Fuel Cell Technology

Program Mission

Fuel Cell Technology is one of two subprograms within the Hydrogen, Fuel Cells and Infrastructure Technologies Program. The mission of the program is to research, develop, and validate fuel cell and hydrogen production, delivery, and storage technologies for transportation and stationary applications.

The Fuel Cell Technology Subprogram is a key component of the Administration's FreedomCAR and the new Hydrogen Fuel initiatives. FreedomCAR is a cooperative automotive research program with an ultimate vision of developing technologies that will free the Nation's personal transportation system from petroleum dependence and from harmful emissions, with a particular emphasis on fuel cell vehicles powered by hydrogen. Hydrogen fuel will be focused on developing the technologies for the hydrogen production and distribution infrastructure needed to power the FreedomCAR vehicles as well as stationary fuel cell power sources. These initiatives aim to:

- Dramatically reduce dependence on foreign oil.
- Promote the use of diverse, domestic, and sustainable energy resources.
- Reduce carbon and criteria emissions from energy production and consumption.
- Increase the reliability and efficiency of electricity generation by utilizing distributed fuel cells.

The Hydrogen Fuel and FreedomCAR initiatives will allow the Nation to aggressively move forward to achieving a vision of a secure, emissions-free energy future. The vision of the program is a prosperous future for the Nation where hydrogen energy and fuel cell power are clean, abundant, reliable, and affordable and are an integral part in all sectors of the economy and all regions of the country. The Hydrogen Fuel initiative, and the complementary FreedomCAR initiative announced in January 2002, will facilitate a decision by industry to commercialize hydrogen-powered fuel cell vehicles in the year 2015, allowing rapid market penetration, significant oil displacement and environmental benefits for the year 2020 and beyond.

In November 2002, Energy Secretary Abraham announced the release of the National Hydrogen Energy Roadmap developed by over 200 technical experts from public and private organizations. This document lays out research and development pathways, and serves as a guide to public and private investment in hydrogen technologies. The Roadmap will serve as the action plan for carrying out the Hydrogen Fuel initiative.

To accomplish the mission, activities are carried out under the Hydrogen Fuel and FreedomCAR initiatives with auto and power equipment manufacturers and energy companies, as well as with electric and natural gas utilities, building designers, other Federal agencies, State government agencies, universities, national laboratories, and other stakeholder organizations. The activities address the application of hydrogen energy systems and fuel cells for transportation, distributed stationary power, and portable power applications. Stationary applications in buildings include combined heat and power generation. Transportation applications include hydrogen production, storage, and infrastructure development. Power applications include distributed energy systems using fuel cells and are coordinated with the Distributed Energy and Electricity Reliability Program.

Strategic Context

Accomplishing this mission and these activities contributes to several national energy and environmental policies. With respect to hydrogen energy systems, the National Energy Policy recommends: 1) the development of next generation technologies, 2) the development of an education campaign that communicates the potential benefits, and 3) the development of more integrated subprograms in hydrogen, fuel cells, and distributed energy.

Energy Secretary Abraham remarked at the Detroit Auto Show in January 2002 that, "The President's Plan directs us to explore the possibility of a hydrogen economy…." President Bush has said, "We happen to believe that fuel cells are the wave of the future; that fuel cells offer incredible opportunity." Both of these points are covered in one of the goals of the FreedomCAR initiative, "To enable the transition to a hydrogen economy, ensure widespread availability of hydrogen fuels, and retain the functional characteristics of current vehicles."

As a new initiative, hydrogen fuel has yet to establish specific technical targets. FreedomCAR has nine 2010 technology specific goals that are divided between two EERE program offices. Hydrogen fuel will likely adopt, or jointly share responsibility for, FreedomCAR goals, as well as develop new technical goals.

The Office of FreedomCAR and Vehicle Technologies has responsibility for these goals:

- Electric Propulsion Systems with a 15-year life capable of delivering at least 55 kW for 18 seconds, and 30 kW continuous at a system cost of $12/kW peak.
- Internal Combustion Engine Powertrain Systems costing $30/kW, having a peak brake engine efficiency of 45 percent, and that meet or exceed emissions standards.
- Electric Drivetrain Energy Storage with 15-year life at 300 Wh with discharge power of 25 kW for 18 seconds and $20/kW.
- Material and Manufacturing Technologies for high volume production vehicles which enable/support the simultaneous attainment of: 50 percent reduction in the weight of vehicle structure and subsystems, affordability, and increased use of recyclable/renewable materials.
- Internal Combustion Engine Powertrain Systems operating on hydrogen with cost target of $45/kW by 2010 and $30/kW in 2015, having a peak brake engine efficiency of 45 percent, and that meet or exceed emissions standards. *(shared)*

The Office of Hydrogen, Fuel Cells, and Infrastructure Technologies has responsibility for these goals:[a]

- 60 percent peak energy-efficient, durable direct hydrogen fuel Cell Power Systems (including hydrogen storage) that achieves a 325 W/kg power density and 220 W/L operating on hydrogen. Cost targets are $45/kW by 2010 and $30/kW by 2015.
- Fuel Cell Systems (including an on-board fuel processor) having a peak brake engine efficiency of 45 percent, and that meet or exceed emissions standards with a cost target of $45/kW by 2010 and $30/kW by 2015.
- Hydrogen Refueling Systems demonstrated with developed commercial codes and standards and diverse renewable and non-renewable energy sources. Targets: 70 percent energy efficiency well-to-pump; cost of energy from hydrogen equivalent to gasoline at market price, assumed to be $1.50 per gallon (2001 dollars).
- Hydrogen Storage Systems demonstrating an available capacity of 6 weight percent hydrogen, specific energy of 2.0 kWh/kg, energy density of 1.1 kWh/l at a cost of $5/kWh.
- Internal Combustion Engine Powertrain Systems operating on hydrogen with cost target of $45/kW by 2010 and $30/kW in 2015, having a peak brake engine efficiency of 45 percent, and that meet or exceed emissions standards. *(shared)*

The Nation currently imports more than half of the oil it consumes and the Energy Information Administration predicts an increasing dependence on foreign oil over the next 20 years. As a whole, America's transportation sector (including aviation) is 95 percent dependent on oil.

[a] To be coordinated with Hydrogen Fuel partnership.

In addition, America's electric power system is in a state of transition. Capital investment is needed to expand electricity supplies and upgrade existing systems. Clean power generation systems are needed to enable expansion of capacity without increasing air pollution. This is paramount if construction permits are to be obtained for siting facilities in non-attainment areas. To address these issues, utilities, and customers with needs for high levels of reliability and power quality (e.g., high-tech manufacturing plants and information and telecommunication service providers), are installing distributed energy devices and demanding lower cost, lower emission, and more energy efficient distributed energy equipment, including fuel cells, as well as new business practices and regulations to speed installation and facilitate distributed energy operations.

Hydrogen is the most common element in the universe. It can be produced through thermal, electrolytic, or photolytic processes using fossil feedstocks, biomass, or water. The Nation lacks the economical and efficient means to produce hydrogen from hydrocarbons and water, and deliver it to consumers in a clean, affordable, safe, and convenient manner as an automotive fuel or for power generation. To overcome these problems, the development of hydrogen -related technologies need to be accelerated, particularly in addressing the lack of efficient, affordable hydrogen production methods; lightweight, compact, and affordable hydrogen storage tanks; and cost-competitive fuel cells.

In addition, there is a dilemma regarding the development of a hydrogen energy infrastructure to support the use of fuel cells. Fuel cells and hydrogen infrastructure need to be developed in parallel. For fuel cells to be accepted in the market place, consumers need to have convenient access to hydrogen, as they have today with gasoline, electricity, or natural gas. In addition, concerns about the safe use of hydrogen need to be addressed and codes and standards for hydrogen equipment and fuel cell designs and installations need to be implemented.

Management Strategy

The Hydrogen, Fuel Cells and Infrastructure Technologies Program primarily supports long-term research, development, and technology validation activities, which are aimed at reducing oil consumption across a range of energy applications and sectors of the economy. Activities focus on addressing the high risk, critical technology barriers through cost-shared government-industry partnerships. These efforts are augmented by fundamental and applied research at national laboratories and universities.

As part of the recent reorganization of the Office of Energy Efficiency and Renewable Energy (EERE), the Hydrogen, Fuel Cells and Infrastructure Technologies Program was created to support the National Energy Policy Recommendation to "...integrate current programs regarding fuel cells, hydrogen, and distributed energy." The program receives appropriations from both Interior and Related Agencies and Energy and Water Development. The program has been organized into the following major areas of activity.

- Fuel Cell Technology (Interior)
    - Transportation Systems
    - Distributed Energy Systems
    - Fuel Processor R&D

- Stack Component R&D
- Technology Validation

- Hydrogen Technology (Energy and Water Development)
  - Production and Delivery
  - Storage
  - Infrastructure Validation
  - Safety, Codes & Standards and Utilization
  - Education and Cross-cutting Analysis

The Fuel Cell Technology subprogram's goal is to develop and demonstrate fuel cell power system technologies for transportation and stationary applications. This goal is consistent with DOE's strategic goal to dramatically reduce, or even end, dependence on foreign oil. Fuel cells are more efficient and less polluting than conventional energy conversion devices. Widespread commercialization of hydrogen-powered fuel cells in mobile and stationary applications will support our national security interests by reducing and ultimately eliminating our reliance on foreign oil. Hydrogen-powered fuel cells will improve electric power infrastructure security, reliability, and slow the growth of greenhouse gas emissions.

Today, fuel cells are being recognized as an important new technology in U.S. and international markets. However, the system cost for fuel cells is currently too high to make them cost-effective in transportation applications, and significant research is needed to improve the efficiency and reliability of fuel cells in distributed generation applications.

The Fuel Cell Technology subprogram foresees that the decision to enter into full scale commercialization for transportation applications will be made by industry in the 2015 time-frame, provided technical barriers are removed to significantly lower the system cost of fuel cells to $30/kW while simultaneously meeting durability and performance targets. Other significant criteria for transportation fuel cell commercialization include the need to have fuel cell technologies developed and validated that are: (1) capable of being refueled with an untaxed fuel cost of $1.50/gallon gasoline equivalent; (2) 45 percent energy efficient (gasoline-based) and /or 60 percent efficient (hydrogen-based) at 1/4 rated power; (3) compliant with EPA Tier 2, Bin 2, emissions regulations; and (4) able to operate in vehicles while having comparable performance, safety, and reliability to the gasoline internal combustion engine. For stationary applications, industry will enter into commercialization earlier as the cost falls below $1,500/kW over the next few years, with large markets being attained in the 2010 time frame when the fuel cell system cost of a 50kW system is reduced to $400-800/kW (dependent on application) with 40,000 hours of reliability and 40 percent[a] electrical efficiency.

[a] Efficiency target changed to be based on the electrical efficiency, defined as the ratio of dc output energy to the lower heating value of the input fuel (average value at full/rated power over the life of the powerplant). This efficiency value is a better measure of the fuel cell system, as it does not "mix" in the combined heat and power portion, which is unrelated to the fuel cell. Fuel cell systems will still endeavor to include combined heat and power to realize high efficiencies (ultimately exceeding 50 percent), but will measure the electrical efficiency for progress measurement purposes.

The Fuel Cell Technology subprogram activities address both stationary and mobile applications and include fuel cell stacks, fuel processors, and balance-of-plant components. The activities that support transportation applications are organized in cooperation with the U.S. Council for Automotive Research (USCAR). This collaboration, implemented through technical teams, provides a mechanism for developing requirements, industry consensus, and recommendations for program direction. These technical teams are composed of government and industry experts that meet on a periodic basis to review and provide guidance on projects. The transportation-related activities are closely coordinated with the FreedomCAR and Vehicles Technologies Program.

Distributed energy fuel cell development activities include stationary power and combined heat and power systems, primarily for use in buildings. Utility-scale fuel cell development is the responsibility of DOE's Office of Fossil Energy. In carrying out these activities, the program coordinates with the EERE Distributed Energy and Electricity Reliability Program, the EERE Buildings Technologies Program, and the Office of Fossil Energy's Solid State Energy Conversion Alliance (SECA) research effort. For the distributed energy applications, the program works with industry partners in cost-shared projects to remove technical barriers, thereby facilitating the near-term introduction of fuel cell technology in a variety of applications that include energy generation for buildings, uninterruptible power systems, and portable power devices such as consumer electronics. Demonstration and validation activities support the introduction of pre-commercial fuel cell vehicles and stationary systems to controlled user-groups such as utilities or military installations. These demonstrations validate technology performance in staged increments while providing the experience needed by both manufacturers and end-users to allow the eventual successful introduction of commercial products.

Inputs from energy, hydrogen, and fuel cell experts from outside of the U.S. Department of Energy are obtained for merit review of current activities and help ensure that the directions and priorities of the program are aligned with those of industry. The program conducts peer review meetings and supports the development of industry-driven technology roadmaps.[a] These efforts are used to focus the program's investments on activities that are within the Federal government's role and that address top priority needs.

As mentioned above, one of the top priority activities being supported by the program is the FreedomCAR initiative, which is a partnership formed between the Department and USCAR. USCAR is the organization founded by Ford, General Motors and Daimler-Chrysler to manage collaboration on pre-competitive research. USCAR member companies work closely with the Department to provide inputs for establishing priorities, goals and technical targets and to evaluate progress.

The national laboratories receive direct funds for fuel cell technology research and development, based on their capabilities and performance. An advisory panel consisting of automotive and fuel cell industry experts reviews each laboratory project at the annual Merit Review and Peer Evaluation of National Laboratory R&D. Projects are evaluated based on the following criteria: 1) technical approach; 2) technical accomplishments and progress toward DOE goals; 3) technology transfer and collaborations with industry, universities, and other national laboratories; and 4) proposed future research. The panel

[a] See the following reports. Fuel Cell Report to Congress, Feb. 2003. A National Vision of America's Transition to a Hydrogen Economy, March 2002. National Hydrogen Energy Roadmap, November 2002.

also evaluates the strengths and weaknesses of each project, and recommends additions to or deletions from the scope of work. The program organization facilitates supplier-customer relationships to ensure that R&D results from federally sponsored laboratories are transferred to industry suppliers and that industry supplier developments are made available to the domestic automakers and stationary power producers.

Program Benefits

Each year, EERE estimates the benefits of program activities to support Government Performance and Results Act (GPRA) reporting. Methods are complex and vary by program. A complete explanation of methodology and assumptions will be posted this spring on line at www.eren.doe.gov/eere/budget.html. An overview of the methods and results for the Hydrogen, Fuel Cells, and Infrastructure Technology Program is provided below.

EERE's benefits estimate modeling starts with the Energy Information Administration's (EIA's) National Energy Modeling System (NEMS) and modifies it to create NEMS-GPRA04. The Baseline for transportation vehicle and fuels programs is essentially the EIA's Annual Energy Outlook (AEO) 2002 reference case, which includes some increase in the efficiency of vehicle technologies, but not the market introduction of hydrogen fuel cell vehicles. The goals for Hydrogen, Fuel Cell, and Infrastructure Technologies Program are modeled along with the vehicle goals for the FreedomCAR and Vehicle Technologies Program in NEMS-GPRA04 by incorporating the resulting vehicle costs, vehicle performance and efficiency, and hydrogen fuel costs in NEMS-GPRA04 for the program case. Hydrogen is assumed to be taxed at the same rate as gasoline in addition to the $1.50 per gallon gasoline equivalent (gge) cost for delivered hydrogen in 2010.

As a mid-term model, the NEMS-GPRA04 framework does not contain sufficient structure to analyze the production and delivery of hydrogen or the impacts of the program's goals for developing building codes and other specifications that would facilitate the development of hydrogen infrastructure. As a result, external assumptions are made about hydrogen availability. The Hydrogen, Fuel Cells and Infrastructure Technologies Program goal, in conjunction with related hydrogen-research in the Office of Fossil Energy and other DOE offices, and vehicle-related research in the FreedomCAR and Vehicle Technologies Program, of enabling a commercialization decision to be made in 2015, would provide for the development of hydrogen markets thereafter. Since, hydrogen vehicle sales are likely to depend on fuel availability, a range of benefits was developed assuming up to 10 percent of fueling stations by 2018 and up to 25 percent of fueling stations nationwide by 2020.

Based on this information, the NEMS-GPRA04 model estimates market share for hydrogen fuel cell vehicles, along with other types of vehicles and fuels included in the base case. The results are highly sensitive to the consumer vehicle choice assumptions contained in the model. The fuel cell vehicles were modeled along with the FreedomCAR & Vehicle Technologies Program, which reduces the estimated benefits compared to each program being modeled separately, given their overlapping markets.

The Hydrogen, Fuel Cell, and Infrastructure Technologies Program's fuel cell research also will reduce the costs of stationary fuel cells for production of electricity and heat for buildings and factories. The

current stationary fuel cell goals are presently being evaluated and, as a result, could not be included in this year's benefit estimates. As a result, these initial program benefits probably are underestimated.

FY 2004 GPRA Benefits Estimates for Hydrogen, Fuel Cells and Infrastructure Technologies Program (NEMS-GPRA04)[a]			
	2005	2010	2020
Non-Renewable Energy Savings (quads)	0.00	0.00	0.11-0.24
Oil Savings (quads)	0.00	0.00	0.11-0.23
Carbon Savings (MMT)	0.0	0.0	2.2-4.6
Energy Expenditure Savings (B2000$)	0.0	0.1	2.0-3.9

A hydrogen energy system would provide the country with unparalleled energy choices and energy security flexibility. Estimates for energy savings, oil savings, carbon emission reductions, and energy expenditure savings resultant from realization of Hydrogen, Fuel Cells, and Infrastructure Technologies Program goals are shown in the table above only through 2020. As a result, only the very early availability of commercial fuel cells and hydrogen sources are reflected in the 2020 timeframe reported here, and hydrogen fuel cell vehicles would be expected to increase market share thereafter. The rate of adoption of hydrogen vehicles will depend on a number of market and policy conditions, not readily reflected in NEMS-GPRA04. At the expected 2020 world oil price of about $25 a barrel (in 2001 dollars)[b],combined with the development of the infrastructure necessary to provide hydrogen at refueling stations nationwide, achievement of program goals could result in the sale of up to 800,000 hydrogen fuel cell vehicles per year by 2020.

These estimates reflect EIA reference case assumptions about future energy markets. Once these technologies are available, the country will have additional flexibility in responding to higher oil prices, greater energy security threats, or new environmental concerns, and the opportunity for oil demand to fall more rapidly than base case assumptions might suggest. Carbon emission estimates are based on the NEMS-GPRA04 model's identification of natural gas as the least expensive near-term source of market-scale hydrogen production. The development of lower cost renewable-based hydrogen would reduce those emissions further.

Program Strategic Performance Goals

The Program Strategic Performance Goals represents the Hydrogen, Fuel Cell, and Infrastructure Technologies Program in its entirety, and thus encompasses efforts under both the Energy and Water Appropriation and the Interior Appropriation:

The Hydrogen, Fuel Cells, and Infrastructure Technologies Program has the following Program Strategic Performance Goals:

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[a] Benefits reported are annual, not cumulative, in the year given for the entire Hydrogen Technologies Program (both Interior and EWD funded portions). Estimates reflect the benefits associated with program activities from FY 2004 to the benefit year or to program completion (whichever is nearer), and are based on program goals developed in alignment with assumptions in the President's Budget.

[b] EIA, Annual Energy Outlook 2002, Table 12.

- The Hydrogen Technology Subprogram will:

    - Develop and demonstrate distributed hydrogen generation technology that will reduce the cost of producing hydrogen from natural gas from $5.00 per gallon of gasoline equivalent (untaxed) in 2000, when produced in large quantities, to $1.50 per gallon of gasoline equivalent (untaxed) at the station in 2010.

    - Develop and demonstrate hydrogen production from renewables at $2.60/kg ($2.55/gge) at the plant gate in 2008, using biomass-based production.

    - Develop and validate a hydrogen storage technology with specific energy of 2.0 kWh/kg (6 weight percent capacity), and energy density of 1.5 kWh/l by 2010; 2015 targets are 3.0 kWh/kg (9 weight percent), and 2.7 kWh/l.

    - Validate projected cost of $3.00 per gallon gasoline equivalent at the station using infrastructure and vehicle interface technologies by 2008.

    - Draft the technical specifications for a U.S. agreement on a global technology regulation for hydrogen fuel cell vehicles and infrastructure regulation by 2007.

    - Educate key target audiences (i.e., students and teachers, local and State government representatives, large scale end users), and increase the percentage of each target audience that understands the concept, and how it may affect them, of a hydrogen economy by five percent (relative to the 2004 baseline).

The Fuel Cell Technology subprogram will:

- Reduce the production cost of the hydrogen- or gasoline-fueled, 50 kW vehicle fuel cell power system (including hydrogen storage) from $275/kW in 2002 to $45/kW in 2010 at production levels of 500,000 units per year (projected cost)

- Increase the electrical efficiency of natural gas or propane fueled 50kW stationary fuel cell systems from 29 percent in 2002 to 40 percent in 2010

- Validate the performance and vehicle interface issues of hydrogen fuel cell vehicles to demonstrate an increase in durability from approximately 1,000 hours today to 2000 hours by 2008 in a vehicle fleet

The goals, performance indicators, and results for the Fuel Cell Technology Subprogram are:

Transportation Fuel Cells R&D – Fuel Cell R&D activities will reduce the production cost of the hydrogen- or gasoline-fueled, 50 kW vehicle fuel cell power system (including hydrogen storage) from $275/kW in 2002 to $45/kW in 2010 at production levels of 500,000 units per year (projected cost).

Performance Indicator

Cost of the hydrogen-or gasoline-fueled, 50 kW vehicle fuel cell power system.

Annual Performance Results and Targets

FY 2002 Results	FY 2003 Targets	FY 2004 Targets
$275/kW for a hydrogen fueled 50kW fuel cell power system (including hydrogen storage)	$225/kW for a hydrogen fueled 50kW fuel cell power system (including hydrogen storage)	$200/kW for a hydrogen fueled 50kW fuel cell power system (including hydrogen storage) Complete major Go/No Go decision milestone to determine a future course of on-board fuel processing activities.

