0
▪ Columbia Gorge Community College Wind Energy Workforce Training Nacelle (OR)	238	0	0
▪ Commercial Building Energy Efficiency Demonstration (IL)	0	500	0
▪ Comprehensive Wind Energy Program, Purdue University-Calumet, IN (IN)	0	500	0
▪ Compressed Natural Gas Fueling Facility (MO)	0	700	0
▪ Concentrator Photovoltaic Technology (AZ)	0	900	0
▪ Consolidated Alternative Fuels Research (OK)	0	250	0
▪ Consortium for Plant Biotechnology Research (Multiple States)	3,806	3,000	0
▪ Controlled Environmental Agriculture and Energy Project (NY)	476	200	0
▪ Cooling, Heating and Power (Micro-CHP) and Bio-fuel Application Center (MS)	1,903	2,000	0
▪ Creighton University Training & Research in Solar Power (NE)	0	1,200	0
▪ Daemen College Alternative Energy/Geothermal Technologies Demonstration Program, Erie County, NY (NY)	0	950	0
▪ Dedham Municipal Solar Project (MA)	0	500	0
▪ Demonstration Plant for Biodiesel Fuels from Low-impact Crops (IL)	0	500	0
▪ Design and Implementation of Geothermal Energy Systems at West Chester University (PA)	0	300	0

(dollars in thousands)

	FY 2009	FY 2010	FY 2011
▪ Developing New Alternative Energy in Virginia: Bio-diesel from Algae (VA)	714	0	0
▪ Development of an Economic and Efficient Biodiesel Production Process (NC)	0	750	0
▪ Development of Biofuels (NV)	1,024	0	0
▪ Development of Biofuels Using Ionic Transfer Membranes (NV)	0	1,500	0
▪ Development of High Yield Feedstock and Biomass Conversion Technology for Development of High Yield Tropical Feedstocks and Biomass Conversion (HI)	0	6,000	0
▪ Development of High Yield Feedstock and Biomass Conversion Technology for Renewable Energy Production and Economic Development (HI)	1,427	0	0
▪ Development of Pollution Prevention Technologies (NY)	0	900	0
▪ Downtown Detroit Energy Efficiency Street Lighting (MI)	951	0	0
▪ DRI Renewable Energy Center (REC) (NV)	476	500	0
▪ Dueco Plug-in Hybrid Engines (WI)	1,903	0	0
▪ East Kentucky Bioenergy Capacity Assessment Project (KY)	0	250	0
▪ Eastern Illinois University Biomass Plant (IL)	0	1,000	0
▪ Ecologically Sustainable Campus-New England College (NH)	300	0	0
▪ Energy Audit, Efficiency Improvements, and Renewable Energy Installations, Township of Branchburg, NJ (NJ)	0	1,000	0
▪ Energy Conservation and Efficiency Upgrade of HVAC Controls (NY)	0	500	0
▪ Energy Conservation Upgrades, Ingham Regional Medical Center, Lansing, MI (MI)	0	250	0
▪ Energy Efficiency Enhancements (AL)	0	250	0
▪ Energy Efficiency Repairs and Air Quality Improvements at Lyonsdale Biomass (NY)	0	500	0
▪ Energy Efficiency Upgrades, New Rochelle, NY (NY)	0	1,000	0
▪ Energy Efficiency/Sustainable Energy Project (NC)	951	0	0
▪ Energy Efficient Buildings, Salt Lake County, Utah (UT)	618	0	0
▪ Energy Efficient Electronics Cooling Project (IN)	952	0	0
▪ Energy Efficient Lighting Project (KY)	190	0	0
▪ Energy Production Through Anaerobic Digestion (NJ)	476	0	0
▪ Energy Reduction and Efficiency Improvement Through Lighting Control (PA)	0	120	0
▪ Energy Saving Retrofitting for the CFCC Main Campus (FL)	0	300	0
▪ Energy Storage/Conservation and Carbon Emissions Reduction Demonstration Project (MA)	0	400	0
▪ Energy Efficient Innovations for Healthy Buildings (NY)	0	500	0
▪ EngenuitySC Commercialization and Entrepreneurial Training Project (SC)	0	500	0

