

FY 2005

Budget-in-Brief



U.S. Department of Energy
Energy Efficiency and Renewable Energy

www.eere.energy.gov

TABLE OF CONTENTS

| | <u>Page</u> |
|--|-------------|
| <i>Introduction</i> | <i>1</i> |
| <i>Biomass & Biorefinery Systems R&D</i> | <i>3</i> |
| <i>Building Technologies</i> | <i>5</i> |
| <i>Distributed Energy Resources</i> | <i>7</i> |
| <i>Federal Energy Management Program</i> | <i>9</i> |
| <i>Geothermal Technologies</i> | <i>11</i> |
| <i>Fuel Cell Technologies</i> | <i>13</i> |
| <i>Hydrogen Technology</i> | <i>15</i> |
| <i>Industrial Technologies</i> | <i>17</i> |
| <i>Solar Energy Technologies</i> | <i>21</i> |
| <i>Vehicle Technologies</i> | <i>23</i> |
| <i>Weatherization & Intergovernmental</i> | <i>29</i> |
| <i>Wind & Hydropower Technologies</i> | <i>33</i> |
| <i>Program Management and Program Direction</i> | <i>37</i> |
| <i>EERE Funding Summary by Program</i> | <i>39</i> |

Introduction

The mission of the Office of Energy Efficiency and Renewable Energy (EERE) is to strengthen America's energy security, environmental quality, and economic vitality through public-private partnerships that enhance energy efficiency, bring clean, reliable and affordable energy production and delivery technologies to the marketplace, and make a difference in the everyday lives of Americans by enhancing their energy choices and their quality of life.

EERE sponsored research, development, and deployment of advanced clean energy technologies are making a difference in everyday lives of Americans today and will make an even larger difference tomorrow. Advanced energy efficient technologies and practices that use less energy, as well as renewable energy technologies that produce power and heat more cleanly than conventional sources, are well on their way to becoming today's answers to tomorrow's energy and environmental challenges.

The Department allocates more funding for energy efficiency and renewable energy than it does for any other energy activity. The Fiscal Year 2005 Budget Request for EERE is \$1.25 billion, a \$15.3 million increase over the Fiscal Year 2004 comparable funding level and \$4.6 million more than the Fiscal Year 2004 request. Rather than new program starts, stops, and reversal in direction, this budget builds on successes already achieved and represents a resolve to stay the course and deliver on promises and commitments made in past budget requests. The Department's Fiscal Year 2005 budget request continues to implement the priorities established in the National Energy Policy and Department of Energy Strategic Plan, and reflects priorities set in the EERE Strategic Program Review. EERE also used the research and development investment criteria called for in the President's Management Agenda to evaluate its portfolio and focus its research and development dollars on long-term, potentially high payoff activities that require Federal involvement to be successful and achieve public benefit.

Finally, the Fiscal Year 2005 budget reflects Secretary Abraham's challenge to take a bold approach to EERE-sponsored work. Recognizing increasing dependence on energy from areas of the world that can be unstable, and recognizing that questions surrounding climate change can force a focus on a carbon-free society, the Secretary directed that the program take a *revolutionary*, rather than an *evolutionary* approach to meeting National Energy Policy goals of increased energy security, greater freedom for Americans in their energy choices, and reduced costs and environmental impacts associated with those choices.

- One such revolutionary approach is embodied in the President's *FreedomCAR and Hydrogen Fuel Initiative*, the goal of which is an industry decision by 2015 to commercialize hydrogen-powered fuel cell vehicles. To the extent that hydrogen is produced from domestic resources in an environmentally sound manner, hydrogen fuel cell vehicles will require no petroleum-based fuels and emit no criteria pollutants or carbon dioxide, and their commercial success would essentially remove personal transportation as an environmental issue and substantially reduce our dependence on foreign oil. *The FreedomCAR and Hydrogen Fuel Partnership* now includes both auto manufacturers and energy companies, helping to ensure that hydrogen will be available and affordably priced when fuel cell vehicles are ready for commercialization. Over the past year significant R&D advances have increased confidence that the 2015 goal is

realistic and attainable. Together with programs in Fossil Energy, Nuclear Energy, and Science, the Department's Fiscal Year 2005 commitment to this initiative is more than \$300 million.

- Solid State Lighting represents a revolutionary approach to lighting our homes and businesses that has the potential to more than double the efficiency of general lighting systems in the coming decades, conserving enough electricity nationally to power the states of Arizona, Colorado, and Mississippi. The Fiscal Year 2005 Budget Request of \$10.2 million for Solid State Lighting keeps the Department on track to overcoming technical barriers to everyday use of these innovative technologies.
- In the deployment area, the Fiscal Year 2005 budget maintains the President's commitment to increase funding for the Weatherization Assistance Program by \$1.4 billion over ten years to help those low-income Americans who spend a disproportionately high share of their income on energy. This effort takes on special significance given increases in natural gas and heating oil prices. This year's budget request will allow the weatherization of 119,000 low-income homes, saving \$1.30 in energy costs for every dollar invested.

This *Budget in Brief* summarizes these and other key activities in the EERE Fiscal Year 2005 Budget Request. The *Budget in Brief* is a consolidated document organized by individual program rather than appropriation¹. Charts delineating both the budget by appropriation and the budget by individual program are found on page 42. Additional information on the Fiscal Year 2005 EERE Budget Request can be obtained at www.eere.energy.gov.



U.S. Department of Energy
Energy Efficiency
and Renewable Energy

¹ The EERE budget is funded through two separate appropriations – Interior/Related Agencies and Energy/Water Development, and budgets are normally presented separately for each appropriation.

Biomass and Biorefinery Systems R&D Program

The mission of the Biomass and Biorefinery Systems R&D Program (“Biomass Program”)² is to foster research and development on advanced technologies that will transform the Nation’s domestic biomass resources into affordable biofuels, biopower, and high-value bioproducts. The program’s research focus is in three areas: Feedstock Infrastructure, for reducing the cost of collecting and preparing raw biomass; Platforms R&D, for reducing the cost of outputs and byproducts from biochemical and thermochemical processes; and Utilization of Platform Outputs, for developing technologies and processes that co-produce liquid and gaseous fuels, chemicals and materials, and heat and power, and on integrating those technologies and processes in biorefinery configurations. The next generation biorefinery will produce value-added chemicals and materials together with fuels and/or power from non-conventional, lower cost feedstock such as agricultural and forest residues and other biomass materials.

The program receives appropriations from both the Energy and Water Development and the Interior and Related Agencies subcommittees. Energy and Water activities focus on developing advanced technologies for biorefineries, including producing low cost sugars, syngas, and pyrolysis oils from biomass. These intermediates will be used as building blocks for the production of fuels, chemicals and materials. Interior activities focus on developing advanced technologies for more energy efficient industrial processes and high-value industrial chemicals and materials.

FY 2005 Budget Request Biomass & Biorefinery Systems R&D

| Activity | Funding (dollars in thousands) | | |
|--|--------------------------------|-------------------|--------------------|
| | FY 2003 Approp | FY 2004 Approp | FY 2005 Request |
| Biomass and Biorefinery Systems R&D (Energy Supply) | | | |
| Feedstock Infrastructure | 2,405 | 2,212 | 2,000 |
| Platforms R&D | 44,841 | 41,491 | 43,000 |
| Utilization of Platform Outputs | 38,037 | 42,768 | 27,596 |
| Biomass and Biorefinery Systems R&D (Conservation) | | | |
| Utilization of Platform Outputs | 8,960 | 7,110 | 8,280 |
| Industrial Gasification | 14,279 | 0 | 0 |
| Technical Program Management | 811 | 396 | 400 |
| TOTAL | 109,333 | 93,977 | 81,276 |

In Fiscal Year 2005, the Department is requesting \$81.3 million for Biomass program activities, a decrease of \$12.7million from the Fiscal Year 2004 Comparable Appropriation. The Fiscal Year 2004 Energy and Water Development biomass appropriation included nearly \$41 million in Congressionally directed activities.

² Biomass includes agricultural crops and trees, wood and wood wastes and residues, plants, grasses, residues, fibers, animal wastes, municipal solid wastes, and other waste materials. Biorefineries are processing facilities that extract carbohydrates, oils, lignin, and other materials from biomass, and convert them into multiple products such as transportation fuel, chemicals, and materials.

Feedstock Infrastructure (Energy Supply)

In Fiscal Year 2005, the program will continue harvesting and logistics research and development, including the evaluation of one-pass harvesting systems concepts for wheat straw and corn stover, innovative densification and storage system concepts, infrastructure systems optimization, and regional sustainability analysis. (\$2.0 million)

Platforms R&D (Energy Supply)

- Thermochemical Platform conducts research, testing, integration, and feasibility studies on thermochemical conversion of biomass to provide the foundation for advanced and integrated systems that focus on syngas and pyrolysis oils. In Fiscal Year 2005, the program will test the continuous production, cleanup and conditioning of biomass syngas and pyrolysis oils suitable for conversion to fuels, chemicals or hydrogen. The program will examine the production of hydrogen from biomass via the synthesis gas pathway. (\$24.0 million)
- Bioconversion Platform R&D for Sugars will continue work with industry on pretreatment and analytical technologies, and improved process integration capabilities to enable industrial biorefineries. The program may continue to fund existing partnerships for more productive and lower-cost cellulase enzyme systems, and may form additional partnerships to further improve the procession operations leading to cheaper biomass-based sugars. (\$19.0 million)

Utilization of Platform Outputs (Energy Supply)

- Integration of Biorefinery Technologies will continue to integrate and test handling, pre-treatment, hydrolysis, and fermentation operations to evaluate performance and costs of converting corn fiber to fuels and co-products. (\$20.0 million)
- Products Development will continue to work with other organizations, including Federal agencies, to identify opportunities for expanding the biomass R&D portfolio. The State/Regional Partnerships activity will involve collaboration with States on technology transfer, research, development, and other efforts to overcome market barriers. (\$7.6 million)

Utilization of Platform Outputs (Conservation)

This effort will continue to focus on processes for the production of chemicals and materials that can be integrated into biorefineries. Projects with industrial partners will focus on novel separations technologies, bio-based plastics, novel products from oils, and lower cost and energy use in biomass harvesting, pre-processing and storage. Additional work with industry, universities and the National Laboratories will focus on improvements to increase the efficiency of individual process steps, e.g., catalysis, separations, etc. The program will continue collaborative efforts with stakeholders in validating the sustainability of biobased products. (\$8.3 million)

Industrial Gasification (Conservation)

No Fiscal Year 2005 funds are requested for this activity in order to focus on higher priority work that is better aligned with the Administration's R&D Investment Criteria.

Building Technologies Program

The mission of the Building Technologies Program 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 over one-third of the Nation's total energy consumption, including two-thirds of the electricity generated in the United States. This level of energy use costs the Nation about \$240 billion annually. Improving the energy efficiency of buildings and equipment reduces energy consumption—especially during critical peak demand periods—which also reduces America's vulnerability to energy supply disruptions, energy price spikes and constraints on the Nation's electricity infrastructure. The funding supports a portfolio of activities that includes solid-state lighting, improved energy efficiency of other building components and equipment, and their effective integration using whole-building-system-design techniques. The program also includes the development of codes and standards.

FY 2005 Budget Request Building Technologies

The Fiscal Year 2005 request for the Building Technologies program is \$58.3 million, a decrease of \$1.6 million from the Fiscal Year 2004 Comparable Appropriation.

Residential Buildings Integration

The long-term goal of Residential Buildings Integration is to develop cost effective designs for net Zero Energy Buildings (ZEB)—houses that produce as much energy as they use on an annual basis—by 2020.

| Activity | Funding (\$ in thousands) | | |
|---|---------------------------|-------------------|--------------------|
| | FY 2003 Approp | FY 2004 Approp | FY 2005 Request |
| Residential Buildings Integration | 12,133 | 13,067 | 18,932 |
| Commercial Buildings Integration | 4,386 | 4,440 | 4,995 |
| Emerging Technologies | 30,564 | 29,997 | 25,057 |
| Equipment Standards and Analysis | 9,635 | 10,387 | 7,800 |
| Oil Heat Research for Residential Buildings | 0 | 494 | 0 |
| Technical/Program Management Support | 1,609 | 1,481 | 1,500 |
| TOTAL | 58,327 | 59,866 | 58,284 |

- **Research and Development: Building America** will focus on reducing total energy use in a new home by 60 to 70 percent. During Fiscal Year 2005, research and development will focus on practical strategies to reduce new home energy use by 40 to 50 percent and evaluate the application of these strategies in existing homes to achieve energy savings of 20 percent. Activities will be carried out in partnership with designers, builders and component manufactures. (\$18.4 million)
- **Residential Building Energy Codes.** Energy efficient revisions to the International Energy Code Council 2006 Edition, the National Fire Protection Association and the National Fenestration Rating Council will be proposed, and appropriate revisions to the residential building codes will

be developed that support the cost effective design, construction, and operation of Zero Energy Homes. (\$0.6 million)

Commercial Buildings Integration

The long-term goal of this subprogram is to develop cost effective designs for commercial buildings that produce as much energy as they use on an annual basis. Research will focus on reducing total energy use in a commercial building by 60 to 70 percent.

