Fiscal Year 2011
Budget-in-Brief

U.S. Department of Energy

Energy Efficiency and Renewable Energy

Bringing you a prosperous future where energy is clean, abundant, reliable, and affordable

www.eere.energy.gov

Table of Contents

Preface

The Office of Energy Efficiency and Renewable Energy (EERE) requests $2.4 billion in FY 2011 to pursue its mission of undertaking research, development, demonstration, and deployment (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. EERE's management focus and pathway to meet its goals are achieved through developing and delivering high impact innovation; attracting and employing the Nation's best talent and management approaches; and pursuing goals at a speed and scale that will capture the public's interest, imagination, and actions by productively improving their energy choices and quality of life, and enabling individuals, communities and businesses to meet their energy and economic security goals.

EERE's 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 for widespread use by commercial enterprises, creating new businesses and jobs.

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 National Laboratories, technology partners, the 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 through a wide variety of public-private partnerships that provide a stream of market solutions for our Nation's energy needs and economic growth.

The FY 2011 budget is designed to ensure that accelerated projects funded by the Recovery Act are built upon within EERE's our portfolio and sustained by private investment. The budget activities also enable the planning and implementation of critical provisions of energy policy related legislation. EERE's budget will ensure robust, transparent, and accountable program management and support functions that will efficiently and effectively execute and inform the organization's critical mission.

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 increase profits while reducing demand for fuels and electricity.

First, EERE will accelerate gains in energy efficiency, which is the cheapest, cleanest, fastest energy source to deploy, and the most cost-effective way to reduce GHG emissions and energy bills. EERE will identify 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 enable 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, EERE will facilitate a shift 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 clean energy technologies. These resources can produce competitive sources of fuel 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, as well as facilitate permitting and acquisition of rights of way. EERE is extensively collaborating with DOE's Office of Electricity and others as energy storage and smart grid systems are an important part of this investment.

Fourth, DOE's RE-ENERGYSE program will reinvigorate 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.

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 that will integrate key stakeholders in government and industry:
  - Large Scale Biopower - Commercial use of biopower from cellulosic feedstocks at a scale that will validate the potential of biopower, and cost sharing with private sector;
  - Concentrating Solar Power (CSP) - More than one gigawatt (GW) of CSP in a single cluster; and
  - Offshore Wind - 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 high quality 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 investments to enable cost-effective retrofits for homes, commercial buildings, and government buildings. This will be achieved through a 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 local governments. EERE will also help design model 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 of the transportation systems.

- 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.

Benefits

In recent years, EERE programs have played essential roles in encouraging private investments in technologies and providing key technology advances that enable energy related legislation such as standards and incentives that will continue to have major impacts on U.S. energy usage. Increasing the market penetration of renewable energy sources, efficiency technologies, and advanced transportation measures has helped to reduce America's reliance upon petroleum from unstable regions of the world, thereby improving national economic stability, balance-of-trade, and energy security.

EERE's balanced portfolio of RDD&D and commercialization activities already catalyzes unprecedented growth in renewable energy and efficiency technologies. Renewable energy capacity (excluding large-scale hydropower) has grown by 150 percent during the last eight years[1], and the U.S. now leads the world in wind energy production[2]. Biofuels production has reached record levels, with the U.S. producing over 10 billion gallons annually[3]. In addition to energy supply gains, U.S. deployment of energy efficiency technologies has contributed to a reduction in energy intensity (energy consumption per dollar of gross domestic product) of 15 percent for the U.S. economy since 2000[4].

EERE continues to work to amplify these trends, and estimates that with the continued leveraging of EERE technologies and achievement of performance goals are on a performance trajectory that can: significantly reduce U.S. net oil imports limit by 57 percent and CO_2 emissions by 19%; save consumers 24 percent on energy costs and reduce primary energy consumption 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)[5], 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 http://www1.eere.energy.gov/ba/pba/program_benefits.html for additional for additional portfolio data). Focus on innovative technology and policy, rapid leveraged deployment and partnerships, and new technology pathways are expected to significantly increase these benefits.

However, government funding alone will not be sufficient to address all the challenges of changing our Nation's energy portfolio. EERE efforts today and in the future need to develop solutions that stimulate large-scale public and private actions and the investment necessary to meet national energy

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[1] This is accurate as calculated based on year 2008 with 38,493 MW capacity vs. year 2000 with 15,572 MW capacity. Renewables include wind, biomass, geothermal, solar thermal and PV. Source: Electric Power Annual 2008, Released: January 21, 2010. http://www.eia.doe.gov/cneaf/electricity/epa/epaxlfile1_1.pdf

[2] By the end of 2009, U.S. wind generation was 35,159 MW. Source: American Wind Energy Association, http://www.awea.org/publications/reports/4Q09.pdf
Wind generation in Germany, the country with the next largest capacity, reached 25,777 MW in 2009. Source: European Wind Energy Association, http://www.ewea.org/fileadmin/ewea_documents/documents/statistics/general_stats_2009.pdf

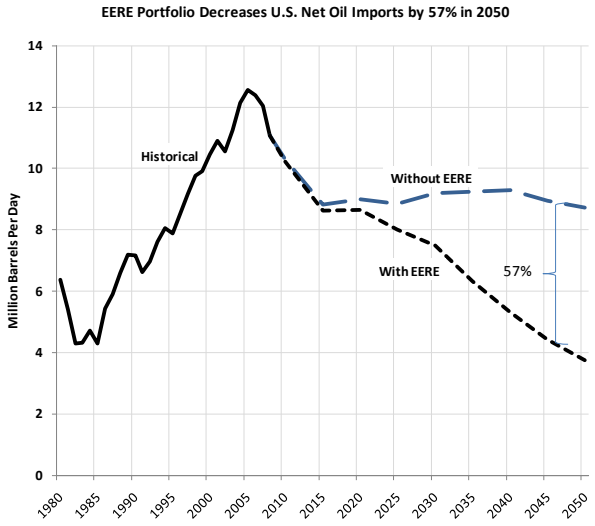
[3] Data is from U.S. Energy Information Administration / Monthly Energy Review December 2009 and includes fuel ethanol and biodiesel production, and is projected to reach 10.7 MMgal for 2009. This reflects a 15% increase from 2008.

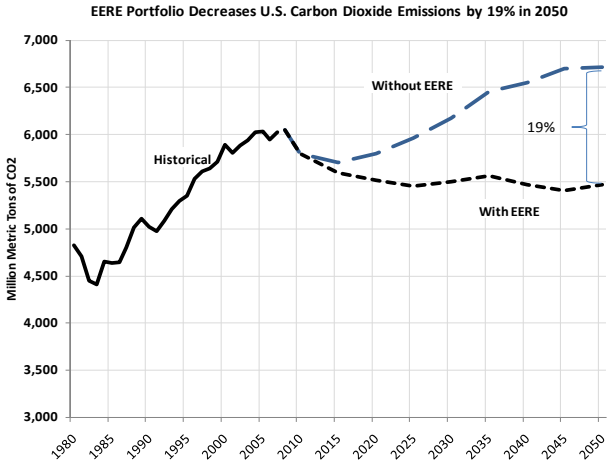
[4] The value of 15% is correct for 2008 data published by U.S. Energy Information Administration / Monthly Energy Review December 2009

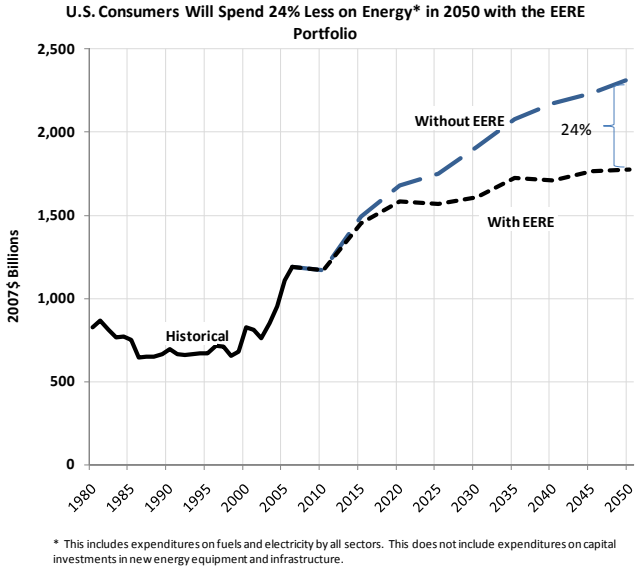
[5] Annual Energy Review. Energy Information Administration, Office of Energy Markets and End Use. Washington: June 2009, page xxiii. http://www.eia.doe.gov/aer/pdf/aer.pdf

requirements. With action plans, performance milestones, and clearly articulated deliverables, execution and implementation of EERE's programs will strengthen dynamic partnerships with private industry and academia that will continue to improve the Nation's economic well-being. Laboratory partnerships will also increasingly result in clean energy technology commercialization at unprecedented levels.

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







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

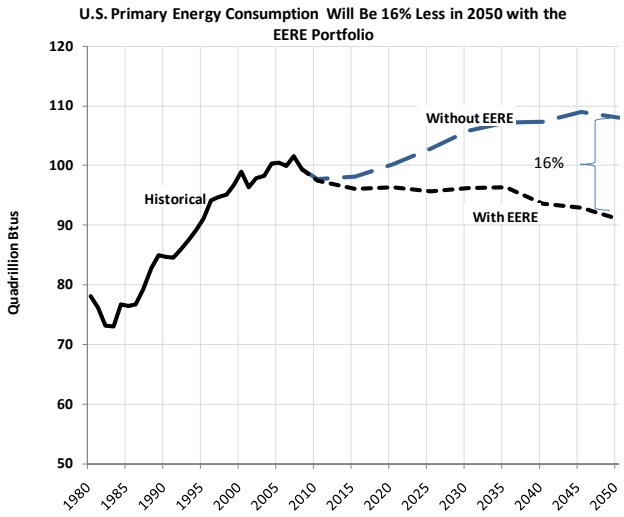


Table 1. Cumulative Impacts of Technology Leveraged by EERE Programs[1]

	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

[1] 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

Highlights: Investing in Accelerating and Scaling-up Clean Energy Solutions

The EERE portfolio leads the growth in U.S. efforts to invest in clean energy research, reduce dependence on oil and other volatile foreign energy sources, and transform how the U.S. powers the economy by focusing on scientific discovery, job creation, energy transformation, and climate change impacts. EERE's FY 2011 portfolio investment:

- Significantly advances the RD&D of technologies and practices in **energy efficiency** in the built environment, including investments in Building Technologies ($230.7 million requested; increase of $8.7 million), Industrial Technologies ($100.0 million requested; increase of $4.0 million), Weatherization and Intergovernmental Program activities ($385.0 million requested; increase of $115.0 million), and the Federal Energy Management Program (FEMP; $42.3 million requested; increase of $10.3 million);

- Fosters the deployment of **clean, renewable electricity technologies**, including Solar Energy ($302.4 million requested; increase of $55.4 million), Wind Energy ($122.5 million requested; increase of $42.5 million), Water Power ($40.5 million requested; decrease of $9.5 million), and Geothermal Technology ($55.0 million requested; increase of $11.0 million); and Hydrogen and Fuel Cell Technologies ($137.0 million requested; decrease of $37.0 million);

- Continues to build upon the recent investments, RD&D, and improvements in **advanced transportation technologies**, including Biomass and Biorefinery Systems R&D ($220.0 million requested), Vehicle Technologies ($325.3 million requested; increase of $13.9 million);

- Increases funding for **Program Direction** ($200.0 million requested; increase of $60.0 million) to scale-up staffing and continue oversight, transparency and reporting activities of all EERE programs. This increase is commensurate with the more than one billion dollar expansion to the EERE portfolio since FY 2007;

- Significantly expands **Program Support** ($87.3 million requested; increase of $42.3 million) to allow more effective analysis of EERE's portfolio regarding energy security, climate change, and economic impacts, fund ongoing commercialization and communication efforts for clean energy technologies, and build strategic partnerships with China, India, and other growing economies;

- Builds upon the recent investments in **Facilities and Infrastructure** ($57.5 million requested; increase of $38.5 million) to ensure the continued growth and efficacy of NREL; and

- Initiates the DOE-wide **RE-gaining our ENERGY Science and Engineering Edge program** (RE-ENERGYSE; $50.0 million requested) to fund scholarships, research grants, and vocational training programs for advanced energy jobs.

Program Priorities

Building Technologies ─ Implementing a systems approach in deploying technologies for "net-zero" energy buildings that produce as much energy as they consume emphasizing integration and systems optimization in new buildings while increasing the focus on maximizing near-term efficiency gains obtained by retrofitting existing buildings.

Federal Energy Management Program ─ Help Federal agencies save 54 trillion lifecycle Btus. Project financing activities will secure over $240 million in alternative financing from private sector investment and utility sources, which will result in about 3.7 million metric tons of CO_2 carbon dioxide equivalent saved over the lifecycle of the projects.

Hydrogen and Fuel Cell Technologies ─ Continues focusing on R&D to reduce cost and improve performance and durability for stationary, portable, and transportation applications.

Geothermal Technology ─ Focusing on Enhanced Geothermal Systems (EGS) that could allow geothermal energy to be harnessed nationwide providing up to 10 percent of our Nation's future electricity. Priority efforts include: evaluation and validation of reservoir stimulation techniques, assessment of a stimulated reservoir, and expanding EGS component R&D.

Industrial Technologies ─ Cost-effectively improving the energy efficiency of the U.S. economy by advancing RD&D of transformational manufacturing technologies—dramatically reducing industry's energy and carbon intensity. Expanding partnerships with energy intensive industries through the highly successful *Save Energy Now* effort as its energy assessments have already 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.

RE-ENERGYSE ─ This DOE-wide initiative targets education and training efforts, develops a "green energy" workforce with expertise in science, technology, engineering and mathematics (STEM) and associated energy fields and trades to ensure U.S. leadership in advanced energy systems for a low carbon, clean energy economy.

Solar Energy ─ Achieve grid parity by 2015 for both Photovoltaics - through manufacturing improvements and advanced R&D along the entire supply chain; and Concentrating Solar Power – through thermal energy storage research and a large scale deployment to demonstrate advanced CSP technology.

Vehicle Technologies ─ Continue to focus on technologies for transportation electrification, which include advanced batteries, power electronics, and electric motors for hybrid, plug-in hybrid, and electric vehicles and deployment activities to develop infrastructure for transportation electrification.

Water Power ─ Validate and support marine and hydrokinetic technologies through the development and testing of innovative device designs, targeted R&D into high risk components, reduction in permitting costs, and detailed assessments of each resource class; identify opportunities for additional generation at existing hydropower facilities and non-powered dams, and improved environmental performance, and the development of accurate markets for pumped storage and grid services.