(dollars in thousands)

	FY 2009	FY 2010	FY 2011
Environmental Impact Protocols for Tidal Power (ME)	0	1,000	0
Environmental System Center at Syracuse University (NY)	714	0	0
Ethanol from Agriculture (AR)	951	500	0
Ethanol Pilot Plant (MA, CT)	2,664	0	0
Fairbanks Geothermal Energy Project (AK)	0	1,000	0
Fairview Department of Public Works Building and Site Improvements (NY)	0	500	0
Fallon Paiute-Shoshone Tribe Demonstration Energy Park (NV)	0	200	0
Farm Deployable Microbial BioReactor for Fuel Ethanol Production (AL)	0	800	0
Fast Charging Electric Vehicle Demonstration Project in Charlottesville, Virginia (VA)	0	500	0
Feasibility Study and Design of "Brightfield" Solar Farm (PA)	0	200	0
Flexible Thin-Film Silicon Solar Cells (OH)	1,189	0	0
Florida Renewable Energy Program (FL)	714	1,000	0
Fluid Flow Optimization of Aerogel Blanket Process Project (MA)	1,427	300	0
Forestry Biofuel Statewide Collaboration Center (MI)	1,427	0	0
Fort Mason Center Pier 2 Project (CA)	0	2,000	0
Frostburg State University Sustainable Energy Research Facility Equipment and Staffing (MD)	856	0	0
Fuel Cell Optimization and Scale-up (PA)	351	0	0
Gadsden State Community College Green Operations Plan (AL)	0	75	0
Gas Heat Pump Cooperative Training Program (NV)	0	250	0
Genetic Improvement of Switchgrass (RI)	1,427	1,500	0
Georgetown South Commercial Park, Photovoltaic Generation Facility (TX)	0	100	0
Georgia Southern University Biodiesel Research (GA)	0	250	0
Geothermal Development in Hot Springs Valley (MT)	0	491	0
Geothermal Energy Project at Roberts Wesleyan College (NY)	476	0	0
Geothermal Power Generation Plant at Oregon Institute of Technology (OR)	1,522	1,000	0
Global Green New Orleans - Holy Cross Project (LA)	0	550	0
Gogebic Community College (GCe) - Campus Energy Efficient and Weatherization Upgrade (MI)	0	300	0
Great Basin College Direct-use Geothermal Demonstration Project (NV)	683	1,000	0
Great Lakes Institute for Energy Innovation (OH)	951	1,000	0
Great Plains Wind Power Test Facility, Texas Tech University, Lubbock, TX (TX)	1,903	2,000	0
Green Building Research Laboratory (OR)	0	1,000	0
Green Buildings - Bradley University (IL)	476	0	0

(dollars in thousands)