Stationary Fuel Cells R&D – Stationary Fuel Cell R&D activities will increase the electrical efficiency of natural gas or propane fueled 50kW stationary fuel cell systems from 29 percent[a] in 2002 to 40 percent[b] in 2010 (see table footnotes, next page).

Performance Indicator

Electrical efficiency of natural gas or propane fueled stationary fuel cell system with 40,000 hours of reliability and costing $400-800/kW, at a production level of 1,000 units per year.

Annual Performance Results and Targets

FY 2002 Results	FY 2003 Target	FY 2004 Proposed Targets
35 percent efficiency[a] at full power for a natural gas or propane fueled 50kW stationary fuel cell system.	30 percent efficiency[b] at full power for a natural gas or propane fueled 50kW stationary fuel cell system.	31 percent efficiency[b] at full power for a natural gas or propane fueled 50kW stationary fuel cell system.

Technology Validation - Validate the performance and vehicle interface issues of hydrogen fuel cell vehicles to demonstrate an increase in durability from an approximately 1,000 hours today to 2,000 hours by 2008 in a vehicle fleet.

Performance Indicators

Durability of fuel cell vehicles systems operated under real-world conditions.

Annual Performance Results and Targets

FY 2002 Results	FY 2003 Target	FY 2004 Proposed Targets
No activity.	Plan technology validation activity.	Industry contracts are awarded and initial vehicles delivered.

Significant Program Shifts

Significant Accomplishments During Fiscal Year 2002:

- Demonstrated in the lab an advanced 50 kW fuel-flexible fuel processor subsystem for automotive fuel cell systems achieving >80 percent hydrogen generation efficiency, a power density of 800W/l and a specific power of 550 W/kg (targets for operation on gasoline). Since a hydrogen infrastructure is currently unavailable, a fuel processor on-board the vehicle that can derive hydrogen from fuels such as gasoline, alcohols, or natural gas will allow fuel cell vehicles to enter the market without an established hydrogen infrastructure.

[a] Efficiency target met for 2002 based on PEM fuel cell systems with combined heat and power (efficiency defined as total energy realized by the fuel cell system, both electrical and thermal, divided by the lower heating value of the input fuel).

[b] Efficiency target recalibrated to be based on the electrical efficiency, defined as the ratio of dc output energy to the lower heating value of the input fuel (average value at the rated power over the life of the powerplant, for 2002 the comparable electrical efficiency level was 29 percent). This efficiency value is a better measure of the fuel cell system, as it does not "mix" in the combined heat and power portion, which was the basis for the original calibration, and is unrelated to the fuel cell. Fuel cell systems will still endeavor to include combined heat and power to realize very high efficiencies (ultimately exceeding 50 percent), but will measure the electrical efficiency for performance progress measurement purposes.

- Completed the independent evaluation and testing of a fuel-flexible 50kW integrated fuel cell power system with 32 percent electrical efficiency at 1/4 peak power. This system is the world's first fully functional, 50kW automotive fuel cell power system which operated on gasoline with extremely low emissions.

Significant Subprogram Shifts for Fiscal Year 2004:

- All hydrogen-related projects (e.g., storage, off-board natural gas reforming, etc.) funded by the Fuel Cell R&D Subprogram in the past will be funded by the Hydrogen Technology Subprogram within the Energy and Water Appropriation. All fuel cell projects funded by the Hydrogen Subprogram in the past will be funded by the Fuel Cell Technology Subprogram within the Interior Appropriation.

- Beginning in FY 2004, Fuel Processor R&D and Stack Components R&D key activities will now include development activities that address targets for both transportation and stationary applications. Both applications rely on the success of the other: transportation applications need the early market success of stationary fuel cells to establish component manufacturing facilities; while stationary fuel cells benefit from the investment of the automotive supply base, which is motivated by large transportation markets.

- The subprogram will conduct a major Go/No Go review in late FY 2004 to determine the future course of on-board vehicle fuel processing activities for transportation applications. The review will focus on critical technical targets, including start-up time (<0.5 minutes). If R&D to date cannot confirm a clear path to meet this target, a major change in research direction may be required.

- The request reflects an increased emphasis on Technology Validation to support cost-shared controlled fleet demonstrations. The demonstrations will validate performance and reliability of fuel cell systems to aid in managing technology risks and expectations during the important early development period.

- Increases for fuel cell stack component research and development support FreedomCAR and Hydrogen Fuel by lowering the risk of attaining the fuel cell cost goal of $45/kW in 2010.

Funding Profile[a]

(dollars in thousands)

	FY 2002 Comparable Appropriation	FY 2003 Amended Request	FY 2004 Request [b]	$ Change	% Change
Fuel Cell Technologies					
Total, Fuel Cell Technologies	46,682	57,500	77,500	+20,000	+34.8%

Public Law Authorization:

P.L. 94-163, "Energy Policy and Conservation Act" (EPCA) (1975)
P.L. 95-91, "Department of Energy Organization Act" (1977)
P.L. 102-486, "Energy Policy Act of 1992"
P.L. 93-577, "Federal Non-nuclear Energy Research and Development Act of 1974"
P.L. 93-275, "Federal Energy Administration Act of 1974"
P.L. 94-413, "Electric and Hybrid Vehicle Research, Development and Demonstration Act of 1980"
P.L. 94-413, Title III - "Automotive Propulsion Research and Development Act of 1978"
P.L. 95-238, "Methane Transportation Research, Development and Demonstration Act of 1980"
P.L. 96-512, "Alternative Motor Fuels Act of 1988"

[a] Includes funding transfer of $743,000 for SBIR/STTR (from EE-05-02 transportation) and $0 (from EO-01-01 stationary) . The FY 2002 Defense Authorization Act authorized a $10 million prorata reduction among all Renewable Energy Resources programs to supplement the Electric Reliability Program (formerly Electric Energy Systems and Energy Storage Program) and the Hydrogen and Fuel Cells Infrastructure R&D Program transferred $0 to the Electric Reliability Program. The application of the FY 2002 General Reduction was $0. The FY 2002 rescission (P.L. 107-206) for travel and administrative expenses reduced this program by $0.

[b] Includes SBIR estimates of 2.5 percent of total, i.e. $1,438,000 in FY 2003 and $1,938,000 in FY 2004.

Funding by Site[a]

	(dollars in thousands)				
	FY 2002	FY 2003	FY 2004	$ Change	% Change
Albuquerque Operations Office					
Albuquerque Operations Office	13,069	25,900	24,000	-1,900	-7.3%
Golden Field Office[c]	0	500	28,550	+28,050	+5,610.0%
Los Alamos National Laboratory	5,655	6,000	6,500	+500	+8.3%
National Renewable Energy Laboratory[b]	670	1,815	200	-1,615	-89.0%
Total, Albuquerque Operations Office	19,394	34,215	59,250	+25,035	+73.2%
Chicago Operations Office					
Brookhaven National Laboratory	100	270	300	+30	+11.1%
Chicago Operations Office	10,068	6,442	0	-6,442	-100.0%
Argonne National Laboratory	8,187	8,100	9,712	+1612	+19.9%
Total, Chicago Operations Office	18,355	14,812	10,012	-4,800	-32.4%
National Energy Technology Laboratory	100	600	300	-300	-50.0%
Oakland Operations Office					
Lawrence Berkeley National Laboratory	400	400	400	0	0.0%
Lawrence Livermore National Laboratory	275	425	400	-25	-5.9%
Total, Oakland Operations Office	675	825	800	-25	-3.0%

[a] "On December 20, 2002, the National Nuclear Security Administration (NNSA) disestablished the Albuquerque, Oakland, and Nevada Operations Offices, renamed existing area offices as site offices, established a new Nevada Site Office, and established a single NNSA Service Center to be located in Albuquerque. Other aspects of the NNSA organizational changes will be phased in and consolidation of the Service Center in Albuquerque will be completed by September 30, 2004. For budget display purposes, DOE is displaying non-NNSA budgets by site in the traditional pre-NNSA organizational format."

[b] National Renewable Energy Laboratory reduction reflects transfer of hydrogen storage R&D responsibility to the Hydrogen subprogram, funded by the Energy and Water appropriation.

[c] Increase indicates the decision to fund industry Cooperative Agreements from the Golden Field Office (previously funded through the Chicago Operations Office).

	(dollars in thousands)				
	FY 2002	FY 2003	FY 2004	$ Change	% Change
Oak Ridge Operations Office					
Oak Ridge National Laboratory	3,972	2,230	2,300	+70	+3.1%
Total, Oak Ridge Operations Office	3,972	2,230	2,300	+70	+3.1%
Richland Operations Office					
Pacific Northwest National Laboratory	1,800	2,700	2,500	-200	-7.4%
Total, Richland Operations Office	1,800	2,700	2,500	-200	-7.4%
Washington Headquarters	2,386	2,118	2,338	+220	+10.4%
Total, Fuel Cells Technologies	46,682	57,500	77,500	+20,000	+34.8%

Site Descriptions

Albuquerque Operations Office

The Albuquerque Operations Office administers the Fuel Cell Technology Subprogram's Cooperative Agreements with recipients conducting research and development for advanced fuel cell materials and components.

Golden Field Office

The Golden Field Office provides procurement services and technical oversight of the research, development, and demonstration activities conducted by the recipients of Cooperative Agreements.

Los Alamos National Laboratory

Los Alamos National Laboratory (LANL) serves as the lead laboratory in research and development of fuel cell components, reducing precious metal loading while maintaining performance and characterizing the poisoning of fuel cell catalysts by impurities in air and fuel feeds. To facilitate heat rejection and improve CO tolerance of membrane electrode assemblies, LANL is leading a major effort to design, synthesize, and characterize membranes which operate at high temperatures, above 120EC for transportation applications and above 150EC for stationary applications. Characterization of direct methanol fuel cells at LANL will accelerate high-volume manufacturing processes for fuel cells. LANL is developing CO sensors to allow optimization of operating efficiencies of fuel processors and PEM fuel cells with control systems. LANL is characterizing the durability of fuel cell stacks operating on both hydrogen and on reformate (5,000 hours for transportation applications and 40,000 hours for stationary applications), since the durability of fuel cell stacks has not been demonstrated, LANL is also characterizng the effects of fuel composition on fuel processor performance.

National Renewable Energy Laboratory

National Renewable Energy Laboratory (NREL) models the technical, economic, and integration aspects of fuel cell vehicle systems and control strategies using the ADVISOR software developed at the lab to provide guidance for the development of hydrogen fuel cell vehicles.

Brookhaven National Laboratory

Conducts research and development of electrocatalyst alloys for fuel cells focusing on synthesis and characterization of the materials.

Chicago Operations Office

The Chicago Operations Office administers the Fuel Cell Technology Subprogram's Cooperative Agreements with recipients conducting research and development for advanced fuel cell materials and components.

Argonne National Laboratory

Argonne National Laboratory (ANL) is the lead laboratory in all facets of the research and development

of fuel processor catalysts and fuel cell system analysis. ANL provides technical assistance in the management of DOE cooperative agreements with industry. ANL continues to develop catalysts, materials, and processes for the CO clean-up and autothermal reforming of gasoline and other fuels including diesel, to examine the effect of fuel additives on fuel processor performance, and to characterize the stability and degradation of fuel processing catalysts. In addition, ANL is developing a fast-start fuel processor for gasoline, with support from other National Laboratories such as PNNL and other suppliers.

National Energy Technology Laboratory

National Energy Technology Laboratory (NETL) models the technical, economic, and integration aspects of fuel cell vehicle systems and control strategies using the ADVISOR software developed at the lab to provide guidance for the development of hydrogen fuel cell vehicles.

Lawrence Berkeley National Laboratory

Lawrence Berkeley National Laboratory (LBNL) develops electrocatalysts for membrane electrode assemblies with the goal of increasing understanding of fundamental electrochemical phenomena.

Lawrence Livermore National Laboratory

Lawrence Livermore National Laboratory (LLNL) develops hydrogen and carbon monoxide sensors, both for safety and for fuel stream monitoring in a fuel cell vehicles. Technology development is followed by construction and testing of prototype hydrogen sensors

Oak Ridge National Laboratory

Oak Ridge National Laboratory (ORNL) is the primary lab for materials R&D aimed at reducing the weight and cost of fuel cell components. ORNL carries out R&D on bipolar plates and membrane characterization and it develops high-thermal-conductivity graphite foam for fuel cell humidification.

Pacific Northwest National Laboratory

Pacific Northwest National Laboratory (PNNL) develops compact, microchannel fuel reformer components. Microchannel technology offer heat and mass transfer advantages allowing PNNL to reduce the size and weight of fuel processing components such as steam reformers, water gas shift reactors, and preferential oxidation subsystems.

Funding Schedule

(dollars in thousands)

	FY 2002	FY 2003	FY 2004	$ Change	% Change
Fuel Cell Technology					
Transportation Systems	7,466	7,600	7,600	0	0.0%
Distributed Energy Systems	5,500	7,500	7,500	0	0.0%
Stack Component R&D	12,595	14,900	28,000	+13,100	+87.9%
Fuel Processor R&D	20,921	25,300	19,000	-6,300	-24.9%
Technology Validation	0	1,800	15,000	+13,200	+733.3%
Technical/Program Management Support	200	400	400	0	0.0%
Total, Fuel Cell Technology	46,682	57,500	77,500	+20,000	+34.8%

Detailed Program Justification

	(dollars in thousands)		
	FY 2002	FY 2003	FY 2004
Transportation Systems	**7,466**	**7,600**	**7,600**

Transportation Systems conducts R&D and analysis activities that address key barriers to fuel cell systems for transportation applications. Key systems level barriers include attainment of extremely low cost and high reliability technical targets. Because of the strong level of industry development of complete systems, this activity does not develop complete, integrated systems. The activity supports the development of individual component technology critical to systems integration as well as systems level modeling activities that serve to guide R&D activities, benchmark systems progress, and explore alternate systems configurations on a cost-effective basis. Other activities of Transportation Systems include studies that 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 (APU's) for heavy vehicle applications. Systems components developed under Transportation Systems include compressor/expanders, sensors, actuators, heat exchangers and water management devices. The Transportation Systems activity will include competitively selected R&D projects that include significant industry cost share.

FY 2002: Completed the test and evaluation of a 10-kW system, that addressed system control issues such as start-up and transient response. An integrated power system model was updated and validated to include data from the results of 50-kW integrated systems testing, and the cost and system trade-off analyses was updated. The progress of available technology was benchmarked relative to revised year 2005 performance targets of 250 W/l system power density, 250 W/kg system specific power, near-zero emissions, 40 percent efficiency at 25 percent power, $125/kW cost and more than 2,000 hours durability in a fuel-flexible fuel cell system. The development of fuel cell system sensors (CO, H_2, NH_3, H_2S, temperature, pressure relative humidity, etc.) suitable for automotive use was continued. The development of compact humidifiers/heat exchangers was initiated. An advanced, mixed-flow turbocompressor which meets established pressure-ratio turndown requirements was demonstrated. SBIR/STTR funding in the amount of $134,000 was transferred from this subprogram to the Science Appropriation. Participants include: Teledyne, BTI, SAE, Honeywell, Caterpillar, NREL, LLNL, Tiax, ANL, UTC Fuel Cells, IIT, Directed Technologies, Nuvera.

FY 2003: The progress of available technology will be benchmarked relative to achieving revised year 2005 performance targets of 250 W/l system power density, 250 W/kg system specific power, near-zero emissions, 40 percent efficiency at 25 percent power, $125/kW cost and more than 2,000 hours durability in a fuel-flexible fuel cell system. An integrated power system model will be updated and validated to include data from 10-kW integrated system testing, which will include advanced start-up and transient response. Integrated system cost and trade-off analyses will be updated. Fuel cell system sensors (CO, H_2, NH_3, H_2S, temperature, pressure relative humidity, etc.) will be integrated and tested in sub-scale subsystems. The development of compact humidifiers/heat exchangers will continue. Development of fuel cells for auxiliary power in cars and trucks will be initiated. An advanced mixed-flow turbocompressor which meets established pressure-ratio turndown requirements will be integrated

(dollars in thousands)

and tested in a sub-scale stack system.
Participants include: Nuvera, UTC Fuel Cells, Tiax, Honeywell, BTI, SAE, NREL, LLNL, ANL, LANL.

FY 2004: Annual performance improvements will be measured by benchmarking available technology relative to revised year 2005 performance targets of 250 W/L system power density, 250 W/kg system specific power, near-zero emissions, 40 percent efficiency at 25 percent power, $125/kW cost and more than 2,000 hours durability in a fuel-flexible fuel cell system. System cost and trade-off analyses will be updated to include the scenarios for an ambient pressure system and for high temperature operation (150EC). Fuel cell system sensors (CO, H_2, NH_3, H_2S, temperature, pressure relative humidity, etc.) are tested and evaluated in full-scale systems. Test and evaluation of compact humidifiers/heat exchangers in sub-scale systems will be conducted. Prototype fuel cell systems for auxiliary power in trucks to support the 21st Century Truck initiative will be evaluated. Extensive testing and evaluation of a turbocompressor which meets established pressure-ratio turndown requirements in a full-scale fuel cell system will be conducted, and an evaluation of competing air management technologies will be performed. Participants include: Nuvera, UTC Fuel Cells, Tiax, Honeywell, SAE, TBD, NREL, LLNL, ANL, LANL.

Distributed Energy Systems	**5,500**	**7,500**	**7,500**

This subprogram activity 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. This technology will not only save energy and reduce emissions, but its inherent flexibility will help address energy security issues through energy diversity. 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 also will take 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. The Distributed Energy Systems activity will include competitively selected R&D projects that include significant industry cost share.

FY 2002: Finalized the design and built a laboratory prototype Natural Gas Fuel Processor with CO clean-up capability for high temperature stationary PEM fuel cells. Fabricated a laboratory prototype of a Membrane Electrode Assembly (MEA) with advanced high temperature membranes for a PEM fuel cell. Completed phase II design of a 50kW high temperature PEM fuel cell incorporating cooling, heating and power (CHP) principles for recoverable heat. Participants include: GE Energy and Environmental Research, Fuel Cell Energy, ANL, PNNL.

FY 2003: Will initiate testing of a laboratory prototype Natural Gas Fuel Processor with CO clean-up capability for high temperature stationary PEM fuel cell systems. Will begin testing of laboratory prototype of a MEA with advanced high temperature membranes for PEM fuel cells. Based on Phase II

(dollars in thousands)

designs completed in FY 2002, will begin development of prototype 50kW high temperature PEM fuel cell incorporating cooling, heating and power (CHP) principles for recoverable heat. Initiate development of fuel cells for portable power to accelerate manufacturing capability and cost reduction of fuel cell stacks. Participants include: Caterpillar, GE Energy and Environmental Research, Fuel Cell Energy, ANL, PNNL, TBD.

FY 2004: Continue development of an integrated system (including fuel cell stack, air and thermal management system, and power grid interface) to meet the year 2010 durability target of 40,000 hours. Perform detailed cost analysis and determine the smallest power rating and durability of a viable and practical stationary fuel cell system and fuel cell type. Analyze the feasibility of a low temperature (80 °C) PEM fuel cell system to incorporate combined heating and power (CHP) technologies. Benchmark performance and durability of a high temperature membrane (HTM) system. Conduct R&D projects to demonstrate feasibility of fuel cells for portable power applications in terms of performance, cost, and reliability. Use results to benchmark durability of fuel cell stacks. Participants include: Caterpillar, ANL, NREL, PNNL, TBD.

Stack Component R&D	**12595**	**14900**	**28000**

Collaborative research and development efforts with industry, National Laboratories and academia focus on the most critical technical hurdles for Polymer Electrolyte Membrane (PEM) fuel cell stack components for both stationary and transportation applications. Critical technical hurdles include cost, durability, efficiency and overall performance of components such as the polymer electrolyte membranes, oxygen reduction electrodes, advanced catalysts, bipolar plates, etc. Addressing these hurdles at the component level supports the industrial effort to integrate the fuel cell system and develop full-scale fuel cell stacks. The success of these research and development efforts will assist the industry in making their decision regarding commercialization of fuel cells. In previous years, the subprogram supported efforts to integrate fuel cell systems and develop full-scale fuel cell stacks, however, a programmatic shift came about because industry now has the capability to carry out systems integration efforts on their own. Technical targets established at the component level support the FreedomCAR technical targets for transportation fuel cells and industrial targets for stationary fuel cells. Component research and development activities for these two applications 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 supply base, which is motivated by large transportation markets. Beginning in FY 2004, the stack component key activity includes research and development activities for both of these applications.

This activity supports the fuel cell performance targets to: reduce the production cost of the hydrogen- or gasoline-fueled, 50 kW vehicle fuel cell power system (including hydrogen storage) from $275/kW in 2002 to $45/kW in 2010 at production levels of 500,000 units per year (projected cost) and increase the efficiency of natural gas or propane fueled 50kW stationary fuel cell systems from 29 percent in 2002 to 40 percent in 2010 (based on the electrical efficiency).

(dollars in thousands)

FY 2002	FY 2003	FY 2004

FY 2002: Performed research on low-cost, high performance components, increasing power density from 250 to 320 mW/cm^2 at 0.8V to meet PEM fuel cell stack system 2005 cost target of $100/kW and durability target of 2,000 hours. Long-term tests provided data on: durability of stack components and small stack subsystems, and impact of fuel impurities and cycling. Developed high efficiency O_2-reduction electrodes and membrane electrode assemblies (MEAs). Performed research on polymer membranes, MEAs, electrode structures and cell designs to obtain higher fuel cell operating temperatures (120-150°C), in order to increase CO tolerance and facilitate heat rejection. Feasibility of low-cost fabrication processes for MEAs was demonstrated in a pilot plant meeting the MEA cost target of $10/kW. Advanced catalyst deposition techniques were initiated to meet the 2005 precious metal loading target of 0.6g/kW. Demonstrated a direct methanol fuel cell stack incorporating low platinum MEA. SBIR/STTR funding in the amount of $230,000 was transferred from this subprogram to the Science Appropriation.