Wind Energy ─ Focusing on improving cost, performance, and reliability of large and distributed wind turbine technology; facilitate wind energy's rapid market expansion; and addressing potential barriers to offshore wind and to integrating wind into the electric transmission system.

Weatherization and Intergovernmental ─ Utilize technical assistance, formula grants, and competitive grants to support clean energy deployment through the implementation of high impact and innovative grants, energy efficiency and renewable energy projects.

Key Accomplishments

In pursuit of the advancement of the EERE mission this past year several noteworthy accomplishments and intermediate steps took place, including:

Biomass and Biorefinery Systems R&D continues to make progress on integrated biorefinery projects at various scales and phases of construction, with more biofuels production capacity coming online in FY2010 in support of the Energy Independence Security Act (EISA) Renewable Fuel Standards (RFS) targets. The program evaluated hundreds of applications and made awards to Feedstock Logistics and USDA-DOE joint solicitations. The program produced multiple reports, including an updated intermediate blends testing report and a draft algae technology roadmap, to be finalized in FY2010. A series of workshops was also held to explore new initiatives in biopower and bioproducts, as well as obtain key stakeholder input to the high-yield scenario as part of the forthcoming update to the 2005 Billion-Ton Study.

Building Technologies continues to be on schedule for establishing efficiency standards for eight products and test procedures for three products to be completed in FY 2011. Testing also continues on an advanced heat pump introduced into the market in FY 2010 that uses 50 percent less energy than conventional units.

Federal Energy Management Program helped Federal agencies save over 110 trillion lifecycle Btus, more than twice FEMP's annual target. The Super Energy Service Performance Contract (ESPC) awards will generate project investment approaching $430 million and a corresponding guaranteed cost savings of more than $1 billion.

Hydrogen and Fuel Cell Technologies made significant progress in several key areas, extending durability and meeting the 2010 target of 3.0 kW/gPGM (kilowatts per gram of platinum-group metals) in a fuel cell stack, on track to reach the 2015 goal of 8 kW/gPGM.

Geothermal Technology advanced Enhanced Geothermal Systems technology by stimulating a geothermal reservoir in Nevada/California, and completed testing a transducer for a high temperature ultrasonic fracture imaging tool.

Industrial Technologies collaboratively developed advanced technologies with industry, ranging from new membrane-based technologies for low-energy chemicals production to wireless sensor systems for equipment monitoring, and major commercial sales activities. R&D activities supported by the program won three *R&D 100* awards in 2008. The *Save Energy Now* 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.

Solar Energy over the past two years, Sunpower has developed, and is commercially producing, the world's most efficient crystalline silicon modules under one of the Program's Technology Pathway Partnerships. At 20% efficiency, these modules produce over 40% more power than typical silicon-based modules and create significant value by reducing total system costs and producing more power in area constrained applications such as residential rooftops. Tessera Solar and Stirling Energy Systems dedicated a 1.5MW dish/engine power plant in Phoenix, AZ on January 22, 2010. This first of a kind plant consists of sixty 25kW systems and demonstrated a world record 31.2 percent solar-to-grid system conversion efficiency last year. Under the SEGIS project industry has demonstrated an operational advanced inverter using advanced magnetic and capacitor designs that reduce the mass of

100kW size inverters from nearly 1,000 pounds to approximately 100 pounds. Key components for a smart grid inverter using a design to improve communications to PV components and utility features such as VAr support and voltage stabilization on a weak utility grid were also developed.

Vehicle Technologies accelerated activities focused on developing and demonstrating plug-in hybrid components (batteries, electric motors, and power electronics) and vehicles; demonstrated 44 percent improvement in engine efficiency (in a laboratory) over a comparable gasoline engine with a passenger diesel engine; demonstrated (modeled) a passenger vehicle weight reduction of 40 percent, and commercialization of a lithium-ion battery supported by DOE began in FY 2009.

Water Power competitively selected over 30 partnerships with leading technology and project developers. The program also launched an extensive platform of R&D with the National Laboratories to develop and test the Nation's first wave and tidal power systems, design open-ocean renewable energy test facilities, and identify opportunities for increased incremental generation at hydroelectric facilities and non-powered dams.

Wind Energy Program has continued to make progress and achieve major milestones increasing the domestic wind R&D capacity. First, building on investments made through the Recovery Act, the large blade testing facility will accommodate the rapid growth in wind turbine size and demand over the next two decades. A second major milestone will be the completion of an upgraded dynamometer. Wind Energy is also working to complete development of a Large Wind Turbine Drivetrain Testing facility that will enhance the performance, durability, and reliability of utility-scale wind turbines.

Weatherization and Intergovernmental Activities increased utilization of energy savings performance contracting, sustainable energy efficiency finance mechanisms, renewable energy certificate trading programs, and energy efficiency based utility incentives, and also expanded the green workforce in the residential energy retrofit and other energy-related fields.

Key Program Benefits[1]

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

The FY 2011 portfolio analysis includes EERE's program assessment of achievable benefits based on the assumptions that barriers were successfully addressed, technology goals were achieved, and resources were available as necessary. The achievement of EERE program goals will yield the significant short- and long-term results anticipated by EISA 2007, and enable significant additional quantitative climate, energy security, and economic impacts from 2011 budget activities, reflected in the following graphs.

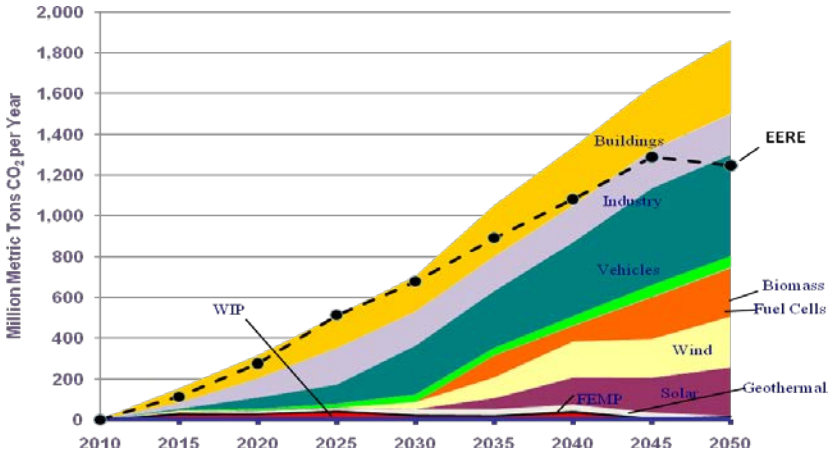
These graphs depict the contributions of individual programs and the integrated impacts of EERE programs that result from marketplace competition (represented by the dotted black line labeled EERE). The integrated impacts are lower than the sum of the individual program impacts due to competitive interaction among the technologies. The Buildings and Solar programs received significant additional resources late in the benefits estimation period; their benefits and integrated impacts will be remodeled and updated by March 2010 and made available at: http://www1.eere.energy.gov/ba/pba/program_benefits.html. EERE's strategic benefits include:

[1]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.

Climate Change

Avoid nearly 6 gigatons of carbon dioxide ($GTCO_2$) emissions by 2030 and more than 25 $GTCO_2$ by 2050 (cumulatively). Relative annual contributions of individual programs to annual avoided CO_2 are shown in Figure 1:

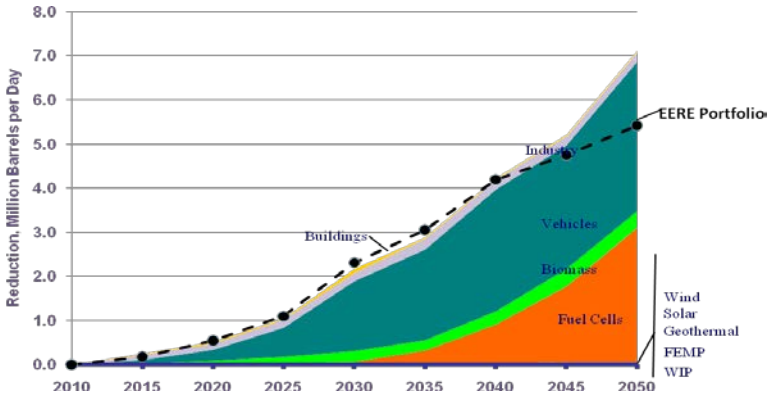
Figure 1: EERE Program Contributions to CO_2 Avoidance



Energy Security

Offset 4 billion barrels of imported oil by 2030 and 30 billion barrels by 2050, considerably diversifying the U.S. energy portfolio with substitutions for oil. Relative annual contributions of individual programs to petroleum import savings are shown in Figure 2:

Figure 2: EERE Program Contributions to Petroleum Import Savings



Economic Impact

Save consumers at least one trillion dollars by the year 2030 and more than $5 trillion by 2050 (cumulatively). Reduce cumulative costs to the electric power sector by $300 billion by 2030 and nearly $800 billion by 2050. Relative annual consumer and utility savings contributions by individual programs are shown in Figures 3 and 4 (note that the scales on the two graphs are significantly different, and that the utility industry savings are a subset of the consumer savings):

Figure 3: EERE Program Contributions to Consumer Savings

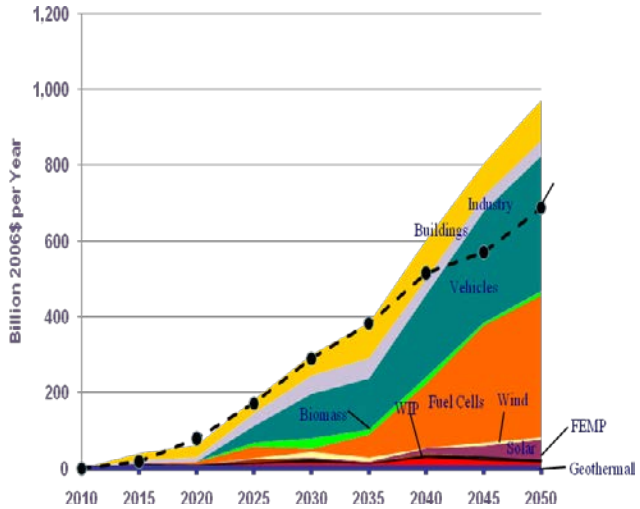
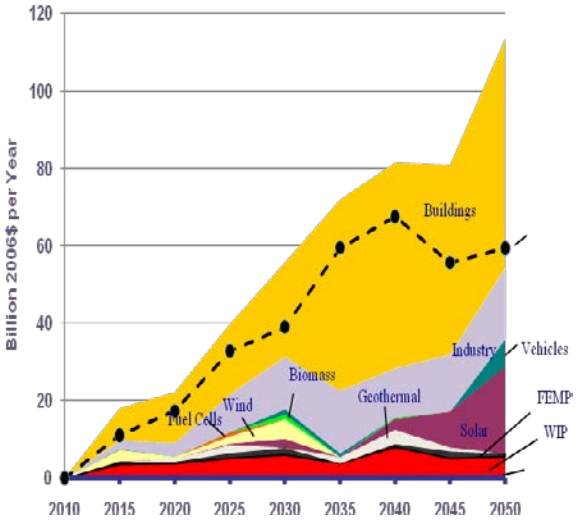


Figure 4: EERE Program Contributions to Electric Power Industry Savings



Much of the increased production of cellulosic ethanol conversion technology and increased light duty vehicle fuel efficiency that, in prior years was attributed to EERE program activities in benefit models, is now assumed to occur as a result of policies such as the EISA 2007 transportation sector-related mandates (RFS and CAFE), as opposed to RDD&D activities. This methodological choice has been made to preserve the philosophical integrity of the model; however achieving the aggressive mandated targets with minimum adverse impact on the U.S. economy will depend on successful current and future EERE RDD&D activities in these programs.

More detailed information is included in the EERE Congressional budget and on the EERE website: http://www1.eere.energy.gov/ba/pba/program_benefits.html; updates will be provided by March 2010.

Key Investments

- *Biomass Program*. The FY 2011 budget request remains level to continue RDD&D investments supporting EISA and its RFS targets. Specifically, the Biomass Program will continue deploying integrated biorefinery technologies through commercial and demonstration scale projects that leverage private sector cost-sharing, while also advancing biomass conversion technologies through targeted R&D work with the National Laboratories, academic institutions, and industry. Sustainable production and logistics will continue to increase biomass feedstock availability while reducing costs and will include evaluating the viability of algae. Strategic analysis and sustainability activities provide critical quantitative data, validation, and risk and feasibility assessments to inform programmatic decision-making and strategic planning, as well as external policy and private sector partners in the nascent domestic advanced biofuels industry. In addition to this RDD&D portfolio in support of the RFS, the Program is launching a similar effort for biopower in FY 2011, through an 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. The Biomass Program has restructured its subprograms in order to better highlight these and other key activities.

- *Building Technologies.* By making new and existing homes and buildings more energy efficient DOE is delivering significant primary energy savings today, with even greater future savings in the pipeline, increasing energy security and transforming the carbon footprint of the built environment. The FY 2011 request allocates an additional $8.7 million to these high priority efforts. R&D for residential and commercial buildings integration focuses on reducing building energy requirements and integrating renewable energy systems to enable commercial production of net Zero Energy Homes and Buildings by 2020 and 2025, respectively. The portfolio of energy efficiency component research, aligned to reduce building electrical loads, includes solid state lighting, more affordable efficient windows, and more efficient heating, ventilation, air conditioning, and refrigeration. The program pursues market transformation activities by developing and disseminating model building codes that are 30 percent more efficient than current codes in both the residential and commercial sector, and will continue to clear the backlog of rulemakings for appliances and commercial equipment and meet EPAct 2005 and EISA requirements. ENERGY STAR activities will focus on developing product test procedures and accelerating verification processes. The Energy Efficient Building Systems Design Innovation Hub, initiated in FY 2010, will continue to go beyond advanced research on building components and develop systems models that optimize and integrate components to provide increased energy savings through synergistic functionality.

- *Federal Energy Management Program.* In 2011 FEMP will continue to assist Federal Agencies meet the requirements of Executive Order 13514 to reduce their GHG emissions. This goal is met by FEMP's continued support for agencies to become more energy efficient, less reliant on nonrenewable energy sources, and decrease water use. FEMP provides assessments, audits, training, rulemaking, coordination, access to alternative private financing, and leadership across the Federal government so it can achieve its legislated and Executive mandates. FEMP supports efforts by DOE to meet or exceed all energy and water goals.