	FY 2009	FY 2010	FY 2011
▪ Green Buildings - Lakeview Museum (IL)	238	0	0
▪ Green Buildings/Retrofitting (VA)	0	350	0
▪ Green Collar and Renewable Energy Training Program, AB Technical Community College (NC)	666	0	0
▪ Green Energy Job Training Initiative (CA)	238	0	0
▪ Green Fuels Depot (IL)	0	1,500	0
▪ Green Power Initiative (IA)	951	0	0
▪ Green Roof Demonstration Project (IN)	0	600	0
▪ Green Roof for the DuPage County Administration Building (IL)	0	250	0
▪ Green Roof Project - Greene County (MO)	476	0	0
▪ Green Vehicle Depot (NY)	285	0	0
▪ Greenfield Community College Hybrid Geo-thermal Project (MA)	0	525	0
▪ Hardin County General Hospital Energy Efficiency Upgrades (IL)	0	500	0
▪ Harlem United Supportive Housing Fund Wind Power Project (NY)	48	0	0
▪ Hawaii Energy Sustainability Program (HI)	3,116	6,000	0
▪ Hawaii Renewable Energy Development Venture (HI)	0	6,000	0
▪ Henderson, Solar Energy Project (NV)	0	500	0
▪ Hidalgo County Waste-to-Energy Project (TX)	119	0	0
▪ High Carbon Fly Ash Use for the U.S. Cement Industry (UT)	951	0	0
▪ High Penetration Wind Power in Tatitlek (AK)	0	900	0
▪ High Performance, Low Cost Hydrogen Generation from Renewable Energy (CT)	952	0	0
▪ High Speed Wind Turbine Noise Model with Suppression (MS)	0	1,000	0
▪ High Temperature Hydrogen Generation Systems (SC)	0	300	0
▪ Hollow Glass Microspheres (NV)	523	0	0
▪ Hospital Lighting Retrofit (IL)	0	500	0
▪ Housatonic River Net-Zero-Energy Building (MA)	0	1,000	0
▪ Hull Municipal Light Plant Offshore Wind Project (MA)	952	750	0
▪ Hydroelectric Power Generation, Quincy (IL)	476	0	0
▪ Hydrogen Optical Fiber Sensors (CA)	952	0	0
▪ Hydrogen Production and Delivery Technology (CT)	0	500	0
▪ Hydrogen Storage System for Vehicular Propulsion (DE)	1,427	0	0
▪ Hydropower from Wastewater Advanced Energy Project (NY)	476	0	0
▪ HyperCAST R&D Funding for Vehicle Energy Efficiency (CO)	1,427	750	0
▪ Illinois Community College Sustainability Network (IL)	0	250	0
▪ Illinois Energy Resources Center at the University of Illinois at Chicago (IL)	0	400	0
▪ Illinois State University-Biomass Research Project (IL)	476	0	0
▪ Improving Fuel Cell Durability and Reliability Initiative (CT)	0	2,500	0

	(dollars in thousands)		
	FY 2009	FY 2010	FY 2011
▪ Independent Energy Community Renewable Power System (UT)	0	1,000	0
▪ Installation of a Solar Canopy (MA)	0	534	0
▪ Institute for Sustainable Energy (AL)	0	1,000	0
▪ Integrated Biomass Refining Institute (NC)	1,208	1,000	0
▪ Integrated Power for Microsystems (NY)	951	250	0
▪ Integrated Renewable Energy & Campus Sustainability Initiative (IA)	0	750	0
▪ Integrated Sustainability Initiative (NV)	951	0	0
▪ Intelligent Controls for Net-Zero Energy Buildings (NE)	476	0	0
▪ Intelligent Facades for High Performance Green Buildings (NY)	714	0	0
▪ Iowa Central Renewable Fuel Testing Laboratory (IA)	476	750	0
▪ Iowa Lakes Community College Sustainable Energy Edu. Center (IA)	476	0	0
▪ Isles Inc. Solar and Green Retrofits (NJ)	238	0	0
▪ Issaquah Highlands Zero Energy Affordable Housing (WA)	0	500	0
▪ Jenks Energy Management Equipment (OK)	0	250	0
▪ Juniata Hybrid Locomotive (PA)	714	1,000	0
▪ Kansas Biofuels Certification Laboratory (KS)	990	0	0
▪ Kansas State University Center for Sustainable Energy (KS)	714	500	0
▪ Kansas Wind Energy Consortium (KS)	714	0	0
▪ La Feria Solar Lighting Initiative (TX)	0	500	0
▪ La Samilla Solar Trough Storage Project (NM)	1,903	0	0
▪ Lake Land College Energy Efficient Buildings (IL)	1,332	0	0
▪ Lancaster Landfill Solar Facility (MA)	0	500	0
▪ Lane Community College Energy Demonstration Building (OR)	0	550	0
▪ Large-Scale Wind Training Program, Hudson Valley Community College, Troy, NY (NY)	0	300	0
▪ Lehigh Valley Hospital Photovoltaic Panel Installation (PA)	951	0	0
▪ Lightweight Composites for Heavy-Duty Vehicles and Hydrogen Storage (WV)	476	0	0
▪ Lignocellulosic Biofuels from New Bioenergy Crops (TX)	0	1,000	0
▪ Long Island 50 MW Solar Initiative (NY)	0	1,750	0
▪ Long Island Biofuels Alliance (NY)	0	2,750	0
▪ Low Cost Production of Thin-Film Photovoltaic (PV) Cells (PA)	0	1,200	0
▪ Low Cost Thin Filmed Silicon Based Photovoltaics (NY)	476	0	0
▪ Macomb Community College Transportation and Energy Technology (MI)	476	0	0
▪ Maine Tidal Power Initiative (ME)	952	0	0
▪ Manufacturing Industrial Development for the Hydrogen Economy (MI)	761	0	0