Participants include: Honeywell, UTC Fuel Cells, Teledyne, Porvair, Tiax, Mechanology, DeNora, DuPont, Superior Micropowders, GTI, 3M, Southwest Research Institute, W.L. Gore, LANL, ANL, ORNL, LBNL, NREL

FY 2003: Research on low-cost, high performance components will be performed to increase power density from 250 to 320 mW/cm^2 at 0.8V, to meet the PEM fuel cell stack system 2005 cost target of $100/kW and durability target of 2,000 hours. Long-term tests will provide data on: durability of stack components and small stack subsystems, and impact of fuel impurities and cycling. High efficiency O_2-reduction electrodes and MEAs will be validated. Options for Polymer membranes, MEAs, electrode structures and cell designs for higher fuel cell operating temperatures (120-150°C) will be down selected to pursue best approaches for increasing CO tolerance and facilitating heat rejection. Low-cost MEA fabrication processes for pilot plant operation, including quality control, will be developed to meet the MEA cost target of $10/kW and 2005 durability target of 2,000 hours. Advanced catalyst deposition techniques will be developed to meet the 2005 precious metal loading target of 0.6g/kW. Non-precious metal catalysts are investigated to reduce MEA cost.

Participants include: Honeywell, UTC Fuel Cells, 3M, Southwest Research Institute, W.L. Gore, Porvair, Tiax, Mechanology, DuPont, DeNora, Superior Micropowders, LANL, ANL, LBNL, NREL, TBD.

FY 2004: Develop low-cost, high performance components to meet FreedomCAR fuel cell stack system 2005 target of $100/kW and durability target of 2,000 hours while increasing power density from 250 to 320 mW/cm^2 at 0.8V. Long-term tests will provide data on: durability of stack components and impact of fuel impurities and cycling.

Complete validation of high efficiency O_2-reduction electrodes and MEAs which began in FY 2002. Investigate novel polymeric membranes (from downselect process), MEAs, electrode structures and cell designs for higher operating temperatures. Develop an advanced cost-driven membrane technology that is not fully fluorinated, tolerates a strong oxidizing environment, and operates at conventional

(dollars in thousands)

temperature and operating conditions. Demonstrate MEA fabrication processes in pilot plant operation. Pilot plant operational data will be used to refine low-cost MEA fabrication processes, including quality control, to meet MEA cost target of $10/kW and 2005 durability target of 2,000 hours. Develop cell component durability diagnostics and accelerated tests to establish and improve MEA stability, and to establish the role of changes to the hydrophilic and hydrophobic nature of components in cell durability. Develop dispersed, low-loading, catalyst deposition techniques and ultra-low Pt catalyst structures that are not Ruthenium based, are stable in the fuel cell operating environment and built upon a non-oxidizing substrate to meet the 2005 precious metal loading target of 0.6g/kW. Investigate non-precious metal catalysts to reduce MEA cost. Investigate biometric complexes as an alternative to Pt, and implement advances in quantum chemistry, combinatorial synthesis and in situ characterization to identify promising non-Pt catalyst systems. Participants include: UTC Fuel Cells, 3M, Southwest Research Institute, Porvair, Tiax, Mechanology, DuPont, DeNora, Superior Micropowders, LANL, ANL, LBNL, NREL, TBD.

Fuel Processor R&D	**20,921**	**25,300**	**19000**

The subprogram is pursuing the development of on-board fuel processors as an alternative to the direct hydrogen approach for transportation and stationary applications. Fuel processing technology is fuel flexible and capable of reforming fuels such as gasoline, methanol, ethanol, and natural gas into hydrogen. Fuel cell vehicles (FCV's) could be fueled by an advanced petroleum-based fuel, which is "gasoline like," as a strategy to fuel FCV's before a hydrogen infrastructure is available. The interim strategy would be compatible with the existing refueling infrastructure, could potentially fuel both internal combustion engines and FCV's and eliminate the hydrogen storage barrier. On-board fuel processing has technical and economic challenges that may not be overcome in the required "transition" timeframe. As a result, the subprogram will conduct a major go/no-go decision in June 2004 to determine the future course of on-board fuel processing activities for transportation applications. The review will focus on critical technical targets, with start-up time (less than 30 seconds) being a major criterion. If R&D to date cannot confirm a clear path to meet this technical target, a major change in research direction may be required.

FY 2002: Developed advanced on-board hydrogen storage technologies, in collaboration with the Hydrogen Technology subprogram, to meet technical targets of 1100 Wh/l and 2000 Wh/kg. Demonstrated components of an advanced fuel-flexible fuel processor meeting 2005 technical targets of 78 percent efficiency, 700 W/l, 700 W/kg, and less than Tier 2 emissions. Demonstrated low pressure fuel processor to reduce air management requirements. Investigated innovative fuel processing techniques to allow rapid start-up (<30sec.). Demonstrated a high compact (>1500W/l) prototype 50kW microchannel steam reformer capable of reforming methanol, ethanol, natural gas and gasoline in conjunction with other fuel processing components, such as heat exchangers and steam generators. Investigated high activity, sulfur tolerant shift catalysts for fuel processor system, required to reduce reactor size and precious metal content, while meeting the 2,000 hour durability target, and reducing a 200,000 ppm CO input to <2,000 ppm, allowing final reduction to <10 ppm by preferential oxidation. Initiated development of hydrogen enhancement technologies to improve system performance. Assessed

performance, durability, and safety of fuel options (methanol, ethanol, natural gas, and petroleum) for generation of hydrogen both on-board and off-board the fuel cell vehicle, including research to determine the effects of fuel properties and impurities on the fuel cell system. SBIR/STTR funding in the amount of $379,000 was transferred from this subprogram to the Science Appropriation. Participants include: Nuvera, University of Michigan, UTC Fuel Cells, United Technologies R&D Center, University of Kentucky, Catalytica, Sud-Chemie, McDermott, ANL, LANL, PNNL.

FY 2003: Low pressure hydrogen storage evaluation capability will be established that is suitable for fuel cell vehicle use. In collaboration with the Hydrogen Technology subprogram, development of innovative low pressure hydrogen storage technologies will be accelerated, including carbon-based nanotechnology and chemical hydrides. Performance of advanced components/concepts in a sub-scale fuel processing system that meets 2005 technical targets will be validated. Innovative fuel processing techniques are investigated to meet rapid start-up (<30sec.). A microchannel fuel processing system will be demonstrated including the reformer, heat exchangers, steam generators, sensors, controls, etc. High-activity, sulfur-tolerant shift catalysts for fuel processor systems will be developed to reduce reactor size and precious metal content. Promising catalysts will be demonstrated on monolith substrates so that they can be incorporated into fuel processor systems for testing. Build, test, and evaluate prototype hydrogen enhancement and purification technologies to improve system performance. Continue to assess the performance, durability, and safety of fuel options (methanol, ethanol, natural gas, and petroleum) for generation of hydrogen, including research to determine the effects of fuel properties and impurities on the fuel cell system. Collect data from the Technology Validation projects to feed back into technology development. Participants include: Nuvera, University of Michigan, Catalytica, Sud-Chemie, United Technologies, University of Kentucky, ANL, LANL, PNNL.

FY 2004: Demonstrate a full scale transportation on-board fuel processing system that meets 2005 technical targets of 78 percent efficiency, 700 W/1, 700 W/kg, less than 1 minute start-up, and less than Tier 2 emissions. Demonstrate innovative fuel processing techniques to allow rapid start-up (<30sec.), including system with integrated turbine/air management system. Demonstrate a 10kW microchannel fuel processing system, including the reformer, shift and CO clean-up reactors, heat exchangers, steam generators, sensors, controls, etc. Demonstrate high-activity, sulfur-tolerant shift catalysts for fuel processor systems to reduce reactor size, start-up time and precious metal content. Investigate hydrogen separation techniques for reduced shift reactor size and fast start-up. Develop diesel fuel processing technology for Auxiliary Power Unit (APU) applications. Develop compact, efficient fuel processing technology for natural gas or propane fueled stationary applications. Complete performance, durability, and safety assessment of fuel options (methanol, ethanol, natural gas, and petroleum) for generation of hydrogen. Use all demonstration results to make major Go/No Go decision on whether to continue on-

board component of fuel processing activity.
Participants include: Nuvera, University of Michigan, Catalytica, Sud-Chemie, United Technologies, ANL, LANL, PNNL, TBD

Technology Validation 0 1800 15000

The Technology Validation activity of the Fuel Cell subprogram will be implemented in close coordination with the Infrastructure Validation activity (the Infrastructure Validation activity is funded through the Energy and Water appropriation). These two activities together make up the Controlled Fleet and Infrastructure Technology Validation Project. This project is a 50/50 cost shared effort between the government and industry and will include automobile manufacturers, energy companies, suppliers, universities, and State governments. The validation effort will be an important opportunity to validate component R&D in a systems contest under real-world operating conditions, and for industry to gain experience in the manufacture, maintenance and fueling of hydrogen fueled vehicles. By manufacturing and fielding these vehicles in a controlled manner, all participating parties will be able to quantify the performance and reliability, document any problem areas, and to provide valuable information to researchers to help refine and direct future R&D activities related to fuel cell vehicles.

FY 2002: No activity.

FY 2003: Initiate new government/industry cooperative program to test and evaluate fuel cell research vehicles to determine future research needs and to validate fuel cell durability, reliability, energy efficiency and environmental benefits of state-of-the-art fuel cell technology. This cooperative program will be based on an assessment requested by Congress. Continue the participation with the California Fuel Cell Partnership. Participants include: auto manufacturers, fuel providers, suppliers, universities, States, NREL, ANL, California Fuel Cell Partnership members.

FY 2004: Implement cooperative agreements for a controlled fleet demonstration of fuel cell vehicles to validate performance, cost, reliability, maintenance requirements, environmental benefits and to develop a better understanding of vehicle and infrastructure interface issues. The demonstrations will be carried out through a government/industry partnership with at least a 50 percent cost-share. By 2008, this activity – the Controlled Fleet and Infrastructure Technology Validation Project ($15,000,000) – will demonstrate the ability to operate for 2,000 hours under real-world conditions. Establish geographical locations and demonstration sites. Prepare vehicle test plans. The transportation partnership that will implement the demonstration will be between government and industry and will provide needed information regarding durability and reliability of state-of-the-art fuel cell technology. Data from demonstrations will be used to refine research and development activities, to gain a clear understanding of remaining technology barriers, to evaluate the safety standards required for fuel cell vehicles to store hydrogen on board, and to begin a public education campaign to provide information on the characteristics of fuel cell powered vehicles. Participation in the California Fuel Cell Partnership will be continued. Field evaluations of distributed fuel cell systems under real world conditions to validate system durability and performance will begin in coordination with the hydrogen infrastructure validation

activity. Participants include: Original equipment manufacturers, utilities, energy providers, suppliers, universities, States, NREL, ANL, California Fuel Cell Partnership members and others.

Technical/Program Management	**200**	**400**	**400**

FY 2002: Provided critical technical and program management support services.

FY 2003: Provide critical technical and program management support services.

FY 2004: Representative activities will include preparation of program, strategic plans, and operating plans; evaluation of the impact of new legislation on R&D programs; identification of performance methodologies (including GPRA); data collection to assess program and project performance, efficiency and impacts; and development of performance agreements with management.

Explanation of Funding Changes

	FY 2004 vs. FY 2003 ($000)
Stack Component R&D	
▪ Increase shifts subprogram emphasis to address critical stack component performance and cost reduction targets for both transportation and stationary applications. Develop a non-fully fluorinated conventional membrane technology to meet cost requirements. Develop cell component durability diagnostics and accelerated testing to improve MEA stability. Initiate program for cost reduction of catalyst-coated membranes using nonprecious metal catalysts and ultra-low Pt built upon non-oxidizing substrates. Demonstrate pilot plant production of low cost membrane electrode assemblies..	+13,100
Fuel Processor R&D	
▪ Reduction reflects the decrease in mortgages to reach the FY 2004 go/no go milestone for on-board fuel processing under the FreedomCAR Program. Activities will focus on sub-system and component fuel processing technologies that have the potential to facilitate achievement of overall system start-up technical target of <0.5 minutes and to benefit synergistic stationary applications. In addition, hydrogen storage work has been eliminated under the fuel processing activity. All hydrogen storage work will be conducted under the Hydrogen Technology Subprogram supported by the Appropriations Subcommittee on Energy and Water Development..	-6,300
Technology Validation	
▪ An expansion of subprogram activity in Technology Validation supports demonstrations to validate performance and reliability of fuel cell systems and to aid in managing risk in the early commercialization period. In combination with the infrastructure validation effort being carried out under the Hydrogen subprogram (Energy and Water appropriation), will also characterize an understanding of vehicle and infrastructure interface issues. The demonstrations will be carried out through a government/industry partnership with at least 50 percent cost share. By 2008, demonstration efforts will confirm the ability to operate for 2000 hours under real-world conditions. Initial field evaluations of stationary systems to validate system durability and performance are also planned..	+13,200
Total, Fuel Cells Technology	+20,000

Distributed Energy Resources

Program Mission

The mission of the Distributed Energy and Electricity Reliability (DEER) Program is to strengthen America's electric energy infrastructure and provide utilities and consumers with a greater array of energy efficient technology choices for the generation, transmission, distribution, storage, and demand management of electric power and thermal energy.[a] This effort is accomplished through research, development, demonstration, technology transfer, and education and outreach activities in partnership with industries, businesses, utilities, States, other Federal programs and agencies, universities, national laboratories, and other stakeholders.

The program covers a portfolio of technologies, tools, and techniques including advanced industrial turbines, microturbines, reciprocating engines, chillers, desiccants (for humidity control), combined heat and power systems, energy storage devices, load management programs, transmission operations software, and high temperature superconducting cables and transformers. The program addresses the development of utility interconnection and other codes and standards, environmental siting and permitting regulations, and policies that affect the use of these distributed energy and electricity reliability technologies, tools, and techniques.

Distributed energy involves the use of relatively small-scale and modular energy generation devices that can be installed onsite or near the customer's premises. They are options for utilities and industrial, commercial, institutional, and residential consumers to use, along with grid connected services and other energy efficiency and renewable energy devices and equipment, for back-up, peak shaving, baseload, and combined heat and power applications. For example, a chemical plant could retrofit its facilities and install an advanced industrial turbine to make electricity and thermal energy to meet its energy needs and make money by selling excess power to the grid when power system conditions warrant. Or, a new commercial building could include onsite power generation and natural gas-fired chillers and desiccant systems in its architectural designs. They would do this to reduce costs and improve power reliability and quality for sustaining critical operations when grid-connected power is not available or sufficient.

Strategic Context

Accomplishing this mission contributes to several national energy and environmental goals. For example, expanding the use of distributed energy and electricity reliability technologies will upgrade America's aging electricity power infrastructure, relieve congestion on transmission and distribution systems, reduce consumption and increase supplies during periods of peak demand, accelerate the introduction of advanced systems to improve the efficiency of market operations, support the transition from traditional monopoly regulation to more competitive markets, and reduce environmental emissions, including greenhouse gases.

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[a] This Interior section is focused on the distributed energy portion of the program. The Energy and Water section focuses on electricity reliability.

America's power system is in a state of transition. Capital investment is needed to expand electricity supplies and upgrade existing systems. Policy makers are looking for opportunities to expand competition to replace traditional monopoly regulation, where it is appropriate to do so. Digital systems are replacing electro-mechanical devices in electric power networks. High speed telecommunications systems and the Internet are being integrated into power system operations, thus enabling real-time responses to system emergencies and changes in supply-demand conditions. Customers with needs for high levels of reliability and power quality (e.g., high-tech manufacturing plants and information and telecommunication service providers) are installing distributed energy devices and demanding lower cost, lower emission, and more energy efficient equipment, as well as new business practices and regulations to speed installation and facilitate distributed energy operations.

The President's National Energy Policy (NEP) contains more than twenty recommendations pertaining to the development of distributed energy and electricity reliability technologies and programs. For example, microturbines are referred to as a technology that offers a number of "significant advantages" over currently available small-scale power generators. These include having fewer moving parts, compact size and light weight, optimal efficiency, lower emissions and electricity costs, and the ability to use waste fuels. The NEP refers to combined heat and power (CHP) as "...one of a group of clean, highly reliable distributed energy technologies that reduce the amount of electricity lost in transmission while eliminating the need to construct expensive power lines to transmit power from large central power plants". The National Transmission Grid Study, which was released in June 2002, contains 51 recommendations for relieving congestion and boosting the efficiency transmission system operations, including expanded development of advanced, clean distributed energy resources and electricity reliability systems.

In fact, distributed energy and electricity reliability devices provide utilities and consumers with more choices and control over how their energy needs are met, and are thus essential for more openly competitive electricity and natural gas markets to flourish. Distributed energy and electricity reliability devices address critical needs of utilities and consumers by:

- reducing energy losses from transmitting electricity over long distances
- providing utilities with tools for more efficient grid operations
- reducing the need for major capital expenditures for electricity infrastructure (e.g., large scale power plants, transmission facilities, substations, and feeder lines)
- offering industrial, commercial, and ultimately residential users with more opportunities for increasing energy efficiency, managing energy costs, achieving desired levels of reliability and power quality, and reducing environmental emissions, including greenhouse gases.

Several regulatory and institutional barriers currently interfere with the expanded use of these technologies, tools, and techniques. These barriers include the lack of uniform utility interconnection standards, the lack of uniform environmental siting and permitting regulations, the lack of appropriate building, fire, and safety codes, the lack of real-time electricity pricing that reflects the marginal costs of production and delivery, and the lack of comprehensive national policies for achieving competitive utility markets across the country. Needed are policies and procedures in these areas to create a regulatory framework that is more conducive to competition and choice for Federal, regional, State, and local government agencies to follow.

Management Strategy

The program conducts research, development, demonstration, technology transfer, and education and outreach activities in partnership with industry, State agencies, universities, national laboratories, and other stakeholder organizations. It solicits opinions from experts outside of the U.S. Department of Energy to guide decision making about program directions and priorities. To accomplish this the program develops technology roadmaps and holds peer reviews.[a] A key element of the strategy is to build RD&D partnerships with industry and others to make distributed energy and electricity reliability systems more energy efficient, reliable, and affordable to consumers than the energy services they currently receive, and for these systems to have better power quality and lower environmental impacts. The ultimate aim is to improve the energy and environmental performance of distributed technologies, and increase the level of distributed technology integration among on-site energy generation alternatives so that the Nation can achieve a more flexible and smarter energy system. This new energy infrastructure will operate seamlessly alongside the existing system to enable consumers to make wiser energy choices and implement customized solutions, thereby boosting the Nation's economic productivity, energy efficiency, and environmental stewardship.

To address the regulatory and institutional barriers, the program has initiated analysis, education, and outreach activities, in concert with industry groups and government agencies, to support the development of better environmental siting and permitting regulations, more effective building codes and standards, and more open and competitive utility markets and business practices. The aim is to streamline procedures, accelerate distributed energy project development timetables, and lower the costs of regulatory compliance. The program is working with manufacturers and building code officials to ease the process for using distributed technologies in buildings for electricity and combined heat and power applications.

The program receives appropriations from both the Interior and Related Agencies and the Energy and Water Development subcommittees. Interior activities focus on the development of cleaner and more energy efficient distributed energy generation equipment and integration into end-use applications. Energy and Water development activities focus on developing advanced electricity reliability technologies, including high temperature superconducting systems.

[a] For example, Distributed Energy Resources - The Power to Choose, Peer Review, November 28-30, 2001

The Program is organized into the following areas of activity:

- Distributed Energy (Interior)
  - Distributed generation technology development
  - End-use systems integration and interface

- Electricity Reliability (Energy and Water)
  - High temperature superconducting R&D
  - Transmission reliability R&D
  - Distribution and interconnection R&D
  - Energy storage R&D
  - Electricity restructuring

In conducting these activities, the program operates a comprehensive set of RD&D partnerships. For example, collaborations include competitively awarded cost-shared projects. Federal partnerships include participation with the Federal Energy Management Program (FEMP) to promote and install distributed energy systems at Federal facilities; the State Energy Program to increase awareness, promote benefits, and remove barriers to distributed energy; and small businesses through the Small Business Innovation Research program.

The DEER program complements the Hydrogen Program by developing technologies that could utilize hydrogen based fuels for onsite power generation and combined heat and power applications. In addition, the program coordinates with the Industrial and Buildings Technologies Programs to identify co-funding opportunities for assessing distributed energy systems in these sectors. The program also partners with the U.S. Environmental Protection Agency on education and outreach efforts to address environmental siting and permitting of combined heat and power (CHP) and other distributed energy devices. Partnerships with State agencies include the California Energy Commission, the New York State Energy Research and Development Agency, and the Texas Natural Resources and Public Utilities Commissions. The program works with national laboratories including Oak Ridge National Laboratory (ORNL), National Renewable Energy Laboratory (NREL), Sandia National Laboratories (SNL), Pacific Northwest National Laboratory (PNNL), and National Energy Technology Laboratory (NETL) to develop an integrated national laboratory support effort that assembles the capabilities of the various labs and makes them available to manufacturers and end-users for testing and evaluation of the performance and integration of the various distributed energy systems.

Program Benefits

Each year, EERE estimates the benefits of program activities to support Government Performance and Results Act (GPRA) reporting. Methods are complex and vary by program. A complete explanation of methodology and assumptions will be posted this spring on line at www.eren.doe.gov/eere/budget.html. An overview of the methods and results for the DEER Program is provided below.

EERE's benefits estimate modeling starts with the Energy Information Administration's (EIA's) National Energy Modeling System (NEMS) and modifies it to create NEMS-GPRA04. The Baseline for the DEER program is essentially the EIA's Annual Energy Outlook (AEO) 2002 reference case, which includes considerable improvement in distributed generation (DG) technologies over time. The NEMS-GPRA04 baseline limits the rate of new technology adoption and the maximum share of DG technologies based on the extent to which future markets are expected to be able to accommodate these technologies. The Program goals for development of distributed electricity technologies (microturbines, reciprocating gas engines, and IC engines at 800 kW and 3,000 kW) are modeled directly in NEMS-GPRA04 by incorporating the improved costs, efficiencies, and other attributes in NEMS-GPRA04 for the program case. NEMS-GPRA04 compares these improved distributed technologies with other expected future sources of electricity (e.g., combined cycle natural gas plants). The portions of the program designed to enhance the ability of electricity markets to absorb and manage DG are modeled by increasing the maximum CHP market share. Because NEMS-GPRA04 cannot model markets for high-temperature superconductivity (HTS) products, the benefits from these products are modeled directly as reductions in transmission and distribution losses for electricity systems, based on estimates by Energetics of kilowatt-hour reductions from HTS generators, transformers, cables, and motors. The portions of the program which reduce market barriers to consumer investment are addressed by adjusting the model's consumer acceptance curves (market adoption rates by payback period) for CHP.