- *Hydrogen and Fuel Cell Technologies.* Fuel cells provide power that can be cleanly produced from a wide range of abundant domestic energy resources, including renewable resources (such as biofuels and by-products from biomass) and natural gas, which can lead to substantial reductions in

CO_2 emissions and petroleum. The program is investing $67 million to reduce the cost and improve the durability and performance of fuel cell systems by addressing stack components such as catalysts and membranes, as well as balance of plant components, degradation and water transport. The program is also investing $40 million in Hydrogen Fuel R&D, to reduce the cost of hydrogen produced from renewable resources by 80 percent by 2015.

- *Geothermal Technology*. The FY 2011 request, an increase of $11 million, focuses on exracting heat from the earth through Enhanced Geothermal Systems (EGS) that could provide 100,000 MW of electric power by 2050. Investments support research and demonstrations of EGS technology at different geological field sites to increase reservoir production rates and lifetimes and complement accelerated activities enabled by the Recovery Act.

- *Industrial Technologies Program.* The FY 2011 request supports a critical expansion of the "*Save Energy Now"* (SEN) initiative necessary for realizing the program's "25 in 10" goal of reducing industrial energy intensity by 25 percent over 10 years through voluntary collaborative partnerships. This goal derives from EPAct 2005, which prescribed a 2.5 percent per year reduction over 10 years. Through SEN, 2,421 energy use assessments have been completed from 2006 through November 2009, identifying savings of more than $1.3 billion annually in potential energy costs and avoiding 11.7 million metric tons of CO_2 emissions. Additionally, the program will continue to conduct a diverse portfolio of industry-specific and crosscutting RD&D activities, ranging from ultra-high efficiency boiler systems to innovative low-energy chemical membrane systems and the development of cutting-edge nanotechnologies. Another major program focus will be the development of energy-efficient combined heat and power (CHP) systems. The Manufacturing Energy Systems Program (MESP) will be initiated to serve as knowledge development and dissemination centers organized around distinct manufacturing areas with critical technical needs.

- *REgaining our ENERGY Science and Engineering Edge Program (RE-ENERGYSE).* This program will focus on creating a highly skilled U.S. workforce dedicated to developing and implementing advanced energy technologies, processes, and systems that can help the U.S. accelerate its transition to a low carbon economy. Through a competitive process, this program will provide fellowships, internships, and other hands-on research opportunities for undergraduate, graduate, and post-doctoral students focusing on clean energy and innovative new energy systems. The program will also support the development of interdisciplinary professional masters programs in advanced energy systems and management. RE-ENERGYSE will also dedicate resources to technical training to equip workers with the skills needed to enter clean energy jobs in the near-term, as well as for K-12 students to ensure a pipeline of inspired and well-educated individuals prepared to solve our Nation's greatest energy and climate change challenges.

- *Solar Energy*. DOE request an additional $55 million to enable the U.S. to compete in the global marketplace with cost-competitive solar energy by 2015. The PV subprogram is advancing module and system manufacturing technologies to achieve higher performance and lower-cost products with faster throughput and continuing reliability research to increase the lifetime of PV components and systems, and prove the bankability of new PV technologies. The CSP subprogram is developing low-cost systems with thermal storage to compete in the intermediate and baseload power markets, assisting industry deployment by identifying land environmentally suitable for utility-scale solar projects, addressing issues related to water consumption and transmission, and launching a demonstration of new CSP technologies that could lead to over 1 GW of projects. The Systems Integration subprogram is addressing the technical barriers to wide scale deployment of solar technologies by modeling performance and analyzing 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. The Market Transformation subprogram is reducing installed cost and increasing market penetration of solar technologies by training solar installers, and providing information and technical assistance to key stakeholders such as States, utilities, and local governments on how to develop policies and business models that accelerate adoption of solar energy.

- *Vehicle Technologies*. The FY 2011 budget significantly increases the emphasis on technologies that facilitate cost effective plug-in hybrid vehicles, and deployment activities to develop infrastructure for transportation electrification. Plug-in hybrid vehicles will reduce oil use beyond standard hybrid configurations by enabling electricity to become a significant transportation fuel. By accessing the Nation's electricity grid at off-peak times to charge high energy batteries, plug-in hybrid vehicles can operate in electric-only mode for up to 40 miles—meeting the needs of most drivers for commuting and short distance driving. Operating in an electric mode produces no tail-pipe emissions and consumes no petroleum. Vehicles Technologies R&D also continues in materials, advanced combustion, and fuels, as well as deployment efforts to accelerate the adoption of advanced transportation vehicles.
- *Water Power.* FY 2011 is a critical year for the Water Power program to test marine and hydrokinetic devices and conduct feasibility studies at hydroelectric facilities and non-powered dams. The Program plans to invest $10 million in public-private partnerships for the development and testing of innovative device designs to support establishing baseline cost of energy and performance for marine and hydrokinetic technologies based on resource type and device design. Of the $19.5 million for conventional hydropower, the program's main investment in FY 2011 will be $10.4 million in feasibility studies to identify opportunities for increased incremental generation via efficiency, capacity upgrades, and powering existing non-powered dams.
- *Wind Energy.* The FY 2011 budget request includes $49 million to "jump start" the domestic offshore wind industry and ensure that U.S. manufacturing and engineering firms achieve a position of global leadership in that industry. In FY 2011, the program will work to mitigate the barriers that have thwarted U.S. offshore development to date, which can be overcome through a concerted national effort with technical leadership from DOE. DOE's will support demonstration activities to reduce the environmental, technical, regulatory, and public acceptance risks of offshore wind deployment, as well as R&D of wind resource prediction tools, loads modeling, and other technical tasks which facilitate domestic manufacturing and deployment.
- *Weatherization and Intergovernmental Activities.* Weatherization and Intergovernmental Activities accelerate sustainable energy integration and clean energy deployment in partnership with States, U.S. Territories, the District of Columbia, and Native American tribal governments. The State Energy Program supports the expanding State role in utility, renewable energy, building code policies and other high impact energy projects. Tribal Energy Activities support feasibility assessments, planning, and implementation of clean energy projects on Tribal lands. The Weatherization Assistance Grants program, through a State-managed network of local weatherization providers, supports home energy retrofits for low-income families and career development opportunities for workers.

This Budget-in-Brief summarizes the key activities and changes in each of the 14 program areas. A chart summarizing the FY 2011 budget request is on page 76. More detailed program information, including the EERE FY 2011 budget request, can be found at www.eere.energy.gov.

Biomass and Biorefinery Systems R&D

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. These directly support the RFS mandated by EISA 2007. This work contributes to the near term creation of domestic green jobs and long-term reductions in GHG emissions and foreign oil dependence.

The Biomass Program addresses technical barriers to producing affordable biofuels across the supply chain. Biomass includes organic materials grown for the purposes of being converted to energy, such as agricultural wastes, forest resources, energy crops, and algae. To grow a domestic biofuels industry capable of sustainably producing large enough quantities of affordable biofuels to support EISA, the Biomass Program developed an approach centered on the integrated biorefinery concept. A biorefinery is a facility similar in function to a petroleum refinery that uses biomass instead of crude oil to produce fuels and a variety of useful co-products. In addition to its ongoing support of the RFS, in FY 2011 the program is also launching a similar effort for biopower, through a deployment 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.

FY 2011 Budget Request
Biomass and Biorefinery Systems R&D

Activity	Funding ($ in thousands) FY 2009 Approp.	FY 2010 Approp.	FY 2011 Request
Feedstocks	15,092	36,993	26,000
Conversion Technologies	51,993	85,108	80,000
Utilization of Platform Outputs R&D	147,160	97,899	0
Integrated Biorefineries	0	0	54,000
Analysis and Sustainability	0	0	10,000
Large Scale Biopower	0	0	50,000
TOTAL	**214,245**	**220,000**	**220,000**

In Fiscal Year 2011, the Department is requesting $220.0 million for the Biomass Program, the same as the FY 2010 appropriation.

In order to aggressively deploy integrated biorefinery technologies and a large scale biopower initiative with industry partners, the Biomass Program works with external partners to develop technical feedstock production and logistics solutions to lower feedstock costs and provide environmentally sustainable feedstock sources. Coupled with these feedstock efforts are the program's robust R&D

efforts to innovate and improve conversion technologies to equip biorefiners and biopower facilities with the best tools possible for producing affordable biofuels and renewable electricity. Finally, the Biomass Program conducts strategic analysis and sustainability activities to inform programmatic decision-making and strategic planning, as well as policy evaluation. The program continues to actively seek external feedback through the Biomass R&D Board, a stakeholder-comprised Technical Advisory Committee, and a range of other sources to inform its mission.

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 reducing GHG emissions; and, 3) create economic opportunities across the Nation.

The program directly supports the development of 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, that thereby diversify and expand the energy supply. It also addresses the goals and recommendations of the Farm Security and Rural Investment Act of 2002; EPAct 2005; EISA; and the Food, Conservation, and Energy Act of 2008 (FCEA).

The program funds key technology pathways that contribute to achieving these goals. An intermediate programmatic cost-competitive cellulosic ethanol target has been established based on EIA oil price projections in order to track progress toward the goals. Currently the cost target is $1.76 per gallon of cellulosic ethanol by 2012 (in 2007$), which includes feedstock and conversion costs. The program's technology pathways and respective contributions are detailed below.

Feedstocks

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. The overarching strategic goal is to develop 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.

- Sustainable Production focuses on ensuring that sound production strategies, both economically viable and environmentally sustainable, are developed and utilized. Sustainable Production also 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, trials will include increased emphasis on environmental sustainability, including measuring fluxes of water, soil carbon, and GHG emissions. 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 ($11 million).

- Logistics focuses on reducing costs associated with feedstock production, collection, storage and transportation 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. ($11 million)

- Algae is focuses on: 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 efforts include assessments on the availability of land, water and micronutrients on a national scale. Results of these modeling and analysis projects will be used as input for 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 ($4 million).

Conversion Technologies

- The Thermochemical key activity conducts research, testing, integration, and feasibility studies to convert biomass to fuels, chemicals and power via gasification, pyrolysis, and catalytic hydrotreating and hydrocracking processing technologies. The major technical challenges include: understanding feedstock requirements; improving conversion technologies to produce fuel intermediates such as clean synthesis gas and stable pyrolysis oils; improving catalysts and conversion technologies for production of fuels; process integration to optimize, intensify, and consolidate conversion processes; and understanding fundamentals and developing new concepts. In particular, efforts 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 to reduce overall costs of the next generation of biofuels derived from a wide range of feedstocks ($31 million).

- The Biochemical key activity focuses 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 ($49 million).

- The Algae key activities are **now categorized in Feedstock subprogram (formerly Feedstock Infrastructure)**

Integrated Biorefineries

- The Integrated Biorefineries will continue to support companies with the intent of commercializing biorefineries for the production of transportation fuels as the main product, with co-products (such as materials and chemicals, heat and power) as authorized by Section 932 of EPAct 2005 and in support of EISA 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 ($54 million).

Analysis and Sustainability

Systems 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 to successfully establishming a sustainable and economically viable U.S. cellulosic biofuels industry. With 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. Key activities include: Systems Analysis, Crosscutting Sustainability, and Systems Integration.

- 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 will be applied and 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 ($4 million).

- 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 ($4 million).

- 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: 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 public deployment of a streamlined version of the Biomass Scenario Model for use by the research community ($2 million).

Large Scale Biopower

A biopower deployment initiative will be launched to release a competitive solicitation for biopower and biochar RD&D, including an assessment of feedstock supplies with the ultimate goal of adding 500MW capacity by 2017. The new initiative will leverage 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. These activities will address challenges of 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 ($50 million).

Building Technologies Program

The mission of the Building Technologies Program (BT) is to develop technologies, techniques, and tools for making residential and commercial buildings more energy efficient, productive, and affordable. Energy use by residential and commercial buildings accounts for 40 percent of the Nation's total energy consumption, including 73 percent of the electricity and 56 percent of the natural gas consumed within the U.S. This level of energy use costs the U.S. approximately $400 billion annually. BT's activities are instrumental to the Nation's energy independence and economic viability. Increasing the energy efficiency of residential and commercial buildings leads to reductions in the consumption of electricity, natural gas, and to a lesser extent, oil; thus, America will be less vulnerable to energy supply disruptions, energy price volatility, and constraints in the Nation's electricity infrastructure. The FY 2011 request supports a portfolio of activities that includes advanced building technologies, such as solid state lighting, and their effective integration using whole-building-system-design techniques that will enable the design of net Zero Energy Buildings (ZEB), research on the latest retrofit technologies, and practices that will reduce consumption in existing homes and businesses. The program also includes the development of building energy codes and appliance standards that eliminate the most inefficient existing technologies in the market.

Residential Buildings Integration

The long-term goal of Residential Buildings Integration is to develop cost-effective technologies and building practices that will maximize the efficiency and user comfort in buildings and lower the required investments in renewable technologies for those that want to achieve zero energy homes.

FY 2011 Budget Request
Building Technologies

Activity	Funding ($ in thousands) FY 2009 Approp.	FY 2010 Approp.	FY 2011 Request
Residential Buildings Integration	21,900	40,000	39,000
Commercial Buildings Integration	32,057	39,000	39,000
Emerging Technologies	42,896	86,000	92,698
Technology Validation and Market Introduction	21,260	22,000	20,000
Equipment Standards and Analysis	20,000	35,000	40,000
TOTAL	**138,113**	**222,000**	**230,698**

The Fiscal Year 2011 request for the Building Technologies Program is approx. $230.7 million, an increase of $8.7 million from the FY 2010 appropriation.

Increased funding will support an industry-driven research program designed to accelerate the development and adoption of advanced building energy technologies in new and existing homes. BT will develop integrated cost-effective whole-building strategies to reduce the energy consumption of residential buildings by 70 percent and integrate cost effective renewable energy for the remaining 30 percent. During FY 2011, research for production-ready new residential buildings that are 50 percent more efficient will continue (one climate zone).

BT will also accelerate research in the marketplace to achieve 30 percent energy savings in thousands of new single family homes and research strategies to support home performance contracting to achieve 30 percent reductions in the energy use of existing homes ($39.0 million).

Commercial Buildings Integration

The Commercial Buildings Integration subprogram will develop cost-effective technologies and building practices to enable the design and construction of low energy intensive buildings, enhancing user comfort and reducing the required investments in renewable technologies for those that want to achieve zero energy buildings.

Commercial building research will accelerate the goal of 50 to 70 percent reduced energy consumption through activities with commercial building partners in three commercial building segments: retail, commercial real estate, and hospitals. BT will work with these key market segments to identify new or underused energy efficiency technologies for advancement in the marketplace. DOE will work with selected commercial building partners to construct or retrofit buildings that achieve savings of 50 percent and 30 percent respectively above ASHRAE/IESNA Standard 90.1-2004.