- Research and Development. Fiscal Year 2005 activities will focus on developing packages of cost-effective technologies for small commercial buildings to reach 50 percent, 75 percent, or zero net energy. These packages will build on the knowledge gained from the intensive case studies of six high performance buildings, completing the broad-based assessments of technology and market opportunities, system optimization methods and design strategies and continuing work with designers, developers and owners of high performance buildings. (\$4.4 million)
- Commercial Building Energy Codes. Energy efficient revisions to the International Energy Code Council 2006 Edition/ASHRAE Standard 90.1-2004, the National Fire Protection Association and the National Fenestration Rating Council will be proposed. Code change proposals will be developed that encourage code officials to accept newer technologies in support of the 2025 goal of marketable zero energy commercial buildings. (\$0.54 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 can reduce the total energy use in buildings 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.

- Solid State Lighting can capture at least a 50 percent electricity peak demand reduction in commercial buildings' lighting load, while continuously saving energy during all operating hours. Projects will be implemented (from the Fiscal Year 2003 solicitation) to develop general illumination projects that achieve energy efficiencies of up to 70 percent through creation of a technical foundation to revolutionize the energy efficiency, appearance, visual comfort, and quality of lighting. Activities will focus on the areas of quantum efficiency, lifetime performance, packaging, infrastructure, first cost, and applied technologies to enable manufacture of LEDs. (\$10.2 million)
- Conventional Lighting R&D will focus on technology breakthroughs for conventional types of lamps to improve efficiency and on the development of lighting system technologies, strategies and guidelines that support optimum building performance and ZEB goals. (\$2.3 million)
- Space Conditioning and Refrigeration R&D will focus on space conditioning technology applications that will reduce peak electric demand in residential and commercial buildings by 50 percent for new construction and 30 percent for existing buildings. (\$3.0 million)

- Building Envelope R&D will conduct a competitive research for windows to improve performance, manufacturer yields, and fundamental processes of electrochromic devices that have passed rigorous laboratory durability and field tests. Limited research will be conducted to pursue highly insulating windows and daylighting technologies. (\$5.0 million)
- Analysis Tools and Design Strategies will focus on the research, development and implementation of the new EnergyPlus simulation software modules that enable compliance with current and near-term building energy standards, incorporating new building energy efficiency technologies such as displacement cooling and ventilation, integrated building systems, equipment control systems and strategies, multi-speed heating and cooling equipment and fans, and hybrid heating and cooling systems and equipment. (\$2.8 million)

Equipment Standards and Analysis

This subprogram seeks to develop minimum energy efficiency standards that are technologically feasible and economically justified. During Fiscal Year 2005, the focus will be on completing the energy efficiency standards rulemakings for three priority products: electric distribution transformers; commercial central air conditioners and heat pumps; and residential furnaces and boilers. (\$7.8 million)

Distributed Energy Resources Program

The mission of the Distributed Energy Resources (DER) Program is to strengthen America's energy infrastructure and provide utilities and consumers with a greater choice of energy efficient technologies for the on-site generation of electricity and use of thermal energy. The program seeks to develop and deploy by 2015 a diverse array of integrated distributed generation and thermal energy technologies that are competitively priced and highly efficient. Distributed energy technologies can expand the use of the Nation's aging electricity power infrastructure, relieve congestion on transmission and distribution systems, increase supplies during periods of peak demand, and reduce environmental emissions.

FY 2005 Budget Request Distributed Energy Resources

| Activity | Funding (\$ in thousands) | | |
|--|---------------------------|-------------------|--------------------|
| | FY 2003 Approp | FY 2004 Approp | FY 2005 Request |
| Distributed Generation Technology Development | 39,796 | 40,413 | 32,689 |
| End-Use System Integration and Interface | 19,732 | 20,086 | 19,861 |
| Technical/Program Management Support | 526 | 524 | 530 |
| TOTAL | 60,054 | 61,023 | 53,080 |

The Fiscal Year 2005 Budget Request for Distributed Energy Resources is \$53.0 million, a \$7.9 million reduction from the Fiscal Year 2004 Comparable Appropriation. The reduction reflects the reallocation of funds given advances made in previous years and changes within the overall energy R&D portfolio.

Distributed Generation Technology Development

This effort seeks to develop a portfolio of electricity generation and heat utilization technologies with a focus on efficiency, emissions, RAMD (reliability, availability, maintainability and durability), and meeting cost targets. By improving the efficiency of thermally activated systems and advancing the efficiency and emissions characteristics of these power generation technologies, the program provides the building blocks necessary to develop advanced integrated systems.

- Industrial Gas Turbines focuses on advanced materials research, such as composite ceramics and thermal barrier coatings that will improve performance and durability. Research will test cost effective low emissions technologies, and continue efforts to lower manufacturing costs and increase durability of ceramics, catalytic combustion systems, and combustor designs for gas turbines. (\$3.0 million)
- Microturbines are a new type of combustion turbine for use in distributed energy generation applications. About the size of a refrigerator, microturbines produce 25 to 500 kilowatts of energy and can be located on sites with limited space for power production. Waste heat recovery can be used in combined cooling, heating, and power (CHP) systems with the potential to achieve energy efficiency levels greater than 80 percent. Activities will include a national effort to design, develop, test, and demonstrate a new generation of microturbines for DER applications that are cleaner, more affordable, reliable, and efficient than products currently available. (\$7.0 million)
- Advanced Reciprocating Engines offer a wide range of power generation at less cost than other technologies. Reciprocating engines can be used for many purposes, such as, local power grid and substation support, peak-shaving, remote power, on-site generation, combined CHP applications and others. Activities will include a national effort to design, develop, test, and demonstrate a new generation of gas-fired reciprocating engines for distributed energy applications that are cleaner, more affordable, reliable, and efficient than products commercially available today. (\$9.0 million)
- Advanced Materials, such as ceramics and thermal barrier coatings, are some of the key enabling technologies to improve the efficiency of stationary industrial gas turbines, microturbines and reciprocating engines. Engineered ceramics offer all the advantages of ceramics—resistance to heat, corrosion, erosion, and chemical activity—while adding strength and thermal shock resistance that conventional ceramics do not demonstrate. (\$8.3 million)
- Thermally-Activated Technologies (TAT) convert natural gas, exhaust, or rejected heat into heating, cooling, humidity control, thermal storage, or bottoming cycles. TAT are the essential building blocks for CHP integrated systems, widely recognized as the next wave of energy efficient power generation devices that will transform central power station electric power generation into discrete, economical, reliable, and secure distributed power generation. (\$5.2 million)

End-Use System Integration and Interface

The focus of the End-Use Integration and Interface subprogram is to develop highly efficient integrated energy systems that can be replicated across an end-use sector that will help demonstrate an R&D objective or address a technical barrier.

- Distributed Energy Systems Applications Integration facilitates acceptance of distributed energy resources in end-use sectors by partnering with industry consortiums in commercial building, merchant stores, light industrial, supermarkets, restaurants, hospitality, healthcare, and high-tech industries. Building upon research initiated last year work will be undertaken to: (1) quantify the energy and emissions benefits and installation and retrofit costs; (2) research integration issues and recommend improvements; and (3) correlate data to analytical models and tools for end use customers. (\$7.9 million)
- Cooling, Heating and Power Integration (CHP) reduces energy costs and emissions by using energy resources more efficiently. In conventional conversion of fuel to electricity, over two-thirds of the energy input is discarded as heat to the environment and not used for productive purposes. CHP makes greater use of fuel inputs by utilizing the discarded heat with system potential efficiencies from 60 to 80 percent. Research and development are focused on integration of prime movers such as turbines, microturbines, and reciprocating engines with thermally activated technologies (chillers, dehumidification, etc) for plug-and-play integrated CHP systems. (\$12.0 million)

Federal Energy Management Program

Federal Energy Management Program (FEMP) alternative financing programs help Federal agencies access private sector financing to fund energy improvements through Energy Savings Performance Contracts and Utility Energy Service Contracts at no net cost to taxpayers. FEMP also provides technical assistance to Federal energy managers so they can identify, design, and implement new construction and facility improvement projects in areas such as energy and water audits for buildings and industrial facilities, peak load management, and new technology deployment, including combined heat and power, distributed energy and renewable technologies. In addition, FEMP promotes a whole-building design strategy and provides awards to groups within Federal agencies that achieve excellence in energy management.

The Departmental Energy Management Program (DEMP) implements the FEMP mission specifically for Department of Energy (DOE) facilities by providing funding support and technical assistance for energy management projects and expanding the use of private sector financing for energy management. The Department owns or leases about 11,000 buildings at more than 50 sites across the United States. Overall, DOE has already reduced its energy intensity per square foot by more than 40 percent (compared to 1985) and will save over \$100 million annually in avoided costs.

**FY 2005 Budget Request
Federal Energy Management Program**

| Activity | Funding (\$ in thousands) | | |
|--|---------------------------|-------------------|--------------------|
| | FY 2003 Approp | FY 2004 Approp | FY 2005 Request |
| Federal Energy Management Program (Energy Conservation) | | | |
| Project Financing | 7,839 | 8,126 | 7,450 |
| Technical Guidance and Assistance | 7,825 | 8,140 | 7,900 |
| Planning, Reporting and Evaluation | 2,751 | 2,571 | 2,550 |
| Technical Program/ Management Support | 884 | 879 | 0 |
| Departmental Energy Management Program (Energy Supply) | | | |
| Energy Management Project Support | 1,084 | 1,472 | 1,467 |
| Energy Management Model Program Development | 361 | 491 | 500 |
| TOTAL | 20,744 | 21,679 | 19,867 |

The Fiscal Year 2005 requests is \$17.9 million for FEMP and \$2.0 million for DEMP, \$1.8 million less than the Fiscal Year 2004 Comparable Appropriations, to continue meeting the goals of reducing Federal energy consumption. As FEMP's core activities have evolved, efficiencies have increased, enabling a reduced funding level in Fiscal Year 2005. More efficient use of resources in meetings, awards, publications, and technical funding projects will allow FEMP to continue to meet its historically high level of achievement.

Project Financing

FEMP alternative financing programs help agencies access private sector financing to fund needed energy improvements. FEMP helps Federal agencies use Energy Savings Performance Contracts (ESPC) and Utility Energy Service Contracts (UESC) to finance energy saving improvements at no net cost to taxpayers. These funds pay for energy improvements at Federal facilities that are in need of significant energy system retrofits. Projects include all types of energy improvements including lighting upgrades, new heating and ventilation systems, and improved control systems. (\$7.5 million)

Technical Guidance and Assistance

This effort helps Federal energy managers identify, design, and implement new construction and facility improvement projects. FEMP provides unbiased, expert technical assistance in areas such as energy and water audits for buildings and industrial facilities, peak load management, and new technology deployment, including combined heat and power and distributed energy and renewable technologies. In addition, FEMP helps agencies acquire the most energy efficient products through procurement training, product efficiency recommendations, communications and outreach, and assistance to agencies in amending their guide specifications to incorporate requirements for energy efficient products. (\$7.9 million)

Planning Reporting and Evaluation

Through this activity, FEMP promotes building energy security through the whole building design approach, facilitates meetings with senior Federal energy officials, and provides support to the Federal Energy Management Advisory Committee. In Fiscal Year 2005, FEMP will collect and publish data for the Annual Report to Congress, provide support to ensure accuracy in reporting and analysis of trends, and conduct a Federal awards program. (\$2.5 million)

Energy Management Project Support

DEMP provides direct financial assistance for energy projects at DOE facilities to increase energy efficiency and reduce future utility and maintenance costs. Funding will be provided to multiple projects that are selected through competition to both maximize return on investment and demonstrate leadership in implementing emerging energy savings technologies. DEMP will fund approximately 4-13 energy projects that will provide a rate of return of at least 20 percent per dollar invested and achieve annual savings of 20 billion Btus by 2006. (\$1.5 million)

Energy Management Model Program Development

Energy management model program development involves a comprehensive approach to making energy improvements at DOE facilities by providing direct funding for the implementation of "best practices." Model programs have included such initiatives as sustainable building design, the acquisition of Energy Star Labels for buildings, building re-commissioning, and energy consumption reductions in excess buildings. (\$0.5 million)

Geothermal Technologies Program

The Geothermal Technologies Program works in partnership with industry to establish geothermal energy as an economically competitive contributor to the U.S. energy supply. Geothermal energy production, a \$1.3 billion a year industry, generates electricity or provides heat for direct applications including aquaculture, crop drying, and district heating, or for use in heat pumps to heat and cool buildings. The technologies developed by this program will provide the Nation with new sources of electricity that are highly reliable and cost competitive and do not add to America's air pollution or the emission of greenhouse gases. Geothermal electricity generation is not subject to fuel price volatility and supply disruptions from changes in global energy markets. Geothermal energy systems use a domestic and renewable source of energy.