Not all kWh of electricity have equal value to consumers. Market experience suggests that at least a portion of consumers are willing to pay more for electricity that is more reliable, of higher quality, locally controllable, available during emergency, or cleaner. While market information was available to incorporate the impact of "green power" preferences in these benefit estimates, they do not include consumer purchases based on preferences for improved reliability, load management, or power quality advantages of distributed generation. As a result, these benefit estimates are likely based on an underestimate of the demand for these products under baseline market assumptions.

FY 2004 GPRA Benefits Estimates for the Distributed Energy Resources Program (NEMS-GPRA04)			
	2005	2010	2020
Electricity Capacity (GW)	2.3	7.4	25.0
Electricity Generation (BkWh)	16.7	53.8	180.1
Non-Renewable Energy Savings (quads)	0.08	0.19	0.46
Oil Savings (quads)	0.00	0.01	0.02
Carbon Savings (MMT)	1.4	3.4	8.5
Energy Expenditure Savings (B2000$)	0.7	3.1	9.0

Estimates for additions to electricity capacity and generation, energy savings, oil savings, carbon emission reductions, and energy expenditure savings resultant from realization of DEER Program goals are shown in the table above through 2020.[a] By facilitating the development of distributed electricity generation and improving the ability to manage peak demand loads for electricity, the DEER program helps alleviate the growing pressure on our Nation's critical electricity infrastructure, reducing the need for new generating and transmission capacity. The need for new central power construction is reduced by about 27 GW (the 25 GW of distributed power reported above displaces 27 GW of centrally-generated electricity capacity when transmission and other lines loses are factored in) by 2020, or 11 percent of expected needed additional capacity during this period (2005 to 2020). Almost 90 percent are gas turbines or combined cycles, and 10 percent are coal steam plants. Energy savings are measured as the displaced energy from central station plants and thermal building use, net of fuel consumed by the DG technologies.

These estimates reflect EIA reference case assumptions about future energy markets. The development of these technologies will also provide the nation with the opportunity to produce additional clean distributed energy if future electricity markets are more constrained than EIA projections expect (e.g., transmission lines prove more costly or difficult to site than expected), or if additional environmental policies associated with electricity production are implemented.

In addition to the quantified benefits identified above, the DEER program provides significant public energy reliability and security benefits. By improving the local availability and controllability of electricity, the DEER program helps achieve the electricity reliability and quality required demanded by our information economy and provides local sources of electrical power during emergencies.

Program Strategic Performance Goals

The Program Strategic Performance Goal represents the Distributed Energy and Electricity Reliability Program in entirety, and thus encompasses efforts under both the Energy and Water Appropriation and the Interior Appropriation:

The DEER Program has the following overall performance goals: 1) by 2008, DEER Program will complete development and testing of a portfolio of distributed generation and thermally activated technologies that show an average 25 percent increase in efficiency (compared to 2000 baseline) with NOx emissions less than 0.15 grams/kWh.; 2) by 2008, demonstrate the feasibility of integrated systems in three new customer classes, which could achieve 70 percent efficiency and customer payback in less than 4 years, assuming commercial-scale production; 3) by 2008, demonstrate the capability to double the power carrying capacity of transmission and distribution wires compared to that available in 2000, and 4) by 2012, develop a portfolio of technologies and software tools that allow real-time monitoring, understanding, and control of the transmission and distribution system by identifying over 90percent of

[a] Benefits reported are annual, not cumulative, for the year given for the entire DEER program (both the Interior and EWD portions). Estimates reflect the benefits associated with program activities from FY 2004 to the benefit year or to program completion (whichever is nearer), and are based on program goals developed in alignment with assumptions in the President's Budget.

incipient system disturbances and cue the operator for action as necessary (reducing response time through automated actions) to mitigate disturbance propagation.

Performance Indicators

The Interior section focuses on distributed energy, and addresses sub-program goals (1) and (2) in the stated performance goal. The respective performance indicators and technology baselines are stated below:

Performance Indicator

Distributed Energy Resources (Technology Development) - By 2008, DEER Program will complete development and testing of a portfolio of distributed generation and thermally activated technologies that show an average 25 percent increase in efficiency (compared to 2000 baseline) with NOx emissions less than 0.15 lbs/MWh with an equivalent reduction in cost compared to 2000 baseline.

Average efficiency of a portfolio of distributed generation and thermally activated technologies. *2000 Technology Baseline*: Microturbine - 25 percent; Reciprocating engine - 36 percent[a]; Dessicant (primary energy COP) - 0.5

Performance Indicator

Distributed Energy Resources (End-Use System Integration) - By 2008, demonstrate the feasibility of integrated systems in 3 new customer classes[b]; these systems will achieve 70 percent efficiency and customer payback in less than 4 years, assuming commercial-scale production.

Demonstration of integrated system. *2000 Technology Baseline*: no commercially-available integrated systems in specified customer classes.

[a] These are estimates; actual data to be tracked via public source (e.g. Diesel and Gas Turbine Worldwide, 2001)

[b] Note: Integrated systems traditionally have focused on industrial CHP applications; these "new" customer classes target commercial, light industrial, and microgrid systems, which are representative of thousands of applications throughout the United States. After final determination, specific Standard Industrial Classification (SIC) codes will be added to the metrics [e.g. Grocery Stores - 4451; Limited-Service Eating Places - 7222; Hospitals - 622; Hotels (except Casino Hotels) and Motels - 72111; Broadcasting and Telecommunications - 513; Information Services and Data Processing Services - 514]

Annual Performance Results and Targets

FY 2002 Results	FY 2003 Targets	FY 2004 Targets
Demonstrated a microturbine package (highly efficient for reducing peak loads) at a university site. Completed preliminary systems designs for a 40 percent efficient microturbine and a low emission reciprocating engine. Demonstrated an advanced ceramic combustor liner in an industrial gas turbine for over 16,000 hours service. Completed testing and evaluation of a large absorption chiller.	Complete testing of 12 Beta Ambian units of high efficiency natural gas-fired heat pump (60percent better than pulse combustion furnace) and install at field test sites hosted by major U.S. Gas Utilities. Complete 4,000 hour field test of ceramic composite shroud components to demonstrate performance and emission benefits to a gas turbine. Demonstrate 5 percentage point increase in efficiency for an advanced microturbine system.	Complete and demonstrate heating coefficient of performance of 1.4 for commercial introduction of a thermally activated system (approximately 40 percent more efficient than a conventional heating system) Complete final design and initiate field testing of low emission technology with less than 7 ppm NOx. Demonstrate 6 percentage point increase in efficiency for an advanced reciprocating engine. Complete final design and initiate field testing and evaluation of a complete, fully functional integrated CHP system consisting of a turbine, absorption chiller and control system.

The following table represents the installed base of distributed generation in the United States.

Installed Base of Distributed Generation and CHP (GW)[a]

	1998	1999	2000	2001
Distributed Generation Excluding Renewables, Biomass and Off-Site Power	15.2	15.4	15.6	16.2
CHP	56.8	59.0	61.7	67.4

Distributed generation estimates exclude wind, solar, geothermal, and sources that export over 90percent power off-site. Data is for non-emergency generators, non-utility owned, under 50 MW, and over 1 MW. CHP estimates include all fuel sources (except wind and hydro) and prime mover types that self-classify as cogenerator or FERC-qualifying cogenerator.

Significant Program Shifts

The program completed the Advanced Turbine Systems subprogram in fiscal year 1999. This subprogram successfully resulted in the development of a new design for an advanced industrial turbine for distributed energy applications that achieved the goals set forth at the subprogram's inception in 1992 for improved energy efficiency and lower environmental emissions. The developer of that advanced design, Solar Turbines, Inc., is reviewing the potential commercialization of its advanced turbine system, the Mercury 50. This product is cost competitive with other products in its class but uses less fuel and emits less nitrogen oxides. It is capable of meeting air emissions regulations in non-attainment areas.

The program is following a similar RD&D model in pursuing activities in microturbines, reciprocating engines, thermally activated devices, and other areas. Plans call for supporting RD&D partnerships in the development of advanced designs for these products, cost sharing field testing and demonstrations to validate performance up to 8,000 hours of operation. These milestones are expected to be reached for microturbines in 2007 and reciprocating engines in 2010. Until then, efforts will be focused on cost shared RD&D to select promising approaches that lead to the achievement of RD&D goals for energy efficiency, environmental emissions, and cost effectiveness.

The Stationary Fuel Cell Program (formerly Building Fuel Cells) has been transferred to Fuel Cells program.

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[a] Sources: DG: 2000 EIA Form 860B, for 1998-2000 data, and Resource Dynamics Corporation estimates for year 2001, based on Diesel and Gas Turbine Worldwide estimates for 2001 in U. S.

CHP: 2001 EIA Form 860B, for 1998-2000 data, and Resource Dynamics Corporation estimates for year 2001, based on Diesel and Gas Turbine Worldwide estimates for 2001 in U. S. for units under 100 MW, and for units over 100 MW based on EIA capacity additions for 2001 that self-classify themselves as cogenerators.

Funding Profile[a]

(dollars in thousands)

	FY 2002 Comparable Appropriation	FY 2003 Amended Request	FY 2004 Request	$ Change	% Change
Distributed Energy Resources					
Total, Distributed Energy Resources	55,137	54,784	51,784	-3,000	-5.5%

Public Law Authorizations:

P.L. 94-163, Energy Policy and Conservation Act (1975)
P.L. 94-385, Energy Conservation and Production Act (1976)

[a] SBIR/STTR funding in the amount of $ 1,259,000was transferred to the Science appropriation in FY 2002. Estimates for SBIR/STTR budgeted in FY 2003 and FY 2004 are $ 1,250,940 and $ 1,182,437 respectively.

Funding by Site[a]

(dollars in thousands)

	FY 2002	FY 2003	FY 2004	$ Change	% Change
Albuquerque Operations Office					
Argonne National Lab (East)	410	775	775	0	0.0%
Golden Field Office	110	100	17,039	+16,939	+16,939.0%
National Renewable Energy Lab	2,300	1,814	1,814	0	0.0%
Total, Albuquerque Operations Office	2,820	2,689	19,628	+16,939	+629.9%
Chicago Operations Office					
Brookhaven National Lab	525	450	0	-450	-100.0%
Chicago Operations Office	23,130	20,689	1,200	-19,489	-94.2%
Total, Chicago Operations Office	23,655	21,139	1,200	-19,939	-94.3%
National Energy Technology Laboratory	3,000	1,600	1,600	0	0.0%
Oakland Operations Office					
Lawrence Berkeley National Lab	624	200	200	0	0.0%
Total, Oakland Operations Office	624	200	200	0	0.0%
Oak Ridge Operations Office					
Oak Ridge National Laboratory	23,178	25,574	25,574	0	0.0%
Office of Scientific & Technical Information	27	45	45	0	0.0%
Total, Oak Ridge Operations Office	23,205	25,619	25,619	0	0.0%
Richland Operations Office					
Pacific Northwest National Lab	523	1,200	1,200	0	0.0%
Total, Richland Operations Office	523	1,200	1,200	0	0.0%
Washington Headquarters	1,310	2,337	2,337	0	0.0%
Total, Distributed Energy and Electricity Resources	55,137	54,784	51,784	-3,000	-5.5%

[a] "On December 20, 2002, the National Nuclear Security Administration (NNSA) disestablished the Albuquerque, Oakland, and Nevada Operations Offices, renamed existing area offices as site offices, established a new Nevada Site Office, and established a single NNSA Service Center to be located in Albuquerque. Other aspects of the NNSA organizational changes will be phased in and consolidation of the Service Center in Albuquerque will be completed by September 30, 2004. For budget display purposes, DOE is displaying non-NNSA budgets by site in the traditional pre-NNSA organizational format."

Site Description

Argonne National Laboratory

Argonne National Laboratory (ANL) performs research and development including non-destructive evaluation (NDE) of advanced ceramics, high temperature recuperators and coatings and laser ignition research for reciprocating engines. The NDE laboratory at ANL is renown for the techniques they have developed for the DEER technologies.

Golden Field Office

Golden Field Office (GO) administers and manages cost-shared cooperative agreements with industry participants for the industrial gas turbine, microturbine, reciprocating engine and communication and controls activities.

National Renewable Energy Laboratory

National Renewable Energy Laboratory (NREL) conducts research and development of novel material and processing techniques for advanced dessicant systems for humidity control and mitigation of Indoor Air Quality (IAQ). NREL also performs analysis addressing regulatory and institutional barriers to distributed energy resources

Brookhaven National Laboratory

Brookhaven National Laboratory (BNL) performs research and development of novel concepts in oil heat combustion and fuel flexibility technologies. This work has lead to proof-of-concept systems and to the acceleration of commercialization and integration of advanced technologies necessary to bring oil heating equipment to their practical potential. These technologies contribute to the combined heat and power initiative.

Chicago Operations Office

Chicago Operations Office (CO) administers and manages cost–shared cooperative agreements with industry participants for the industrial gas turbine, microturbine, reciprocating engine and communication and controls activities. The R&D managed by the Chicago Operations Office is crucial to the success of the DEER program.

National Energy Technology Laboratory (NETL)

National Energy Technology Laboratory (NETL) manages the university program that supports the advanced reciprocating engine program and performs in house R&D for that program.

Lawrence Berkeley National Laboratory

Lawrence Berkeley National Laboratory (LBNL) will perform analysis tasks to quantify benefits of distributed generation technologies to the customer, the system and the nation.

Oak Ridge National Laboratory (ORNL)

Oak Ridge National Laboratory (ORNL) is the primary lab for DEER technology development and end-use systems integration. ORNL conducts research and development in advanced materials and sensors for industrial gas turbines and microturbines, advanced reciprocating engines, thermally activated technologies, and combined heat and power (CHP). To conduct this research, ORNL leverages state-of-the-art, unique resources such as the High Temperature Materials Laboratory (HTML) User Center, the Building Technology User Center, and the CHP Integration User Center.

Office of Scientific and Technology Information

The Office of Scientific and Technology Information (OSTI) performs standard distribution of information for the Energy Efficiency programs. This distribution consists of publishing and maintaining on-line full text electronic current awareness publications and the production of CD-ROM disks containing program reports and documents.

Pacific Northwest National Laboratory

Pacific Northwest National Laboratory (PNNL) performs research, development, demonstration and deployment of advanced communication and control solutions to enable interoperable and integrated operation of large numbers of distributed energy resources from varying suppliers to achieve optimization in power quality, power reliability and economic performance.

Funding Schedule

(dollars in thousands)

	FY 2002	FY 2003	FY 2004	$ Change	% Change
Distributed Generation Technology Development					
Industrial Gas Turbines	4,500	4,500	3,000	-1,500	-33.3%
Microturbines	11,000	7,000	7,000	0	0.0%
Reciprocating Engines	11,000	10,000	9,000	-1,000	-10.0%
Technology Based - Advanced Materials and Sensors	6,997	8,256	8,256	0	0.0%
Fuel Flexibility	500	500	0	-500	-100.0%
Thermally-Activated Technologies	4,660	4,660	4,660	0	0.0%
Subtotal, Distributed Generation Technology Development	38,657	34,916	31,916	-3,000	-8.6%
End-Use Systems Integration and Interface					
Distributed Energy Systems Applications Integration	4,950	7,338	7,338	0	0.0%
Cooling, Heating and Power (CHP) Integration	11,000	12,000	12,000	0	0.0%
Subtotal, End-Use Systems Integration and Interface	15,950	19,338	19,338	0	0.0%
Technical/Program Management Support	530	530	530	0	0.0%
Subtotal, Technical/Program Management Support	530	530	530	0	0.0%
Total, Distributed Energy Resources	55,137	54,784	51,784	-3,000	-5.5%

Detailed Program Justification

	(dollars in thousands)		
	FY 2002	FY 2003	FY 2004
Distributed Generation Technology Development	**38,657**	**34,916**	**31,916**
▪ **Industrial Gas Turbines**	**4,500**	**4,500**	**3,000**

Industrial gas turbines are used in many industrial and commercial applications ranging from 1MW to 20MW. A key effort in the Industrial Gas Turbine Program has been to enhance the performance of gas turbines for applications up to 20MW. The focus of this effort is on advanced materials research, such as composite ceramics and thermal barrier coatings, which will continue to improve performance. Efficiency gains can be achieved with materials like ceramics, which allow a significant increase in engine operating temperature. The increased operating temperature also lowers its greenhouse gas and NOx emissions. In addition, low emissions technology research and development will improve the combustion system by greatly reducing the NOx and CO produced without negatively impacting turbine performance. These technologies use techniques to control the conditions for combustion so that NOx is not formed in the first place. Recent breakthroughs will allow these important technologies to move forward.

FY 2002: Continued durable cost effective low emissions technology research and development to field test emission levels of less than 7 ppm NOx for advanced gas turbines. Demonstrated technical feasibility of achieving low emissions under rig conditions. Continued R&D that demonstrates innovative high temperature materials such as coatings and ceramics in gas turbines to achieve endurance levels of greater than 8,000 hours. Initiated field testing of advanced thermal barrier coating and ceramic shrouds in gas turbine engines.

FY 2003: Field and rig test cost effective low emissions technologies with the goal of less than 7 ppm NOx for advanced gas turbines. Continue research and development on promising low emissions technologies and will develop perspective new technologies including fuel flexibility. Investigate long-term durability of developed low emission technologies. Continue R&D to demonstrate innovative high temperature materials such as coatings and ceramics in gas turbines to improve endurance levels and push beyond 8,000 hours. Continue testing of advanced ceramic components and add additional components to advanced turbine field tests. Based on field test results, will modify material systems to improve durability and life. Investigate additional components and materials to improve efficiency and emissions in gas turbine engines.

FY 2004: Continue field and rig test of cost effective low emissions technologies with the goal of less than 7 ppm NOx for advanced gas turbines. Will continue research and development on promising and new low emissions technologies with more stringent goal of less than 5 ppm NOx, including efforts to lower the manufacturing costs and increase the durability of gas turbines and other distributed generation technologies. New system attributes could include fuel flexibility and dual fuel capabilities. Research integration of low emissions technologies into

new and existing distributed generation technologies. Develop methods to measure, verify very low emissions levels and model the impact. Continue R&D and testing to demonstrate innovative high temperature materials such as prime reliant coatings and ceramics in gas turbines to improve endurance levels and push beyond 8,000 hours. Modify material systems to improve durability and life and decrease manufacturing costs. Investigate additional components and materials to improve efficiency and emissions. Research technology attributes compared to competing technologies to assess and quantify expected benefits and market acceptance.

- **Microturbines 11,000 7,000 7,000**

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 kW 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 to achieve energy efficiency levels greater than 80 percent. Microturbines offer many advantages over other technologies for small-scale power generation, including the ability to provide reliable backup power, provide power for remote locations, and peak shave. Other advantages include less maintenance and longer lifetimes because of a small number of moving parts, compact size, lighter weight, greater efficiency, lower emissions, and quicker starting. Microturbines also offer opportunities to use waste fuels such as landfill gas. The Microturbine subprogram will lead 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 that are currently available.

FY 2002: Continued efforts on second generation of advanced microturbines to achieve electrical efficiencies of at least 40 percent, single digit emissions, fuel flexibility, and 10 percent reduction in costs. Fabricated and began testing of key critical components and subsystems such as recuperators, turbine, combustor, gas compressor, and control package to improve efficiency, reliability, and durability.

FY 2003: Continue efforts on second generation of advanced microturbines to achieve electrical efficiencies of at least 40 percent, single digit emissions, fuel flexibility, and 10 percent reduction in costs. Continue fabrication and testing of key critical components and subsystems such as recuperators, turbine, combustor, and power electronics to improve efficiency, reliability, and durability. Initiate subsystem integration tasks.

FY 2004: Begin to verify design and subsystems necessary to meet the advanced microturbine goals of at least 40 percent electrical, single digit emissions, fuel flexibility, and 10 percent reduction in costs. Research technology readiness and advancements with respect to current state of the art and end use applications. Continue design, fabrication and rig testing of subsystems such as recuperators, turbine, combustor, turbine hot section, generator, and power electronics to improve efficiency, reliability, and durability. Continue efforts to integrate subsystems into microturbine engine and initiate rig testing of modified engine packages.

(dollars in thousands)

FY 2002	FY 2003	FY 2004

- **Reciprocating Engines 11,000 10,000 9,000**

Gas-fired reciprocating engines offer many advantages over other technologies for small-scale power generation. With their wide power range and operating flexibility, reciprocating engines can be used for many purposes—local power grid and substation support, peak-shaving, remote power, combined cooling, heating, and power (CHP) applications, high-density electric loads, standby power, and mechanical drive used for compressors and pumps—in industrial, commercial, institutional, and residential applications. The Advanced Reciprocating Engine Program will lead a national effort to design, develop, test, and demonstrate a new generation of gas-fired reciprocating engines for DER applications that are cleaner, more affordable, reliable, and efficient than products that are commercially available today.

FY 2002: Continued to support the development of the advanced reciprocating engines systems (ARES) program to develop a 50 percent efficient reciprocating engine with single digit emissions and 10 percent reduction in costs. Engine manufacturers begin development and testing of specific engine components and subcomponents. Pre-competitive R&D continued with National Laboratories. Continued partnership with National Energy Technology Laboratory on reciprocating engine University research program.

FY 2003: Continue to support the development of the advanced reciprocating engines systems (ARES) program to develop a 50 percent efficient reciprocating engine with single digit emissions and 10 percent reduction in costs. Engine manufacturers will continue development and testing of specific engine components and subcomponents. Pre-competitive R&D will also continue with National Laboratories. Continue partnership with National Energy Technology Laboratory on reciprocating engine University research program.

FY 2004: Continue to support the development of internal combustion reciprocating engines in the ARES program. With industry cost shared programs, develop engines with potential efficiencies of 50 percent, single digit emissions, and 10 percent reduction in cost. Engine manufacturers will continue design and analysis of advanced material for critical components. Begin fabrication and laboratory testing of critical components based on initial design and analysis. Continue search for advanced process techniques for incorporation in to new build gas engines. Continue development of critical components i.e., turbo-chargers, catalyst, advanced spark plugs, combustion techniques and emission controls for improved life, reliability and reduced cost. Continue University R&D program with industry partners and National Laboratories. Research engine technology opportunities and advances in state-of-the-art to evaluate the benefit of engine performance enhancements and impacts on market acceptance.