(dollars in thousands)

	FY 2009	FY 2010	FY 2011
▪ MARET Center (MO)	951	1,500	0
▪ Marine Energy Technology (WA)	0	1,750	0
▪ Marine Renewable Energy Center (MA)	952	750	0
▪ Marquette University Anaerobic Biotechnology (WI)	476	0	0
▪ Martin County Hydrogen Fuel Cell Project (NC)	1,427	0	0
▪ Miami Children's Museum Going Green Initiative (FL)	714	1,000	0
▪ Michigan Alternative and Renewable Energy Center Offshore Wind Demonstration Project (MI)	1,427	0	0
▪ Middlesex Community College's Geothermal Project (MA)	238	0	0
▪ MidSouth/Southeast Bioenergy Consortium (AR)	1,903	1,000	0
▪ Mill Seat Landfill Bioreactor Renewable Green Power Project (NY)	1,903	1,000	0
▪ Minnesota Center for Renewable Energy (MN)	714	0	0
▪ Modular Energy Storage System for Hydrogen Fuel Cell (MI)	1,189	0	0
▪ Montana Algal Biodiesel Initiative (MT)	0	500	0
▪ Montana Bio-Energy Center of Excellence (MT)	0	2,250	0
▪ Morris County Renewable Energy Initiative (NJ)	0	2,000	0
▪ Moving Toward an Energy Efficient Campus at Maffei College (MA)	0	400	0
▪ Mt. Wachusett Community College Wind Project (MA)	1,189	1,000	0
▪ Multifunctional Solar Energy Systems Research (UT)	1,332	0	0
▪ Multi-Hybrid Power Vehicles with Cost Effective and Durable Polymer Electrolyte Membrane Fuel Cell and Lithium Ion Battery for Ohio University (OH)	0	600	0
▪ Municipal Building Energy Efficient Window Replacement Program (NJ)	0	180	0
▪ Municipal Complex Solar Power Project (NJ)	0	200	0
▪ Munster Waste-to-Energy Cogeneration Project (IN)	951	0	0
▪ Nanostructured Materials for Energy (NC)	952	1,000	0
▪ Nanostructured Materials for Improved Photovoltaics (MS)	0	1,000	0
▪ Nanostructured Solar Cells for Increased Efficiency and Lower Cost (AR)	1,189	0	0
▪ NaSi and Na-Sg Powder Hydrogen Fuel Cells (NY & NJ)	952	0	0
▪ National Agriculture-Based Industrial Lubricants (IA)	571	0	0
▪ National Center for Manufacturing Sciences Light-Weight Vehicle Materials (MI)	1,903	0	0
▪ National Center of Excellence in Energy Storage Technology (OH)	0	1,000	0
▪ National Offshore Wind Energy Center (TX)	0	2,000	0
▪ National Open-Ocean Energy Laboratory (FL)	0	2,000	0
▪ National Wind Energy Center (TX)	2,379	0	0
▪ NCMS (IL)	0	900	0

(dollars in thousands)