BT will support commercial retrofit programs through technical assistance (technical specifications; best practices and contractor qualification). The goal is to facilitate 500,000 to one million retrofits per year ($39.0 million).

Emerging Technologies

The Emerging Technologies subprogram seeks to develop cost-effective technologies (e.g., lighting, windows, and space heating and cooling) for residential and commercial buildings that enable reductions in building energy use by 60 to 70 percent. The improvement in component and system energy efficiency, when coupled with research to integrate onsite renewable energy supply systems into the commercial building, can result in marketable net zero energy designs ($92.7 million).

- Solid State Lighting will develop technologies that can reduce commercial building lighting electricity consumption by at least 50 percent. Projects will focus on the development of general illumination technologies that achieve energy efficiencies of up to 123 lumens per Watt, through the creation of a technical foundation to revolutionize the energy efficiency, appearance, visual comfort, and quality of lighting ($27.4 million).

- Space Conditioning and Refrigeration R&D will demonstrate design concepts with the long-term potential to reduce annual heating, ventilation, and air-conditioning (HVAC) energy consumption by 50 percent in new residential buildings including the development of an air-to-air integrated heat pump (IHP) system that can meet the air heating, cooling, dehumidifying, ventilating, and water heating requirements of a tight-envelope mechanically ventilated near-zero energy house and the development of a ground-source integrated heat pump (GSIHP) ($8.9 million).

- Building Envelope R&D will develop new envelope materials to continuously improve the energy efficiency of buildings. Specifically, this research will include phase change materials that adjust to optimize building performance. For example, the U.S. construction market uses predominantly light-weight walls that have low thermal storage. Historically, masonry walls have exhibited high heat storage capability that has buffered or reduced heating and cooling loads. BT's research will allow light-weight, low-cost construction practices to function similarly to heavy mass walls. In addition, BT will continue competitive fundamental 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. BT will continue its research on highly insulating windows such as vacuum glazings that can achieve R10 performance, approximately three times that of today's ENERGY STAR windows. Thermal loads will be decreased and cooling costs reduced by means cool roof R&D ($18.7 million).

- Analysis Tools and Design Strategies will conduct research on developing, improving, verifying, and maintaining software packages for engineers, architects, and builders who design or retrofit buildings to be more energy efficient and comfortable. Activities will focus on research and additions to whole-building energy simulation software that enables building designers, operators, owners, and researchers to evaluate technologies for improving the energy efficiency and comfort of buildings while reducing operating costs ($5.7 million).

- Solar Heating and Cooling focuses on the challenges of integrating solar technologies into building systems and products. Activities include: research on exemplary low-cost solar water heating systems in cold climates and development of prototype systems; R&D of combined solar heating, cooling, and water heating systems that utilize seasonal storage to achieve high solar fractions; continued development of dehumidification applications for combined photovoltaic/thermal systems; and support of a solar rating and certification system ($7.4 million).

- Energy Innovation Hub: Energy Efficient Building System Design initiated in FY 2010 that focuses on integrating smart materials, designs, and systems to tune buildings to conserve energy and control the allocation of lighting, heating, air conditioning, and electricity. Support for this Hub will continue in FY 2011 ($24.6 million).

Technology Validation and Market Introduction

The Technology Validation and Market Introduction subprogram funds activities that accelerate the adoption of clean, efficient, and domestic energy technologies. The major activities are:

- ENERGY STAR, a joint DOE/Environmental Protection Agency (EPA) activity, will focus its efforts on developing test procedures for ENERGY STAR products. In addition, increased efforts will be directed at the creation of verification procedures to ensure the brand integrity of ENERGY STAR products ($10.0 million).

- Rebuild America has been merged with the Commercial Building Integration R&D activity to accelerate the adoption of advances in commercial building integrated design, software tools, practices and advanced controls, equipment and lighting. BT will continue implementation of the EnergySmart Hospitals activity within the Commercial Buildings Integration subprogram.

- Building Energy Codes will support the development and upgrade of model building energy codes such as the ASHRAE Standard 90.1 for commercial buildings, and the International Code Council's International Energy Conservation Code (IECC) for residential buildings. DOE will also provide determinations as required on new ASHRAE or IECC building codes, and update the code compliance software, REScheck and COMcheck, to the efficiency levels in the current residential and commercial codes. DOE will provide technical assistance to States to promote code implementation ($10.0 million).

- Solar Decathlon, a high-profile university competition held biennially in Washington, D.C., promotes public awareness of highly efficient building technologies and zero-energy homes using solar energy. The FY 2011 budget request proposes a relocation of the Solar Decathlon to the proposed RE-ENERGYSE program, where it is proposed to be funded at $5.0 million.

Equipment Standards and Analysis

The Equipment Standards and Analysis subprogram develops minimum energy efficiency standards that are technologically feasible and economically justified as required by law. Federal energy conservation standards that have gone into effect since 1988 are projected to save 75 quadrillion Btus (Quads) of energy cumulatively by the year 2045. DOE committed to clear the backlog of delayed actions that accumulated during prior years, while simultaneously implementing all new requirements of EPAct 2005. EISA 2007 significantly increases the number of efficiency standards and test procedures DOE must develop, including incorporating standby and off mode power consumption into test procedures for residential products. 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). These will continue in FY 2011 along with the initiation of test procedures for 10 products. In FY 2011, DOE anticipates initiating energy conservation standard rulemakings on commercial clothes washers, small motors, and heating products ($35.0 million).

Federal Energy Management Program

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. These goals are accomplished through alternative financing contract support, technical assistance and training, coordination of Federal reporting and evaluation, supporting the introduction of advanced technologies into the Federal vehicle fleet and other leadership activities that support Federal agencies in meeting Executive Orders 13514 and 13423, as well as EPAct 2005 and EISA 2007 requirements. FEMP facilitates the award of alternative financing contracts between Federal agencies and the private sector, enabling agencies to install energy efficiency improvements quickly and pay off the costs incurred over a period of time using dollars saved on energy bills. Federal energy managers receive technical assistance from FEMP to identify, design, and implement energy efficient and renewable energy technologies and practices. FEMP publishes an annual Report to Congress on Federal energy efficiency and renewable energy use and conducts an awards program to recognize individuals and groups within Federal agencies that achieve excellence in energy management. FEMP will continue to support private sector development of alternative fuel stations at Federal sites, demonstrate opportunities for petroleum displacement to increase alternative fuel use, and conduct reporting and analysis of the Federal vehicle fleet. Through the DOE Specific Investments subprogram, FEMP will support technical assistance and direct funding of capital investments activities designed to establish DOE as the Federal agency leader in environmental, energy savings, and alternative fuels management.

FY 2011 Budget Request

Federal Energy Management Program

	Funding ($ in thousands)		
Activity	**FY 2009 Approp.**	**FY 2010 Approp.**	**FY 2011 Request**
Project Financing	8,000	11,800	12,072
Technical Guidance and Assistance	4,000	8,000	10,000
Planning, Reporting and Evaluation	2,000	3,000	5,000
Federal Fleet	2,000	3,000	3,000
DOE Specific Investment	6,000	6,200	12,200
TOTAL	**22,000**	**32,000**	**42,272**

The Fiscal Year 2011 request is $42.3 million, an increase of approx. $10.3 million from the FY 2010 appropriation.

Project Financing

FEMP facilitates Federal agencies' access to private sector financing to fund energy efficiency improvements through its Energy Savings Performance Contracts (ESPCs), public benefit funds, and Utility Energy Service Contracts (UESCs) program support. It provides guidance, documentation, and individual project assistance to Federal agencies that utilize these programs which help develop and finance energy improvements at Federal facilities that can benefit from significant energy system

retrofits. Under ESPCs and UESCs, agencies can take advantage of private sector expertise with little or no upfront cost to the Government ($12.1 million).

Technical Guidance and Assistance

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 energy produced at the site (a net zero energy building). 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, and energy assessments and assistance to help other agencies develop their own comprehensive planning and internal processes to reduce energy use and achieve water conservation goals ($10.0 million).

Planning Reporting and Evaluation

The National Energy Conservation and Policy Act (as amended by EISA 2007) requires DOE to collect, verify, and report on progress by the Federal agencies (including the DOE) toward the Federal energy management goals of reducing energy intensity in buildings, reducing petroleum usage, and conserving water. FEMP collects and publishes data for the annual Report to Congress and responds 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. FEMP activities include strategic communications and marketing, improved analysis of investments and financing, training for FEMP personnel and critical contractor support staff, as well as support for the GovEnergy conference. Activities include GHG accounting, reporting and guidance development required by EO 13514 ($5.0 million).

Federal Fleet

Federal vehicle fleet activities include the required tracking and reporting activities for the Federal fleet and the promotion of the increased use of alternative fuel for Federal Agency sites. Federal vehicle fleet activities support the integration of buildings, electricity, and electric vehicles or plug-in hybrid electric vehicles. FEMP will demonstrate opportunities for increased petroleum displacement through increased alternative fuel use ($3.0 million).

DOE Specific Investments

DOE Specific Investments includes activities designed to implement Federal environmental, energy, and transportation management goals throughout the DOE complex as set forth in Executive Orders 13514 and 13423, and EPAct 2005 and EISA 2007. Executable plans have been developed by DOE program offices that ensure that they will meet, exceed, and lead in the implementation of legislated and Executive Order goals. FEMP efforts will include providing project financing assistance, technical guidance and direct investment in DOE capital projects ($12.2 million).

Hydrogen and Fuel Cell Technologies

The mission of the Hydrogen and Fuel Cell Technologies (HFCT) Program is to reduce petroleum use, 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 goals are to advance theRDD&D of these technologies to make them competitive with alternative technologies in terms of cost, reliability and performance, and to reduce the institutional and market barriers to hydrogen and fuel cell commercialization.

FY 2011 Budget Request
Hydrogen and Fuel Cell Technologies

Activity	Funding ($ in thousands) FY 2009 Approp.	FY 2010 Approp.	FY 2011 Request
Fuel Cell Systems R&D	–	–	67,000
Hydrogen Fuel R&D	–	–	40,000
Hydrogen Production and Delivery R&D[a]	10,000	15,000	–
Hydrogen Storage R&D[a]	57,823	32,000	–
Fuel Cell Stack Component R&D[b]	61,133	62,700	–
Transportation Fuel Cell Systems[b]	6,432	3,201	–
Distributed Energy Fuel Cell Systems[b]	9,750	11,410	–
Fuel Processor R&D[b]	2,750	171	–
Systems Analysis	7,520	5,556	5,000
Market Transformation[c]	4,747	15,026	9,000
Manufacturing R&D	4,480	5,000	5,000
Technology Validation[d]	–	13,097	11,000
Safety and Codes and Standards[c,d]	–	8,839	–
Education[d]	–	2,000	–
TOTAL	**164,638**	**174,000**	**137,000**

[a] Consolidated into Hydrogen Fuel R&D in FY2011.

[b] Consolidated into Fuel Cell Systems R&D in FY2011.

[c] Consolidated into Market Transformation in FY2011, however only safety, codes and standards activities are funded by Market Transformation in FY2011.

[d] Technology Validation, Safety and Codes & Standards, and Education were funded within the Vehicles Technology Program in FY 2009: total $31,227.

The Fiscal Year 2011 budget request for Fuel Cell Technologies is $137.0 million, $37.0 million less than the FY 2010 appropriation.

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 end-user susceptibility to energy price fluctuations, GHG emissions, 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. These include renewable resources such as biofuels and by-products from biomass, as well as conventional fuels such as natural gas. Depending on the resource used in the fuel cell and considering the entire energy path, substantial reductions in CO_2 emissions and petroleum use can be attained. Since fuel cells are quiet, clean and efficient, they are ideal for generating electricity and heat in commercial, industrial, or residential applications. Fuel cell systems have been shown to be economically favorable over conventional technologies for material handling equipment in two- and three-shift indoor warehouse operations and for combined heat and power (CHP) applications, including cooling and reliable electricity for data centers. Other early market applications include backup power for critical loads, such as telecommunications. Fuel cells and hydrogen can be used for storing energy on the 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.

PROGRAM FOCUS

The HFCT Program maintains a strong effort in key areas of hydrogen and fuel cell research for the long term as part of the Department's balanced portfolio of clean energy options which continues to focus on battery and biofuel approaches for more near term impact. Increasing market penetration for both near term and long term applications requires a sustained effort in Fuel Cell Systems R&D to deliver higher performance and lower cost materials and components. For the mid- and longer term, a sustained effort in Hydrogen Fuel R&D is necessary to improve alternate hydrogen production pathways from a diverse portfolio of energy resources, including domestic or renewable resources such as 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 and energy security, and job creation. HFCT will include multiple fuel cell technologies (such as solid-oxide, alkaline and polymer electrolyte membrane fuel cells) for multiple fuel sources (including bio-derived renewable fuels such as methanol and fuels derived from other renewable resources, as well as natural gas and diesel). 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 Fuel Cell Systems R&D subprogram proposes to consolidate the efforts of four previous subprograms (Fuel Cell Stack Components R&D, Transportation Fuel Cell Systems, Distributed Energy Fuel Cell Systems, and Fuel Processor R&D), to allow for more cross-cutting, technology neutral R&D that can address long-term applications including transportation, as well as applications

with near-term impact such as distributed energy. Current projects to improve the membranes and bipolar plates in fuel-cell stacks have made sufficiently good progress that no new projects starts in those areas is planned for FY 2011, although the existing projects will continue.

The Hydrogen Fuel R&D subprogram consolidates two previous subprograms: Hydrogen Production and Delivery R&D and Hydrogen Storage R&D, in order to leverage the technological synergies inherent to production, delivery and storage of hydrogen, such as systems that generate and store hydrogen from intermittent renewable energy sources. Hydrogen Fuel R&D activities will focus on hydrogen storage materials and engineering R&D, and on production and delivery R&D for hydrogen from renewable resources, while deferring some longer-term materials R&D.

The Market Transformation activity consolidates its prior early-market activities with Education and Safety, Codes and Standards activities critical for early-market activities and commercialization of fuel cell technology. In FY 2011, Market Transformation focuses on safety, codes and standards and defers additional funding for education and early-market activities. The Recovery Act provided substantial funding for early-market activities, which continue in FY 2011.

Technology Validation will continue to collect and analyze real-world operating data from fuel cells in stationary and vehicle applications. Several current projects will be completed in FY 2010 and do not require additional support in FY 2011.