- **Technology Based - Advanced Materials and Sensors 6,997 8,256 8,256**

Advanced materials, such as ceramics and thermal barrier coatings, are some of the key enabling technologies for stationary industrial gas turbines and microturbines to improve the efficiency

and to meet strict emission standards by operating at higher temperatures. Engineered ceramics, such as ceramic matrix composites offer all of 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. Advanced microturbines will require improved high-temperature performance and reliability from their recuperators in order to achieve higher efficiency. Researchers are working with microturbine manufacturers and materials suppliers to develop metallic alloys with more oxidation/corrosion resistance and tensile/creep strength at higher temperatures must be developed.

FY 2002: Completed development, testing, and integrating of advanced materials with superior high temperature strength and fatigue, corrosion, and wear resistance for combustor liners and other applications in distributed generation systems. Developed and tested Continuous Fiber Ceramic Composites (CFCC) for applications such as combustor liners and shrouds in gas turbine applications. CFCC components completed field testing under commercial operating conditions for at least 4,000 hours.

Developed and tested advanced ceramics, coatings and high temperature metals for the next-generation microturbines. New materials for hot section components such as rotors and combustor liner and recuperators are under development. Material properties and durability in microturbine environments, including temperature, pressure and water vapor are determined. Testing of next generation candidate recuperator materials is initiated. SBIR/STTR funding in the amount of $1,259,000 was transferred from this subprogram to the Science Appropriation.

FY 2003: The technology base will continue to develop and test enabling technologies such as materials, information technologies, sensors and power electronics for distributed generation systems. Continue development and testing of advanced materials with superior high temperature strength and fatigue, corrosion, and wear resistance for hot section components and other applications in distributed generation systems.

Develop and test advanced ceramics, coatings and high temperature metals for the next-generation microturbines. New materials for hot section components such as rotors and combustor liner and recuperators will be developed. Material properties and durability in microturbine environments, including temperature, pressure and water vapor will be determined by laboratory experiments and high and medium velocity rigs. Next generation candidate recuperator materials will be evaluated in real microturbine environments.

FY 2004: The technology base will continue to develop and test enabling technologies such as materials, information technologies, sensors and power electronics for a wide variety of distributed generation systems. Will evaluate technology advancements to assess the cross-cutting impacts and benefits of the developments on distributed generation systems and end-use applications.

(dollars in thousands)

FY 2002	FY 2003	FY 2004

Will continue development and testing of advanced materials with superior high temperature strength and fatigue, corrosion, and wear resistance for hot section components and other applications in distributed generation systems. Will continue to develop, fabricate and test advanced ceramics, coatings and high temperature metals for the next-generation turbines. New materials for hot section components such as rotors and combustor liner and recuperators will be developed. Material properties and durability in microturbine environments, including temperature, pressure and water vapor will be assessed determined by laboratory experiments and rigs. Methods to improve material environmental resistance and fabrication technologies to produce cost effective high quality engine parts will be developed.

- **Fuel Flexibility 500 500 0**

The Fuel Flexibility Program develops ultra-low emissions combustion technologies that can be used in distributed generation and cooling, heating, and power (CHP) applications. The program develops technologies specifically for oil combustion in CHP chiller hybrid systems, where high preheated air is useful. R&D efforts focus on the dynamics of low NO_x flames, oil-fired cooling application development, NO_x reduction in conventional appliances, and improved burner performance and the viability of low-sulfur fuel and biofuels for cleaner feedstock.

FY 2002: Continued to improve the quality of oil combustion systems and fuel flexibility for distributed energy resource applications, including combined heat and power.

FY 2003: Continue to improve the quality of oil combustion systems and fuel flexibility for distributed energy resource applications, including combined heat and power. Test of an advanced oil combustion system in a modified microturbine.

FY 2004: No activity.

- **Thermally-Activated Technologies 4,660 4,660 4,660**

Thermally-Activated Technologies (TAT) use the viable heat energy from gas-fired systems and rejected/waste heat from industrial processes or electricity generation. TAT provide important keys for achieving the overall efficiency benefits of distributed energy technologies by converting natural gas, exhaust, or rejected heat into useful energy services like heating, cooling, humidity control, thermal storage, or bottoming cycles. TAT are the essential building blocks for CHP integrated systems, which are 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. The program facilitates research, development, testing, and integration of advanced heating, cooling, dehumidification, and refrigeration equipment.

(dollars in thousands)

FY 2002	FY 2003	FY 2004

FY 2002: Fabricated several engineering prototype residential GAX (Generator/Absorber Heat Exchange) heat pumps for multiple unit field test. Continued laboratory testing of solid/vapor "high cool" complex compound 3-ton heat pump. Completed laboratory testing of prototype ammonia/water heat pump for light commercial application, and began fabrication of a field test unit. Continued test and evaluation of an Absorption Chiller at the Clark Country Office Building in Las Vegas, NV. Initiated concept design of an air-cooled absorption chiller for commercial application. Continued working with the gas industry and Georgia Tech Research Institute to commercialize desiccant technology for improved ventilation and indoor air quality. Continued R&D on advanced novel desiccant material for improved performance in humidity control, regeneration time and energy, and reduced cost. Completed fabrication and began testing and evaluation of an engineering model on Advanced Liquid Desiccant systems.

FY 2003: Begin field testing several GAX residential heat pumps. Complete laboratory testing of solid/vapor "high cool" complex compound 3-ton heat pump. Finalize design and begin fabrication of an engineering prototype unit. Begin field test of a prototype ammonia/water heat pump for light commercial application.

Continue design and begin fabrication of critical components for an air-cooled absorption chiller for commercial application. Continue working with the gas industry and Georgia Tech Research Institute to commercialize desiccant technology for improved ventilation and indoor air quality. Continue R&D on advanced novel desiccant material for improved performance in humidity control, cost, regeneration time and energy, and reduced cost. Continue testing and evaluation of an engineering model on Advanced Liquid Desiccant systems.

FY 2004: Efforts focus on developing gas-fired technologies and waste-heat utilization technologies in support of CHP package systems. Complete field testing of several 3-ton residential ammonia/water GAX absorption heat pumps. Complete laboratory testing of "Hi-cool" 3-ton residential heat pumps. Fabricate an 8-ton ammonia/water engineering prototype heat pump for light commercial applications and testing. Field test and evaluate advanced desiccant systems for improved humidity control and indoor air quality in buildings. Reduce cost and improve performance of advanced desiccant materials. Complete the development of a regenerator for separating water and liquid desiccants. Incorporate that design into LiCl liquid desiccant unit and laboratory test. Test feasibility of technology to remove anthrax spores, bio-aerosols, and other contaminants in indoor air. Continue development of sensors to assess efficacy of equipment for decontaminating indoor air. Explore integration of multiple heat sources to regenerate desiccants and develop hybrid systems for improved heat utilization. Complete a roadmap for thermal-based technologies to explore new concepts for thermal management such as thermo-electric technologies and heat/mass transfer that promise low-cost conversion of heat directly to electricity and evaluate potential impacts on markets and applications.

(dollars in thousands)

	FY 2002	FY 2003	FY 2004
End-Use Systems Integration and Interface	**15,950**	**19,338**	**19,338**
■ **Distributed Energy Systems Applications Integration**	**4,950**	**7,338**	**7,338**

This activity facilitates acceptance of distributed energy resources (DER) in end-use sectors by forming partnerships with industry consortiums in the commercial building, merchant stores, light industrial, supermarkets, restaurants, hospitality, healthcare and high-tech industries. In high-tech industries such as telecommunications, commercial data processing and internet services, the use of electronic data and signal processing have become a cornerstone in the US economy. This industry represents a high potential for DER due to the ultra-high reliability and power quality requirements and related large cooling loads. Projects include development of decision and design tools and integration of DER technologies at customer sites to meet power and thermal needs and quantify value (such as energy and emissions benefits, installation and retrofit costs and high efficiency, reliability, etc.). Results from assessments are disseminated as information and education materials among the industries, utilities and States.

As these activities are proliferated, advanced communications and controls (C&C) technologies are needed to enable integration and interoperability functions of a broad range of distributed energy resources. These technologies offer a digitally controlled, "smart" electricity network with broadband communication capabilities. Through improvements in communication, information management, and controls, distributed energy technologies can be aggregated to operate in grid-connected or stand-alone modes

FY 2002: Continued supporting R&D solicited for direct support to utility/industrial teams and State partners in addressing power generation/cogeneration reliability issues, and mechanical drive applications. Performed comprehensive assessment of existing and new distributed generation installations at industrial and commercial sites to determine reliability/availability and benefits. These assessments included advanced hybrid technologies and options. Results from assessments were disseminated as information and education materials among potential consumers. Initiated projects to encourage widespread adoption and implementation of distributed energy resources, including combined cooling, heating and power in the data processing and telecommunications industries. These industries have special ultra-high reliability and power quality needs for which only distributed energy resources can supply. The program initiated partnerships with industry consortiums (grocery chains, fast food restaurants, retail stores) to identify promising application for distributed energy technologies.

As the penetration of distributed generation technologies increase throughout the electric system, communication and control functional requirements need to be developed to ensure that the distributed generation technologies can contribute to the grid adequacy and security by providing sufficient generation resources and can communicate in a coordinated manner. Advanced communications and controls need to be cost effective and reliable with "plug and play" capability, including flexibility to handle different types of distributed generation technologies

with seamless integration. The program initiated activities with industry on development of communications architecture and functional requirements.

FY 2003: Continue partnerships with industry consortiums (commercial buildings, merchant stores, light industrial) to identify promising applications for distributed energy technologies and systems, and will initiate validation projects to quantify the potential energy and emissions benefits. Beginning field testing of technologies (including combined heat and power systems) to validate anticipated benefits to data processing and telecommunications industries that have special ultra-high reliability and power quality needs that can only be met by implementing distributed energy resources. Continuing support of R&D to utility/industrial teams and State partners in addressing power generation/cogeneration reliability issues, and mechanical drive applications.

Supporting solicitations to address development of open, scalable communication and control systems required to aggregate and control the operation of large numbers of DER systems from different vendors while integrating with utility control and protection systems.

FY 2004: Will continue partnerships with industry consortiums (commercial building, merchant stores, light industrial, supermarkets, restaurants, hospitality, healthcare industries) to identify promising applications for distributed energy technologies to meet power and specialized thermal needs. Will initiate validation projects to: 1) quantify the energy and emissions benefits and installation and retrofit costs, and other benefits; 2) research potential integration issues and recommend improvements; 3) correlate data to analytical models and tools for end use customers. Will continue design of integrated distributed energy systems (including combined heat and power systems) and begin field testing of technologies to validate anticipated benefits to data processing and telecommunications industries that have special ultra-high reliability and power quality needs that can only be met by implementing distributed energy resources. Will continue development of methodology and analysis tools that will allow end-users to compare the true value of DER technologies with other traditional alternatives for high quality, reliability, and availability of power. Results from assessments will be disseminated as information and education materials among potential consumers. Will continue support of R&D to utility/industrial teams and State partners in addressing power generation/cogeneration reliability issues, and mechanical drive applications.

Will facilitate the establishment of a standardized system architecture with scalability and flexibility to integrate and optimize multi-participant DER systems to meet the dynamic nature of demand-side management.

- **Cooling, Heating and Power (CHP) Integration 11,000 12,000 12,000**

Cooling, Heating and Power 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 efficiencies from 60 to 80 percent. The Industry CHP Program goal, which DOE is supporting, is to double the capacity of CHP in the United States to 92 GW by 2010 and develop and test CHP Packages for use integrated in overall building system design. Using the viable heat energy rejected from the making of electricity, high efficiencies can be achieved and package technologies can be integrated and optimized for end-use application. By using the viable rejected heat energy from the making of electricity, these packaged systems will achieve efficiencies of 75 percent or higher. The National CHP Roadmap will be used to guide the program's activities in the areas of raising awareness, eliminating barriers and developing technologies and markets. Research and development is focused on the 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. This work includes the development of necessary controls for seamless integration into buildings systems.

FY 2002: Supported the joint DOE-Industry goal of doubling the amount of CHP capacity in the U.S. by 2010. Conducted CHP technology assessments and provide the technical tools and expertise necessary for documenting how the successes of CHP systems can benefit the industrial, building, and district energy sectors. Results increase awareness and confidence in CHP technologies and demonstrated their benefits.

Packaged combined heat and power systems moved to Cooling, Heating and Power Integration. Awarded six contracts on packaged combined heat and power systems.

FY 2003: Support the industry goal of doubling the amount of CHP capacity in the U.S. by 2010. Continue to raise CHP awareness and assist in eliminating the barriers to CHP installations. Continue CHP technology assessments and provide the technical tools and expertise necessary for documenting how the successes of CHP systems can benefit the industrial, building, and district energy sectors. Building on successful assessment results, implement the most promising projects. These projects will increase awareness of and confidence in CHP technologies including their benefits in efficiency and emissions.

Continue contract support with industry funding (award) to design, and develop new integrated plug and play packages which combine power generation technologies such a gas turbines, microturbines and reciprocating engines with thermally activated technologies such as chillers and desiccant systems along with the necessary control technologies. Testing of prototype packages will begin under laboratory conditions before proceeding to commercial field test sites.

FY 2004: Will support the joint DOE-Industry goal of doubling the amount of CHP capacity in the U.S. by 2010. Activities will support the CHP Technology Roadmap, including raising CHP awareness, eliminating barriers, and developing technologies and markets. Activities will include projects that examine the benefits of CHP, develop analysis tools, develop case studies

and lessons learned that can benefit future CHP installations, collect relevant data on small CHP installations, and analyze emissions data and emissions credits for CHP and propose guidance for future standards. These projects will increase awareness of and confidence in CHP technologies including their benefits in efficiency and emissions.

Continue industry cost-shared design and development of Integrated Energy Systems in seven contract awards. Begin fabrication and testing of critical components, interface needs, controls heat exchangers and distribution systems. Investigate alternate applications and methods of heat recovery from reciprocating engines cooling-jacket water and flue gas. Systems will use advanced absorption chillers and desiccants in a variety of building applications for system efficiencies approaching 80 percent.

Technical/ Program Management Support	**530**	**530**	**530**

The addition of distributed energy resources as a power choice is a complex issue. This task forms the technical foundation that assists and guides the DER research activities to ensure relevance to the market. Markets, technology advances, and regulations are dynamic, and this task continually monitors available information and adjusts the program direction as necessary to be responsive.

FY 2002: Efforts included activities which are an integral part of the distributed generation technology development program. Representative activities included preparation of program, strategic plans, and operating plans, R&D feasibility studies and trade-off analysis, evaluation of the impact of new legislation on R&D programs, analysis of energy issues pertinent to the R&D program, identification of performance measures and methodologies (including GPRA), data collection to assess program and project performance, efficiency and impacts; and development of performance agreements with management.

FY 2003: Includes activities which are integral part of the distributed generation technology development program. Representative activities include preparation of program, strategic plans, and operating plans, R&D feasibility studies and trade-off analysis, evaluation of the impact of new legislation on R&D programs, analysis of energy issues pertinent to the R&D program, identification of performance measures and methodologies (including GPRA), data collection to assess program and project performance, efficiency and impacts, and development of performance agreements with management.

FY 2004: Includes activities which are integral part of the distributed generation technology development and end-use systems integration. Activities will include preparation of program strategic plans, multi-year plans, technology roadmaps, and operating plans, peer reviews and technical workshop/conferences specific to Distributed Energy Resources Technology Development and End-Use Systems Integration, technical data collection and methodology to support DER performance goals, DER technology assessments and market status.

	(dollars in thousands)		
	FY 2002	FY 2003	FY 2004
Total, Distributed Energy Resources	**55,137**	**54,784**	**51,784**

Explanation of Funding Changes

	FY 2004 vs. FY 2003 ($000)
Technology Development	
■ Decrease support for Industrial Gas Turbines to encourage increased cost share for demonstration activities. .	-1,500
■ Decrease support for Reciprocating Engines to shift to higher cost share activities	-1,000
■ Terminate support for Fuel Flexibility. Work is being transitioned to industry. .	-500
Total, Technology Development	-3,000
Total Funding Change, Distributed Energy Resources	**-3,000**

Building Technologies Program

Program Mission

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. This involves research, development, demonstration, and technology transfer activities in partnership with industry, government agencies, universities, and national laboratories. The portfolio of activities includes efforts to improve the energy efficiency of building components and equipment, and their effective integration using whole-building-system-design techniques. It involves the development of building codes and equipment standards. It also involves the integration of renewable energy systems into building design and operation.

Strategic Context

Accomplishing this mission contributes to several national energy and environmental policies. For example, the President's National Energy Policy calls for "modernizing energy conservation" and relieving congestion on the Nation's electricity transmission and distribution system. It calls for "establishing a national priority for improving energy efficiency." It also calls for improvements in the energy efficiency of appliances, including the setting of higher standards where technically feasible and economically justified and expanding the scope to address additional appliances.[a] The President's Clear Skies Initiative calls for reducing air pollution. The National Transmission Grid Study calls for taking steps to reduce congestion on the Nation's electricity transmission system.

Increasing the energy efficiency of residential and commercial buildings leads to reductions in the consumption of oil, natural gas, and electricity, thus reducing America's vulnerability to energy supply disruptions, energy price spikes, and constraints in the Nation's electricity infrastructure. Reductions in energy use in buildings also produces reductions of environmental emissions, including greenhouse gases.

Residential and commercial buildings account for more than one-third of the Nation's total energy consumption. The growth in the economy, as well as the nation's rising population is leading to more, larger, and better equipped homes and commercial buildings, resulting in increasing energy consumption in this sector. Introduction of new energy efficiency technologies can have significant economic and environmental benefits. The production of energy consumed in buildings, primarily electricity, represents a major source of acid rain, smog, and greenhouse gas emissions, and includes 47 percent of U.S. sulfur dioxide emissions, 22 percent of nitrogen oxide emissions, and 35 percent of carbon dioxide emissions.

Buildings consume two-thirds of the electricity generated in the U.S. Electric air conditioning in buildings is one of the major loads during periods of peak electricity demand. Improving the energy

[a] The BT budget request reflects the NEP discussions in the Overview (pages ix, xi-xii), Chapter One: Taking Stock (pages 1-3 to 1-4), Chapter Two: Striking Home (pages 2-1 to 2-5), Chapter Three: Protecting America's Environment (pages 3-1, 3-5 to 3-7), Chapter 4: Using Energy Wisely (pages 4-1 to 4-5, 4-6 to 4-8).

efficiency of buildings and equipment will reduce consumption of electricity during peak demand periods.

Buildings are exceptionally long-lived capital assets. Buildings in existence today represent more than 85 percent of the buildings that will exist in 2010. Improvements in the energy efficiency of existing and new buildings help alleviate demands on the energy supply system over the in the near-, mid-, and long-terms. The economic impacts of reductions in energy use can be significant, since the Nation's energy bill for buildings is about $240 billion annually.

There are several factors which interfere with the private sector making R&D investments in energy efficient building technologies. These include, for example, a fragmented industry comprised of thousands of builders and manufacturers, none of which has the capacity to sustain research and development activities over multi-year periods. Another factor is the compartmentalization of the building professions, in which architects and designers, developers, construction companies, engineering firms, and energy services providers do not typically apply integrated strategies for siting, construction, operations, and maintenance. This fragmentation and compartmentalization of the buildings industries means there is a need for a facilitator to build consensus on research directions and priorities, industry-wide codes and standards, technology transfer, and education, outreach, and information exchange.

Management Strategy

The majority of the program's activities are in the area of applied technology development, which include efforts that are in our national interest but are too risky or long-term to be conducted by the private sector alone. These technology development efforts are supplemented with activities to address the needs for codes and standards and to accomplish effective technology transfer and information exchange.

The program receives appropriations from the Interior and Related Agencies and Energy and Water Development subcommittees. Interior activities focus on the development of more energy efficient buildings and equipment. Energy and Water activities focus on the integration of renewable energy technologies into building design, construction, and operations to achieve the concept of zero energy buildings.

The program is organized into the following areas of activity:

Interior
- Residential Buildings Integration
- Commercial Buildings Integration
- Emerging Technologies
- Equipment Standards and Analysis
- Technical / Program Management Support

Energy and Water
- Zero Energy Buildings

The Residential Buildings Integration activities focus on improving the efficiency of the approximately

1.3 million new homes built each year and the 100 million existing homes, including multifamily units, through research, development, demonstrations, and technology transfer strategies. The activities include efforts to improve the energy efficiency of residential energy uses such as space heating and cooling, ventilation, water heating, lighting, and home appliance loads. It includes support for the development of residential building codes and standards to enable application of whole-building design techniques. These activities support efforts to develop solar energy applications for buildings and the concept for Zero Energy Buildings.

The Commercial Buildings Integration activities address opportunities in new commercial buildings ($640 billion annual capital construction) by working with competitively selected industry groups on cost-shared projects that accelerate the development and adoption of new building technologies and design practices, and addresses the need for commercial building codes. It includes technology development efforts to validate energy efficiency designs and practices, improve sensors and controls, and develop more energy efficient ventilation systems. It also includes efforts to improve commercial building codes and standards and coordinates with the Zero Energy Buildings activity.

The Emerging Technologies activities include R&D and technology transfer of energy-efficient products and technologies for both residential and commercial buildings. These efforts address the multitude of building components such as lighting, building envelope technologies including advanced windows, and new designs for appliances. Efficiency advances for this equipment will support the Zero Energy Buildings activity.

The Equipment Standards and Analysis activities lead to improved efficiency of appliances and equipment by conducting analyses and developing standards that are technologically feasible and economically justified, under the Energy Policy and Conservation Act, as amended (EPCA). Analysis performed under this program will support related program activities such as Energy Star, to ensure a consistent methodology is used in setting efficiency levels for each related program.