	FY 2009	FY 2010	FY 2011
▪ Near Zero Carbon Footprint Energy Creation Through Thermal Oxidation (PA)	0	1,000	0
▪ Neighborhood Weatherization Collaborative (CO)	0	500	0
▪ Nevada Renewable Energy Integration and Development Consortium (NV)	0	3,000	0
▪ Nevada Virtual Renewable Energy Integration and Development Center (NV)	2,560	0	0
▪ New School "Green" Building (NY)	1,903	0	0
▪ Newark Museum Alternative Energy Enhancement Program (NJ)	0	500	0
▪ Next Generation Composite Wind Blade Manufacturing Technologies (ME)	0	250	0
▪ Next Generation Wind Turbine (MA)	0	1,000	0
▪ Niagara River Hydropower (NY)	476	0	0
▪ NIREC - Nevada Institute for Renewable Energy Commercialization (NV)	476	1,000	0
▪ North Carolina Center for Automotive Research (NC)	476	0	0
▪ Northern Illinois University Transportation Energy Program (IL)	0	1,000	0
▪ Northern Nevada Renewable Energy Training Project (NV)	0	500	0
▪ Norwich Cogeneration Initiative (CT)	0	750	0
▪ Notre Dame/NiSource Geothermal Ionic Liquids Research Collaborative (IN)	952	0	0
▪ Novel Photocatalytic Metal Oxides (NE)	0	250	0
▪ NTRCI Legacy Engine Demonstration Project (TN)	0	500	0
▪ NY State Center for Advanced Ferrite Production (NY)	0	300	0
▪ Oakland University Alternative Energy Education (MI)	0	500	0
▪ Offshore Wind Initiative (ME)	0	5,000	0
▪ Offshore Wind Project Study (NY)	0	500	0
▪ Ohio Advanced Energy Manufacturing Center (OH)	952	500	0
▪ Omega Optical Solar Power Generation Development (VT)	1,427	0	0
▪ One Kilowatt Biogas Fueled Solid Oxide Fuel Cell Stack (NY)	952	0	0
▪ Orange County Solar Demonstration & Research Facility (FL)	0	300	0
▪ Oregon Solar Highway - Innovative Use of Solar Technology (OR)	951	1,000	0
▪ OU Center for Biomass Refining (OK)	714	500	0
▪ Passive NOx Removal Catalyst Research, Notre Dame University, IN (IN)	0	900	0
▪ Pecos Valley Biomass Energy Project (NM)	2,379	0	0
▪ Peru Electrical Department Wind Turbine Generation (IL)	0	1,000	0
▪ Phipps Conservatory CTI Waste-to-Energy Project (PA)	0	500	0
▪ Phoenix Children's Hospital Central Energy Plant Expansion (AZ)	0	2,000	0
▪ Photovoltaic Power Electronics Research Initiative (PERI) (FL)	0	700	0
▪ Photovoltaic System at Town Landfill in Islip (NY)	476	0	0

(dollars in thousands)

	FY 2009	FY 2010	FY 2011
▪ Pinellas County Regional Urban Sustainability Demonstration and Education Facility (FL)	476	0	0
▪ Pittsburgh Green Innovators (PA)	571	1,500	0
▪ Placer County Biomass Utilization Pilot Project (CA)	1,427	1,000	0
▪ Plug-In Hybrid Initiative (MI)	0	750	0
▪ Plug-in Hybrid and Ethanol Research Platforms (NC)	809	0	0
▪ Pope/Douglas Third Combustor Expansion (MN)	951	0	0
▪ Port of Galveston Solar Energy Project (TX)	0	250	0
▪ Prototyping and Development of Commercial Nano-Crystalline Thin Film Silicon for Photovoltaic Manufacturing (NY)	0	500	0
▪ Purdue Hydrogen Technologies Program (IN)	952	0	0
▪ Purdue Solar Energy Utilization Laboratory, West Lafayette, IN (IN)	0	425	0
▪ R&D of Clean Vehicle Technology (OH)	0	1,000	0
▪ Redirection of FY 2008 for Biodiesel Injection Blending Facilities (PA)	-702	0	0
▪ Renewable Energy Center (NC)	0	750	0
▪ Renewable Energy Clean Air Project (RECAP) (MN)	952	1,000	0
▪ Renewable Energy Demonstration (IL)	0	500	0
▪ Renewable Energy Development Venture (HI)	3,799	0	0
▪ Renewable Energy Feasibility Study (NJ)	476	0	0
▪ Renewable Energy Feasibility Study and Resources Assessment (NV)	0	500	0
▪ Renewable Energy Initiative (IL)	0	500	0
▪ Renewable Energy Initiatives for Clark County, Nevada Parks and Recreation (NV)	0	1,000	0
▪ Renewable Energy/Disaster Backup System for Hawaii Red Cross Headquarters Building (HI)	0	240	0
▪ Renewable/Alternative Energy Center (FL)	951	0	0
▪ Renewable/Sustainable Biomass Project (AK)	476	0	0
▪ Research and Development of Liquid Carriers for Hydrogen Energy (WA)	0	500	0
▪ Research on Fuel Cell Powered by Hydrogen Production from Biomass to Provide Clean Energy for Remote Farms Away from Electric Grids (NY)	0	675	0
▪ Rhode Island Ocean Special Area Management Plan (RI)	666	0	0
▪ Richland Community College Bioenergy Program (IL)	0	500	0
▪ Running Springs Retreat Center Solar Upgrade (CA)	0	1,000	0
▪ Saint Joseph's University Institute for Environmental Stewardship (PA)	0	1,000	0
▪ San Diego Center for Algae Biotechnology (SD-CAB) (CA)	0	750	0
▪ San Francisco Biofuels Program (CA)	951	0	0