Fuel Cell Systems R&D

The goals of the Fuel Cell Systems R&D subprogram (FCS) are to address the key challenges of improving the durability, reducing the cost, and improving the performance (power, start-up time, transient response, etc.) of fuel cell systems. These advances are necessary to enable fuel cells to expand into new markets and compete with other advanced technologies, and will require improvements in fuel cell stack and balance of plant components. FCS R&D will improve multiple core technologies, including: membrane-electrode assemblies (MEA), catalysts, membranes, and balance of plant components for polymer electrolyte membrane (PEM) fuel cells; interconnects, catalysts, and design configurations for solid oxide fuel cells; and catalysts, improved tolerance to contaminants, and design configurations for alkaline fuel cells.

In FY 2011, Fuel Cell Systems catalyst R&D will include 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.

FCS will develop high temperature membranes that allow better catalyst utilization, reduce the negative effects of impurities and decrease the size of the cooling system, and will continue current projects to 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.

R&D on fuel cell system degradation will include studies of fuel cell materials and components to identify the degradation mechanisms, as well as approaches for mitigating the effects of these mechanisms. 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.

The subprogram will also continue efforts in imaging, characterizing and modeling water transport within fuel cell stacks. As technology advances in membranes and catalysts allow for increased fuel cell power density, water production in fuel cells also intensifies. Fuel cells must be designed to manage the transport of water within fuel cell stack component materials for a wide range of ambient temperature, humidity, and pressures at which fuel cells must operate. Humidity is essential to maintaining proton conductivity in the fuel cell membranes. However, adequate removal of product water is essential to avoid flooding, which inhibits fuel and air from reaching the active sites in the MEA catalyst layer. It is also essential to remove the residual water from the stack before shut-down to avoid damage resulting from freezing conditions.

New R&D projects in FY 2011 will develop integrated MEAs. As membrane and catalyst projects produce promising candidates for integration, the MEA projects will take a multi-disciplinary approach to design the MEA system, addressing the interfacial, chemical, mechanical issues and considering manufacturability of integrating the component materials into a functional sub-system.

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. FCS will focus on the development of low-cost novel and durable humidification materials that perform in all operating environments while meeting size and weight restrictions. Advances will be made in air compression technology to decrease the size and material cost of the components. Low-cost and reliable hydrogen sensors are being developed to ensure the cost target for fuel cell systems is met. Ongoing portable power R&D projects focus on materials such as the anode, cathode, and membrane improvements for fuel cells that convert fuels such as methanol and ethanol to electrical power. Anode and cathode catalyst loading for portable power fuel cells will be reduced, while improving catalytic activity and durability ($67 million).

Hydrogen Fuel R&D

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 end user operations of compression, storage and dispensing.

The hydrogen storage component 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 will be 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. This research is also applicable to energy storage systems that enable intermittent, renewable energy resources and combined heat, hydrogen, and power (CHHP) applications ($40 million).

Systems Analysis

The Systems Analysis subprogram supports program decision-making by evaluating the risks and benefits of fuel cell technologies and pathways. These efforts determine 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 and systems.

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 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 ($5.0 million).

Market Transformation

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 RDD&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.

In FY 2011, the Market Transformation activity will include efforts previously included in the Safety and Codes & Standards and Education subprograms. No funding is planned for education or early-market activities in FY 2011 under Market Transformation. Instead, the HFCT Program will assess the impact of $42 million awarded from the Recovery Act to help stimulate market pull, increase manufacturing volumes and reduce the cost for fuel cell systems. Potential future efforts for Market Transformation will be determined based on the impact of the Recovery Act projects. Funding is provided for Safety, Codes and Standards activities required to help accelerate Market Transformation. For example, the Program 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-effective verification of fuel purity. Metering technologies will also be supported to allow accurate measurement of delivered fuel. DOE will collaborate with DOT, EPA, NIST and other government agencies to ensure that fuel, fuel storage and dispensing standards development proceeds in agreement with existing regulatory authorities.

In addition, funding will facilitate the development of computational fluid dynamics models to support risk assessment activities for fueling, production infrastructure, and transportation of alternative fuels in tunnels, garages, and other confined spaces. The activity will also conduct R&D to characterize the release of hydrogen when impeded by various obstacles/equipment to provide the input necessary to

determine codes for setback distances.

Early Market Activities previously collaborated 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 capitalizes on an excellent opportunity for testing fuel cells under real world conditions, and providing feedback to manufacturers. Operations and performance data of the fork lifts will continue to be collected and analyzed, but new activities are deferred while FY 2009 Recovery Act projects are completed and evaluated ($9.0 million).

Manufacturing R&D

The Manufacturing R&D subprogram will continue to 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 and developing a robust domestic supply base.

In FY 2011, the subprogram will expand 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 ($5.0 million).

Technology Validation

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 FY 2011, data from stationary fuel cells in early market applications will be collected and evaluated. In addition, limited validation activities will be conducted to address fuel cell systems used in applications such as 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. Validation activities will include an evaluation of data from fuel cell buses. Collaboration with the DOT includes validating fuel cell and hydrogen technologies in transit bus applications in coordination with the Federal Transit Administration, and harmonizing data collection efforts with other fuel cell bus 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 projects have completed objectives in 2010, and the remainder of the projects, which include second generation vehicles, will conclude by the end of 2011 ($11 million).

Geothermal Technology

The Geothermal Technology Program (GTP) works in partnership with industry to establish geothermal energy as an economically competitive contributor to the U.S. energy supply. Geothermal energy generates electricity or supplies heat for direct applications, including aquaculture and district heating, or for use in heat pumps to heat and cool buildings. The technologies developed by this program provide the Nation with sources of electricity that are highly reliable and cost competitive that do not add to air pollution or GHG emissions. Geothermal electricity generation is also not subject to fuel price volatility and supply disruptions from changes in global energy markets.

The program focuses on Enhanced Geothermal Systems (EGS), which are engineered reservoirs created to produce energy from geothermal resources deficient in economical amounts of water and/or permeability. EGS is a new pathway for producing geothermal energy by drilling wells into hot rock, fracturing the rock between the wells, and circulating a fluid through the fractured rock to extract the heat. While EGS reservoirs have been designed, built, and tested in various countries, a number of technical hurdles remain—the most important involving creation of EGS reservoirs with commercial production rates and lifetimes. DOE will overcome these hurdles by initially concentrating on technologies for reservoir creation, operation, and management.

This strategy involves working with cost-sharing partners at existing geothermal fields to develop, test, and perfect the tools needed to fracture hot, impermeable rock and efficiently circulate fluids. Technology development will rely on R&D and multiple field experiments in partnership with industry with support from various research institutions.

FY 2011 Budget Request
Geothermal Technology

Activity	Funding ($ in thousands) FY 2009 Approp.	FY 2010 Approp.	FY 2011 Request
Enhanced Geothermal Systems	43,322	44,000	55,000
TOTAL	**43,322**	**44,000**	**55,000**

The Fiscal Year 2011 request is $55.0 million, an increase of $11.0 million from the FY 2010 appropriation.

A feasibility study by the Massachusetts Institute of Technology (MIT) estimates that EGS could provide 100,000 MW of electric power—10 percent of currently installed electric capacity—by 2050[1]. This compares with today's 2,900 MW of installed capacity at existing U.S. geothermal power plants. Operating as a closed loop (no water exchange outside of the system), EGS power plants will have no atmospheric or greenhouse gas emissions. Expected program outcomes will include creation of a commercial-scale geothermal reservoir (approximately 5 MWe in capacity) capable of operating for seven years by 2015.

[1] 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

In FY 2010, 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 recover heat from the stimulated rock volume using water as the heat mining fluid. Additional field demonstrations will support higher production well flow rates and allow innovative heat extraction techniques that will eventually lead to commercial applications. GTP also issued an EGS demonstration solicitation in FY 2010 to evaluate innovative, environmentally benign technologies. 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 research on low temperature geothermal, international, induced seismicity, as well as analysis, and planning. GTP will collaborate 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.

These activities 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. 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 yet been validated with field testing. In FY 2011, EGS efforts at demonstration field sites are expected to increase the EGS flow rate to 12 kilograms 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 ($55.0 million).

Industrial Technologies Program

The Industrial Technologies Program (ITP) seeks to reduce the intensity of energy use (energy per unit of output) of the U.S. industrial sector through the targeted research, development, and deployment (RD&D) of next generation manufacturing technologies, and the leveraging of collaborative industry partnerships for the adoption of efficient technologies and process improvements. Industrial energy consumption accounts for about one-third of all U.S. energy use, and 94 percent of industrial carbon emissions.

In 2006, the most recent year for which complete data is available, ITP directly contributed to industrial energy savings of almost 500 trillion Btus. ITP estimates that technologies developed and activities undertaken since 1977 have cumulatively saved more than 103 million metric tons of carbon equivalent ($MMCO_2E$) and over 5.6 Quads of energy. The heart of ITP's success is a strong emphasis on collaboration with industry partners. This collaboration is illustrated by ITP's *Save Energy Now* initiative (SEN). Between its inception in 2006 and November 2009, the initiative has completed 2,421 assessments at the Nation's most energy-intensive industrial facilities, identifying ways to save over 122 trillion Btus of natural gas, roughly equivalent to natural gas use by 1.7 million average U.S. homes. Building upon these successes, ITP will expand these partnership efforts. Simultaneously, ITP will continue to forge ahead on the cutting-edge of technological innovation with diverse RD&D partners, and initiate transformational R&D activities to address long-term climate change issues.

FY 2011 Budget Request

Industrial Technologies

Activity	FY 2009 Approp.	FY 2010 Approp.	FY 2011 Request
	Funding ($ in thousands)		
Industries of the Future (Specific)	15,160	12,121	2,627
Industries of the Future (Crosscutting)	53,469	53,005	55,213
Industrial Technical Assistance	19,567	30,874	32,160
Manufacturing Energy Systems	0	0	10,000
TOTAL	**88,196**	**96,000**	**100,000**

The Fiscal Year 2011 budget request of $100.0 million for Industrial Technologies is $4.0 million more than the FY 2010 appropriation.

Industries of the Future (Specific)

To reduce the energy consumption and improve environmental performance, Industries of the Future (Specific) cost-shares RD&D of advanced technologies with partners from the chemicals industry and continues on-going multi-year activities initiated in prior years with the forest and paper products,

steel, and aluminum industries until completion. Key technologies under investigation and development within the chemical industry include industrial process equipment improvement, alternative chemical feedstocks, and application of new scientific understanding of chemistry to chemical processing applications. In FY 2011, ITP will also undertake an exploratory study with the cement industry to identify the pathways for significant carbon emission reduction ($2.6 million).

Industries of the Future (Crosscutting)

Industries of the Future (Crosscutting) activities involve cost-shared RD&D for advanced technologies with potential applications across many industries and crosscutting outreach efforts that promote the use of energy efficient technologies and practices throughout all industries.

ITP conducts crosscutting RD&D work through its key activities to maximize the reach of its benefits to industry. The Energy-Intensive Process R&D key activity is comprised of four areas: industrial reaction and separation, high-temperature processing, waste energy minimization and recovery, and sustainable manufacturing. The Industrial Materials of the Future key activity involves R&D on durable materials for energy systems and separations, advanced materials solutions for waste energy recovery, new high temperature corrosion-resistant materials, and advanced manufacturing processes such as low cost titanium production. The Nanomanufacturing key activity involves collaborative efforts to build upon existing science and develop next-generation nanomanufacturing processes to dramatically reduce energy intensity, including technologies and processes for enabling the mass production and application of nano-scale materials, structures, devices, and systems. In FY 2011, ITP will also undertake an explorative study to focus on issues surrounding water resources related to industrial processes. Specifically, ITP will investigate the current and state-of-the art desalinization technologies utilized for both potable and industrial applications.

In Combined Heat and Power Generation, activities will support the CHP 2030 plan to accelerate the market adoption of combined heat and power (CHP) in industry. CHP is an optimal energy efficiency solution that creates green jobs, reduces GHG emissions, and improves the efficiency of U.S. industry. R&D will focus on advanced prime movers, key components, and integrated systems for clean, efficient, and fuel-flexible CHP systems (<20 MW) focusing on non-traditional CHP applications, including untapped markets in the industrial sector. Market transformation will be accomplished through partnerships including the regional Clean Energy Application Centers. Fuel and Feedstock Flexibility key activity work will support efforts to replace natural gas and oil use by continuing R&D and analysis addressing fuel and feedstock flexibility technology platforms and industrial process integration issues in order to increase market adoption of emerging energy technologies ($55.2 million).

Industrial Technical Assistance

The Industrial Technical Assistance key activity will continue to drive the latest energy efficient technologies practices to industry through the Energy Services Development and *Save Energy Now* (SEN) Leaders Partnership key activities, which will help energy-intensive plants and new emerging sectors implement cost-effective, energy-saving, and carbon-reducing technology solutions through the dissemination of energy assessment, tools, information, and training either directly or through State, utility and local partners. In Energy Services Development, the Industrial Assessment Center (IAC) will fund a network of universities that deploy undergraduate and graduate engineering students to conduct free energy audits of small and medium-size manufacturers. A strategic expansion of SEN activities will be undertaken through targeted corporate outreach efforts with the most energy intensive industries, including partnerships with leading industrial companies, plants, and supply chains to

reduce their energy intensity by 25% over a 10 year period. Through SEN, ITP will continue conducting plant energy assessments and audits, and delivering other ITP services, technologies, and products to plants nationwide either directly or through State, utility and local partners ($32.2 million).

Manufacturing Energy Systems

The Manufacturing Energy Systems Program (MESP) establishes 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 CO_2 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 products. In FY 2011, ITP will initiate activities by selecting critical areas to be funded, competitively solicit for MESP centers, and initiate program activities ($10.0 million).

RE-gaining our ENERGY Science and Engineering Edge

The mission of the RE-gaining our ENERGY Science and Engineering Edge (RE-ENERGYSE) program 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. This DOE-wide program will:

- Fund fellowships for highly qualified undergraduate, graduate, and post-doctoral students to study and conduct research in technical subjects with a focus on low carbon energy systems;
- Fund the development of interdisciplinary master's programs that combine engineering, business, environmental science, and other fields to produce well-rounded energy professionals.
- Support community colleges and training centers in developing programs to educate and train workers with specialized expertise needed in the energy field;
- Support the Solar Decathlon, a DOE-led university student competition that integrates energy efficiency and renewable energy technologies in the design and construction of net-zero energy homes; and
- Provide education and energy literacy to K-12 schools, educators, and students to ensure a sufficient pipeline of well-educated and inspired individuals to enter the workforce.