The current technology relies on extracting energy in the form of steam or hot water from geothermal reservoirs. In order to sustain productivity of the resource, used geothermal water and condensed steam typically are injected back into the reservoir. In the case of municipal effluent, geothermal reservoirs provide a safe, effective means of wastewater disposal.

FY 2005 Budget Request Geothermal Technologies

The Fiscal Year 2005 Budget Request for Geothermal Technologies is \$25.8 million, a \$0.3 million increase from the Fiscal Year 2004 Comparable Appropriation. The Fiscal Year 2004 appropriation included \$2 million in funds earmarked to specific recipients.

| Activity | Funding (\$ in thousands) | | |
|------------------------|---------------------------|-------------------|--------------------|
| | FY 2003 Approp | FY 2004 Approp | FY 2005 Request |
| Technology Development | 18,656 | 17,905 | 19,750 |
| Technology Application | 9,734 | 7,603 | 6,050 |
| TOTAL | 28,390 | 25,508 | 25,800 |

Technology Development

- Resource Development deals with finding, characterizing, and assessing the geothermal resource through understanding the formation and evolution of geothermal systems. This activity subsumes portions of the former subactivities of Core Research, University Research, and Detection and Mapping. The work builds on continuing research that investigates seismicity, isotope geochemistry, 3-D magnetotellurics, and remote sensing as exploration tools. Available exploration technology from related industries (e.g., petroleum, mining, waste management) is evaluated for adaptation to geothermal environments. In Fiscal Year 2005, the program will develop a suite of improved remote sensing, geophysical, and geochemical techniques and test them in collaboration with industry as reliable means to locate hidden geothermal resources. Cost-shared investigations of promising new sites will be conducted to verify the presence of resources. The program will continue to collaborate with the U.S. Geological Survey on a national geothermal resource assessment. An interagency report will be issued on geothermal resources in the Great Basin. (\$3.2 million)
- Enhanced Geothermal Systems (EGS) includes portions of the former subactivities of Core Research and University Research as well as EGS. EGS are engineered reservoirs created to produce energy from geothermal resources deficient in economical amounts of water and/or permeability. EGS technology will increase the productivity and lifetime of those reservoirs. DOE estimates that the application of EGS technology can more than double the amount of viable geothermal resources in the West. In Fiscal Year 2005, the program will conduct the following major activities: long-term flow testing of the enhanced reservoir at the Coso Hot Springs geothermal field on the U.S. Naval Weapons Air Station (China Lake, California); preliminary flow testing of the reservoir enhanced in Fiscal Year 2004 at Desert Peak, Nevada; and evaluation of wellbore stimulation experiments conducted in Fiscal Year 2004. The program will conduct analyses of flow tests at The Geysers and perform chemical stimulation of a well at Glass Mountain. (\$8.0 million)
- Systems Development subsumes the former subactivities of Innovative Drilling Subsystems and Advanced Heat and Power Systems. Drilling research aims to produce new technologies for reducing the cost of geothermal wells through an integrated systems approach that focuses on improvements to key subsystems. Systems Development also focuses on improved energy conversion technologies including better heat exchangers and condensers. In Fiscal Year 2005, the program will demonstrate a robust Diagnostics-While-Drilling subsystem in geothermal wells, including a high-speed data link, a downhole instrumented sub-assembly for controlling a

drag cutter drill bit, and a software package to assist the driller in controlling the drilling operation. (\$8.6 million)

Technology Application

- Technology Verification subsumes a portion of the former key subactivity of Detection and Mapping and includes cost-shared projects and deployment of near-commercial research products. Technology Verification moves technologies from research and development to a level where the technologies are accepted and actively used and applied by the U.S. geothermal industry and other stakeholders. All development components of exploration, EGS, drilling, and energy conversion should eventually be field tested to demonstrate improvements in technology performance at a commercial scale. The program will collaborate with ten new industry partners chosen from a Fiscal Year 2004 competitive solicitation to find and evaluate new geothermal resources using DOE-sponsored technology improvements. The program will also test innovative energy conversion technology with an industry partner at a new power plant (\$4.0 million)
- Technology Deployment addresses the factors affecting the deployment of geothermal systems, such as complex regulations that can stymie the transition from a prototype to a commercial product. In Fiscal Year 2005, the program will conduct outreach activities focused on key State and regional development issues. In addition, analytical work will continue on the performance and economics of geothermal systems. (\$2.0 million)

Fuel Cell Technologies Program

The Fuel Cell Technologies Program works closely with the Hydrogen Technology program to research, develop, and validate fuel cell and hydrogen production, delivery, and storage technologies for transportation and stationary applications. The program seeks to have hydrogen produced from diverse domestic resources and used in a clean, safe, reliable, and affordable manner in fuel cell vehicles, central station electric power production, and distributed thermal electric and combined heat and power applications. The Fuel Cell Technologies program supports the President's *FreedomCAR and Hydrogen Fuel Initiative* which has as its goal an industry decision to commercialize hydrogen-powered fuel cell vehicles by the year 2015 and the vision of a diverse, secure, and emissions-free energy future. The major focus of the Fuel Cell Technologies program continues to be high-risk research and development to overcome technical barriers centered on core research of key fuel cell components, with industry focused on engineering development of complete systems.

FY 2005 Budget Request Fuel Cell Technologies

The Fiscal Year 2005 Fuel Cell Technologies budget request is \$77.5 million, a \$12.3 million increase over the Fiscal Year 2004 Comparable Appropriation.

Transportation Systems

This subprogram conducts research, development and analysis that address key barriers to fuel cell systems for transportation applications. Key systems level barriers include cost and durability. The activity supports development of

individual component technology critical to systems integration as well as systems level modeling activities that serve to guide research and development and integration activities, benchmark systems progress, and explore alternate systems configurations. Other activities will include studies to appraise the status of critical performance measures (such as cost) and assess important materials issues (such as catalyst usage). Transportation Systems also supports the development of vehicle Auxiliary Power Units (APUs) for automotive or heavy vehicle applications and the demonstration of the feasibility of fuel cells for portable power applications. Systems components developed under Transportation Systems include compressor/expanders, sensors, actuators, heat exchangers, and water management devices. (\$7.6 million)

| Activity | Funding (\$ in thousands) | | |
|--------------------------------------|---------------------------|----------------|-----------------|
| | FY 2003 Approp | FY 2004 Approp | FY 2005 Request |
| Transportation Systems | 6,160 | 7,506 | 7,600 |
| Distributed Energy Systems | 7,268 | 7,408 | 7,500 |
| Stack Component R&D | 14,803 | 25,186 | 30,000 |
| Fuel Processor R&D | 23,489 | 14,815 | 13,858 |
| Technology Validation | 1,788 | 9,877 | 18,000 |
| Technical/Program Management Support | 398 | 395 | 542 |
| TOTAL | 53,906 | 65,187 | 77,500 |

Distributed Energy Systems

This effort develops high-efficiency Polymer Electrolyte Membrane (PEM) fuel cell power systems as an alternative power source to grid-based electricity for buildings and other stationary applications. The Distributed Energy Systems activity focuses on overcoming the barriers to stationary fuel cell systems, including cost, durability, heat utilization, start-up time, and managing power transients and load-following requirements. Improved heat usage and recovery are addressed for combined heat and power generation to maximize overall efficiency of thermal and electrical systems. This activity takes advantage of the synergy between transportation systems and distributed energy systems, particularly in the areas of developing improved materials for high temperature membranes, improving fuel cell component durability, and water thermal management. (\$7.5 million)

Stack Component R&D

This effort focuses on overcoming critical technical hurdles at the component level to improve overall fuel cell performance and durability while lowering cost. Addressing these hurdles at the component level supports the industrial effort to integrate the fuel cell system and develop full-scale fuel cell stacks. Collaborative research and development efforts with industry, National Laboratories and academia focus on the most critical technical hurdles for PEM fuel cell stack components for both stationary and transportation applications. These include cost, durability, efficiency and overall

performance of components such as the polymer electrolyte membranes, oxygen reduction electrodes, advanced catalysts, bipolar plates, etc. Component research and development activities for these two applications (transportation and stationary) are synergistic. Transportation fuel cell components depend on the early market success of stationary fuel cells to establish the component manufacturing facilities, while stationary fuel cells benefit from the investment of the automotive manufacturers, which are motivated by large transportation markets. (\$30.0 million)

Fuel Processor R&D

This effort develops the subsystem that aids the widespread use of fuel cell power technology by making the fuel source flexible. Because an extensive hydrogen fueling infrastructure does not currently exist, fuel cells can operate on more conventional fuels such as gasoline, natural gas, and diesel and reap some of the environmental and efficiency advantages until hydrogen becomes more readily available. Even in a future hydrogen economy, the option of using a diversity of fuels to produce energy will be a significant contributor to energy independence. The Fuel Processor R&D activities pursue development of fuel processors for transportation, stationary, APU, and portable power applications. Fuel processors are fuel flexible and capable of reforming fuels such as gasoline, methanol, ethanol, natural gas, and propane into hydrogen. Distributed generation fuel cells could be fueled by reformat from natural gas, propane, or renewable fuels, while auxiliary power units in trucks will likely be fueled by diesel or propane. (\$13.9 million)

Technology Validation

For the automotive, utility, and fuel industries to make commercialization decisions by 2015, integrated vehicle and infrastructure systems need to be validated and individual component targets need to be met under real-world operating conditions. This effort provides critical statistical data on the status of fuel cell vehicle technology in meeting targets in the areas of efficiency, durability, storage system range, and fuel cost. Technology Validation also provides information needed to write standards and demonstrate vehicle and infrastructure safety. The Controlled Hydrogen Fleet and Infrastructure Demonstration and Validation Project (also funded by the Hydrogen Infrastructure Validation subprogram) is a 50/50 cost-shared effort between the government and industry that will include automobile manufacturers, energy companies, suppliers, universities, and State governments. By operating hydrogen fuel cell vehicles in a controlled manner, all participating parties will be able to quantify performance and durability, document problem areas, and provide valuable information to researchers to help refine and direct future R&D activities. (\$18.0 million)

Hydrogen Technology Program

The Hydrogen Technology Program is a key component of the FreedomCAR and Hydrogen Fuel Initiative which seeks to facilitate a decision by industry to commercialize hydrogen-powered fuel cell vehicles in the year 2015 and allow the Nation to move forward to achieve the vision of a diverse, secure, and emissions-free energy future. Research undertaken by the Hydrogen Technologies Program is targeted to reduce the cost of distributed production of hydrogen from natural gas by a factor of 3 to 4, enable cost competitive production of hydrogen from renewables, and provide storage technology that enables greater than 300 mile driving range for vehicles.

FY 2005 Budget Request Hydrogen Technology

The Fiscal Year 2005 Budget Request for Hydrogen Technology is \$95.3 million, a \$13.3 million increase over the Fiscal Year 2004 Comparable Appropriation. Additional and realigned resources will allow the program to successfully reach key milestones that enable achievement of the goals of the FreedomCAR and Fuel Partnership. The Fiscal

| Activity | Funding (\$ in thousands) | | |
|--|---------------------------|-------------------|--------------------|
| | FY 2003 Approp | FY 2004 Approp | FY 2005 Request |
| Production and Delivery R&D | 11,215 | 22,564 | 25,325 |
| Storage | 10,790 | 29,432 | 30,000 |
| Infrastructure Validation | 9,680 | 18,379 | 15,000 |
| Safety, Codes, and Standards Utilization | 5,431 | 5,904 | 18,000 |
| Education and Crosscutting Analysis | 1,897 | 5,712 | 7,000 |
| TOTAL | 38,113 | 81,991 | 95,325 |

Year 2004 appropriation included more than \$35 million in funds directed to specific activities that may be outside of program goals.