(dollars in thousands)

	FY 2009	FY 2010	FY 2011
▪ San Francisco Electric Vehicle Initiative (CA)	0	1,000	0
▪ Sandia National Lab Concentrating Solar (NM)	2,855	0	0
▪ Sapphire Algae to Fuel Demonstration Project Portales (NM)	951	0	0
▪ Senior Housing Project Green Building, Cerritos (CA)	381	0	0
▪ Shenandoah Valley as a National Demonstration Project Achieving 25 Percent Renewable Energy by the Year 2025 (VA)	0	750	0
▪ Show Me Energy Cooperative Biomass Development (MO)	0	900	0
▪ Smart Energy Program (CT)	0	500	0
▪ Snohomish County PUD No. 1 Geothermal Energy Study (WA)	476	0	0
▪ Solar Compactor Energy Efficiency Research Demonstration Project (MA)	0	300	0
▪ Solar Demonstration and Research Facility (FL)	238	0	0
▪ Solar Electric Power for Nonsectarian Educational and Social Services Facilities (NV)	0	500	0
▪ Solar Electric Power System (NY)	67	0	0
▪ Solar Energy Development (ME)	0	800	0
▪ Solar Energy Parking Canopy Demonstration Project (CA)	0	3,000	0
▪ Solar Energy Program (FL)	0	800	0
▪ Solar Energy Research Center Instrumentation Facility, University of North Carolina at Chapel Hill (NC)	0	1,000	0
▪ Solar Energy Windows and Smart IR Switchable Buildings (PA)	1,189	0	0
▪ Solar Energy Zone Planning and Infrastructure for the Nevada Test Site and Adjacent Lands (NV)	0	1,000	0
▪ Solar Furnace Research Program, Valparaiso University, IN (IN)	0	500	0
▪ Solar Hot Water Project in Greenburgh, NY (NY)	0	169	0
▪ Solar Lighting Demonstration Project (NV)	761	0	0
▪ Solar Lighting for Artesia Parks (CA)	0	250	0
▪ Solar Panel Expansion Initiative (TX)	0	500	0
▪ Solar Panels and Environmental Education (NJ)	951	0	0
▪ Solar Panels for the Haverhill Citizens Energy Efficiency (MA)	238	0	0
▪ Solar Panels in Municipal Owned Buildings (NJ)	0	1,000	0
▪ Solar Panels on Hudson County Facilities (NJ)	0	500	0
▪ Solar Pioneer and Solar Entrepreneur Programs (NY)	0	500	0
▪ Solar Power for Maywood (NJ)	0	300	0
▪ Solar Power Generation (NJ)	285	0	0
▪ Solar Powered Compressed Natural Gas Refueling Station (NY)	0	500	0
▪ Solar Powered Lighting for Forest Preserve District of DuPage County, IL (IL)	0	300	0
▪ Solar Thermal Demonstration Project (NV)	1,189	0	0
▪ Solid Oxide Fuel Cell Systems PVL Pilot Line (OH)	0	1,000	0