FY 2011 Budget Request
RE-ENERGYSE

Activity	Funding ($ in thousands) FY 2009 Approp.	FY 2010 Approp.	FY 2011 Request
Higher Education	0	0	35,000
Technical Training and K-12 Education	0	0	15,000
TOTAL	**0**	**0**	**50,000***

The Fiscal Year 2011 request for RE-ENERGYSE is $50.0 million. Funding shown here does not include $5 million requested in the Office of Nuclear Energy for the Nuclear Energy Fellowship.

Higher Education

The Higher Education activity will provide competitive fellowships, internships, and post-doctoral research opportunities in fields of study relevant to the invention and commercialization of advanced clean energy technologies and systems, such as net-zero energy buildings, nanotechnology-based solar cells, energy storage for advanced electric cars, smart grid technologies, and other areas. In particular, RE-ENERGYSE will offer up to 60 three-year fellowships for graduate students in engineering and relevant fields; up to 70 post-doctoral one-year research opportunities; and up to 1,000 undergraduate assistantships to support hands-on summer research and continued study in the clean energy field with participating faculty members; two new interdisciplinary professional master's programs in clean energy; and the Solar Decathlon, involving more than 3,000 university students each year ($35.0 million).

Technical Training and K-12 Education

The Technical Training and K-12 Education activity will support the development of effective training programs at community colleges and other training centers. Competitively-selected institutions will develop up-to-date, technically accurate curricula and training programs focused on clean energy systems and management. These activities will be designed to meet current and near-term local and regional market needs for a clean energy workforce. RE-ENERGYSE will also seek to engage and empower K-12 students and educators to develop the education-to-workforce pipeline necessary to ensure U.S. leadership in energy and climate change mitigation ($15.0 million).

Solar Energy

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 green jobs.

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. Developing technologies that can reliably and affordably harvest this resource will greatly enhance national energy security while reducing the effects of global warming and create U.S. jobs. 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.

Targeting improved performance and reliability with reduced cost, the Solar Program partners with industry, universities and National Laboratories to focus its RDD&D activities in five subprograms: Photovoltaics R&D, Concentrating Solar Power, Systems Integration, and Market Transformation.

FY 2011 Budget Request

Solar Energy

Activity	Funding ($ in thousands) FY 2009 Approp.	FY 2010 Approp.	FY 2011 Request
Photovoltaic Energy Systems	142,793	128,490	152,000
Concentrating Solar Power	29,621	49,720	98,200
Systems Integration	0	23,250	30,698
Market Transformation	0	23,540	21,500
Solar Electricity Energy Innovation Hub	0	22,000	0
TOTAL	**172,414**	**247,000**	**302,398**

The Fiscal Year 2011 budget request for Solar Energy of $302.4 million is an increase of $55.4 million over the FY 2010 appropriation.

Photovoltaic R&D

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 to: 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 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; and continue reliability research to increase the lifetime of PV components and systems, and prove the profitability of new PV technologies ($152.0 million).

Concentrating Solar Power (CSP)

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,DOE is ramping up CSP RD&D efforts. These efforts, which leverage the capabilities of both industry partners and the National Laboratories, are directed toward the development of parabolic trough, dish/engine, and power tower CSP systems. In FY 2011 the CSP subprogram will focus on three major areas:

- Conducting R&D on low cost systems that include thermal storage to achieve cost competitiveness in the intermediate and baseload power markets;
- 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; and
- Launching a demonstration of new CSP technologies that could lead to over 1 GW of projects ($98.2 million).

Systems Integration

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 ($30.7 million).

Market Transformation

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. Efforts also 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 ($21.5 million).

Vehicle Technologies

The Vehicle Technologies (VT) program focuses on highway vehicles (passenger and commercial vehicles), which account for 55 percent of total U.S. oil use ─ more than all U.S. domestic oil production.

Cost-competitive, more energy-efficient and fuel diverse vehicles will enable individuals and businesses to accomplish their daily tasks while reducing petroleum consumption and GHG emissions.

The program supports 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 program's R&D efforts pursue four technology pathways, each of which can improve vehicle efficiency relative to conventional technology, thus lowering vehicle oil use and GHG emissions: improve hybrid electric vehicle (HEV) component efficiency (up to 50 percent improvement in fuel economy); improve plug-in hybrid electric vehicle (PHEV) and electric vehicle (EV) components (up to 300 percent improvement in fuel economy); improve combustion engines and fuel characteristics (up to 40 percent improvement in fuel economy and displacement of oil by non-petroleum fuels); and reduce the weight of vehicles (up to 30 percent improvement in fuel economy).

FY 2011 Budget Request

Vehicle Technologies

Funding ($ in thousands)

Activity	FY 2009 Approp.	FY 2010 Approp.	FY 2011 Request
Batteries and Electric Drive Technology	101,572	101,405	120,637
Vehicle and Systems Simulation & Testing	21,126	44,328	44,328
Advanced Combustion Engine R&D	39,657	57,600	57,600
Materials Technology	38,786	50,723	50,723
Fuels Technology	19,560	24,095	11,000
Outreach Deployment & Analysis	46,442	33,214	41,014
TOTAL	**267,143**	**311,365**	**325,302**

The Fiscal Year 2011 request is $325.3 million for the Vehicle Technologies Program, a $13.9 million increase over the FY 2010 appropriation..

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 improvement for commercial vehicles. Achievement of the Nation's transportation goals for reductions in petroleum use and GHG emissions will require a measure of success in all of these

R&D areas.

In FY 2011, a proposed budget structure change gives batteries and electric/hybrid vehicles a dedicated budget line, Batteries and Electric Drive Technology. This change emphasizes the program's increased focus on technologies for PHEVs, in particular the development and deployment of enough advanced battery manufacturing capacity to support 500,000 plug-in hybrid electric vehicles a year by 2015. The Battery and Electric Drive Technology subprogram contains all the activities of the former Hybrid Electric Systems subprogram except for Vehicle and Systems Simulation and Testing (VSST), which is now a separate subprogram. VSST was made a separate subprogram to better emphasize crosscutting and non-electric/hybrid activities that tie together all of the Vehicle Technologies R&D.

Batteries and Electric Drive Technology (formerly Hybrid Electric Systems)

This subprogram funds core technology R&D necessary for hybrid and electric vehicles to achieve significant improvements in fuel economy without sacrificing safety, the environment, performance, or affordability. The subprogram focuses on the basic building blocks of electric drive vehicles: advanced batteries and electric drive (power electronics and electric motors) ($120.6 million).

- The Battery/Energy Storage R&D activity addresses the first building block of a hybrid-electric vehicle: electricity storage. 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. Activities support the development of advanced high-energy and high-power batteries for electric drive vehicles and R&D into advanced materials to enable the development of next generation batteries and systems. The activity coordinates with other DOE programs working in advanced battery technologies, such as the Office of Science and the Office of Electricity Delivery and Energy Reliability, in order to maximize returns on DOE's investments. 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.
- Full system development continues in cooperation with multiple battery suppliers both through the United States Advanced Battery Consortium (USABC) and direct contracts with DOE. The program will continue to develop full-sized lithium-ion modules using thermally stable, high-performance anode and cathode materials in order to lower cost and improve performance. The activity supports the development of a lithium-ion materials supply base through direct development contracts with industry. All subcontracts are awarded under a competitive process and are at least 50 percent cost-shared by developers.
- Longer term research focuses on developing advanced materials for the next generation of energy storage technologies through research at universities and National Laboratories. The primary goal of this activity is to develop and engineer higher-energy electrodes utilizing high capacity cathode and anode materials. Optimal cell chemistries will be developed and evaluated using the most promising higher energy density materials and evaluated. The activity will continue to develop advanced diagnostic techniques to investigate and better understand life- and performance-limiting processes in lithium-based batteries in transportation applications. This activity will develop and apply electrochemical models to understand failure and thermal runaway mechanisms in lithium batteries, and to design new functional materials.
- FY 2011 activities will further accelerate the development of batteries for PHEVs including: (1) expanding work on next generation energy storage; (2) developing low cost packaging and thermal

management technologies; (3) developing battery computer aided engineering design tools; and (4) investigating 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 ($96.7 million).

- Advanced Power Electronics and Electric Motors R&D addresses the second building block of hybrid-electric and electric vehicles, which include the electric and electronic devices that deliver the power stored in the battery to the vehicle's drive-train. These include: power control circuits; charging circuits; electric motors and magnetic materials; logic to synchronize the power from the battery and motors with the main vehicle engine; and other related components.

- Existing work in these areas will be expanded in FY 2011 to address the more stringent performance requirements for PHEVs. Activities focusing on advanced materials will be enhanced to enable the production of prototype devices to accelerate the process of transferring research results to device manufacturers. Additionally, a new solicitation will be issued to fund industry R&D efforts to develop power electronics and electric motors, with goals of achieving substantial reductions in cost, weight, and volume ($23.9 million).

Vehicle and Systems Simulation and Testing

- The Vehicle and Systems Simulation and Testing subprogram includes a number of crosscutting activities that tie together all Vehicle Technology R&D. The VSST activity integrates modeling, systems analysis, and testing efforts to define R&D technical targets and requirements; guides technology development; validates technology performance; and integrates advanced energy storage, power electronics, electric motors, and other technologies to maximize vehicle efficiency. The activity develops and validates advanced computer models and simulation programs used to:
  - Develop performance targets for vehicle platforms and their components, and
  - Develop advanced control strategies to optimize the performance and efficiency of advanced hybrid electric, plug-in hybrid electric, battery electric, and fuel cell vehicles.

  The activity also performs R&D on heavy vehicle systems to achieve the fuel efficiency goals of the 21st Century Truck Partnership by:
  - Developing advanced heavy vehicle systems models, and
  - Reducing non-engine parasitic energy losses from aerodynamic drag, friction and wear, under-hood thermal conditions, and accessory loads.

  Funding for FY 2011 will support the laboratory and field evaluations of large-scale demonstration fleets of advanced commercial and passenger PHEVs and EVs, which were expanded in FY 2010. These evaluations will collect significant data on the interaction of electric-drive vehicles with charging infrastructure and the electric utility grid. VSST will also expand efforts to address codes and standards needed to enable wide-spread adoption of transportation electric-drive technologies. Work will continue with industry partners on the development, validation, and deployment of an industry standard advanced component and vehicle modeling and simulation tool that will reduce the need for repetitive modeling tool development, reduce the cost of component and vehicle development, and increase the speed at which technologies enter the marketplace for light, medium, and heavy vehicles. VSST will expand activities in the SuperTruck Initiative to develop and integrate technologies addressing aerodynamic load reduction, hybridization, auxiliary load reduction, and idle reduction to greatly improve commercial vehicle efficiency. VSST will validate, in a systems environment, performance targets for deliverables from the power electronics and

energy storage technology R&D activities, and examine overall vehicle impacts associated with integration of other advanced vehicle technologies ($44.3 million).

Advanced Combustion Engine R&D

This subprogram focuses on removing critical technical barriers to commercialization of higher efficiency, advanced internal combustion engines for passenger and commercial vehicles. The goals are to develop engine technologies to dramatically increase the fuel economy of passenger vehicles by 25% to 40% and commercial vehicles by 20% while meeting cost, durability, and emissions constraints, and allowing earlier market introduction.

- The Combustion and Emission Control R&D activity develops technologies to improve the thermal efficiency of internal combustion engines by optimizing combustion, fuel injection, air handling, emission control, and waste heat recovery systems, along with reducing friction and pumping losses, while minimizing emissions. Research will continue to emphasize development of engines that can operate in advanced combustion regimes (Homogeneous Charge Compression Ignition and other modes of low temperature combustion) and in lean-burn gasoline mode to achieve the fuel economy goals for cars and trucks by 2015. Research to meet future emission standards will focus on projects that include the development of low-cost base metal catalysts (to replace expensive platinum group metals), lighter and more compact multifunctional components, and new control strategies resulting in near-zero emissions of NO_x and particulate matter ($48.6 million).
- Solid State Energy Conversion activity develops technologies to convert waste heat from engines to electrical energy that will improve the overall thermal efficiency and reduce emissions. This activity will continue cost-shared cooperative agreements awarded in FY 2009 and FY 2010 to develop and fabricate high efficiency thermoelectric generators and thermoelectric air conditioning for passenger vehicles. The activity will also investigate scaling up production of thermoelectric modules for demonstration in vehicle applications with the potential to improve vehicle fuel economy by up to 10 percent ($9.0 million).

Materials Technology

The Materials Technologies subprogram supports the development of cost-effective materials and manufacturing processes that can contribute to fuel-efficient passenger and commercial vehicles. The subprogram consists of three activities: Propulsion Materials Technology, Lightweight Materials Technology, and the High Temperature Materials Laboratory (HTML).

- The Propulsion Materials Technology 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 VT.
- In FY 2011, research efforts will support Advanced Combustion Engines, Fuels and Hybrid Electric Systems to achieve energy efficiency improvements and petroleum displacement goals. Researchers will 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. 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 ($13.4 million).

- The Lightweight Materials Technology activity supports R&D on advanced concepts to reduce the weight of vehicles, accomplished primarily by the substitution of lower density or stronger materials for current materials. Materials include magnesium, aluminum, advanced high-strength steels and titanium, as well as polymer- and metal-matrix composites reinforced with fibers and particulates. Since cost-effectiveness is the major materials challenge, this element supports R&D and validation of low cost materials and processes needed to meet the goal of 50% 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.
- 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 ($31.5 million).
- The High Temperature Materials Laboratory is an advanced materials R&D industrial user center at the Oak Ridge National Laboratory that develops cutting-edge analytical techniques to identify innovative materials for use in surface transportation applications ($5.8 million).

Fuels Technology

The Fuels Technology subprogram supports R&D that will provide vehicle users with cost-competitive fuel options that enable high fuel economy, deliver low emissions, and contribute to petroleum displacement.

- In FY 2011, Advanced Petroleum-Based Fuels (APBF) activities will be discontinued to reflect a shift in emphasis to higher priority transportation technologies, including transportation electrification.
- The Non-Petroleum-Based Fuels and Lubricants (NPBFL) activity formulates and evaluates non-petroleum-based fuels and lubricants that can be used as neat (pure) alternative fuels or as blendstocks in transportation fuels. 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 ($11.0 million).

Outreach, Deployment and Analysis (formerly Technology Integration)

The Technology Integration subprogram is renamed Outreach, Deployment and Analysis to better reflect the nature of the subprogram activities. This subprogram accelerates the adoption and use of alternative fuel and advanced technology vehicles to help meet national energy and environmental goals and accelerate dissemination of advanced vehicle technologies through demonstrations and education. The regulatory elements include legislative, rulemaking, and compliance activities associated with alternative fuel requirements identified within the Energy Policy Acts of 1992 and 2005. Advanced Vehicle Competitions and Graduate Automotive Technology Education activities that support the development of students with technical skills in the same areas of technology where the program is engaged in advanced R&D will also continue.