Production and Delivery R&D

This effort includes research and development of advanced technologies for producing and delivering hydrogen. Activities encompass a diversity of feedstocks for hydrogen production, such as natural gas, petroleum, and renewable sources such as biomass and wind. The majority of EERE funding focuses on renewable sources while work involving other feedstocks is largely funded by, and coordinated with, other DOE offices (i.e., Fossil Energy and Nuclear Energy). Technology areas include an array of processes and techniques such as reforming, separating, purifying, compressing, and delivering hydrogen. (\$25.3 million)

Storage

Current hydrogen storage systems for vehicles are inadequate to meet customer driving range expectations without intrusion into vehicle cargo or passenger space. The Hydrogen Storage activities focus on the development of compact, lightweight, low-cost, and efficient on-board vehicular hydrogen storage systems to achieve a driving range of greater than 300 miles. The activity will emphasize research and development of solid-state materials and chemical hydride approaches for hydrogen storage systems capable of meeting targets. In addition, the activity will develop hydrogen storage systems for off-board applications such as the hydrogen delivery and refueling infrastructure. (\$30.0 million)

Infrastructure Validation

This effort provides critical statistical data on the status of fuel cell vehicle technology in meeting targets in the areas of efficiency, durability, storage system range, and fuel cost. Technology Validation also provides information needed to write standards and demonstrate vehicle and infrastructure safety. This activity includes the validation of advanced hydrogen technologies with full-scale demonstrations. Validation of hydrogen technology targets under real world conditions occurs three years after the research demonstrates potential to achieve the targets. Hydrogen technology R&D

are then verified at commercial scale for performance against established R&D goals which include high pressure storage tanks, production and delivery processes, and hydrogen refueling station technologies. (\$15.0 million)

Safety, Codes & Standards Utilization

In order for industry to make commercialization decisions, the technologies must meet safety standards. This requires a comprehensive and defensible database on component reliability and safety, published performance-based domestic standards, and international standards or regulations that will allow the technologies to compete in a global market. This activity includes identifying critical failure modes and safety issues for hydrogen and fuel cell technologies and development of the technical data required for codes and standards for hydrogen production, delivery and storage. Activities also include the development of passive and active safety systems based on new sensor technologies, comprehensive safety analysis and compilation of a defensible database on safety. (\$18.0 million)

Education and Crosscutting Analysis

The Education and Cross Cutting Analysis activities communicate hydrogen benefits, safety, and utilization information to key stakeholders. Crosscutting analysis will be used to assess the potential impact and benefits of hydrogen technology in society. Activities will increase the number of people in each target audience who understand the concept of a hydrogen economy and how it may affect them, and will also help establish a fully functional systems integration capability. Activities include development and distribution of educational materials and training to serve the specific needs of target audiences that can facilitate the transition to a hydrogen economy. Materials include films, manuals, lesson plans and modules, and instruction books/booklets about hydrogen production, delivery, storage, and safety processes, as well as technology applications. (\$7.0 million)

Industrial Technologies Program

The Industrial Technologies Program seeks to improve the energy intensity (energy demand per unit of industrial output) of the U.S. industrial sector through coordinated research and development, validation, and dissemination of energy-efficiency technologies and operating practices. Industry energy consumption accounts for about 35 percent of all U.S. energy use, and improved industrial energy intensity will reduce the need for new powerplants, reduce the need to import petroleum from foreign sources, and lower environmental emissions. In addition, more energy efficient production processes and technologies will accelerate industrial modernization and enable U.S. companies to compete more successfully in global markets.

FY 2005 Budget Request Industrial Technologies

The Fiscal Year 2005 budget request for Industrial Technologies is \$58.1, a \$34.9 million reduction from the Fiscal Year 2004 Comparable Appropriation. This funding level reflects a shift from activities that industry can perform on its own behalf, given that energy-intensive companies have strong economic incentives to reduce energy consumption, and increased support for multi-industry *Grand Challenges* for next generation manufacturing and energy systems that would require high-risk investment to achieve much lower energy use than current processes.

| Activity | Funding (\$ in thousands) | | |
|---|---------------------------|----------------|-----------------|
| | FY 2003 Approp | FY 2004 Approp | FY 2005 Request |
| Industries of the Future (Specific) | 59,293 | 47,247 | 22,409 |
| Industries of the Future (Crosscutting) | 33,533 | 39,904 | 31,900 |
| Technical Program Management Support | 3,998 | 5,917 | 3,793 |
| TOTAL | 96,824 | 93,068 | 58,102 |

Industries of the Future (Specific)

Industries of the Future (Specific) supports cost-shared research, development, and demonstration of advanced technologies to improve the energy intensity and environmental performance of America's energy-intensive and waste intensive industries. To provide the best value and optimum use of public investments, this activity focuses on a few basic materials processing industries that can achieve the highest returns on Federal investments.

- Forest and Paper Products. The goal of the Forest and Paper Products activity is to implement advanced water removal technologies in papermaking resulting by 2010 in an energy efficiency improvement of 10 percent. Fiscal Year 2005 activities will include conduct of energy bandwidth studies to determine which energy intensive areas have the greatest potential to achieve significant energy savings. Voluntary efforts by the American Forest & Paper Association and other industry organizations to improve their energy efficiency and environmental performance through the industry's Agenda 2020 will be supported. The collaborative activities will include cost-shared R&D as well as the utilization of new improved energy technologies, industrial energy efficiency tools and energy management best practices. (\$3.0 million)
- Steel Industry. The goal of the Steel Industry activity is to develop by 2010 a commercially ready technology that will cut the use of energy intensive coke as a feedstock in the steelmaking process. Activities with the highest long-term energy saving potential, such as the Mesabi Nugget iron-making pilot, a new iron-making technology that uses a rotary hearth furnace to turn iron ore fines and pulverized coal into iron nuggets of similar quality as blast furnace pig iron will be continued. This process requires less energy, capital, and operating costs than existing pig iron technology. A Grand Challenge solicitation will focus on cokeless iron making. Voluntary efforts by the American Iron and Steel Institute and the Steel Manufacturers' Association and other industry organizations to improve their energy efficiency and environmental performance will be supported. The collaborative activities will include cost-

shared R&D as well as the utilization of new improved energy technologies, industrial energy efficiency tools, and energy management best practices. (\$3.8 million)

- Aluminum Industry. The goal of the Aluminum Industry activity is to develop with the aluminum industry by 2010 advanced technologies, such as carbothermic aluminum reduction, and inert anodes and wettable cathodes that would result in significant net energy savings in primary aluminum production. Based upon a feasibility study to be completed in Fiscal Year 2004, the program will participate in a Grand Challenge solicitation with a focus on reduction technology to produce aluminum with over 30 percent energy savings and a potential of 32-38 percent reduction in greenhouse gas emissions related to energy consumption. Part of the portfolio will consist of projects to improve energy efficiency in secondary aluminum processing (rolling & forming) with an emphasis on reducing scrap and minimizing re-melting of scrap. (\$2.7 million)
- Metal Casting enables major technical advances in the metal casting industry that implement new design techniques and practices, increase yield, and reduce energy use and generation of scrap. Fiscal Year 2005 activities will include tools to validate lost foam pattern tooling design software. The program will participate in a Grand Challenge solicitation with a focus on advanced melting. Work will continue with over 320 cost-sharing industry partners in 35 States. (\$2.0 million)
- Glass develops advanced glass technologies that will reduce the gap between actual melting energy use (more than 11 million Btu to melt a ton of glass as measured in 1996) and the theoretical minimum (2.5 million Btu per ton) by 50 percent by 2020. An analysis of the progress toward this goal will be conducted as data from the 2002 Manufacturing Energy Consumption Survey is released. The program will participate in a Grand Challenge solicitation with a focus on a next generation melter. (\$1.8 million)
- Chemicals develops separation and new process chemistry technologies that increase energy efficiency by up to 30 percent by 2020, compared to 1998 technologies. An analysis of the progress to date toward this goal will be conducted as data from the 2002 Manufacturing Energy Consumption Survey is released. In Fiscal Year 2005, research will begin in the areas of separations, reactions, and enzymatic processes. The program will participate in a Grand Challenge solicitation with a focus on distillation technologies. (\$7.0 million)
- Mining develops mining technologies that can reduce the energy intensity required to crush a short ton of rock by 20-30 percent from the 1998 baseline. An analysis of the progress to date toward this goal will be conducted as data from the 2002 Manufacturing Energy Consumption Survey is released. Fiscal Year 2005 activities will include development of wear-resistant component applications for the Fibrous Monolithic composites to reduce downtime and energy use, and completion of the materials coating projects to improve wear resistance for high wear crushing and grinding applications. (\$1.4 million)
- Supporting Industries seeks to substantially reduce the energy consumption of material forming and finishing processes and powder metal parts and components manufacturing. Potentially, according to estimates in project proposals, 32 trillion Btu/yr. can be saved by 2020. Fiscal

Year 2005 projects will define a new program management approach to identify supporting industries with the greatest potential for energy savings. (\$0.7 million)

The Industries of the Future (IOF) (Crosscutting)

Industries of the Future (Crosscutting) focuses on technologies that have potential applications across many partner industries and bring the potential of significant National economic, energy, and environmental benefits.

- Industrial Materials of the Future research and development focuses on new materials consistent with the needs identified in the IOF visions and technology roadmaps. Fiscal Year 2005 focus will include degradation resistance, thermophysical databases and modeling, and materials for engineering components. The goal of these efforts is to improve materials properties for in-service performance and develop appropriate fabrication methods for various applications. (\$11.0 million)
- Combustion's goal is to develop by 2010 boilers with thermal efficiencies 10-12 percent higher than conventional technology and with commercially available single digit ppm NO_x emissions. Fiscal Year 2005 activities will include beginning of field evaluation of a package boiler capable of greater than 94 percent efficiency and less than five ppm NO_x emissions, participation in a Grand Challenge solicitation with a focus on superboiler, and continued research and field evaluation of a prototype ultra-high efficiency, low emission refinery process heater. (\$1.6 million)
- Gasification Programs is transferred to the Biomass Program. Robotics research efforts are combined with the activities in the Sensors and Automation area.
- Sensors and Automation seeks by 2010 to develop the technology necessary to move from batch production to a continuous process using new sensor systems, starting with the recently completed demonstration of the technology in the aluminum industry. Fiscal Year 2005 activities will include initiation of research in the areas of advanced sensor technology, affordable wireless technology, next generation control automation, and improved information processing. (\$3.1 million)
- Industrial Assessment Centers seeks to complete more than 14,500 Industrial Assessment Audits, train more than 2,900 engineering students, and provide technical assistance to over 10,000 plants to save over 600 trillion Btu of energy by deploying a portfolio of assessments, tools, training, and operational practices. In Fiscal Year 2005, the program will provide energy, waste, and productivity training to more than 150 engineering students at 26 participating universities to help provide a nationwide cadre of experienced and trained engineering alumni. The student certification program will provide approximately 150 students with credentials important in their further graduate studies and/or in their careers in industry. (\$7.7 million)
- Best Practices software tools and training continue to be a key strategy for increasing energy efficiency in manufacturing plants. The program partners with trade and technical associations in the use of Best Practices software tools that have contributed to the use of these tools in the end-user community. Although this strategy has been very successful with significant energy

savings, there is a need to improve existing software tools, create new software tools, and to explore other ways to expand the use of software tools. (\$8.5 million)

Solar Energy Technologies Program

The mission of the Solar Energy Technologies Program (“Solar Program”) is to help meet America’s energy needs by developing solar energy devices and systems that are more efficient, reliable and affordable. This can be accomplished on scales ranging from kilowatts to megawatts and can be used by electric utilities, manufacturing plants, commercial buildings, and residences. To accomplish its mission, the program focuses research on new and advanced types of solar devices and is directing efforts in the interrelated research areas of Photovoltaics, Solar Buildings, and Concentrating Solar Power. Technologies developed in this program will provide the Nation with a widely available domestic energy resource to help meet electricity needs, particularly peak need in areas with large air conditioning loads, and reduce the stress on our critical electricity infrastructure.