(dollars in thousands)	FY 2009	FY 2010	FY 2011
▪ Somerset County Renewable Energy Initiative (NJ)	0	2,000	0
▪ South Jersey Wind Turbines (NJ)	0	500	0
▪ Southern Pine Based Biorefinery Center (GA)	0	1,000	0
▪ Southern Regional Center for Lightweight Innovative Designs (MS)	3,806	4,000	0
▪ Southwest Alaska Regional Geothermal Energy Project (AK)	2,855	2,500	0
▪ Springfield Hospital Green Building (OH)	3,806	0	0
▪ St. Clair Community College (MI)	190	0	0
▪ St. Luke's Miners Memorial Hospital Energy Efficiency Improvement Project (PA)	0	525	0
▪ St. Marks Refinery Redevelopment (OH)	0	350	0
▪ St. Petersburg Solar Pilot Project (FL)	1,427	1,000	0
▪ St. Petersburg Sustainable Biosolids/Renewable Energy Plant (FL)	0	2,500	0
▪ Stamford Waste-to-Energy Project (CT)	1,903	0	0
▪ State Colleges' (VSC) Statewide Energy Efficiency and Renewable Energy Initiative (VT)	0	450	0
▪ Storage Tanks and Dispensers for E85 and Bio-diesel (IL)	376	0	0
▪ Strategic Biomass Initiative (MS)	476	500	0
▪ Street Lighting Fixture Energy Efficiency Retrofit Project (CA)	0	500	0
▪ Sun Grant Initiative (SD)	3,806	2,750	0
▪ Sustainable Algal Energy Production and Environmental Remediation (VA)	0	500	0
▪ Sustainable Energy for Homes and Businesses (VT)	714	0	0
▪ Sustainable Energy for Vermont Schools Competition (VT)	856	0	0
▪ Sustainable Energy Options for Rural Nebraska (FL)	0	500	0
▪ Sustainable Energy Research Center (MS)	10,466	10,000	0
▪ Sustainable Hydrogen Fueling Station, California State University Los Angeles (CA)	476	0	0
▪ Sustainable Las Vegas (NV)	951	0	0
▪ Sweet Sorghum Alternative Fuel and Feed Pilot Project (AZ)	0	750	0
▪ Switchgrass Biofuel Research: Carbon Sequestration and Life Cycle Analysis (FL)	0	500	0
▪ Synthesis of Renewable Biofuels from Biomass (MT)	0	500	0
▪ The Biorefinery in New York-Bio Butanol from Biomass (NY)	0	400	0
▪ The Boston Architectural College's Urban Sustainability Initiative (MA)	0	1,600	0
▪ The CUNY Energy Institute (NY)	0	1,550	0
▪ The Institute for Energy, Environment, and Sustainability (KS)	714	0	0
▪ The Johnston Avenue Solar Project (NJ)	0	500	0
▪ The Ohio State University-Ohio Agricultural Research and Development Center (OH)	381	0	0

(dollars in thousands)