- The Graduate Automotive Technology Education (GATE) activity in FY 2011 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 will release a solicitation for the next round of GATE Centers of Excellence ($1.0 million).
- Advanced Vehicle Competitions. FY 2011 will be the third year of the EcoCAR Challenge, a three-year competition that builds on the 20-year history of DOE advanced vehicle technology competitions by giving engineering students the chance to design and build advanced vehicles that demonstrate leading-edge automotive technologies, with the goal of minimizing the environmental impact of personal transportation and illustrating pathways to a sustainable transportation future ($2.0 million).
- The Legislative and Rulemaking activity consists of implementation of the State and Alternative Fuel Provider Regulatory Program; alternative fuel designations; the Private and Local Government Fleet Regulatory Program; and other EPAct requirements including reports and rulemaking; analyses of the impacts from other regulatory and pending legislative activities; and the implementation of legislative changes to the EPAct fleet activities as they occur. Fleet programs require selected covered fleets to procure alternative fuel passenger vehicles annually ($2.0 million).
- The Vehicle Technologies Deployment activity will continue to promote the adoption and use of petroleum reduction technologies and practices by working with local Clean Cities coalitions and their stakeholders, industry partners, fuel providers, and end-users. The program also will continue efforts to provide technical assistance for early adopters of technologies and provide education, training, and workshops to coalitions, public safety officials, and stakeholders related to infrastructure development and targeted niche market opportunities. FY 2011 funding includes $20 million to support 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 electric drive vehicles and infrastructure will also be conducted ($35.5 million).
- Biennial Peer Reviews - Funding is used to conduct reviews of the government/industry partnerships by an independent third party to evaluate the progress and direction of the program ($0.5 million).

Water Power

The mission of the Water Power Program is to research, test, and develop innovative technologies capable of generating renewable, environmentally responsible, and cost-effective electricity from water. These include marine and hydrokinetic technologies, a new suite of emissions-free renewable technologies that harness the energy from untapped wave, tidal, current, and ocean thermal resources. In addition, the Water Power Program works to develop technologies and processes to improve the efficiency, flexibility, and environmental performance of conventional hydroelectric generation, which currently accounts for approximately seven percent of the U.S. electricity supply.

The Water Power Program plays a key role in the nascent marine and hydrokinetic industry in FY 2011 by providing significant support to drive the development and deployment of these emissions-free technologies. With FY 2011 funding, the program also has the opportunity to support cost-effective measures to increase clean, renewable energy generation at existing hydropower facilities and to maximize hydropower's value to the U.S. electricity grid. Investment in both of these sectors will expand the Nation's renewable energy portfolio by providing additional sources of clean, domestic energy, contribute to economic prosperity by spurring demand for new green jobs, and signal strong U.S. commitment to lowering greenhouse gas emissions to address climate change.

Marine & Hydrokinetic Technologies

The Water Power Program is in a unique position to help make marine and hydrokinetic (MHK) energy a commercial reality in an accelerated time frame by funding activities that will reduce costs and risks across the whole sector. MHK devices and components are still in the early stages of testing and development, with few in the U.S. yet reaching full-scale demonstration or deployment. A critical next step for advancing the state of the industry is to test and validate a variety of device designs in various stages of development to establish baseline cost of energy and performance by technology and resource type. In addition to testing activities, the program is continuing to fund the development of optimized components and devices; higher-resolution resource assessments to quantify and validate estimates of extractable energy by location; environmental effects studies to understand and mitigate potential impacts and reduce project development costs; and integrated National Marine Renewable Energy Centers to support R&D, device testing, validation, and information-sharing across the industry.

FY 2011 Budget Request

Water Power

	Funding ($ in thousands)		
Activity	**FY 2009 Approp.**	**FY 2010 Approp.**	**FY 2011 Request**
Water Power	39,082	50,000	40,488

The FY 2011 budget request is $40.50 million, a $9.5 million decrease from the FY 2010 appropriation. The program continues work initiated in FY 2009 and FY 2010.

The program's specific activities to support device testing and validation include supporting rigorous technology development and testing processes, collecting and disseminating validated cost and performance data, and developing numerical and physical tools to assist industry in device and system design and operation. An increased emphasis in FY 2011 ramps up testing activities by developing rigorous testing protocols and supporting the construction of test facilities. In FY 2011, the program will test at least two MHK devices as it ramps up testing activities. This will lead to additional testing in outyears, the identification of technology improvement opportunities, and a future outyear performance target for reducing cost of energy for these technologies. The program is also supporting the design of the Nation's first open-water grid connected test facilities.

In FY 2011, the program is continuing the development of higher resolution resource assessments to identify the total quantity, locations, and characteristics of MHK resources in the U.S, including current, river in-stream, and ocean thermal energy conversion resource assessments and the development of an integrated MHK resource database.

Assessing the potential environmental effects of these technologies is a major focus for the program and funding will continue for related studies initiated in FY 2009. Activities include 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 ($19.7 million).

Conventional Hydropower

Conventional hydropower (CH) is a significant contributor to the U.S. electricity portfolio, representing approximately 7 percent of total U.S. energy generation and approximately 67 percent of current U.S. renewable energy generation (EIA data[1]). There is a significant opportunity to increase the Nation's incremental hydroelectric generation, quantify and maximize the ancillary benefits to the U.S. electric grid, and improve environmental performance of the U.S. hydroelectric infrastructure.

Substantial generation gains can be made at existing hydroelectric facilities through capacity and efficiency upgrades. These opportunities will expand clean renewable generation within the U.S. energy portfolio and contribute to building a competitive, low carbon-economy and securing America's energy future. To assess opportunities for rapid, cost-effective, and environmentally sustainable incremental or new hydropower generation, the program will conduct 20 feasibility studies at hydroelectric facilities, non-powered dams, or pumped storage hydropower sites in FY 2011. This effort is intended to lead to increased deployment (in FY 2013) of megawatts of incremental hydropower installed at sites identified through the feasibility studies.

CH also has the potential to increase the flexibility and stability of the U.S. electric grid and to support the integration of variable renewable resources. 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 the growth of an efficient market to monetize the value of these benefits, and facilitate development and deployment of advanced pumped storage technologies. The program will also launch a university hydropower initiative to stimulate new academic interest and develop a new generation of engineers and scientists in the hydropower industry.

[1] 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

In FY 2011, the program will continue supporting the development of technologies and methods that reduce environmental impacts associated with hydropower operations. Improved environmental performance will help reduce regulatory constraints on licensing for new projects, result in increased power generation and quality by mitigating existing environmental impacts associated with flexible scheduling, and reduce impacts and stresses on wildlife and the environment ($19.7 million).

Weatherization and Intergovernmental Activities

The mission of the Weatherization and Intergovernmental Activities program 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.

Program activities complement and contribute to clean energy and economic prosperity through:

- Supporting innovative State and local energy projects, programs, and policies;
- Preparing thousands of workers for "green" careers;
- Stimulating clean energy project planning and construction on tribal lands;
- Obtaining immediate energy savings benefits from weatherizing thousands of low-income homes;
- Encouraging increased utilization of energy savings performance contracting and sustainable energy efficiency financing mechanisms;
- Facilitating expansion of renewable energy certificate trading programs and energy efficiency based utility incentives; and
- Maintaining effective management of base appropriated and Recovery Act funded ($11.5 billion) State and local clean energy projects.

Weatherization Assistance Grant

The Weatherization Assistance Grants program and technical assistance concurrently reduce national energy consumption and energy costs for low-income families. The program is implemented by States and other grantees through a national network of approximately 900 weatherization agencies. These community-based organizations manage client intake and the home energy retrofit process.

FY 2011 Budget Request

Weatherization and Intergovernmental Activities

	Funding ($ in thousands)		
Activity	**FY 2009 Approp.**	**FY 2010 Approp.**	**FY 2011 Request**
Weatherization Assistance Grants	450,000	210,000	300,000
State Energy Program	50,000	50,000	75,000
Tribal Energy Activities	6,000	10,000	10,000
International Renewable Energy Program	5,000	0	0
Renewable Energy Production Incentive	5,000	0	0
TOTAL	**516,000**	**270,000**	**385,000**

The Fiscal Year 2011 request for Weatherization and Intergovernmental Activities is $385.0 million, $115.0 million more than the FY 2010 appropriation.

The program makes buildings more energy efficient, affordable, and sustainable. Grantees develop and implement specialized training programs for thousands of workers in the residential energy audit and retrofit field. DOE also develops and shares effective and technically advanced energy efficiency tools and methods to improve program performance. The increase supports the President's goal to increase the number of low-income homes weatherized ($300.0 million).

State Energy Program

The State Energy Program 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. Formula grants allow state energy offices the flexibility to develop energy projects focused on building, electric power, industry, and transportation sectors, as well as crosscutting policy initiatives. Competitive Special Project grants address specific and important deployment and policy opportunities. Other program activities include enhanced outreach and technical assistance to grantees and continued development of web-based reporting and monitoring systems. The increase in FY 2011 supports the expansion of State capabilities to deploy high impact energy efficiency and renewable energy technologies to local governments, businesses, and consumers ($75.0 million).

International Renewable Energy Program

Through FY 2009, the International Renewable Energy Program expanded international clean energy technology deployment through environmentally effective and economically sustainable projects. Information on current and planned international projects and funding is included in the Program Support budget request. This reflects the consolidation and integration of international activities at the corporate level.

Tribal Energy Activities

Tribal Energy Activities build partnerships with tribal governments to address residential, commercial, and industrial energy needs of Native Americans. The program provides competitive grants to evaluate and develop promising energy efficiency projects and renewable energy resources. Key areas of technical assistance are: 1) the development of model financial solutions and legal frameworks to advance broader project development; and 2) expanded outreach and technical support to tribes and Alaskan Native corporations ($10.0 million).

Renewable Energy Production Incentive

The Renewable Energy Production Incentive (REPI) was created by the Energy Policy Act of 1992 to spur the deployment and operation of renewable energy facilities by not-for-profit utilities. The annual incentive payments were based on kilowatt-hours generated and the amount of the fiscal year appropriation. REPI was concluded in FY 2009. The incentive value of the program had diminished significantly over time, given a limited resource pool for payouts and the expanding number of eligible renewable energy facility applicants.

Wind Energy Program

To help meet America's increasing energy needs while protecting our Nation's energy security and environment, the Wind Energy Program is working with industry partners to develop clean, domestic, and innovative wind energy technologies that can compete with conventional fuel sources.

DOE's "20% Wind Energy by 2030" Report[1] concludes that wind turbine performance, reliability, and the challenge of limited transmission and systems integration are some of the key barriers that need to be overcome in order to provide 20 percent of the Nation's electricity with wind energy by 2030. To address these and other barriers, the program will increase its efforts in: 1) supporting research and testing to help mitigate reliability concerns with the existing turbine fleet and improve performance for new technology applications, including a new effort to improve turbine manufacturing; 2) systems interconnection, transmission, and energy storage applications that support high wind energy penetration onto the national electric grid; and 3) offshore wind technology development and resource assessment.

FY 2011 Budget Request

Wind Energy

	Funding ($ in thousands)		
Activity	**FY 2009 Approp.**	**FY 2010 Approp.**	**FY 2011 Request**
Technology Viability	31,370	47,090	90,325
Technology Application	23,000	32,910	32,175
TOTAL	**54,370**	**80,000**	**122,500**

The FY 2011 budget request for Wind Energy is $122.5 million, an increase of $42.5 million from the FY 2010 appropriation.

Technology Viability

Low Wind Speed Technology (LWST) focuses on activities which improve the cost and performance of utility-scale land-based wind turbines. In FY 2011, LWST activities will include Gearbox Reliability Collaborative (GRC) laboratory and field testing activities and a Blade Reliability Collaborative. These collaborative efforts, along with the Turbine Operation and Maintenance reliability Database activity, are key to the program's goals of improving turbine reliability and performance issues during FY 2011 ($12.3 million).

Distributed Wind Technology (DWT) supports the full range of distributed wind technology applications on the distribution side of electric power systems including: residential, small commercial, farm, community, and tribal wind markets. DWT activities improve the quality of small wind turbines and increase consumer confidence in their performance, through independent field testing and certification. In FY 2011, DWT will continue independent, laboratory field testing of distributed wind turbines, provide technical assistance for small wind certification and creation of regional testing

[1] *20% Wind Energy by 2030: Increasing Wind Energy's Contribution to U.S. Electricity Supply*. U.S. Department of Energy, July 2008. http://www1.eere.energy.gov/windandhydro/pdfs/41869.pdf

capabilities, and collaborate with turbine manufacturers to develop a mid-size turbine prototype or value engineered unit ($5.4 million).

Supporting Research and Testing (SR&T) provides laboratory-based, targeted research and testing to improve the reliability, efficiency, and performance of wind turbines in support of LWST projects and achieving the program's goals. Through collaboration with the National Laboratories, engaging specialized technical expertise, and utilizing comprehensive analysis tools, these unique testing facilities perform detailed testing and analysis of drivetrains and blades to improve reliability. A robust R&D plan for the DOE 1.5MW wind turbine will be developed and the initial phase of performance testing will begin. SR&T activities will utilize improved research and testing capabilities supported by the Recovery Act, including new large blade and dynamometer test facilities focusing on detailed testing and analysis of wind turbine drivetrain and blade reliability, manufacturing processes and materials research, aerodynamics and aeroacoustics testing. R&D activities investigating the impact of large wind turbines on radar systems will continue ($22.6 million).

Offshore Wind Energy

In FY 2011, investments and activities that promote and accelerate responsible U.S. commercial offshore wind project development will address common barriers and risks to offshore projects including: financial, regulatory, technical, environmental, and social risks. EERE's new offshore demonstration project will provide implementation, wind resource prediction tools, and loads modeling. These technical tasks will accelerate domestic manufacturing and deployment of offshore wind technology. The project 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, as well as inform siting strategies for future projects in all coastal and Great Lakes regions of the U.S. ($49.0 million).

Technology Application

Systems Integration (SI) focuses on planning and utility operational issues associated with interconnecting wind and other renewable energy into the electricity system. In FY 2011, continued coordination with DOE's Office of Electricity Delivery and Energy Reliability will focus upon interconnection issues related to wind energy, with special emphasis on support for transmission planning efforts. The program will accelerate wind resource characterization and measurement, improving the understanding of wind resources and characteristics. Systems Integration will also work to expand the manufacturing supply chain through improved advanced designs, fabrication techniques, and automation processes for wind equipment manufacturing. These research projects will improve U.S. wind manufacturing competitiveness by increasing labor productivity, decreasing manufacturing costs, and improving equipment reliability ($21.0 million).