FY 2005 Budget Request Solar Energy Technologies

The Fiscal Year Budget Request for Solar Energy Technologies is \$80.3 million, a \$3.1 million decrease from the Fiscal Year 2004 Comparable Appropriation.

| Activity | Funding (\$ in thousands) | | |
|-----------------------------|---------------------------|----------------|-----------------|
| | FY 2003 Approp | FY 2004 Approp | FY 2005 Request |
| Photovoltaic Energy Systems | 73,249 | 75,053 | 75,433 |
| Solar Heating and Lighting | 3,783 | 2,944 | 2,900 |
| Concentrating Solar Power | 5,298 | 5,396 | 2,000 |
| TOTAL | 82,330 | 83,393 | 80,333 |

Photovoltaic Energy Systems

Photovoltaic (PV) technologies are semi-conducting materials that directly convert sunlight into electricity. The Solar Program focuses on achieving the Department’s long-term goal of making solar energy an important part of the National energy supply portfolio through the development of highly reliable PV systems with user lifetime energy costs of approximately \$0.06/kWh. Modular by nature with no moving parts, they can be sized to every need and placed almost anywhere sunlight is available. The PV subprogram attempts to achieve this goal by (1) increasing sunlight-to-electricity conversion efficiency (performance), (2) increasing system operating lifetime and reliability, and (3) reducing the manufacturing cost of cells, modules, and systems.

The basic building block of a PV system is a power module, which is typically one square meter in size and produces 120 Watts of power. The power module comprises 50 percent of the cost of an installed system and presents the greatest opportunity for cost savings. The current state-of-the-art modules are made of crystalline silicon cells that are approximately 12 percent efficient and produce electricity at 19 to 24 cents/kWh (lifetime system user cost over 30 years). To lower costs and improve performance, the program is developing next-generation PV technologies such as “Thin-film” PV cells and “Leap-frog” technologies such as polymers and nanostructures, while conducting systems

engineering efforts to increase the durability of fielded systems and developing technologies to improve system interconnections with the electric grid.

- Fundamental research is critical to continued advancement of photovoltaic technology to meet the Solar Program's long-term goal of \$0.06/kWh electricity by 2020. *Measurements and Characterization* capabilities at the National Laboratories focus on improving the efficiency of cell materials and devices by investigating their fundamental properties and operating mechanisms. *Basic Research and University* investigates innovative ideas and leapfrog technologies through laboratory and university research. In support of this research, \$2.1 million will be used in Fiscal Year 2005 to equip the new Science and Technology Facility at the National Renewable Energy Laboratory. The *High Performance Initiative* supports research to substantially increase the efficiency of two key technologies: (1) large-area, monolithically interconnected multi-junction thin films and (2) super high-efficiency multi-junction concentrating cells. (\$30.0 million)
- Advanced Materials and Devices. The *Thin Film Partnership* has formed strong research teams to focus R&D on promising thin-film candidates, such as amorphous silicon, copper indium diselenide, cadmium telluride, and thin-film silicon. The *Crystalline Silicon R&D* strategy is to use a small amount of Federal funding to leverage continued industry research to improve module efficiencies to 14 percent by 2006. *Advanced Manufacturing R&D* partners with the domestic PV industry with the goal of reducing costs, increasing efficiency, and increasing capacity to help enhance the industry's leadership in the development and manufacture of PV modules. (\$29.0 million)
- Technology Development. *Systems Engineering and Reliability* focuses on the critical need to improve reliability of the entire PV system, including balance-of-system components such as DC-to-AC power inverters and battery charge controllers. This work is led by Sandia National Laboratory and is implemented in close partnership with industry and the Southeast and Southwest Regional Experiment Stations. *Building Integrated Photovoltaics* is a promising solar application in which PV modules serve the dual purpose of replacing conventional building materials and generating electricity. *Outreach and Analysis* activities include testing, verification, and deployment activities for grid-connected applications and analyzing private sector commercialization options to better target R&D pathways. (\$16.4 million)
- Million Solar Roofs supports States and local communities in developing a strong commitment to the sustained deployment of solar energy technologies. To ensure positive and productive results, the Million Solar Roofs Initiative focuses on those communities that have formed strong partnerships. (\$2.0 million)
- Southeast and Southwest Experimentation Stations work in close partnership with National Laboratories on a number of photovoltaic R&D efforts. (\$2.0 million)

Solar Heating and Lighting (SHL)

This effort provides hot water and space heating for residential and commercial buildings in collaboration with industry partners. The glass-and-copper configuration of current solar water heaters makes them costly to manufacture, difficult to install and maintain, and inflexible in their applications.

The SHL subprogram uses new formulations of lightweight polymer materials to modernize solar water heaters, making them easier to install, while lowering the cost of solar water heating in non-freezing climates by 50 percent from an equivalent of \$0.08/kilowatt hour in 2003 to \$0.04/kilowatt hour in 2006, which is expected to expand the market. (\$2.9 million)

Concentrating Solar Power (CSP)

CSP systems utilize the heat generated by concentrating and absorbing the sun's energy to drive a heat engine/generator to produce electric power. The concentrated sunlight produces temperatures ranging from 600°F to over 1500°F, which run heat engines or steam turbines for generating power or producing fuels such as hydrogen. In light of recent studies by an independent engineering firm, Sargent and Lundy, and the National Research Council, the Department is funding concentrating solar power (CSP) activity in Fiscal Year 2005. While the technical potential exists for great benefits through CSP, a more thorough investigation of the proper R&D course necessary to realize those benefits needs to be conducted. The program is requesting \$2 million to maintain essential facilities, support work with several States on the establishment of 1,000 MW of CSP solar power in the Southwest, and develop a comprehensive program plan for the coming fiscal years. (\$2.0 million)

Vehicle Technologies Program

Activities in the Vehicle Technologies program contribute to two cooperative government/industry initiatives: the *FreedomCAR and Fuel Partnership* (where CAR stands for Cooperative Automotive Research) and the *21st Century Truck Partnership*. The *FreedomCAR and Fuel Partnership* is a collaborative effort between the three domestic automobile manufacturers and DOE for cooperative, precompetitive research on advanced automotive technologies having significant potential to reduce oil consumption. Activities in the *FreedomCAR and Fuel Partnership* focus on advanced, high-efficiency vehicle technologies including advanced combustion engines, hybrid vehicle systems, high-powered batteries, materials, and power electronics. These critical technologies can lead to near-term oil savings when used with gasoline or diesel-fueled hybrid vehicles; they are also the foundation for the hydrogen fuel cell vehicles of tomorrow. The *21st Century Truck Partnership* has similar objectives but is focused on heavy vehicles. The partnership involves key members of the heavy vehicle industry, truck equipment manufacturers, hybrid propulsion developers, and engine manufacturers along with other Federal agencies. The effort centers on improving and developing engine systems, heavy-duty hybrids, parasitic losses, truck safety, and idling reduction.

**FY 2005 Budget Request
Vehicle Technologies**

| Activity | Funding (\$ in thousands) | | |
|--------------------------------------|---------------------------|-------------------|--------------------|
| | FY 2003 Approp | FY 2004 Approp | FY 2005 Request |
| Vehicle Systems | 13,485 | 14,335 | 13,883 |
| Innovative Concepts | 1,590 | 494 | 500 |
| Hybrid and Electric Propulsion | 41,996 | 45,002 | 51,821 |
| Advanced Combustion R&D | 55,267 | 54,405 | 35,936 |
| Materials Technology | 36,094 | 39,744 | 39,799 |
| Fuels Technology | 19,164 | 16,494 | 6,800 |
| Technology Introduction | 4,570 | 4,939 | 6,014 |
| Technical Program Management Support | 2,005 | 2,095 | 1,903 |
| Biennial FreedomCAR Peer Review | 0 | 494 | 0 |
| TOTAL | 174,171 | 178,002 | 156,656 |

In Fiscal Year 2005, the Department is requesting \$156.7 million for the Vehicle Technologies program, \$21 million less than the Fiscal Year 2004 Comparable Appropriation. The Fiscal Year 2005 request fully supports the *FreedomCAR Partnership* goals for Electric Propulsion Systems, Electric Drivetrain Energy Storage, and Material and Manufacturing Technologies.

Vehicle Systems

The Vehicle Systems subprogram funds R&D on advanced vehicle technologies and auxiliary equipment that could achieve significant improvements in fuel economy for light and heavy vehicles without sacrificing safety, the environment, performance, and affordability. This subprogram's funding contributes to both the FreedomCAR Partnership and the 21st Century Truck Partnership.

- Heavy Vehicle (HV) Systems R&D works with heavy vehicle manufacturers and their suppliers, develops technologies that will reduce non-engine parasitic energy losses from aerodynamic drag, tire rolling resistance, friction and wear, under-hood thermal conditions, and accessory loads, as well as ensure powertrain and truck system integration to increase overall system energy utilization and efficiency. These objectives will be accomplished through two efforts, vehicle systems optimization and truck safety systems.
 - *Vehicle Systems Optimization.* Competitive solicitations will be issued on Parasitic Energy Losses and on Essential Power System for heavy vehicles. The major phase of the system electrification project will be completed with road tests of revenue bearing prototype vehicles. With industry participation, a portion of five separately-selected HV fleets will be equipped with promising, off-the-shelf aero drag reduction devices, and HV industry will be provided with validated data for the implementation of near term fuel saving technologies. (\$9.0 million)
- Ancillary Systems seeks to reduce direct and indirect fuel consuming loads imposed on internal combustion engines or fuel cell powered vehicles, such as the air-conditioning system. Technologies for fuel cell vehicles, hybrid electric vehicles, and conventional vehicles will be

developed that use propulsion system waste heat to provide vehicle cabin cooling, eliminating the need for fuel currently required for mobile air conditioners. Industry collaborative testing will evaluate energy efficient mobile air conditioning systems. (\$1.3 million)

- Simulation and Validation develops and validates models and simulation programs to predict the fuel economy and emissions of advanced vehicles. With industry input, these models are used to develop performance targets for the complete range of vehicle platforms and their components to facilitate prioritization of technology research and development activities. (\$3.5 million)

Innovative Concepts

- Graduate Automotive Technology Education (GATE) supports students with technical skills important to advance the improvement of vehicle efficiency and petroleum fuel displacement. In Fiscal Year 2005, new GATE Centers of Excellence will be selected and research fellowships will be provided for approximately 25 students for research in advanced automotive technologies, including fuel cell vehicles. (\$0.5 million)
- Cooperative Automotive Research for Advanced Technology (CARAT) was designed to help small businesses and universities. Stimulate Truck Innovative Concepts and Knowledge (STICK) was designed to help small businesses and universities. Instead of these efforts, the program will work through small business programs to pursue comparable topics. No Fiscal Year 2005 activities are planned.

Hybrid and Electric Propulsion

This subprogram funds research and development for both light and heavy vehicles. Efforts include research in energy storage systems, advanced power electronics and electric machines, and heavy hybrid system development and integration. A key objective of the Hybrid and Electric Propulsion R&D subprogram is to reduce, by 2010, the production cost of a high power 25kW battery for use in light vehicles from \$3,000 in 1998 to \$500.