The Zero Energy Buildings activity is an effort to integrate renewable energy technologies, including solar energy technologies and other distributed energy devices, into the design and operation of highly efficient residential and commercial buildings. The concept involves the development of buildings that produce as much energy as they consume on an annual basis. These buildings would incorporate capabilities to enable owners to buy and sell energy. It is a revolutionary concept that requires a whole-buildings approach to properly size energy generation in concert with other energy efficiency measures to effectively deliver energy services.

The Buildings Technologies Program has identified six portfolio strategies to achieve its mission:

1. Accelerate the introduction of highly-efficient technologies and practices through research and development;
2. Modernize the R&D portfolios to ensure that the most promising, revolutionary, technologies and techniques are being explored, and align the Residential and Commercial Integration programs to a vision of zero net energy buildings;
3. Use a “whole buildings” approach to energy efficiency that takes into account the complex and dynamic interactions between a building and its environment, among a building's energy systems, and between a building and its occupants. This approach has achieved energy savings

of 30 percent beyond those obtainable by focusing solely on individual building components, such as energy-efficient windows, lighting, and water heaters;
4. Integrate energy efficiency and renewable energy technologies and practices;
5. Increase minimum efficiency levels of buildings and equipment through codes, standards, and guidelines; and
6. Appropriately exit those technologies which are sufficiently mature or proved to the marketplace, and by closing efforts where investigations prove to be technically or economically infeasible ("off ramps").

Partnerships and cost share arrangements with industry, universities, and other government agencies are a key aspect of the program's management approach. By bringing together relevant stakeholders, the program is able to build the critical mass necessary to address many of the barriers to increasing the energy efficiency of buildings and equipment. As mentioned, a critical barrier is the fragmentation of the design, construction, materials, and equipment manufacturers and building operation and maintenance industries, making it difficult to reach a consensus on new technologies or coordinate efforts on concepts like whole building design. To achieve its mission, the program's management strategy involves four key elements: a customer-focused, team-based organization for greater accountability and improved results; collaboratively developed technology roadmaps to provide for a more integrated, customer driven R&D portfolio; greater competition in project solicitations to increase innovation and broaden research participation; and increased peer review to assure scientifically sound approaches. In addition, the program invests in technical program and market analysis and performance assessment in order to direct effective strategic planning.

The technology roadmap process is a fundamental component of the program's approach. The roadmaps are used to help align government resources with the high-priority needs identified by industry. The roadmaps also are used to guide cooperation among public and private researchers, State and Federal programs, and others involved in helping to achieve the technology goals. The program has developed five road maps (High Performance Commercial Buildings, Windows, Lighting, Building Envelope and Appliances and Controls) which are being updated and incorporated into the R&D portfolio. In addition, the program has utilized the residential housing roadmap developed by the Partnership for Advancing Technology in Housing (PATH) as well as the space conditioning roadmap formulated by the Air Conditioning and Refrigeration Institute (ARI).

The program is focused on technology priorities for buildings based on systems analysis. This "whole buildings" approach allows builders to simultaneously reduce construction and energy costs and helps build energy systems that deliver the proper amount of service (e.g., heating, cooling, lighting, etc.) where needed. The approach also identifies ways that systems can work harmoniously to provide increased energy and construction savings as well as improve the quality and comfort of the buildings.

As part of the President's Management Agenda, the program uses objective investment criteria for determining funding priorities for its portfolio of R&D projects. These criteria focus the program's portfolio on technologies that address national energy policy goals, provide clear public benefits, and that would not be developed by the private sector alone. The application of these criteria addresses the need for performance-based public-private partnerships, well-defined comprehensive program plans, and clear "off ramps" or termination points.

Budget and Performance Integration

To implement the budget and performance integration portion of the President's Management Agenda the Building Technologies program participated in both the OMB R&D Investment Criteria (R&DIC) and the OMB Program Assessment Rating Tool (PART) process. Their criteria were used to guide program budget planning, management review and performance goals and targets. As a result of program management and the PART review the Building Technologies program FY 2004 budget proposal specifically:

- Clarifies program descriptions in the budget to more definitively explain the differences between Zero Energy Buildings and Analysis Tools and Design Strategies.
- Is supporting the Solid State Lighting Initiative by redirecting funds within the lighting technologies, and from residential integration and appliance standards.

OMB recognized the difficulty of applying some of the PART measures criteria to R & D programs, and we are working to develop measures and process to enable our goals and measures above achieve the intent of budget and performance review and integration in FY 2005.

Program Benefits

Each year, EERE estimates the benefits of program activities to support Government Performance and Results Act (GPRA) reporting. Methods are complex and vary by program. A complete explanation of methodology and assumptions will be posted this spring on line at www.eren.doe.gov/eere/budget.html An overview of the methods and results for the Building Technologies Program is provided below.

EERE's benefits estimate modeling starts with the Energy Information Administration's (EIA's) National Energy Modeling System (NEMS) and modifies it to create NEMS-GPRA04. The Baseline for the Buildings Program is essentially the EIA's Annual Energy Outlook (AEO) 2002 reference case, which already includes some penetration of building efficiency technologies. Most of the program technology goals are incorporated directly into the characterizations of available end-use technologies included in NEMS-GPRA04. An exception is where the program goal includes technology improvements with no incremental cost, as this would result in unrealistically fast adoption in NEMS-GPRA04. In these cases, energy savings are estimated off-line and reduced by 30 percent to improve comparability with NEMS-based estimates are incorporated into NEMS-GPRA04. NEMS-GPRA04 model inputs are based on PNNL analysis of capital cost and efficiency improvements for individual program technologies undertaken for both new and existing buildings, different types of buildings (e.g., single family homes, hospital, offices), and different regions of the country (to reflect differences in climate, fuel availability, etc).

Appliance standards are modeled by removing all technologies that are less efficient than the standard from available consumer choices in the year of standard implementation. The standard implementation years and assumed efficiencies are provided by PNNL. Program support for building code development is modeled based on estimated heating and cooling load reductions and adoption rates, as undertaken to determine code certification and provided by PNNL. Because distribution transformer electricity savings cannot be modeled directly in NEMS-GPRA04, these savings are computed by PNNL and

incorporated into NEMS-GPRA04 as reductions in the transmission and distribution losses associated with delivering electricity.

FY 2004 GPRA Benefits Estimates for Building Technologies Program (NEMS-GPRA04)			
	2005	2010	2020
Displaced Electricity Capacity (GW)	0.0	2.3	26.3
Non-Renewable Energy Savings (quads)	0.08	0.41	1.27
Oil Savings (quads)	0.01	0.05	0.13
Carbon Savings (MMT)	1.3	6.8	21.6
Energy Expenditure Savings (B2000$)	0.5	5.5	15.7

Estimates for reduced need for additional electricity capacity, energy savings, oil savings, carbon emission reductions, and energy expenditure savings resultant from realization of Building Technologies Program goals are shown in the table above for the 2020 time frame.[a] The additional energy saved in buildings from these efforts (beyond what is already reflected in the basecase) can reduce U.S. energy expenditures by about $15.7 billion in 2020. In addition to direct energy savings (oil and natural gas), these efficiency improvements also reduce electricity demand, which not only avoids consumption of the energy sources used to produce electricity, but also lessens stress on our overburdened electricity infrastructure. The 26.3 GW of reduced peak electricity demand is approximately 10 percent of needed additional capacity by 2020. The energy and carbon savings reported here reflect this full stream of savings resulting from expected increased market adoption of the improved technologies developed with the assistance of this program, along with the reduced market use of lower-efficiency appliance and building practices due to code and standards enhancements. These estimates reflect EIA reference case assumptions about future energy markets. Development of these technologies would also afford the Nation with increased opportunity to respond to electricity or fuels markets that are more constrained than currently expected or to any emerging environmental needs.

In addition to the types of benefits quantified above, building efficiency and renewable technologies often provide non-energy benefits, such as improved lighting quality and building productivity.

Program Strategic Performance Goals

The Program Strategic Performance Goal represents the Building Technologies Program in entirety, and thus encompasses efforts under both the Energy and Water Appropriation and the Interior Appropriation:

The Building Technologies Program has the following overall performance goals: 1) by 2008, research, develop, and demonstrate at least 10 design packages for specific climates and home types that can achieve from 40 to 70 percent increase in the purchased energy efficiency of new prototype homes relative to the 2000 IECC (Model Energy Code), and 4 to 6 design packages that can achieve 20 percent increase in efficiency of existing homes; 2) develop 5 to 7 design packages that can achieve an average

[a] Benefits are annual, not cumulative, for the year given for the entire program (Interior and EWD portions). Estimates reflect the benefits associated with program activities from FY 2004 to the benefit year or to program completion (whichever is nearer), and are based on program goals developed in alignment with assumptions in the President's Budget.

of 40 percent increase in the purchased energy efficiency in applicable new commercial buildings or 15 percent increase in existing prototype commercial buildings; 3) introduce 5 new cost-effective, ready for transition to market, efficient building products through component and equipment RD&D activities; 4) by 2009 complete 30 formal proposals to enhanced national building codes, and complete 13 formal proposals to enhanced product standards and test procedures; and 5) By 2010, develop 3 to 5 cost-effective, marketable ZEB design packages capable of satisfying 100 percent of whole-house energy requirements, net on an annual basis**.**

The Interior section addresses sub-program goals (1) through (4) in the stated performance goal. The respective performance indicators and technology baselines are stated below:

Performance Indicators:

(Broken down by PSPG Sub-goal)

(1) Residential Buildings Integration – R & D activities will provide the energy technologies and solutions that will catalyze 40-70 percent increases in the energy efficiency of new prototype residential buildings by 2008 relative to the IECC and 20 percent increase in energy efficiency of existing homes. R&D activities will also begin to integrate renewable technologies and energy efficient buildings resulting in a 50 percent reduction in annual energy bills.

Performance Indicators

Number of technological solutions developed, researched, and evaluated. Number of design packages developed, researched, and evaluated against 40 to 70 percent increase in energy efficiency. Number of project and demonstration homes developed in the Building America program. Number of building code change proposals developed and submitted to code development bodies. Number of upgrades of Federal Building Codes completed.

Annual Performance Results and Targets

FY 2002 Results	FY 2003 Target	FY 2004 Proposed Target
Increased knowledge base of residential construction industry by pursuing 6 lines of research investigations focusing on industry identified priorities, e.g. low cost moisture protection, right sized HVAC designs, super efficient distribution systems, etc. Completed at least 850 highly resource-efficient, cost-	Pursue six promising technological solutions considering regional and housing type differences targeting 40 percent reductions in residential space conditioning, hot water, and lighting loads. Based on *Building America* systems research results, develop regional Building System Performance Packages for five climate zones describing "best practice"	Complete 5 design packages that provide promising technological solutions considering regional and housing type differences targeting 40 percent reductions in residential space conditioning loads, compared to IECC 2000, through *Building America* Consortia. Strategies to reduce the major loads, including energy used

FY 2002 Results	FY 2003 Target	FY 2004 Proposed Target
effective project homes through the *Building America* consortia, bringing the total number of homes built through the program to more than 4,500. Published 1 proposal for upgrade to Federal Residential Building codes.	systems that reduce space conditioning energy use by 30 percent Complete at least 800 highly resource-efficient, cost-effective project homes through the *Building America* consortia, bringing the total number of homes built through the program to more than 5,300. Expand focus and resources on the needs of existing residential buildings. Issue 1 upgrade to Federal Residential Building codes.	for hot water, lighting and clothes dryers will also be investigated. Provide technical assistance *to Building America* Consortia builder partners to assist them in incorporating 40 percent design packages into 900 homes which they are building; evaluate the 900 *Building America* homes to ensure performance goals are achieved. Demonstrate system-based energy efficient remodeling approaches in at least 2 U.S. climate regions. Submit 20 code change proposals to IECC 2006 Edition,15 to National Fire Protection Association (NFPA). Complete determination as to whether the IECC 2003 edition is more energy efficient than the IECC 2000 edition.

(2) Commercial Buildings Integration -- By 2008, develop five to seven design packages that can achieve an average of 40 percent increase in the purchased energy efficiency in applicable new commercial buildings or 15 percent increase in existing prototype commercial buildings relative to the IECC.

Performance Indicators

Number of building code change proposals developed and submitted to code development bodies. Number of upgrades of Federal Building Codes issued. Number of design packages developed, researched, and evaluated against 40 percent increase of efficiency in new buildings or 15 percent increase in existing buildings.

Annual Performance Results and Targets

FY 2002 Results	FY 2003 Target	FY 2004 Proposed Target
Established 1 High Performance Buildings Roadmap implementation framework leading to the goal of 30 percent more energy efficient new commercial construction compared to 1996 standard practice. Published 1 proposal for upgrade to Federal Commercial Building codes.	Facilitate a 10 percent increase in commercial building designs that have meaningful consideration of energy efficiency by developing improved design tools, including code compliance tools, and completing six research assisted design case studies in cooperation with industry. Issue 1 upgrade to Federal Commercial Building codes	Based on the results from the 6 building case studies completed in the prior fiscal year, create a strategic framework for improving the design process and applying cutting edge technologies for a selected segment of the commercial building market, which the typical building designer can use to achieve 20 to 40 percent lower energy use. Select 2 to 4 multi-year case studies, covering additional building types and owner types, to develop and test innovative building design packages with 50 percent or better energy performance. Submit 10 code change proposals to IECC 2006 edition, and 10 to National Fire Protection Association (NFPA) that are expected to result in an improvement in energy efficiency in small commercial buildings of approximately five percent.

(3) Emerging Technologies -- Introduce 5 new ready-for-transition-to-market products by 2008 through component and tool R & D activities;

Performance Indicators

Number of products ready for transition to market.
Number of patents.

Annual Performance Results and Targets

FY 2002 Results	FY 2003 Target	FY 2004 Proposed Target
Refined the R&D planning documents for solid state lighting. Completed investigation of barriers to wide spread use of lighting controls for energy efficiency purposes. Concluded field demonstrations of heat pump water heaters, with utility partners. Completed investigation of 4 methods to increase the optimum selection of equipment components for air conditioning and heat pumps. Constructed two-dimensional hygrothermal model and continue material property measurements. Implemented and improved WINDOW 5 for NFRC production runs; train and support NFRC simulators. Began development and testing of Energy Plus Version 1.1. Release Version 2.0 (final version) of SPARK.	Implement research plan for development of practical and efficient solid-state devices for general illumination. Develop 1 lighting control system that can reliably be utilized to reduce peak demand loads while minimizing the disruption to occupants. Complete investigation of 5 methods to increase the optimum selection of equipment components for air conditioning and heat pumps. Field test 3 approaches to retrofit space conditioning systems in existing homes to improve energy efficiency. Complete development of the two-dimensional hygrothermal model and material property measurements. Complete WINDOW 5.2, for basic retrofit product - NFRC rating & labeling- begin algorithm development for complex retrofit/new products and high performance products. Release EnergyPlus Version 1.1 building energy efficiency design tool.	Complete a solicitation and award five or more competitively based research awards for cost-shared research on technology (such as substrate materials and light extraction) for solid state lighting with industry, national labs, and universities. Complete investigation and prepare report on field-verified energy savings from spectrally enriched lighting in office buildings. Expand lighting controls capabilities to enable luminires to receive and respond to signals from sources such as an electric utility companies or Energy Services Companies & others. Develop 3 demonstrations for new higher-efficiency product lines: 1) recessed CFL downlights cans (air-tight, IC rated), 2) high-efficiency unitary air conditioners, and 3) CFL reflector lamps suitable for (air-tight, IC rated) cans. Demonstrate the field testing of leak-tight duct system. Promulgate envelope design guides that address moisture considerations, insulation and venting for home crawlspaces and attics and a web based calculator for advanced roofing systems Establish technical basis

FY 2002 Results	FY 2003 Target	FY 2004 Proposed Target
		including software for the development of complex retrofit/new high performance fenestration. Complete initial technical basis for durability performance standards and engineering guidelines for Low-E/ Solar Control insulated glazing. Release EnergyPlus 1.2; e.g. multi-zone air flow, solar thermal and many new HVAC modules. Release Energy-10 Version 2.0 (final version) also (see Commercial buildings R&D above) Develop a software audit/design program for energy efficient remodeling in existing buildings.

(4) Equipment Standards and Analysis Program – Issue 13 formal proposals for enhanced product standards and test procedures by 2009.

Performance Indicators

Product standards and test procedures proposed/issued. Analyses completed for labeling and Energy Star update and expansion to include new products.

Annual Performance Results and Targets

FY 2002 Results	FY 2003 Target	FY 2004 Proposed Target
Issued 2 rules to amend appliance standards and test procedures.	Conduct 4 rulemakings to amend appliance standards and test procedures	Prepare for DOE issuance up to 4 rules to amend appliance standards and test procedures for some of the following products: Residential Furnaces, Boilers, and Mobile Home Furnaces; Electrical Distribution Transformers; Commercial Unitary Air-Conditioners and Heat Pumps; Residential Niche Product Air-Conditioners and Heat Pumps; and Dishwashers with sensors.

Significant Accomplishments and Program Shifts

Residential Buildings Integration

In addition to the energy savings, which have national security implications, and associated environmental benefits, the Residential Buildings Integration Program will improve the indoor environmental quality, durability, and afford ability of homes. This program also will improve environmental performance by reducing construction waste by 50 percent.

In partnership with homebuilders, industry, States, and communities, the Residential Buildings Integration activities improve the energy efficiency in new and existing homes through R&D, demonstrations, and regulatory strategies. A significant element of the program's R&D portfolio is making homes more energy efficient and environmentally sound at little or no additional cost to the consumer. Increased energy efficiency is achieved through *Building America*, the program's partnership with industry, to jointly fund, develop, demonstrate, and deploy housing that integrates energy-efficient technologies and practices.

Building America employs such strategies as improved design techniques that greatly reduce thermal leakage through the building envelope, or improved insulation and windows the costs of which are offset by resulting reductions in the size of required space-conditioning equipment. These new homes use less energy, save consumers money, are more environmentally benign, and provide more comfortable living space. *Building America* will begin developing and testing system integration and whole-house design that can be applied to the 80 million existing homes in the country. In addition, the program will coordinate with the renewable energy supply and distributed energy activities to develop

residential whole buildings approaches that will enable the cost-effective design, construction, and operation of net-zero-energy buildings. Regulatory activities will focus on updating the IECC residential building code and also develop and promulgate final energy efficiency standards for Federally-owned residential buildings.

Commercial Buildings Integration

In addition to the energy savings, which have national security implications, and associated environmental benefits, the Commercial Buildings Integration Program will improve indoor environmental quality, durability, economic return, and productivity of workers using the buildings.

In fiscal year 2002, Commercial Buildings Integration began emulation of the public/private partnership successes of the residential buildings-oriented Building America Subprogram. Accordingly, the Commercial Buildings Integration effort works with competitively solicited industry groups on cost-shared research assistance on new building projects that accelerate the development and adoption of new building technologies and practices. Regulatory activity will focus on updating the IECC commercial building code and final energy efficiency standards for Federally-owned commercial buildings. The Commercial Buildings Integration activity will align to the vision of "zero net energy commercial buildings."

Emerging Technologies

In collaboration with industry and other stakeholders, the Emerging Technologies activities promote the widespread adoption of energy-efficient products and technologies in both residential and commercial buildings through a balanced program of research, development, demonstrations, codes and standards, and technology transfer. Collaborative R&D is conducted on building components such as innovative lighting, building envelope technologies (e.g. windows, walls, foundations and materials) and appliances, that will increase the energy efficiency of buildings and improve building performance. For example, in the lighting area, R&D will be accelerated in the solid state lighting technologies. Currently solid state lighting technologies for general illumination do not exist. To lay a technical foundation so new products can be brought to the market, research and development is necessary in several areas: quantum efficiency (internal & external), lifetime, performance, packaging, infrastructure, and cost. Coordination occurs with other Federal programs on energy technology activities that affect buildings, such as solar energy, combined heat and power, and fuel cell technology development.

Equipment Standards and Analysis

To date, the 12 appliance standards developed by DOE have saved consumers over $25 billion in cumulative electricity cost.

The Equipment Standards and Analysis subprogram develops, promulgates, and enforces test procedures and energy conservation standards for residential appliances and certain commercial equipment, under the Energy Policy and Conservation Act, as amended (EPCA). In 1996, the Department initiated a more transparent and collaborative process for setting energy conservation standards for appliances, which has been successful in reaching consensus agreements on standards for fluorescent lamp ballasts and clothes washers. Based on this process, the Department has been able to accelerate rulemakings for

these products and include provisions to reduce manufacturers' burdens and provide further benefits to consumers.

Funding Profile[a]

(dollars in thousands)

	FY 2002 Comparable Appropriation	FY 2003 Amended Request	FY 2004 Request	$ Change	% Change
Building Technologies					
Residential Buildings	12,179	13,433	15,230	+1,797	+13.4%
Commercial Buildings Integration	4,403	4,995	4,995	0	0.0%
Emerging Technologies	34,970	22,618	21,821	-797	-3.5%
Equipment Standards and Analysis	8,251	9,197	9,017	-180	-2.0%
Energy Efficiency Science Initiative[b]	1,959	0	0	0	NA
Technical/Program Management Support	1,320	2,320	1,500	-820	-35.3%
Total Program	63,082	52,563	52,563	0	0.0%

Public Law Authorizations:

P.L. 94-163, “Energy Policy and Conservation Act” (EPCA) (1975)
P.L. 94-385, “Energy Conservation and Production Act” (ECPA) (1976)
P.L. 95-91, “Department of Energy Organization Act” (1977)
P.L. 95-618, “Energy Tax Act of 1978”
P.L. 95-619, “National Energy Conservation Policy Act” (NECPA) (1978)
P.L. 95-620, “Power plant and Industrial Fuel Use Act of 1978”
P.L. 96-294, “Energy Security Act” (1980)
P.L. 100-12, “National Appliance Energy Conservation Act of 1987”
P.L. 100-615, “Federal Energy Management Improvement Act of 1988”
P.L. 102-486, “Energy Policy Act of 1992”

[a] SBIR/STTR funding in the amount of $1,310,000 was transferred to the Science appropriation in FY 2002. Estimates for SBIR/STTR budgeted in FY 2003 and FY 2004 are $1,091,556 and $1,091,556 respectively.