Technology Acceptance. 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, the development of regional collaborations allows many organizations to more effectively address common issues. Support will continue 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 ($11.1 million).

Facilities and Infrastructure

The budget request for Facilities and Infrastructure supports operations and maintenance (O&M) for the National Renewable Energy Laboratory (NREL), a single-purpose laboratory dedicated to R&D for energy efficiency, renewable energy, and related technologies.

FY 2011 Budget Request Facilities and Infrastructure National Renewable Energy Laboratory			
	Funding ($ in thousands)		
Activity	**FY 2009 Approp.**	**FY 2010 Approp.**	**FY 2011 Request**
Operation and Maintenance			
General Plant Projects (GPP)	7,000	10,000	10,000
GPP – Upgrade East Access to the NREL South Table Mountain	0	4,000	0
General Capital Equipment	3,000	5,000	5,000
GPE – Scientific Computing at Sandia National Laboratory	12,000	0	0
NREL Maintenance and Repair	0	0	3,000
Total, Operation and Maintenance	**22,000**	**19,000**	**18,000**
Construction			
Energy Systems Integration Facility	41000	0	39,500
Total, Construction	**54,000**	**00**	**39,500**
TOTAL	**76,000**	**19,000**	**57,500**

In Fiscal Year 2011, the Department is requesting $57.5 million for NREL Facilities and Infrastructure, an increase of $38.5 million from the FY 2010 appropriation

Sponsored by EERE as a Federally-Funded Research and Development Center, NREL provides EERE, as well as DOE's Office of Science and the Office of Electricity Delivery and Energy Reliability, with world-class R&D, expert advice, and objective programmatic counsel. The NREL complex is currently home to 1,850 researchers, engineers, analysts, and administrative staff, plus visiting professionals, graduate students, and interns on a 632-acre campus located at three major sites near Golden, Colorado.

Operation and Maintenance

Maintaining EERE's state-of-the-art research facilities at NREL is critical to EERE's R&D mission. The General Plant Projects portion of the O&M request supports the annual investment necessary to provide new research capability and extends the current capabilities of EERE's existing real property and related infrastructure at NREL to meet the real property reinvestment objectives. Projects include safety and security improvements, site utilities and infrastructure, and reconfiguration of existing buildings to accommodate changes or growth in R&D research support needs. The General Purpose Equipment portion of the O&M request maintains EERE's general scientific and administrative equipment through maintenance, repair, or replacement. This includes scientific equipment with multiple program uses across NREL, information technology, site safety and security equipment, and other multiple purpose equipment. Technology-specific capital equipment required by EERE programs is budgeted separately and not included in the general capital and equipment request ($19.0 million).

Construction

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. 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 will enable 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. This is the third and final increment of funding for this project ($39.5 million).

Program Direction

The Program Direction budget request provides the necessary resources for executive leadership, technical direction, and project management and oversight to effectively administer EERE technology development programs. The budget request increases Federal staff and contract support; enhances information technology business systems; expands office space; and provides for the travel, equipment, supplies and materials necessary to implement and execute EERE's rapidly growing programs.

The FY 2011 budget request for Program Direction totals $200.0 million, an increase of $60.0 million above the FY 2010 appropriation. This increase is necessary due to funding levels and corresponding workload for the EERE technology programs have increased substantially over the past five years. The increase in programs, contracts, grants, cooperative agreements, and administrative activities presents significant implementation and oversight challenges for DOE. EERE recognizes the need to ramp up its Federal workforce and contract support services to effectively administer its expanded programs, accelerate the pace at which activities are implemented, and respond to demands for technical assistance, oversight, transparency, and accountability. The requested staffing level provides sufficient Federal employees and support services to execute both the regular appropriation and residual Recovery Act activities. From FY 2007 through FY 2010, Congress appropriated more funding than the Presidential budget requests, almost doubling prior year budgets and workload requirements without commensurate funding in Program Direction. The current workforce is inadequate to provide the proper management and oversight for the current workload. EERE currently manages over 4,800 active contracts, grants, and agreements. In FY 2011 this number is expected to increase to over 7,700 (regular and Recovery Act) and EERE will have more than 700 Congressionally-directed projects in various stages of the procurement/award/implementation process.

FY 2011 Budget Request
Program Direction

Activity	Funding ($ in thousands) FY 2009 Approp.	FY 2010 Approp.	FY 2011 Request
Salaries and Benefits	65,262	84,519	139,285
Travel	3,313	3,697	3,148
Support Services	38,229	32,855	35,700
Other Related Expenses	20,816	18,929	21,875
TOTAL	**127,620**	**140,000**	**200,008**

In Fiscal Year 2011, the Department is requesting $200.0 million for the EERE Program Direction, an increase of $60.0 million from the FY 2010 appropriation.

Program Direction funds operations at Headquarters and the field Project Management Centers (PMC). Headquarters employees are responsible for program planning and management, while the PMC is

responsible for implementation, execution, and project management and oversight of EERE's RDD&D partnerships, National Laboratory contract administration, and a variety of business and technical functions including administering the management and operating contract for the National Renewable Energy Laboratory.

The PMCs will continue to work with States and local communities to accelerate EERE programs and activities, as well as identify and engage community and state partners to help integrate EERE programs with public and private sector activities. The PMCs administer the majority of EERE's program funding to States, localities, and regional organizations and continue to play a key role in administering grants and implementing deployment and outreach programs

The EERE Headquarters responsibilities include:

- Recruiting and developing competent managers and technical staff that understand and can communicate at an executive level the technology status and challenges.
- Developing programmatic goals and strategic roadmaps, multi-year program plans, and Annual Operating Plans.
- Designing budget proposals, regulatory and other actions needed to support these goals.
- Making budgetary decisions on program policy and projects.
- Writing program requirements for Federal Opportunity Announcements and other procurement instruments, ensuring that they are known to the widest possible set of potential providers, and leading the process of high caliber peer reviews or other selection processes.
- Leading the evaluation process for tracking the progress of projects funded by programs to ensure that adequate progress is being made and deciding whether major changes in funded projects are needed, including potential termination.
- Communicating EERE-wide and DOE-wide program analyses and providing briefings and other assistance about areas of their responsibility to DOE leadership, Congress, and the public.
- Ensuring that funded programs are in compliance with all safety and environmental regulations and other applicable statutes.

PMC responsibilities include:

- Administering principal technology deployment grant programs, including the State Energy Program.
- Delivering principal technical assistance programs, including Clean Cities, and the Federal Energy Management Program.
- Serving as a liaison to State energy offices, other state agencies, regional organizations, and other stakeholders involved in energy and environmental quality issues.
- Providing program managers with customer feedback on how to make EERE programs more efficient and effective.

- Ensuring EERE's investments are transparent and have total accountability, management, and oversight consistent with Congressional and Administration initiatives.
- Administering residual Recovery Act projects to ensure accountability and transparency.
- Recruiting and developing competent managers, procurement staff, NEPA and safety officers, and technical monitors that can be responsive to grantee issues and complete pre- and post-award requirements in a timely basis.
- Serving as the primary contact for grantees under the Office of Weatherization and Intergovernmental Programs (OWIP), including providing technical expertise to States, risk mitigation, accountability for the success of grantees' projects, and communicating with OWIP liaisons. In some cases, Project Officers may report directly to headquarters.
- Issuing the Funding Opportunity Announcements and ensuring the legal and contracting officer reviews are complete and consistent with Federal statutes and regulations.
- Negotiating, awarding, and closing out contractual instruments (grants, contracts, etc.). This includes record-keeping of deliverables.
- Ensuring that contractual obligations are being met by awardees and that all fiscal reporting is complete and accurate.
- Identifying problems encountered by awardees to HQ program managers in a timely manner so that new directions can be given, especially related to milestone slippages, cost overruns, tracking earned value management systems (as appropriate, e.g., facilities, biorefineries, battery manufacturing plants, etc.).
- Acquiring contractors with appropriate skill sets to support program missions.
- Undertaking needed reviews and ensuring that any anomalies or problems are quickly reported to Program Managers.
- In coordination with the HQ Program Managers, providing information resources and policy guidance to contractors and others.
- Any other duty supportive of the program responsibilities, upon request of the HQ staff organization and coordination with Field Managers.
- Ensuring that funded programs are in compliance with all safety and environmental regulations and other pertinent statutes.

Program Support

The Program Support budget provides resources for strategic and crosscutting planning, analysis, and performance evaluation for EERE programs and international and outreach activities. The timely, independent, and high quality credible information developed by the Program Support components provides information needed for consultation, collaboration, and decision making related to energy alternatives that will achieve Departmental goals. The FY 2011 budget request for Program Support activities totals $87.3 million, representing a $42.3 million increase from FY 2010. The increase will support the Low-carbon Energy Systems project and other cross-cutting efforts that support and enhance our core research and development mission including: analyzing the potential for clean energy technologies to reduce global GHG emissions; facilitating the commercialization of new technologies; and deploying these technologies on a global basis.

FY 2011 Budget Request
Program Support

Activity	Funding ($ in thousands) FY 2009 Approp.	FY 2010 Approp.	FY 2011 Request
Planning, Analysis and Evaluation	10,078	11,000	12,094
Technology Advancement and Outreach	8,079	11,000	13,000
Strategic Priorities and Impact Analysis	0	6,000	27,000
Commercialization	0	7,000	10,213
International	0	10,000	25,000
TOTAL	**18,157**	**45,000**	**87,307**

The Fiscal Year 2011 request for Program Support Activities is $87.3 million, $42.3 million more than the FY 2010 appropriation.

Planning, Analysis, and Evaluation (PAE) requests $12.0 million in FY 2011 to enable collection and analysis of economic, market, and technology data in support of EERE's programs. It also develops crosscutting analytical tools and models for assessing and forecasting future energy and technology markets by estimating the possible impacts of energy policy, supply, and efficiency technologies and the potential energy, economic, environmental, and social benefits of those impacts represented in the benefits sections of the budget overview, program budgets, and other budget justification materials. These analyses are essential for program planning, prioritization, management, and defense of robust program pathways that can achieve EERE goals in the most cost-effective manner ($12.1 million).

Technology Advancement and Outreach (TAO) requests $13.0 million in FY 2011 to communicate the EERE mission, program plans, accomplishments, and technology capabilities to a variety of stakeholder audiences including Congress, the general public, educational institutions, industry, and other government and non-government organizations. TAO leads outreach efforts for EERE, including energy efficiency campaigns. The funding requested in this budget area enables key EERE public information activities, including managing the EERE website, supporting a toll-free information center,

delivering consumer education materials, and responding to stakeholder inquiries and requests. Use of EERE's websites has expanded rapidly, and continues to grow at a pace of 6.4 million additional "page views" per year. The Information Center annually fields about 27,000 inquiries and delivers roughly 370,000 publications to consumers, businesses, and schools ($13.0 million).

Strategic Priorities and Impact Analysis (SPIA) will consolidate and provide strategic analysis of technology and policy innovation. SPIA, in concert with PAE, provides senior EERE management with credible, reliable, independent analysis essential for informing and making decisions across the broad set of technology programs' challenges. Activities focus primarily on climate change, market, policy, and energy-systems and supply chain issues that impact and are impacted by EERE clean energy technologies. The increase in funding will support low-carbon energy systems work to develop portfolio planning and analytical tools that help emerging economies plan for expanded electrification and introduce clean energy technologies into growing markets ($27.0 million).

Commercialization will further its mission of increasing the speed and scale of the market penetration by the energy efficiency and renewable energy technologies borne out of EERE's investments at the National Laboratories. This funding will support new, and consolidate existing, priority corporate needs that were previously supported through multi-program collaborations. The consolidation at the corporate level enhances overall efficacy and facilitates economies of scale and scope.

Commercialization entails both accelerating National Laboratory technologies into the marketplace, as well as generally growing the American markets for efficiency and renewable technologies. Individual initiatives will 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 enhances both market "push" on the supply side and market "pull" on the demand side. All efforts carry the added benefits of maximizing energy savings, reducing carbon emissions, and enhancing national security, yet the primary focus remains one of interfacing with the capital markets ($10.2 million).

EERE's **International** subprogram will continue to coordinate a variety of international initiatives, partnerships, and events that promote greater understanding and utilization of renewable energy and energy efficiency worldwide. The International subprogram advances EERE's mission globally by promoting U.S. global climate change, energy security, and economic goals; accelerating clean energy innovation and cost reductions; and transforming renewable energy and energy efficiency markets in key developing countries. The subprogram, which was formerly funded within the Office of Weatherization and Intergovernmental Activities Program, leverages DOE's technical expertise, activities, and relationships to make a significant and sustainable impact in addressing climate change and enhancing U.S. energy security and economic vitality ($25.0 million).

EERE Funding Summary by Program

(dollars in thousands)

	FY 2009 Current Approp.	FY 2010 Current Approp.	FY 2011 Request to Congress	FY 2011 Request vs. FY 2010 Approp.
Energy Efficiency and Renewable Energy				
Programs:				
Biomass and Biorefinery Systems R&D	214,245	220,000	220,000	0
Building Technologies	138,113	222,000	230,698	+8,698
Federal Energy Management Program	22,000	32,000	42,272	+10,272
Hydrogen and Fuel Cell Technologies	164,638	174,000	137,000	-37,000
Geothermal Technology	43,322	44,000	55,000	+11,000
Industrial Technologies	88,196	96,000	100,000	+4,000
RE-ENERGYSE	0	0	50,000	+50,000
Solar Energy	172,414	247,000	302,398	+55,398
Vehicle Technologies	267,143	311,365	325,302	+13,937
Water Power	39,082	50,000	40,488	-9,512
Weatherization and Intergovernmental Activities	516,000	270,000	385,000	+115,000
Wind Energy	54,370	80,000	122,500	+42,500
Subtotal, Programs	**1,719,523**	**1,746,365**	**2,010,658**	**264,293**
Other:				
Facilities and Infrastructure	76,000	19,000	57,500	+38,500
Program Direction	127,620	140,000	200,008	+60,008
Program Support	18,157	45,000	87,307	+42,307
Congressionally Directed Activities	228,803	292,135	0	-292,135
Use of Prior Year Balances	-13,238	0	0	0
Subtotal, Other	**437,342**	**496,135**	**344,815**	**-151,320**
Total, Energy Efficiency and Renewable Energy	**2,156,865**	**2,242,500**	**2,355,473**	**+112,973**