- Energy Storage supports long-term research, applied research, and technology development for both light and heavy vehicles. Long-term research is focused on developing advanced energy storage technologies for hybrid and electric vehicle applications. Applied research is focused on the development and validation of low-cost and long-life batteries for hybrid vehicle applications. Technology research and development for all light vehicle energy storage is conducted with industry through the United States Advanced Battery Consortium (USABC). Advanced battery development is coordinated through the Interagency Advanced Power Group (DOE, NASA, Army, Navy, and the Air Force). (\$28.7 million)
 - *High Power Energy Storage.* Fiscal Year 2005 activities will include development of full-sized lithium ion cells using low cost, stable, high performance cathode materials based on abundant, low toxicity manganese oxide. Technology will be transferred to developers and suppliers for validation in laboratory cells and incorporation into full-size prototype cells, modules, and batteries. Development of an advanced battery for use in fuel cell hybrid vehicles will be initiated. Benchmark testing and assessments

will be conducted of non-battery energy storage devices that might be applicable in hybrid vehicle systems. (\$17.7 million)

- *Advanced Battery Development.* The initial development of high-energy lithium ion and lithium sulfur battery technologies by the USABC will be concluded, and efforts to reduce cost of lithium ion batteries for Electric Vehicles will be phased out. (\$1.5 million)
- *Exploratory Technology Research.* Energy storage systems will be explored that exhibit significant improvements over existing technologies for use in hybrid vehicles, including fuel cell hybrid vehicles. Novel anode and cathode materials and electrolytes that have higher energy capability, longer and more stable cycling characteristics, and are lower in cost will be developed. Diagnostic techniques to investigate and better understand life- and performance-limiting processes in lithium-based batteries will be developed. Electrochemical models to understand failure mechanisms and the mechanisms of thermal runaway in lithium batteries will be developed and applied. Solid polymer electrolytes with high room temperature conductivity and good mechanical strength and improved safety will be re-evaluated and developed, as will low cost, abuse tolerant lithium sulfur battery technology. (\$9.5 million)
- Advanced Power Electronics, which includes electric machines, develops low cost converters and motor controllers, and motors needed for fuel cell and hybrid combustion vehicles. Fiscal Year 2005 efforts are focused on advanced motors, converters, low-cost permanent magnet materials, advanced thermal management systems, and motor controller systems to meet both light and heavy vehicle requirements. Expanded thermal management efforts in power electronics thermal management system will be initiated, and preliminary deliverables will be tested at National Laboratories for conformance to specifications. (\$13.9 million)
- Subsystem Integration and Development validates achievement of technical targets for components and subsystems by emulating a vehicle-operating environment. Data gathered are used to validate simulation models, which are used to predict fuel economy and emissions using advanced controls and configurations for hybrid vehicles.
 - *Light Vehicle Propulsion and Ancillary Subsystems* activities will include use of hardware-in-the-loop techniques to emulate fuel cell propulsion systems to determine energy storage requirements for different fuel cell subsystem technologies and configurations. Engine emission models will analyze the impact of emissions control on fuel economy. Performance targets will be validated in a systems environment for deliverables from the power electronics and energy storage technology research and development activities. (\$3.7 million)
 - *Heavy Vehicle Propulsion and Ancillary Subsystems.* Fiscal Year 2005 activities include development, in conjunction with industry teams selected in previous years, of efficient, cost-effective, next generation heavy hybrid components and systems in support of the 21st Century Truck. Research will be directed at developing specific components, advanced powertrain systems, advanced system modeling, system level prototype development, and vehicle level prototypes. (\$5.5 million)

Advanced Combustion R&D

This subprogram focuses on removing critical technical barriers to commercialization of higher efficiency, advanced internal combustion engines in light-duty, medium-duty, and heavy-duty vehicles. The goals are to improve the efficiency of internal combustion engines for light-duty applications to 45 percent by 2012, and for heavy-duty applications, to 55 percent by 2012, while meeting cost, durability, and emissions constraints.

- Combustion and Emission Control supports the goal of energy efficient, clean vehicles powered by advanced internal combustion engines using clean, hydrocarbon- and non-petroleum-based, and hydrogen fuels. In Fiscal Year 2005, there will be increased emphasis on research in advanced combustion regimes that achieve efficiency goals for cars and trucks while maintaining cost and high durability with near-zero emissions. (\$22.0 million)
- Heavy Truck Engine develops technologies for diesel engines, such as optimized fuel injection, emissions control, waste heat recovery systems, and reduced friction and pumping losses, with the goal of improving the thermal efficiency to 55 percent by 2012 while meeting Federal emissions standards. In Fiscal Year 2005, more emphasis will be placed on improving engine efficiency to greater than 45 percent through the utilization of advanced combustion regimes capable of reducing engine-out emissions to near-zero levels. (\$10.4 million)
- Waste Heat Recovery develops technologies to convert waste heat from engines to electrical energy to improve overall thermal efficiency and reduce emissions. (\$1.5 million)
- Health Impacts evaluates the relative toxicity of emissions from new vehicle technologies developed to meet energy efficiency goals. In Fiscal Year 2005, toxicity testing of metallic compounds in fuels and lubricants (man-made additives and trace metals in non-petroleum-based feedstocks) will be initiated to provide feedback on new technologies, and comparative toxicity testing of emissions from natural gas fueled vehicles will be completed. (\$2.0 million)

Materials Technology

This subprogram supports the development of cost-effective materials and materials manufacturing processes that can contribute to fuel-efficient cars and trucks. Better, cost effective materials make lighter vehicle structures (that provide comparable safety) and more efficient power systems possible. Lighter vehicles require less energy to operate and thus reduce the consumption of fuel. Likewise, better propulsion materials can make more efficient power systems possible thus also contributing to a vehicle's reduced energy consumption. This subprogram is a critical enabler for concepts developed in the FreedomCAR and 21st Century Truck Partnerships.

- Propulsion Materials Technology focuses on technologies that are critical in removing barriers to electric drive, advanced combustion, and emissions control research activities.
 - *Automotive Propulsion Materials* will evaluate sensitivity, response time, and stability of a prototype NO_x sensor and invite industrial partners to participate in further development. (\$2.0 million)

- *Heavy Vehicle Propulsion Materials* will assess the viability of using titanium in engine components for higher efficiencies and lighter weight; initiate characterization of new surface modification techniques to reduce friction/wear in engine component materials; assess viability of current concepts to enhance fracture toughness and/or to ductilize ceramics for advanced engine applications; evaluate engine material substitution strategies for lighter weight, cost-effective, higher efficiency engines; assess new analytic and simulation methods that characterize, formulate, and stabilize nano-size atomic clusters to achieve high potency, durable, cost-effective catalysts for controlling exhaust gas emissions; and characterize high-strength, lightweight, wear-resistant metal and ceramic matrix composites for applications in components of advanced high performance, efficient engines. (\$5.0 million)
- Lightweight Materials Technology develops carbon fiber and metal composites to reduce vehicle weight while maintaining safety, performance, and reducing cost.
 - *Automotive Lightweight Materials* will conclude a major thrust on aluminum alloys and carbon-fiber-reinforced polymer-matrix composites (CFRPMC), and enable new manufacturing-focused thrusts initiated in previous years to reach mid-stream of their roughly five-year course. *Metals*: complete development of a binder control system for stamping of aluminum sheet components; conclude initial development of corrosion/wear coatings for completed magnesium components; validate design knowledge and product capabilities for cast magnesium structural components by full size component tests. *Composites*: decisions will be made for future work on carbon-fiber, rapid preforming technology and part fabrication and cost, weight, and performance analysis for a CFRPMC-intensive body-in-white. *Advanced Materials and Processes*: develop predictive models for dimensional control of welded assemblies and an understanding of the effect of strain-rate dependent materials on crash energy absorption capabilities. (\$21.0 million)
 - *Heavy Vehicle High Strength Weight Reduction Materials* will complete assembly of ultra-light 40-foot stainless steel transit bus, insert drive train, and assess improvement of prototype vehicle performance parameters. Other activities include: complete scale-up and evaluation of new magnesium casting process; evaluate potential to produce wrought magnesium alloy sheet components to meet HV requirements, LWM and cost targets; identify and characterize innovative, reliable, cost effective joining techniques for high performance LWM and dissimilar material joints; determine impact of lower cost virgin titanium on its potential use in LWM structural applications on HVs; and quantify/characterize effects of highway ice-clearing chemicals on corrosion of HV materials and components. (\$7.8 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. Projects include investigation of compositional crystallographic conditions of metals, alloys, ceramics, and novel materials under development for vehicle applications. The Nation's first Aberration Corrected Electron Microscope (ACEM) that has both sub-

angstrom level clear imaging and chemical analysis capabilities will be delivered and become fully operational in Fiscal Year 2005. (\$4.0 million)

Fuels Technology

Advanced fuel formulations will enable the development of advanced power systems that will operate at significantly higher efficiencies.

- Advanced Petroleum Based Fuels develops petroleum-based fuels and lubricants that will enable extremely high efficiency engines for heavy vehicle applications. The goal is to identify fuel properties that can enable engines to operate in the highest efficiency mode while meeting emissions standards. (\$4.0 million)
- Non-Petroleum Based Fuels & Lubricants formulates and evaluates biomass-based and synthetic fuels for their effects on petroleum-based fuels when used as blending agents. Specific areas being investigated include molecular make-up, effect on bulk fuel properties, and effect on engine performance, storage, handling, toxicity, and volatility.
 - No Fiscal Year 2005 efforts are planned in the areas of *Medium Trucks, Heavy Trucks, or Fueling Infrastructure*. Work in these areas has supported natural gas engine/vehicle systems development and is considered ready for commercialization.
 - *Renewable and Synthetic Fuels Utilization*. Fiscal Year 2005 activities will include: evaluation of the variance between commercial biomass-based fuels in terms of molecular make-up, effect on engine performance, and effect on overall fuel when blended with petroleum based fuels; and begin development of a specification for biomass-based fuels to ensure that such fuels, when blended with petroleum-based feedstocks, will not impose any adverse effects on engine performance. (\$2.8 million)

Technology Introduction

This subprogram accelerates the adoption and use of alternative fuel and advanced technology vehicles to help meet National energy and environmental goals. The primary functions of Technology Introduction include legislative and rulemaking supporting the Energy Policy Act of 1992 alternative fuel and fleet activities; testing and evaluation of advanced technology vehicles; and advanced vehicle competitions. Advanced Vehicle Competitions provide educational opportunities for university students to learn and use real-world engineering skills while demonstrating the performance of critical vehicle technologies identified by the Department of Energy and industry. (\$6.0 million)

Weatherization and Intergovernmental Program

The Weatherization and Intergovernmental Program develops, promotes and accelerates the adoption of energy efficiency, renewable energy, and oil displacement technologies and practices by State and local governments, weatherization agencies, communities, companies, fleet managers, building code officials, technology developers, Native American tribal governments, and international partners. Weatherization and Intergovernmental activities include technical and

financial assistance to States, local governments and communities, expanding the Energy Star Program and supporting development of energy efficient technologies.

The Weatherization Assistance Program improves the energy efficiency of the homes of low-income families through a network of 970 local agencies throughout the country. The Weatherization and Intergovernmental Program receives appropriations from both the Interior and Related Agencies and Energy and Water Development subcommittees. Interior activities focus on weatherization assistance, State energy programs and deployment. Energy and Water Development activities focus on renewable energy support and implementation.

FY 2005 Budget Request Weatherization and Intergovernmental

The Fiscal Year 2005 request for Weatherization and Intergovernmental Activities is \$380.1 million, \$56.58 million more than the Fiscal Year 2004 Comparable Appropriation. This request addresses the Presidential commitment to increase funding for the Weatherization Assistance Program by \$1.4 billion over ten years and rapid deployment of clean energy technologies and energy efficient products.

| Activity | Funding (\$ in thousands) | | |
|---|---------------------------|----------------|-----------------|
| | FY 2003 Approp | FY 2004 Approp | FY 2005 Request |
| Weatherization and Intergovernmental (Conservation) | | | |
| Weatherization Assistance Grants | 223,537 | 227,166 | 291,200 |
| State Energy Program Grants | 44,708 | 43,952 | 40,798 |
| State Energy Activities | 5,265 | 2,324 | 2,353 |
| Gateway Deployment | 40,645 | 35,170 | 29,716 |
| Intergovernmental Activities (Energy Supply) | | | |
| International Renewable Energy Program | 3,853 | 5,888 | 6,500 |
| Tribal Energy Activities | 5,780 | 4,906 | 5,500 |
| Renewable Energy Production Incentive | 4,816 | 3,926 | 4,000 |
| TOTAL | 328,604 | 323,332 | 380,067 |

Weatherization Assistance Grants (Conservation)

Weatherization Assistance provides technical assistance and formula grants to State and local weatherization agencies throughout the United States. A network of approximately 970 local agencies provide trained crews to perform weatherization services for eligible low-income households in single-family homes, multifamily dwellings, and mobile homes. Of the homes weatherized annually, 49 percent are occupied by an elderly person with special needs or a person with disabilities. Other priorities are given to families with children, and households that spend a disproportionate amount of their income on energy bills. All homes receive a comprehensive energy audit, which is a

computerized assessment of a home's energy use and an analysis of which energy conservation measures are best for the home and a combination of those energy-saving measures are installed.