	FY 2009	FY 2010	FY 2011
▪ The Solar Energy Consortium (NY)	1,903	2,250	0
▪ Thin Film Photovoltaic Research & Development (VT)	0	500	0
▪ Thurgood Marshall College Fund Minority Energy Science Initiative: NNSA (NC)	0	3,000	0
▪ Tidal Energy Study (WA)	476	0	0
▪ Today's Leaders for a Sustainable Tomorrow: A Sustainable Energy Program (MN)	0	1,500	0
▪ Town of Mexico Geothermal Project (NY)	142	0	0
▪ Transpo Bus Operations and Maintenance Center, South Bend (IN)	952	0	0
▪ Transportable Emissions Testing Lab (WV)	952	0	0
▪ Trenton Fuel Works Cellulosic Diesel Biorefinery (NJ)	476	0	0
▪ Tucson Public Building Solar Arrays (AZ)	0	450	0
▪ Unalaska Geothermal Energy (AK)	952	0	0
▪ Unconventional and Renewable Energy Research Utilizing Computer Simulations (UT)	0	3,500	0
▪ Union Terminal (OH)	0	500	0
▪ United Way of Southeastern Michigan (MI)	0	400	0
▪ University of Akron National Polymer Innovation Center (OH)	0	1,000	0
▪ University of Arkansas at Little Rock Nanostructured Solar Cells (AR)	0	500	0
▪ University of Detroit Mercy Energy Efficient Chemistry Building Renovations (MI)	0	800	0
▪ University of Kentucky Bio-fuels Research Laboratory (KY)	428	0	0
▪ University of Louisville Research and Energy Independence Program (KY)	0	2,000	0
▪ University of New Haven Solar Testing and Training Lab (CT)	0	500	0
▪ University of North Alabama Green Campus Initiative (AL)	951	200	0
▪ University of South Carolina Aiken Biofuels Laboratory in Aiken, SC (SC)	0	456	0
▪ University of Southern Indiana Advanced Manufacturing and Engineering Equipment Project (IN)	952	0	0
▪ University of Wisconsin Oshkosh's Anaerobic Dry Digestion Facility (WI)	0	500	0
▪ University of Wisconsin-BaraboojSauk County Net-Zero Energy Building (WI)	0	500	0
▪ University of Wisconsin-Milwaukee Advanced Nanomaterials for High-Efficiency Solar Cells (WI)	0	500	0
▪ UNR - Biodiesel from Food Waste (I\IV) (NV)	0	1,000	0
▪ UNR - Great Basin Center for Geothermal Energy (I\IV) (NV)	0	1,000	0
▪ UNR - Mass Exchanger Technology for Geothermal and Solar Energy Systems (NV)	0	1,200	0
▪ Urban Wood-based Bio-energy System in Seattle (WA)	476	0	0

	(dollars in thousands)		
	FY 2009	FY 2010	FY 2011
▪ USD Catalysis Group for Alternative Energy (DE)	1,047	0	0
▪ UW Northwest National Marine Renewable Energy Center (WA)	0	880	0
▪ Vermont Biofuels Initiative (VT)	1,427	750	0
▪ Vermont Energy Investment Corporation (VT)	0	450	0
▪ Wallowa County Integrated Biomass Energy Center (OR)	0	500	0
▪ Warren Technology and Business Center for Energy Sustainability (OH)	0	2,700	0
▪ Washington State Biofuels Industry Development (WA)	0	1,000	0
▪ Washoe Wind Turbine Demonstration Project (NV)	0	50	0
▪ Water-to-Water Heat Pump Chillers, Phoenix Children (AZ)	1,952	0	0
▪ Wave Energy Research and Demonstration Center (OR)	2,331	0	0
▪ Western Iowa Tech Community College Renewable Energy Economy Corridor (IA)	0	500	0
▪ Western Kentucky University Research Foundation Biodiesel Project (KY)	0	500	0
▪ Wind Turbine Development (MT)	0	1,000	0
▪ Wind Turbine Electric High-Speed Shaft Brake Project (OH)	476	0	0
▪ Wind Turbine Infrastructure for Green Energy and Research on Wind Power in Delaware (DE)	0	1,000	0
▪ Wind Turbine Model and Pilot Project for Alternative Energy (DE)	1,427	0	0
▪ Winooski Community Greening Project (VT)	114	0	0
▪ Wisdom Way Solar Village - Rural Development Inc. (MA)	571	0	0
▪ Woody Biomass Project at SUNY-ESF (NY)	714	0	0
▪ WSU, National Institute for Aviation Research, Advanced Materials Research (KS)	0	1,500	0
▪ Ypsi Civic Center (IL)	0	1,000	0
Total, Congressionally Directed Projects	228,803	292,135	0

Explanation of Funding Changes

	FY 2011 vs. FY 2010 ($000)
Congressionally Directed Projects	
No funding requested.	-292,135
Total, Congressionally Directed Projects	**-292,135**