[b] Reflects FY 2002 Interior and Related Agencies Appropriation (P.L. 107-63) language directing that 50 percent of Energy Efficiency Science Initiative funds for FY 2002 ($2,000,000) and beyond shall be made available to the DOE Fossil Energy Research and Development account.

Funding by Site[a]

(dollars in thousands)

	FY 2002	FY 2003	FY 2004	$ Change	% Change
Albuquerque Operations Office					
National Renewable Energy Laboratory	13,808	9,460	9,460	0	0.0%
Los Alamos National Laboratory	450	0	0	0	0.0%
Total, Albuquerque Operations Office	14,258	9,460	9,460	0	0.0%
Chicago Operations Office					
Brookhaven National Laboratory	466	225	225	0	0.0%
Total, Chicago Operations Office	466	225	225	0	0.0%
National Energy Technology Laboratory	2,022	2,000	2,000	0	0.0%
Oakland Operations Office					
Lawrence Berkeley National Laboratory	13,595	7,382	7,382	0	0.0%
Total, Oakland Operations Office	13,595	7,382	7,382	0	0.0%
Oak Ridge Operations Office					
Oak Ridge National Laboratory	8,281	3,645	3,645	0	0.0%
Total, Oak Ridge Operations Office	8,281	3,645	3,645	0	0.0%
Richland Operations Office					
Pacific Northwest National Laboratory	4,217	2,878	2,878	0	0.0%
Total, Richland Operations Office	4,217	2,878	2,878	0	0.0%

[a] "On December 20, 2002, the National Nuclear Security Administration (NNSA) disestablished the Albuquerque, Oakland, and Nevada Operations Offices, renamed existing area offices as site offices, established a new Nevada Site Office, and established a single NNSA Service Center to be located in Albuquerque. Other aspects of the NNSA organizational changes will be phased in and consolidation of the Service Center in Albuquerque will be completed by September 30, 2004. For budget display purposes, DOE is displaying non-NNSA budgets by site in the traditional pre-NNSA organizational format."

(dollars in thousands)

	FY 2002	FY 2003	FY 2004	$ Change	% Change
Washington Headquarters	20,243	26,973	26,973	0	0.0%
Total, Building Technologies Program	63,082	52,563	52,563	0	0.0%

Site Description

National Renewable Energy Laboratory

The National Renewable Energy Laboratory (NREL), conducts research and development for the following activities in Building Technologies: Residential Buildings, Commercial Buildings, and Emerging Technologies.

Brookhaven National Laboratory

Brookhaven National Laboratory conducts research and development for activities in Building Technologies for Emerging Technologies.

National Energy Technology Laboratory

National Energy Technology Laboratory (NETL), conducts research and development for activities in Building Technologies for Emerging Technologies.

Los Alamos National Laboratory

Los Alamos National Laboratory conducts research and development for activities in the Building Technologies Program.

Lawrence Berkeley National Laboratory

Lawrence Berkeley National Laboratory (LBNL), conducts research and development for the following activities in Building Technologies: Residential Buildings, Commercial Buildings, and Emerging Technologies.

Oak Ridge National Laboratory

Oak Ridge National Laboratory (ORNL), is part of a national laboratory/industry/university consortium conducting research and development for the following activities in Building Technologies: Residential Buildings, Emerging Technologies, and Zero Energy Buildings.

Pacific Northwest National Laboratory

The Pacific Northwest National Laboratory (PNNL), conducts research and development activities for the following activities in Building Technologies: Residential Buildings, Commercial Buildings, and Emerging Technologies.

Funding Schedule

(dollars in thousands)

	FY 2002	FY 2003	FY 2004	$ Change	% Change
Residential Buildings Integration					
Research and Development	11,589	12,843	14,640	+1,797	+14.0%
Residential Building Energy Codes	590	590	590	0	0.0%
Subtotal, Residential Buildings Integration	12,179	13,433	15,230	+1,797	+13.0%
Commercial Buildings Integration					
Research and Development	3,862	4,454	4,454	0	0.0%
Commercial Building Energy Codes	541	541	541	0	0.0%
Subtotal, Commercial Buildings Integration	4,403	4,995	4,995	0	0.0%
Emerging Technologies					
Lighting Research and Development	5,672	7,294	8,794	+1,500	+20.6%
Space Conditioning and Refrigeration R&D	5,633	3,054	3,054	0	0.0%
Appliances and Emerging Technology	2,205	1,755	1,755	0	0.0%
Building Envelope R&D	11,254	5,092	5,092	0	0.0%
Analysis Tools and Design Strategies	3,548	3,126	3,126	0	0.0%
Road Maps.	658	2,297	0	-2,297	-100.0%
Competitive R&D	6,000	0	0	0	0.0%
Subtotal, Emerging Technologies.	34,970	22,618	21,821	-797	-3.5%
Equipment Standards and Analysis Program	8,251	9,197	9,017	-180	-2.0%
Energy Efficiency Science Initiative	1,959[a]	0	0	0	0.0%
Technical/Program Management Support	1,320	2,320	1,500	-820	-35.3%
Total, Building Technologies.	63,082	52,563	52,563	0	0.0%

[a] Congressional committee report directs 50 percent to go to Fossil Energy R&D.

Detailed Program Justification

	(dollars in thousands)		
	FY 2002	FY 2003	FY 2004
Residential Buildings Integration	**12,179**	**13,433**	**15,230**
■ **Research and Development (Formerly Building America)**	**11,589**	**12,843**	**14,640**

FY 2002: Developed over 2,000 highly resource-efficient, cost-effective private sector homes through the *Building America* consortia, bringing the total number of homes to 5,000. Increased from 1,500 units in FY 2001 to 2,000 units in FY 2002. The program conducted detailed research investigations and developed 10 innovative solutions that increased energy efficiency with little or no additional cost. With due consideration to regional and housing differences, the investigations developed, constructed, and evaluated technological concepts that have not been widely tried or utilized. This resulted in scientifically credible information to apply to further adoption. Began limited development and demonstration of technologies and strategies for implementing energy efficiency upgrades (appliances, equipment, building envelope and/or windows, etc.) in existing homes. Conducted pilot programs to develop cost-effective methods to disseminate innovations to other builders. Coordinated with the Office of Power Technologies to develop residential whole buildings approaches that will enable the cost-effective design, construction, and operation of net-zero-energy buildings. The Special Project State Grant Solicitation was conducted to involve State research partners in developing and evaluating advanced retrofit technologies. SBIR/STTR funding in the amount of $254,000 was transferred from this subprogram to the Science Appropriation.

Participants included: Building Science Consortium, Consortium for Advanced Residential Buildings (CARB), Industrialized Housing Partnership, The Integrated Building and Construction bringing Solutions of Pittsburgh (IBACOS), LBNL, National Association of Homebuilders' Research Center (NAHBRC), ORNL.

FY 2003: Continue to support production builder partners from FY2002. *Building America* will continue to monitor and analyze data from a limited number of instrumented homes. An investigation will be undertaken of higher performance structural insulated panels. At this level, 20 more production builders will be engaged than in 2002. Technical assistance will continue for large community scale developments - Civano, Stapleton, Playa Vista and Sommerset at Frick Park. Regional and climatic efforts will have significant impact on buildings research activities. Application of DOE energy conservation technology to the maintenance, replacement and remodeling market of existing homes represents 101 million households and a huge market for energy efficiency manufacturing installation and service jobs. Program will develop effective dissemination methods including software tools, training curricula, and other vehicles designed to increase the exposure of the Building America successes.

(dollars in thousands)

Participants will include successful bidders (TBD) resulting from the FY 2002 re-competition of the *Building America* Program.

FY 2004: Conduct R&D and technology implementation to enable a 60 percent reduction in overall residential building energy use compared to the model code IECC of 2000. These activities also address the efficiency improvement needs of the Zero Energy Buildings (ZEB) program. Technology solutions development: Conduct systems engineering research to pursue 5 additional promising technological solutions that target reductions in residential space conditioning that consider regional and housing type differences. Also investigate strategies to reduce hot water, clothes drying, ventilation, and lighting loads. Initiate research on integrated hot water/space heating systems that reduce water heating and space heating energy use. Complete field research on integrated water heating systems that reduce energy use by 50 percent including high efficiency boilers and heat pumps. Initiate research to evaluate systems energy impacts of clothes dryer combustion and exhaust air. Initiate field studies to evaluate system energy impacts of supplemental ventilation systems for residential buildings. Complete field studies on advanced lighting system effects on overall energy use. House projects and builder partnership research: Conduct system engineering evaluations to validate the performance of at least 900 houses, representing five climate zones, that were constructed to meet Building America performance requirements. Working with 20 builders from the Building America Consortia, investigate the best innovative solutions that match their interests and needs. Existing homes research: Test 5 system approaches to improve energy efficiency in existing buildings with a target of reducing overall energy use by 30 percent. Dissemination methods and tools development: Develop 5 regional Builder System Performance Packages to incorporate cost-effective "best practice" systems that reduce spacing conditioning energy use by 40 percent. Develop two Remodeled System Performance Packages that describe "best practice" system retrofits for existing buildings in two climate regions. Participants will include successful bidders (TBD) from the FY 2002 re-competition of the Building America Program.

■ **Residential Building Energy Codes . . . . . .**	**590**	**590**	**590**

FY 2002: Submitted comprehensive revisions to the IECC codes revision cycle, e.g., reduced the number of climate zones to streamline code requirements and eliminate the Window/Wall Ratio (WWR) method in order to simplify code compliance. Developed an energy code for Federally-owned residential buildings based on the work generated by the IECC comprehensive overhaul initiative funded in FY 2001. Promoted and supported revisions to the residential building codes that will support new energy efficiency technologies and practices. Developed new code compliance tools for use in residential construction to foster a "whole buildings" approach in new and existing residential buildings. Revised the National Fire Protection Association manufactured home standards to reflect increased cost effective energy efficiency. Participants included: NREL, PNNL, Others.

(dollars in thousands)

FY 2002	FY 2003	FY 2004

FY 2003: An essential, though relatively modest, effort will be continued to assure the effectiveness of model energy codes for the residential sector, and for Federal housing units. This activity is essential to ensure that codes are updated in a way that enables builders to utilize the advanced technologies, design approaches, and engineering solutions developed by Building America and others. Participants will include: NREL, PNNL, Others TBD

FY 2004: Develop revisions to the IECC 2006 Edition; the NFPA and the NFRC to promote window assemblies which would be more cost-effective and energy efficient than under the IECC 2003. Develop revisions to the residential building codes that will support the inclusion of systems engineering approaches enabling the cost-effective design, construction, and operation of ZEB. Complete a final energy efficiency code for Federal residential buildings. Participants will include: PNNL, Others TBD.

Commercial Buildings Integration	**4,403**	**4,995**	**4,995**
■ **Research & Development**	**3,862**	**4,454**	**4,454**

FY 2002: Initiated implementation of the Commercial Buildings Roadmap by working and sharing costs with industry groups on 3-5 buildings.

Emulated the public / private partnership successes of the residential Building America program by accelerating the development and adoption of new building technologies and practices.

Conducted industry workshops on metrics R&D needs for energy performance, indoor environmental quality, and other significant areas of building performance. Initiated research on low cost passive, semi-passive and active wireless sensors for building control systems to better control occupant comfort at lower cost. Supported the National Science Foundation building industry-university cooperative research centers (IUCRC), such as the Center for the Built Environment at the University of California Berkeley, California, and the Center for Building Performance and Diagnostics at Carnegie Mellon University. By cost sharing with many industry partners, these IUCRC leveraged DOE funding 10-15 times. SBIR/STTR funding in the amount of $92,000 was transferred from this subprogram to the Science Appropriation. Participants included: Carnegie Mellon University, LBNL, National Institute of Standards and Technology (NIST), NREL, PNNL, University of California, Others.

FY 2003: Actively implement the Commercial Buildings Roadmap by working and sharing costs with industry groups on 3-5 buildings projects that accelerate development and adoption of new building technologies and integration practices, emulating the public/private partnership successes of the residential Building America program. Began to develop and work with industry to define and implement metrics for energy, indoor environment quality, and other significant areas of building performance. Increase will enable expansion of Indoor Environmental Quality R&D activities to include those recommended by building industry in the

(dollars in thousands)

Roadmap; development of an R&D framework for existing commercial buildings, representing 60 billion sq. ft. of space and $80 billion in energy costs and an assessment of energy savings opportunities and R&D needs in whole-building control systems. The program will also establish private-sector participation by soliciting up to 4 new building projects and three new R&D activities from the industry-driven Roadmap, addressing the huge new commercial construction market. Participants will include: Carnegie Mellon University, LBNL, National Institute of Standards and Technology (NIST), NREL, PNNL, University of California, Others TBD.

FY 2004: Based on the results from the six building case studies completed in the prior fiscal year, create generic strategies for improving the design process and applying cutting edge technologies, which the typical building designer can use to achieve 20 to 40 percent lower energy use in a wide range of commercial building types. Work with private-sector partners to provide R&D assistance, design evaluation, post construction research evaluation, and documentation on up to 4 new building projects with 50 percent or better energy performance. The projects will be selected based on the portions of the commercial building stock with the highest energy use (offices, retail, education, and health building types). The new building projects will be designed, constructed, commissioned, and operated to use at least 50 percent less energy than typical new buildings today. Based on the Commercial Building roadmap, the other major research focus is on controls, indoor air quality, and technologies for retrofit of existing buildings. Research will continue to focus on wireless sensors to significantly reduce the cost of monitoring and operating buildings. Exploratory research will be started on whole building control systems and retrofit technologies. Conduct research on 2 improved ventilation technologies that will be used by the design and maintenance community via standards, e.g., ASHRAE 62, journals, newsletters and the web. Participants will include: Carnegie Mellon University, LBNL, National Institute of Standards & Technology (NIST), NREL, PNNL, University of California, and Others TBD.

■	**Commercial Building Energy Codes . . . . . .**	**541**	**541**	**541**

FY 2002: Issued final rulemaking on the next generation of Energy Codes for Federal Commercial and High-Rise Residential Buildings. Supported technical improvement of private sector codes, such as the International Energy Code Council's adoption of a simple method to demonstrate code compliance. Issued DOE determination whether Standard 90.1-2002 will improve the energy efficiency of commercial buildings compared to Standard 90.1-1999. Participants included: PNNL, Others.

FY 2003: An essential, though relatively modest, effort will be continued to assure the effectiveness of model energy codes for the commercial sector, and for Federal commercial buildings. This activity is essential to ensure that codes are updated in a way that enables builders to utilize the advanced technologies, design approaches and engineering solutions developed by the High Performance Buildings effort and others. Support will be continued for the technical improvement of private sector codes, such as the International Energy Code

(dollars in thousands)

Council's adoption of a simple, yet effective, method to demonstrate code compliance. Participants will include: PNNL, and Others TBD.

FY 2004: Develop revisions to the IECC 2006 Edition/ASHRAE Standard 90.1- 2004 including energy efficient revisions to the NFPA and the NFRC to further promote energy efficient window assemblies. The objectives of these revisions are to simplify and update code compliance and enforcement to enable builders to utilize the advanced technologies, design approaches, engineering solutions and increased energy efficiency developed by the High Performance Buildings effort. Initiate revisions that will enable the cost-effective design, construction, and operation of ZEB. Issue a final energy efficiency code for Federal commercial buildings. Participants will include: PNNL, and Others TBD.

Emerging Technologies	**34,970**	**22,618**	**21,821**
■ **Lighting R&D**	**5,672**	**7,294**	**8,794**

FY 2002: Conducted competitively awarded lighting research projects selected from prior year solicitations. Conducted basic and applied research on advanced light sources with an increased focus on the science and enabling technology for solid state lighting. Accelerated research on white light emitting organic LEDs. Developed new approaches to the effective distribution and control of lighting in buildings and determined the impact of lighting on performance and comfort of building occupants. Conducted this work through an integrated program consisting of cost-shared contracts with manufacturers, utilities, and small business R&D firms in addition to scientific support from National Laboratories and universities. In the light sources area, continued research on two paths: to seek technology breakthroughs for conventional types of lamps to improve efficiency by 20 to 50 percent, and to develop revolutionary lighting technologies that can potentially double efficiency. Initiated applied research on substrates, reactor diagnostics tools, luminescent materials, and encapsulate materials as another pathway to improve the efficiency of white-light LEDs. Increased consumer awareness of and confidence in leading-edge technologies by validating performance claims of manufacturers and disseminating objective reviews of the technology by way of a web-based newsletter. Completed synthesis of high color rendering index phosphors and conducted industry workshop on research opportunities in identified quantum-splitting phosphors. Under the lighting controls and distribution research element, initiated research and development of a novel control approach that reduces the size and cost of the ballast and increases lifetime and efficiency of the electrical circuit, an approach that can be applied to a wide range of lamp technologies. Identified major barriers to the use of energy-saving lighting control systems. Worked with stakeholders to develop plausible solutions, strategies, and improvements in technology. Monitored and verified energy savings potential from utilization of the optimized dedicated CFL table lamp developed at LBNL. Established new technologies or configurations of existing technology to reduce lighting loads and enhance task area lighting by a unified task/ambient lighting solution. In the lighting impacts area, completed two preliminary field tests and initiated scotopic dim light

vision demonstration of the most promising concepts for saving energy through improved vision, with a potential savings up to 30 percent in office lighting systems. Utilizing information gathered from the lighting roadmap program worked with the conventional lighting industry trade and technical associations to define specific projects to be initiated and the appropriate role of the government. SBIR/STTR funding in the amount of $121,911 was transferred from this subprogram to the Science Appropriation. Participants included: GE, Fusion Lighting, Cree Lighting, Abratech, Lumineds, LBNL, Lighting Research Center, NETL.

FY 2003: Continue basic and applied research on advanced light sources with an increased focus on the science and enabling technology for solid state lighting. Investigate issue of lighting control compatibility and reliability developing new approaches to the effective distribution and control of lighting in buildings and determine the impact of lighting on performance and comfort of building occupants. Conduct this work through an integrated program consisting of cost-shared contracts with manufacturers, utilities, and small business R&D firms with scientific support from national laboratories and universities. In the light sources area, continue research on two paths: seek technology breakthroughs for conventional types of lamps to improve efficiency by 20 to 50 percent, and develop revolutionary lighting technologies that can potentially double efficiency. Increase research to improve the efficiency of LED and OLED light sources. Complete the cost-shared demonstration for potential energy savings through scotopically, dim light vision, and enriched light sources in office lighting. Continue data gathering work on productivity improvements through optimized lighting systems. Participants will include: LBNL, Lighting Research Center, NETL.

FY 2004: Launch the Solid State Lighting activity, to develop and deploy projects for general illumination that could achieve energy efficiencies upwards of 70 percent though creation of technical foundation to revolutionize the energy efficiency, appearance, visual comfort, and quality of lighting. There are no outyear funding commitments. These activities simply focus existing lighting R&D funding on long-term, high-risk solid state lighting R&D. R&D will focus on several areas: quantum efficiency, lifetime, performance, packaging, infrastructure, and first cost. The R&D plan will be updated to reflect recent achievements in science/engineering and completed DOE-funded projects, e.g., light emitting diodes (LEDs) for spot source lighting, and organic LEDs for general lighting. Complete a solicitation and award contracts for cost-shared research on technology (such as substrate materials and light extraction) for solid state lighting with industry, national labs, and universities. Five million dollars of the lighting R&D budget will be dedicated to Solid State Lighting activities in FY 2004.

Redirect selected activities in basic and applied research through cost-shared contracts on Lighting Roadmap priority needs, including: advanced light sources; fixtures, distribution and controls; and human factors relating to vision and productivity, to support the enhanced Solid State Lighting activity which has potentially higher payoff. Build a balanced R&D program for both improving existing technologies (incandescent, fluorescent, high intensity discharge and lighting control systems) and developing entirely new technologies. Perform light source research on technology breakthroughs for conventional types of lamps to improve efficiency by

20 to 50 percent. Produce outcomes such as high-performance multi-photon phosphors.

In close collaboration with the Commercial Buildings activity, develop lighting system technologies, strategies, and guidelines which support optimum building performance and ZEB goals. Develop solutions to overcome technological barriers to widespread use of lighting control systems in commercial buildings including daylight harvesting controls and load shedding capabilities. These solutions will enable a 20 to 30 percent electricity peak demand reduction in a commercial building's lighting load. Demonstrate the impact of lighting quality and also spectral power distribution (wavelength) on occupant satisfaction and performance producing additional reasons for building owners to invest in energy efficiency and high quality lighting.

Participants will include: Cree Lighting, Fusion Lighting, LBNL, Lighting Research Center, Others TBD.

■ **Space Conditioning and Refrigeration R&D 5,633 3,054 3,054**

FY 2002: Collaborated with manufacturers to investigate alternatives for affordable efficiency advancements and development of design tools for the optimum selection of equipment components for air conditioners and heat pumps. Supported research and initial development of component technologies for applications in existing buildings. Continued to develop refrigeration systems that reduce defrost energy needed for heat pumps and residential and commercial food storage equipment. Continued to develop field test diagnostic tools and test methods to maintain the installed system efficiency of air conditioners and heat pumps. Also supported continuation of the best of competitively awarded research projects. Initiated research for design and demonstration for reduced energy use by refrigerated display cases.

Supported the Air Conditioning and Technology Institute (ARTI) Research for the 21st Century R&D projects and continuation of the best of competitively awarded research projects. Completed analysis of public comments for proposed ASHRAE standard for distribution system losses of installed space conditioning equipment and revised proposed standard for ASHRAE publication. Initiated research to reduce peak energy impacts of residential and commercial roof top air conditioners. SBIR/STTR funding in the amount of $121,098 was transferred from this subprogram to the Science Appropriation. Participants included: BNL, LBNL, NIST, ORNL, Univ of Ill, Univ. of MD.

FY 2003: Conduct R&D for more efficient space conditioning technology, including distribution systems with potential for reducing peak load demand as well as improving annual energy efficiency. Continue collaboration with manufacturers to investigate alternatives for affordable efficiency advancements and development of design tools for the optimum selection of equipment components for air conditioners and heat pumps. Continue to develop refrigeration systems that reduce defrost energy needed for heat pumps and commercial food storage equipment. Continue to develop test methods and field test diagnostic tools to maintain the

installed system efficiency of air conditioners and heat pumps. Field test approaches to retrofit space conditioning systems in existing homes to improve efficiency. Participants will include: BNL, LBNL, NIST, ORNL, Univ of Ill, Univ. of MD, and others that are competitively selected.