- Weatherization Assistance will provide State formula grants to enable the weatherization of 118,900 low-income homes, saving \$1.30 in energy costs for every dollar invested over the life of the measures. Ninety percent of the total funding will be allocated to the States as operating funds for this purpose, i.e., for labor, materials, equipment, administrative systems, etc. Ten percent of the total program funding will be allocated for training and technical assistance, to maintain a high standard of technology application, effectiveness, and results. Most training and technical assistance will be performed at State and local levels. (\$287.0 million)
- Training and Technical Assistance supports effective program operations by the network of State and local Weatherization agencies. DOE will conduct analysis, measure and document program performance, and promote (e.g., through pilot programs, publications, training programs, workshops, and peer exchange) the application of advanced techniques and collaborative strategies to continually improve program effectiveness. (\$4.4 million)

State Energy Program Grants (SEP) (Conservation)

The SEP provides financial assistance to States, enabling State governments to target their own high priority energy needs and expand clean energy choices for their citizens and businesses. With these funds and the resources leveraged by them, the State and Territory Energy Offices develop and manage a variety of programs geared to increase energy efficiency, reduce energy use and costs, develop alternative energy and renewable energy sources, promote environmentally conscious economic development and reduce reliance on oil produced outside the United States. (\$40.8 million)

State Energy Activities (Conservation)

These efforts complement the State Energy Grants Program activities. Cooperative agreements with States provide assistance for energy-related applied research, development, and field-testing (excluded from the State Energy Program enabling legislation). Ten planning and evaluation projects will allow for additional technical assistance to States in support of State Energy Assistance and for necessary information management and evaluation projects on the formula grant programs. (\$2.4 million)

Gateway Deployment (Conservation)

This effort seeks to accomplish effective delivery of the full menu of efficiency and renewable resources aligned with clear community and customer focus. The activity focuses on the end user needs, rather than individual EERE programs. It provides easier access to EERE's vast array of technologies and resources to ensure they are part of the economic solutions for communities across the country. Through an integrated information and outreach approach, Gateway Deployment facilitates "one-stop" access to a variety of specialized technical and financial assistance.

- Rebuild America accelerates energy efficient improvements in existing buildings through community-level partnerships and focuses on K-12 schools, colleges and universities, State and local governments, public and multi-family housing, and commercial buildings. (\$8.8 million)

- Energy Efficiency Information and Outreach. Information-outreach activities will result in packaged information on appropriate EERE technologies for key market segments, e.g., consumers, homeowners, and school officials. (\$1.2 million)
- Building Codes Training and Assistance will provide technical and financial assistance to States to update and implement their energy codes and train approximately 2,000 code officials, designers, and builders to implement these codes. The program will work with 3-5 pilot States, builder organizations, and financial institutions to provide a package combining builder training, Energy Star promotion, and financing for new and existing homes. (\$4.8 million).
- Clean Cities. Clean Cities supports public-private partnerships that deploy alternative fuel vehicles and build supporting infrastructure. Clean Cities works with local businesses and governments to guide them through the process, including goal setting, coalition building, and securing commitments. (\$7.0 million)
- Energy Star Program. Energy Star was introduced by the Environmental Protection Agency in 1992 as a voluntary labeling program designed to identify and promote energy efficient products, with the goal of reducing carbon dioxide emissions. Through its partnership with more than 7,000 private and public sector organizations, Energy Star delivers the technical information and tools that organizations and consumers need to choose energy-efficient solutions and best management practices. (\$5.0 million)
- Inventions and Innovation. Inventions and Innovations provides grants to inventors for energy saving technologies. (\$2.5 million)

Intergovernmental Activities (Energy Supply)

These activities promote the market transfer of clean energy innovations for sustainable development, trade, security, environment, and climate.

- International Renewable Energy Program (IREP) activities are focused in three broad areas: market and trade development; U.S. energy security; and global environmental and energy issues. To address these needs, IREP provides technical assistance, disseminates information, conducts trade missions, and reverse trade missions. Efforts include: (1) continued support for Energy Efficiency and Sustainable Development Centers in countries with transitional economies to gain access to U.S. technologies; (2) support for establishment of Regional Centers in Africa and Latin America in countries with good governance to promote energy innovations in support of sustainable economic development and regional stability; (3) the Hemispheric Energy Initiative, which works with the energy ministers of member countries of the Organization of American States to support their renewable energy programs; (4) the U.S.-China Renewable Energy Cooperation, which supports business development for U.S. renewable and energy efficiency enterprises in China; (5) Russian and other Eastern Europe programs, which cooperate with multilateral agencies on energy efficiency and renewable energy projects and policy development; (6) the Africa Project, which holds workshops and supports the Conference of Energy Ministers in Africa; (7) World Summit on Sustainable Development activities in selected countries; and (8) Clean Energy Initiative. These efforts

provide technical assistance to support sustainable development and emerging market economies. (\$6.5 million)

- Tribal Energy Activities builds partnerships with Tribal governments to help assess Native American energy needs for residential, commercial, and industrial uses. Additionally, it provides technical and financial assistance in energy efficiency and renewable energy development. The activities provide the means for Tribal leaders to make knowledgeable choices regarding their Tribes' energy future, through resource assessments, workshops, training, and energy plan development assistance. Energy projects are competitively awarded on a cost-shared basis for Native American Tribes to implement comprehensive energy plans that incorporate energy efficiency and renewable energy technologies and resources. (\$5.5 million)
- Renewable Energy Production Initiative encourages the acquisition of renewable generation systems that use solar, wind, geothermal, or biomass technologies by State and local governments and non-profit electric cooperatives by providing financial incentive payments. (\$4.0 million)

Wind and Hydropower Technologies Program

The Wind and Hydropower Technologies program conducts research and development in support of the Nation's fastest growing and the most widely used renewable energy resources. The Wind and Hydropower Technologies program addresses National energy, environmental, and security priorities. For example, wind energy and hydropower emit no air pollution or greenhouse gases, and they produce significant amounts of bulk power to meet America's growing need for clean, domestic sources of electricity.

Since 1991, electricity production from wind turbines in the United States more than doubled—a rate faster than any other form of power generation. From 1998 through 2002, the annual growth rate averaged 24 percent, driven in large part by the tremendous reductions in cost that have resulted from wind energy research. That research has reduced the cost of electricity generation by a factor of twenty since 1982, to four cents or less per kilowatt-hour.

Hydropower is the most widely used form of renewable energy in the world today and accounts for about 7 percent of total electricity generation in the United States and over 75 percent of domestic renewable electricity generation. While hydropower electricity generation is done at a relatively low cost, environmental effects, like fish mortality, do occur. The Department of Energy is supporting the development of new turbine technology that reduces fish mortality associated with hydropower plant operation.

Wind Energy Technologies

The mission of the Wind Energy Technologies Program is to lead the Nation's research and development efforts to improve wind energy technology that enhance domestic economic benefit from wind power development, and to address barriers to the use of wind energy in coordination with stakeholders. Achieving the Wind Program's mission will enhance the competitiveness of wind energy in conventional electricity markets, growing the domestic energy supply resource, yielding

environmental benefits by avoiding pollutant emissions, and benefiting the Nation's infrastructure posture by diminishing economic and system reliability effects of fuel price or supply disruptions.

FY 2005 Budget Request Wind Energy Technologies

The Fiscal Year 2005 budget request for Wind Energy is \$41.6 million, a slight (\$300,000) increase over the Fiscal Year 2004 Comparable Appropriation.

| Activity | Funding (\$ in thousands) | | |
|------------------------|---------------------------|-------------------|--------------------|
| | FY 2003 Approp | FY 2004 Approp | FY 2005 Request |
| Technology Viability | 28,209 | 29,235 | 31,000 |
| Technology Application | 13,431 | 12,075 | 10,600 |
| TOTAL | 41,640 | 41,310 | 41,600 |

Technology Viability

This effort focuses on developing new, cost-effective technologies through research and development using competitively selected public/private partnerships closely coordinated with Supporting Research and Testing conducted by National Laboratories.

- Low Wind Speed Technology (LWST) supports multiple large wind system technology pathways (turbines over 100 kilowatts) to achieve the goal of three cents or less per kilowatt-hour for onshore systems or five cents or less per kilowatt-hour for offshore systems in Class 4 winds by 2012. New partnerships to catalyze industry adoption of component technology developments and emerging innovation are supported through a series of three competitive solicitations. These concentrate on three technical areas: conceptual design studies, component development and testing; and full turbine prototype development and testing. The Phase II LWST solicitation offers the opportunity to support offshore wind energy technology development. (\$12.0 million)
- Distributed Wind Technology (DWT) supports multiple small wind system (less than 100 kilowatts) pathways for achieving the program goal of 10-15 cents per kilowatt-hour in Class 3 resources by 2007. The DWT strategy is patterned after the LWST project in its low wind speed focus and project structures. Public-private partnerships selected through DWT project competitive solicitations in Fiscal Year 2003 for concept studies, component development, and full turbine prototype development will be coordinated with Supporting Research and Testing activities, and periodically reviewed against established project milestones to assure performance. (\$2.0 million)
- Supporting Research and Testing (SR&T) provides technical support essential to the LWST and DWT public/private partnerships by engaging the capabilities of the National Labs, universities and other technical support available in private industry. It is composed of three key programs: *Design Review and Analysis* ensures that improved products resulting from advances in R&D are developed in a logical and safe manner and in compliance with the applicable international certification standards; *Enabling Research* activities in advanced rotor development, drive train and power systems, inflow and site characterization, and systems and controls provide the technical improvements in components and integrated systems needed to

support LWST and DWT projects and characterization of the design environment, improved computer simulation codes, advanced components, and integrated systems and controls are the main product outputs; and *Testing Support* includes both facility and field tests of all newly developed LWST and DWT components and systems to ensure design and performance compliance. (\$17.0 million)

Technology Application

This effort addresses opportunities and barriers other than turbine cost of energy concerning use of wind energy systems.

- Systems Integration efforts enhance the compatibility of wind energy technologies with the electric power system, and develop information to assure fair treatment of wind energy by power system operators, transmission owners, and regulators. The scope of the activity includes integration of large wind farms in utility grid systems, small wind turbines in stand-alone applications such as hybrid diesel systems, and wind turbines in distributed applications, often close to customers. Technical assistance is provided to electric utilities, regulators, and other stakeholders to address issues such as system impacts from wind plant power variations, and appropriate treatment for an intermittent source such as wind power to allow such plants to participate in the competitive marketplace. Systems Integration also includes coordinated assessment and analysis of integration of wind with hydropower, other renewable energy systems, and emerging energy-related needs, such as production of hydrogen, and desalination, purification, and delivery of water. (\$3.2 million)
- Resource Assessment. No funds are requested for this activity since core resource assessment and mapping efforts will be completed in Fiscal Year 2004. The program intends to transfer State and local mapping capability completed in previous years to industry, and remaining needs for resource assessment-related activities to other parts of the program.
- Technology Acceptance works with stakeholders to move technology into the power generation market. Wind Powering America (\$3.1 million) addresses barriers to wind development at the national, State, and local levels to facilitate deployment of wind technology to bring economic benefits to the country, enhancing the use of domestic energy resources, supporting Federal sector compliance with renewable energy use goals, and stimulating sustainable Tribal energy sectors. Technology Acceptance also supports cooperative activities with utility-based and other key stakeholder organizations to expand access to wind resource information and to provide data on technical and institutional barriers to wind power development and other topical issues. (\$4.0 million)
- Supporting Engineering and Analysis provides a number of crosscutting functions for supporting the achievement of the program's goals. These include systems analysis to track improvements in wind technology in diverse applications; assessment of future improvements in cost performance of wind technology; market analyses leading to benefits assessments to support the Government Performance and Results Act; investigation of technical, environmental, and institutional issues to address near-term barriers for industry; participation in development of domestic and international design standards for wind turbine design and testing; design review and testing support for the Underwriters Laboratories wind turbine

certification program; and operation and management of the National Wind Technology Center to support staff, facilities, and Technology Application activities. (\$3.4 million)

Hydropower Technologies

The mission of the Hydropower Technologies Program (“Hydropower Program”) is to lead the Nation’s efforts to improve the technical, societal, and environmental benefits of hydropower, and develop cost-competitive technologies that enable the development of new and incremental hydropower capacity, adding to the diversity of the Nation’s energy supply. Achieving the Program’s mission to develop and test new technologies will enable an additional increment of power to be safely developed in the United States without the need for new dams, and allow hydropower to continue its role as an important part of the Nation’s renewable energy portfolio.

FY 2005 Budget Request Hydropower Technologies

The Fiscal Year 2005 Budget Request for Hydropower Technologies is \$6.0 million, a \$1.1 million or 22 percent increase over the Fiscal Year 2004 Comparable Appropriation.

| Activity | Funding (\$ in thousands) | | |
|------------------------|---------------------------|----------------|-----------------|
| | FY 2003 Approp | FY 2004 Approp | FY 2005 Request |
| Technology Viability | 3,811 | 3,487 | 4,400 |
| Technology Application | 1,205 | 1,418 | 1,600 |
| TOTAL | 5,016 | 4,905 | 6,000 |

Technology Viability

This effort focuses on research and development into new advanced technologies, which is important both to achieving environmental improvements and to increasing overall electricity generation. At selected sites where these new technologies are implemented, the Program will measure the operational and environmental improvements. The program currently has large turbine testing planned at four sites to be completed in Fiscal Years 2005-2008. As the technology improves, the results of plant testing are expected to improve so that by the end of the turbine testing projects in Fiscal Year 2008, the program will have shown that at least a six percent generation increase is achievable.

- Advanced Hydropower Technology supports development of technologies that will enable hydropower operators at existing plants to generate more electricity with less environmental impact. This will be done through environmentally enhanced, improved efficiency turbines, as well as with new methods for optimizing unit, plant, and reservoir systems to increase energy production per unit water. (\$3.0 million)
- Supporting Research and Testing (formerly Biologically-Based Criteria Development) addresses the need to fill significant gaps in the scientific understanding of fish response to the physical stresses experienced in passage through turbine systems. The research directly supports advanced technology development by producing biological design criteria. Research under this activity includes studies of fish passage through the hydropower system as a whole, including the cumulative effects of several injury mechanisms. The Department’s research approach involves a unique combination of computer modeling, instrumentation, lab testing,

and field-testing that is improving the design and operation of the next generation of hydropower technology. (\$1.4 million)

Technology Application

This effort assesses the technology requirements that can address barriers to undeveloped hydropower and help develop new sources of hydropower without building new dams.

- Systems Integration and Technology Acceptance (formerly part of Advanced Hydro Turbine Technology) reduces the barriers to hydropower development, and includes the integration of hydropower with other renewables, an activity started in Fiscal Year 2004. With many renewable energies being intermittent in nature, hydropower represents an important stored energy asset that can enable the larger scale deployment of other renewable power plants such as wind. Systems Integration and Technology Acceptance also addresses Program outreach, working with hydropower stakeholders to address their issues and concerns. (\$1.3 million)
- Supporting Engineering and Analysis (formerly Low Head/Low Power Resource Assessment) addresses the characterization of hydropower technologies for developing currently undeveloped hydropower resources, including those resources identified in the Department's Low Head/Low Power Resource Assessment. It also includes the development of new analysis methods to quantify hydropower benefits and values that will provide better understanding of hydropower's role within renewable energy portfolios. (\$0.3 million)

Program Management and Program Direction

The Program Management (Energy Conservation) and Program Direction (Energy Supply) budgets provide resources for executive and technical direction and oversight required for the implementation of EERE programs. The budget request covers Federal staff, as well as associated properties, equipment, supplies, and materials required to support management and oversight of programs. Areas funded by this request include information systems and technology equipment; travel; public information activities; support service contractors; and crosscutting performance evaluation, analysis and planning.

The Fiscal Year 2005 budget requests for Program Management and Program Direction total \$102.4 million, representing a \$5.0 million (five percent) increase over the Fiscal Year 2004 Comparable Appropriations. The increase will fund activities designed to strengthen the analytical underpinnings of EERE's budget, and improve EERE's program and project management practices.

Program Management and Program Direction support staff in both Headquarters and the Field. Headquarters staff is responsible for program management, while Field staff is responsible for project management. The Project Management Center, created by EERE in Fiscal Year 2004, includes the Golden Field Office (GO), staff at the National Energy Technology Laboratory (NETL), the State Technologies Advancement Collaborative (STAC), and the Regional Offices. The Project Management Center is responsible for the field project management of R&D partnerships, laboratory contract administration, and a variety of professional, technical, and administrative functions, including administering the management and operating contract for NREL and providing procurement, legal, business management, and information resource management.

The six Regional Offices are located in Atlanta, Boston, Chicago, Denver, Philadelphia, and Seattle. Staff at these offices work with States and communities to promote EERE programs, identify and engage community and State partners, and integrate EERE programs with public and private sector activities. The Regional Offices represent over a quarter of EERE's Federal workforce, and administer nearly \$0.4 billion in program funding to States, localities, and regional organizations. They play a key role in administering grants and implementing deployment and outreach programs. Major activities include:

- Administering EERE's principal technology deployment grant programs, including the Weatherization Assistance and the State Energy Programs
- Delivering EERE's principal technical assistance programs, including Clean Cities, Rebuild America, and the Federal Energy Management Programs
- Serving as EERE's liaison to State Energy Offices, other State agencies, regional organizations, and other stakeholders involved in energy and environmental quality issues
- Providing EERE's national program managers with customer feedback on how to make EERE programs more efficient and effective

The Planning, Evaluation and Analysis activity funded in Energy Conservation collects economic, market, and technology data, and develops cross-cutting analytical tools and models for forecasting future energy and technology markets, estimating the possible impacts of energy-efficiency technologies, and the potential energy, economic environmental and social benefits of those impacts. These analyses are essential for program planning, prioritization, and management of robust program pathways that can achieve EERE goals in the most cost effective manner.

Information, Communications, and Outreach activities in EERE communicate the EERE mission, program plans, accomplishments, and technology capabilities to a variety of stakeholder audiences including Congress, the public, educational institutions, industry, and other government and non-government organizations. The funding requested in this budget line is focused on two EERE public information activities: managing the EERE public websites and a central information clearinghouse, which provides a toll-free information "hotline." Use of EERE's websites has expanded rapidly, and now exceeds five million "page views" per year. The clearinghouse fields around 30,000 inquiries and delivers roughly 400,000 publications to consumers, businesses, and schools each year.

EERE Funding Summary by Program

(dollars in 1,000s)

| | FY 03 Actual | FY 04 Request | FY 04 Actual | FY 05 Request |
|------------------------------------|------------------|------------------|------------------|------------------|
| Biomass | 109,333 | 78,558 | 93,977 | 81,276 |
| Buildings Technologies | 65,899 | 56,563 | 59,866 | 58,284 |
| Distributed Energy Resources | 60,054 | 51,784 | 61,023 | 53,080 |
| Federal Energy Management Program | 20,744 | 22,262 | 21,679 | 19,867 |
| Fuel Cell Technologies | 53,906 | 77,500 | 65,187 | 77,500 |
| Geothermal Technologies | 28,390 | 25,500 | 25,508 | 25,800 |
| Hydrogen Technology | 38,113 | 87,982 | 81,991 | 95,325 |
| Industrial Technologies | 96,824 | 64,429 | 93,068 | 58,102 |
| Solar Energy Technology | 82,330 | 79,693 | 83,393 | 80,333 |
| Vehicle Technologies | 174,171 | 157,623 | 178,002 | 156,656 |
| Weatherization & Intergovernmental | 328,604 | 373,100 | 323,332 | 380,067 |
| Wind & Hydropower Technologies | 46,656 | 49,089 | 46,215 | 47,600 |
| All Other ³ | 7,737 | 28,700 | 17,869 | 14,480 |
| Program Direction (Energy Supply) | 12,615 | 13,711 | 12,364 | 20,711 |
| Program Management (Conservation) | 76,950 | 76,664 | 85,004 | 81,664 |
| Use of Prior Year Balances | 0 | 0 | - 13,000 | 0 |
| GRAND TOTAL EERE | 1,202,326 | 1,243,518 | 1,235,478 | 1,250,745 |

³ All other includes Facilities & Infrastructure, Energy Efficiency Science Initiative, and Renewable Program Support.

(dollars in thousands)

| | FY 2003 Comparable Approp | FY 2004 Request to Congress | FY 2004 Comparable Approp | FY 2005 Request to Congress | FY 2005 Request vs. FY 2004 Approp. | |
|--|---------------------------------|-----------------------------------|---------------------------------|-----------------------------------|--|---------------|
| Energy Conservation | | | | | | |
| Vehicle technologies..... | 174,171 | 157,623 | 178,002 | 156,656 | -21,346 | -12.0% |
| Fuel cell technologies..... | 53,906 | 77,500 | 65,187 | 77,500 | + 12,313 | +18.9% |
| Weatherization & intergovernmental activities | | | | | | |
| Weatherization assistance grants..... | 223,537 | 288,200 | 227,166 | 291,200 | + 64,034 | +28.2% |
| State energy program grants..... | 44,708 | 38,798 | 43,952 | 40,798 | -3,154 | -7.2% |
| State energy activities..... | 5,265 | 2,353 | 2,324 | 2,353 | + 29 | +1.2% |
| Gateway deployment..... | 40,645 | 27,609 | 35,170 | 29,716 | -5,454 | -15.5% |
| Total, Weatherization & intergovernmental activities..... | 314,155 | 356,960 | 308,612 | 364,067 | + 55,455 | +18.0% |
| Distributed energy resources..... | 60,054 | 51,784 | 61,023 | 53,080 | -7,943 | -13.0% |
| Building technologies..... | 58,327 | 52,563 | 59,866 | 58,284 | -1,582 | -2.6% |
| Industrial technologies..... | 96,824 | 64,429 | 93,068 | 58,102 | -34,966 | -37.6% |
| Biomass and biorefinery systems R&D..... | 24,050 | 8,808 | 7,506 | 8,680 | + 1,174 | +15.6% |
| Federal energy management program..... | 19,299 | 19,962 | 19,716 | 17,900 | -1,816 | -9.2% |
| National climate change technology initiative..... | — | 9,500 | — | — | — | — |
| Program management..... | 76,950 | 76,664 | 85,004 | 81,664 | -3,340 | -3.9% |
| Energy efficiency science initiative..... | 2,440 | — | — | — | — | — |
| Total, Energy Conservation..... | 880,176 | 875,793 | 877,984 | 875,933 | -2,051 | -0.2% |

(dollars in thousands)

| | FY 2003 Comparable Approp | FY 2004 Request to Congress | FY 2004 Comparable Approp | FY 2005 Request to Congress | FY 2005 Request vs. FY 2004 Approp. | |
|---|---------------------------------|-----------------------------------|---------------------------------|-----------------------------------|--|---------------|
| Energy Supply | | | | | | |
| Energy Efficiency and Renewable Energy | | | | | | |
| Hydrogen technology..... | 38,113 | 87,982 | 81,991 | 95,325 | + 13,334 | +16.3% |
| Solar Energy..... | 82,330 | 79,693 | 83,393 | 80,333 | -3,060 | -3.7% |
| Zero energy buildings..... | 7,572 | 4,000 | — | — | — | — |
| Wind energy..... | 41,640 | 41,600 | 41,310 | 41,600 | + 290 | +0.7% |
| Hydropower..... | 5,016 | 7,489 | 4,905 | 6,000 | + 1,095 | +22.3% |
| Geothermal technology..... | 28,390 | 25,500 | 25,508 | 25,800 | + 292 | +1.1% |
| Biomass and biorefinery systems R&D..... | 85,283 | 69,750 | 86,471 | 72,596 | -13,875 | -16.0% |
| Intergovernmental activities..... | 14,449 | 16,500 | 14,720 | 16,000 | + 1,280 | +8.7% |
| Departmental energy management program..... | 1,445 | 2,300 | 1,963 | 1,967 | + 4 | +0.2% |
| Renewable program support..... | — | — | 4,919 | — | -4,919 | -100.0% |
| National climate change technology initiative..... | — | 15,000 | — | 3,000 | + 3,000 | — |
| Facilities and infrastructure | | | | | | |
| National renewable energy laboratory | | | | | | |
| Operation and maintenance..... | 4,527 | 4,200 | 9,025 | 4,800 | -4,225 | -46.8% |
| Construction | | | | | | |
| 02-E-001 Science and technology facility, National renewable energy laboratory Golden, CO..... | | | | | | |
| | 770 | — | 3,925 | 6,680 | + 2,755 | +70.2% |
| Total, Facilities and infrastructure..... | 5,297 | 4,950 | 12,950 | 11,480 | -1,470 | -11.4% |
| Program direction..... | 12,615 | 13,711 | 12,364 | 20,711 | + 8,347 | +67.5% |
| Subtotal, Energy Supply..... | 322,150 | 367,725 | 370,494 | 374,812 | + 4,318 | +1.2% |
| Adjustments: | | | | | | |
| Use of prior year balances..... | — | — | -13,000 | — | + 13,000 | -100.0% |
| Total, Energy Supply..... | 322,150 | 368,475 | 357,494 | 374,812 | + 17,318 | +4.8% |