FY 2004: Focus research on a 50 percent reduction of peak electricity demand for air conditioning, on the elimination of system performance degradation in the field, and on the research needs identified in the field from the Building America activities. Approaches would include research to determine how to optimize equipment sizing, increase HVAC air distribution system efficiency, and develop field diagnostic tools such as: (1) Reduce energy losses in air conditioning distribution systems by developing a novel leak-tight duct system and improved duct insulation materials. (2) Field test an HVAC air handler designed for a 50 percent reduction in electric power required. (3) Field test of phase change materials coupled with air conditioner to reduce peak power required. (4) Develop field test guidelines for compressor downsizing and replacement for use by HVAC contractors and technicians. (5) Field test diagnostic tools for a refrigerant charge indicator with remote monitoring capabilities. (6) Implement air conditioner design tools for optimum selection of equipment components with: validated DOE/ORNL heat pump model and industry accepted thermophysical properties model (NIST/REFPROP). (7) Complete development of advanced technology for refrigeration systems with manufacturing partners through: field tests of defrost controls and laboratory tests of prototype energy efficient supermarket display cases. Participants will include: BNL, LBNL, NIST, ORNL, Univ. of Ill., Univ. of MD.

■	**Appliances and Emerging Technologies R&D**	2,205	1,755	1,755

FY 2002: Recruited additional manufacturing partners to introduce heat pump water heaters (HPWH) to market and provide infrastructure support, such as field testing, case study dissemination and fact sheets. Coordinated with utility and end-user partners to enhance marketability and demand for HPWH. Conducted program to establish rooftop A/C and three emerging lighting products on the market with manufacturers and end-user-groups. Worked with end-user groups, utilities, and the research establishment to commercialize the next-generation of smarter, more efficient appliances. Identified and explored potential innovative appliances and emerging technologies for commercial adaption. SBIR/STTR funding in the amount of $49,931 was transferred from this subprogram to the Science Appropriation. Participants included: ORNL, PNNL, NE HPWH Consortium, Dawnbreaker, Others.

FY 2003: Recruit additional manufacturing partners to introduce heat pump water heaters (HPWH) to market and provide infrastructure support, such as field testing, case study dissemination and fact sheets. Coordinate with utility and end-user partners to enhance marketability and demand for HPWH. Continue to establish rooftop A/C, HPWH, and emerging lighting products on the market with manufacturers and end-user-groups. Work with end-user groups, utilities, and the research establishment to commercialize the next-generation of smarter, more efficient appliances. Participants will include: ORNL, PNNL, SE HPWH Council, Others TBD.

(dollars in thousands)

FY 2002	FY 2003	FY 2004

FY 2004: Stimulate the development of emerging, highly efficient appliances and equipment for growth potential and energy savings. Through public-private partnerships: improve the cost-performance attributes of selected products by late-stage engineering and development; establish the viability and reliability of products by engineering field evaluations and lab testing as input to design improvements; verify the cost-performance of products as applied in buildings by field demonstration; and support market development of technology by procurement actions with large volume buyers and manufacturers.

Provide verified lab and field test data on HPWH from additional manufacturers to utility and end-user partners. With coordination between manufacturers and buyers, initiate availability to end-users of new higher-efficiency products: (1) CFL recessed cans, (2) unitary air conditioners, and (3) CFL reflector lenses. Participants will include: ORNL, PNNL, NE HPWH Consortium, Dawnbreaker, Others TBD.

■	**Building Envelope R&D**	**11,254**	**5,092**	**5,092**
•	Competitive Solicitation	2,000	0	0

FY 2002: Awarded 2 additional, second-phase competitive solicitations and awarded new competitively-selected projects to accelerate implementation of the windows and building envelope road map. Participants: NREL, ORNL.

FY 2003: The road maps were completed in FY 2001 and the Federal sector will continue to implement building envelop technology. No competitive solicitation is sought due to the need to accommodate higher priority activities. Participants: NREL, ORNL.

FY 2004: No activities.

•	Thermal Insulation and Building Materials	3,026	1,564	1,564

FY 2002: Drafted update of economics in the DOE Insulation Fact Sheet and prepared a final draft of the Attic Handbook. Solved Building America moisture issues. Initiated development of database of measured hydrothermal properties and included this database in an update of WUFI ORNL/IBP. Developed and tested energy performance of an innovative insulated attic duct system compared to standard ducts. Completed work on monitoring field performance and durability of roof coatings and membranes, and roof-modeling activities for manufacturers, consumers and designers. Initiated project to investigate the potential energy savings on Infrared enhanced pigments. Conducted program with Universities to teach the next generation of building designers about the latest Building envelope research products developed by DOE. Developed "Dynamic Energy Savings Calculator" for massive wall systems. Initiated full scale envelope

energy efficiency testing of a modular home and continued testing of a manufactured home under extreme artificial winds to determine methods, materials and devices to alleviate wind damage and improve energy performance. Continued to develop new Energy Efficient Envelope Construction Technologies to support the Building Envelope Roadmap's emphasis on energy efficiency, durability, safety and moisture control materials and strategies. Developed and tested material properties and retrofit/new construction technologies that minimize materials, energy, time, labor cost and expense through better design and construction. Conducted construction and laboratory and field structural and thermal tests of 2 new envelope construction technologies, that are affordable, durable, safe, healthy, and energy efficient. SBIR/STTR funding in the amount of $237,801 was transferred from this subprogram to the Science Appropriation.

Participants: NREL, ORNL.

FY 2003: Conduct research to improve the thermal performance of the building envelope through the evaluation of materials and construction practices including approaches to retrofit existing home envelopes. Participants: NREL, ORNL.

FY 2004: Conduct applied research to address moisture related problems that are attributed to high energy losses and property damage ($9 billion annually). Using a hygrothermal model and database developed in FY 2002 and FY 2003, "customer" driven needs such as Building America or Rebuild America partner research requirements will be investigated. Building and retrofit guidelines will be established. Modeling tools will be maintained to ensure that they are user friendly by a wide-range of practitioners.

Advanced wall systems that significantly reduce energy losses while maintaining structural integrity and ease of construction will be developed and evaluated, and demonstration plans will be finalized.

Aesthetically pleasing dark roofing products with infrared enhanced pigments that can significantly reduce cooling loads will be developed, and field tests will be initiated.

Based on FY 2003 field results, if unvented crawl spaces and attics are technically viable, alternative building guidelines for various climatic regions will be promulgated.

Demonstrate whether a new termite-resistant foundation system can reduce energy use by 10 percent over current designs. Develop energy efficient materials and construction technologies through partnership with industry and universities and transfer at least one DOE developed technology or tools to building designers and universities. Participants will include: ORNL, NREL, NIST, Minority Education Institutions, Universities, consultants.

(dollars in thousands)

	FY 2002	FY 2003	FY 2004
• Window Technologies	6,228	3,528	3,528

FY 2002: Explored and developed advanced window technologies for existing building retrofit applications, such as durable, high performance Low E and solar control coatings for glass and films. Initiated, in partnership with industry, CEC, HUD, and others, field evaluation of high performance windows including electrochromics. Provided support for the best competitively selected windows research projects. Published Commercial Glazing handbook and initiated companion web-based engineering design and specification tools. Implemented through NFRC new WINDOW 5 rating and design software suite based on International Standards Organization (ISO) procedures. Upgraded software to facilitate rating of 30,000 products per year by NFRC simulators. Initiated research to expand rating & design capability of emerging technologies & most major commercial building window types. Trained builders, architects and manufacturers through Efficient Window Collaborative. Participants included: Florida Solar Energy Center, LBNL, NREL, ORNL, UN. MA, UN. MN, CA Energy Commission, Alliance to Save Energy.

FY 2003: Continue the evaluation of high performance windows. Continue to implement through NFRC new WINDOW 5 rating and design software suite based on International Standards Organization procedures. Continue training of builders, architects and manufacturers through Efficient Window Collaborative. Field test technologies for retrofit in existing homes. Participants will include: LBNL, Florida Solar Energy Center, ORNL, U MA, U MN, PNNL, CA Energy Commission, Alliance to Save Energy.

FY 2004: The net annual energy impact for windows and skylights currently is about 4.8 Quads attributable to heating and cooling loads (3.8 Quads) and non-residential lighting loads (1 Quad). Highly leveraged competitive R&D will be conducted towards capturing this potential, including: basic and exploratory research on advanced optical coatings, frame materials, window systems, and integrated facades and envelope systems; and applied research to support rating, design tools, and implementation of efficient window technologies.

Conduct advanced performance research and development of complex non-residential retrofit widow systems and emerging residential and non-residential technologies that support Zero Energy Buildings systems; publish peer review papers of initial results. An additional outcome of this research is the technical basis for WINDOW 6 design and rating software. Promote and facilitate industry-funded research of high performance, durable solar control coatings and films and next generation reflective electronic technology, i.e., electrochromic. Through Cooperative Research Agreements with industry partners and through competitive solicitations, advance durable silver coatings, and transitional metal reflective hydride windows will be developed and evaluated.

Provide limited durability testing and analysis to industry for insulated glazing units (IGU) and electrochromic windows. Complete draft report on IGU durability addressing the technical basis for durability standards and the IGU design guidelines. Durable, high performance coatings plus durable IGU technology could double the life cycle performance of windows; publish initial results (joint DOE/CEC/HUD field test project).

With increased industry cost-share, focus training of manufacturers, builders, and architects on peak cooling load reduction and retrofit applications. Expand non-residential knowledge base: develop guidelines for energy smart schools. Complete draft of NFRC rating procedures for retrofit technologies (validated by field and lab testing in FY 2003).

Participants will include: NFRC, LBNL, Florida Solar Energy Center, ORNL, U MA, U MN, PNNL, CA Energy Commission, Alliance to Save Energy, and others.

- **Analysis Tools and Design Strategies 3,548 3,126 3,126**

FY 2002: Worked with building industry groups to support energy decision-making for design of new and retrofit of existing residential and commercial buildings. Focused efforts on EnergyPlus development to incorporate new technology simulation capabilities. Concluded development and prepared for release of final versions of SPARK, Building Design Advisor, and Energy-10.

Worked with the International Alliance for Interoperability through release 2.X of their Industry Foundation Classes (IFCs). Updated utilities by sharing building energy related information through software tools.

Conducted performance measurement research with ASHRAE, ASTM, and others to advance the calculation basis of all energy analysis tools. Highlights included issuance of thermal distribution and ventilation standards by ASHRAE. SBIR/STTR funding in the amount of $77,817 was transferred from this subprogram to the Science Appropriation.

Participants included: ASHRAE, Athena Sustainable Materials Institute, Florida Solar Energy Center, GARD Analytics, LBNL, J. Neymark Associates, NREL, Oklahoma State University, Sustainable Building Industries Council, University of Illinois, U.S. Army Construction Engineering Research Laboratory, University of Wisconsin.

FY 2003: Continue working with building industry groups to support early design decision-making and associated software tools, for renewable energy and energy efficiency within residential and small commercial buildings. Focus efforts on EnergyPlus development, releasing Version 1.1. Develop and demonstrate successful energy-efficient design solutions. Participants include: ASHRAE, Athena Sustainable Materials Institute, GARD Analytics, LBNL, J. Neymark

Associates, NREL, Oklahoma State University, University of Illinois/U.S. Army Construction Engineering Research Laboratories, University of Wisconsin.

FY 2004: Research, develop, and implement new EnergyPlus simulation software modules to enable designers to evaluate on-site generation, ventilation strategies, and advanced HVAC controls and sensors. Expand simulation software to support ZEB commercial buildings. Provide technical support to the 15 private sector interface developers and the more than 50 organizations currently developing new EnergyPlus modules. Release the final version of Energy-10 (version 2.0) with complex geometry, HVAC strategies, and lighting controls simulation capability. Worked with the International Alliance for Interoperability through release 3.X of their Industry Foundation Classes (IFCs). Implement utilities to share building energy-related information in Energy Plus v1.2. Participants will include: LBNL, NREL and others TBD.

- **Technology Road Maps 658 2,297 0**

FY 2002: Coordinated the implementation phase of technology road maps with industry partners and disseminated completed road maps for all areas to participants, stakeholders, and the public. SBIR/STTR funding in the amount of $139,00 was transferred from this subprogram to the Science Appropriation. Participants: National Energy Technology Lab (NETL), other National laboratories, and industry partners.

FY 2003: DOE will align the individual R&D programs with the high-priority actions identified in the road maps and coordinate the implementation phase of technology road maps with industry partners. Funding will allow follow-through on the expectations of several hundred industry partner-participants in BT road maps, who are looking to the Federal government as the catalyst and to integrate the effort. Assist research programs in implementation of the technology road maps. Participants: National Energy Technology Lab (NETL), other National laboratories and industry partners TBD

FY 2004: No activities.

- **Competitive R&D 6,000 0 0**

FY 2002: Conducted on-going research projects from previous solicitation. Initiated 6 new projects through full competition and industry cost share. Participants: National Energy Technology Lab (NETL), other National laboratories and industry partners (Competitive R&D)

FY 2003: Complete research projects funded through prior years solicitations.

FY 2004: No activities.

(dollars in thousands)

	FY 2002	FY 2003	FY 2004
Equipment Standards and Analysis	**8,251**	**9,197**	**9,017**

FY 2002: Issued Final Rule for residential central air conditioners/heat pumps energy efficiency standards. Continued to develop Advanced Notice of Proposed Rulemaking (ANOPR) regarding energy conservation standards for electric distribution transformers, which promise high levels of energy savings. Reviewed existing test procedures to ensure that they remain current with advancing technology (e.g., dishwashers, water heaters). Issued final test procedure for residential central air conditioners and heat pumps, dishwashers, commercial furnaces, water heaters, air conditioners, and boilers. Ensured compliance to standards through follow-up inquiries, random audits, and investigations of noncompliance allegations. SBIR/STTR funding in the amount of $175,442 was transferred from this subprogram to the Science Appropriation. Participants included: LBNL, NIST, NREL, PNNL, Others.

FY 2003: Develop ANOPR regarding energy conservation standards for electric distribution transformers and ANOPR for commercial unitary air conditioners and heat pumps, and residential furnaces and boilers, which promise high levels of energy savings. Review existing test procedures to ensure that they remain current with advancing technology, e.g. dishwashers. Ensure compliance to standards through follow-up inquiries, random audits, and investigations of noncompliance allegations. Begin implementation of a plan to add new products to the lighting and appliance standards program. Participants will include: LBNL, NIST, NREL, PNNL, Others TBD.

FY 2004: Develop NOPR regarding energy conservation standards for electric distribution transformers, residential furnaces and commercial unitary air conditioners and heat pump 65-135 and 135-240 kBtu/h, which promise high levels of energy savings. Review existing test procedures to ensure that they remain current with advancing technology and standby power. Conduct analyses which will inform the implementation of a plan to add new products to the lighting and appliance standards program as well as other approaches such as tax incentives and Energy Star to improve and promote the efficiency of appliances and equipment.
Participants will include: LBNL, NIST, NREL, PNNL, others TBD.

Energy Efficiency Science Initiative (EESI)	**$1,959**	**$0**	**$0**

In collaboration with the DOE Office of Fossil Energy, a single award solicitation was issued to address technology gaps between exploratory science and pre-commercial applied R&D. As a part of EERE's ongoing program evaluation activities, this program is being rebaselined in FY 2003 on the results of projects completed during FY 2001 and FY 2002. For this reason, no additional funds are requested in FY 2003 and FY 2004. SBIR/STTR funding in the amount of $41,801 was transferred from this subprogram to the Science Appropriation.

Technical / Program Management Support	**$1,320**	**$2,320**	**$1,500**

FY 2002: Included activities which were an integral part of the technology road maps, residential

buildings integration, commercial buildings integration, emerging technologies, lighting and appliance standards programs. Representative activities included preparation of program, strategic plans, and operating plans; R&D feasibility studies and trade-off analysis; evaluation of the impact of new legislation on R&D programs; analysis of energy issues pertinent to the R&D program; identification of performance methodologies (including GPRA); data collection to assess program and project performance, efficiency and impacts; and development of performance agreements with management.

FY 2003: Includes activities which are integral part of the technology road maps, residential buildings integration, commercial buildings integration, emerging technologies, lighting and appliance standards programs. Representative activities includes preparation of program, strategic plans, and operating plans; R&D feasibility studies and trade-off analysis; evaluation of the impact of new legislation on R&D programs; analysis of energy issues pertinent to the R&D program; identification of performance methodologies (including GPRA); data collection to assess program and project performance, efficiency and impacts; and development of performance agreements with management.

FY 2004: Will include activities which are integral part of the residential buildings integration, commercial buildings integration, emerging technologies, lighting and appliance standards programs. Representative activities will include preparation of program, strategic plans, and operating plans; R&D feasibility studies and trade-off analysis; evaluation of the impact of new legislation on R&D programs; analysis of energy issues pertinent to the R&D program; identification of performance methodologies (including GPRA); data collection to assess program and project performance, efficiency and impacts; and development of performance agreements with management.

Explanation of Funding Changes

	FY 2004 vs. FY 2003 ($000)
Residential Buildings	
■ Research and Development: Incorporate goals and objectives of Zero Energy Buildings, pursue systems research on 5 promising technology areas; and enhance activities to apply practices and approaches developed through Building America to existing residential buildings	+1,797
Emerging Technologies	
■ Lighting Research and Development: Expand research through a Solid State Lighting activities ($5 million) addressing energy efficiency, visual comfort, and quality of lighting. Redirect selected activities in basic and applied research through cost-shared contracts on Lighting Roadmap priority needs, including: advanced light sources; fixtures, distribution and controls; and human factors relating to vision and productivity, to support the enhanced Solid State Lighting activity which has potentially higher payoff	+1,500
■ Technology Road Maps: Road maps and implementation plans are complete	-2,297
Total, Emerging Technologies	-797
Equipment Standards and Analysis Program	
■ Continue analyses that will add new products to the lighting and appliance standards program reflecting changes in program scope	-180
Technical/Program Management Support	
■ Decrease, Technical/Program Management Support	-820
Total Funding Change, Building Technologies Program.	0

Biomass and Biorefinery Systems R&D Program

Program Mission

The mission of the Biomass and Biorefinery Systems R&D Program is to develop new approaches for expanding the use of biomass for energy and industrial products by developing new industrial biorefinery technologies that are cleaner and more efficient, reliable, and lower in cost. The Program develops advanced techniques for several types of conversion processes including hydrolysis, fermentation, chemical conversion, gasification, and other bioconversion and thermochemical methods for extracting energy and chemicals from biomass, focusing primarily on cellulosic feedstock. It also develops advanced equipment and techniques for the harvesting and storage of biomass feedstock.

Biomass includes agricultural crops, crop residues, forest resources and residues, dedicated energy crops, and animal wastes. Carbohydrates, oils, and lignin can be extracted from biomass and converted into gaseous, liquid, and solid fuels for transportation and electric power production. They can also be converted into products such as plastics, coatings, foams, solvents, etc.

Accomplishing this mission contributes to several national energy and environmental priorities. For example, the President's National Energy Policy states that biomass has "...the potential to make more significant contributions in the coming years." Biomass and Biorefinery Systems R&D supports the goals of increasing energy supplies, improving energy efficiency, accelerating the protection and improvement of the environment, and increasing energy security. Accomplishing this mission is in direct support of the Biomass R&D Act of 2000 and the Farm Security and Rural Investment Act of 2002.

Industrial biorefineries are processing facilities for extracting carbohydrates, oils, lignin, and other materials from biomass, converting them into multiple products such as ethanol for transportation fuel, bio-oils or gasses for power generation, and products such as plastics, coatings, and lubricating oils. First generation industrial biorefineries are coming into the market today. They have less than a decade of engineering development experience. In contrast, petroleum refineries - which are petrochemical processing plants for converting crude oil into multiple products such as diesel, gasoline, and naptha - incorporate mature technologies that have 100 years of engineering development experience.

While the concept of the industrial biorefinery is relatively new, biorefineries are not. For example, food processing plants such as corn wet mills and corn dry mills and pulp and paper mills are examples of existing biorefinery facilities that convert corn and wood materials into some combination of food, feed, power, and industrial and consumer products. The program is working with some of the existing biorefineries in technology development and validation that will lead to greater biomass utilization. The deployment of advanced technologies can result in new industrial biorefineries that will contribute significantly to the reduction of fossil fuels use, emissions and costs.

Strategic Context

The biomass contribution to America's energy supplies could be much greater if the technologies for industrial biorefineries were more fully developed and affordable. Because the advanced technologies needed for biorefineries contain elements that are common across products lines, these synergisms may help to lower R&D development costs. For example, advanced conversion technologies for producing low-cost sugars are an integral part of the production process for outputs such as ethanol for automotive fuels and chemicals for coatings and plastics. Advanced biomass gasification technologies provide gaseous fuels for heat and power generation, and can also be used to make bioproducts and liquid biofuels through catalytic conversion.

America possesses abundant biomass resources, which are available in many regions of the country. Biomass currently meets about 3 percent of America's energy needs, using 180 million dry tons of biomass annually. The use of biomass energy increased almost 25 percent from 1990 to 2000 (2.6 to 3.2 quads). The primary existing energy uses of biomass are: 1) corn for making ethanol, which is blended with gasoline for automobile fuel, and 2) wood wastes in pulp and paper mills for firing boilers and turbines in combined heat and power facilities, improving electricity availability.

A few hundred million additional tons of cellulosic biomass per year can be available for conversion into fuels, power, and products. Using biomass for transportation fuels and products reduces the need for oil imports. Using biomass provides a productive means of disposing of underbrush and forest residues, which can reduce the spread of forest fires, and can improve our rural economy.

Management Strategy

To better coordinate its biomass research and development, the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy (EERE) recently consolidated its biomass research programs and created a single, integrated Biomass and Biorefinery Systems R&D Program. The Agricultural Industries of the Future program, the Industrial Gasification area of the Combustion Crosscutting program (along with gasification projects from the Forest Products Industries of the Future program), and the Biofuels and Biopower programs are now under a single management structure. This change is the culmination of steps that have been taken over the past several years to strengthen the technical coordination of bioenergy-related program activities. The intent is to improve the program's effectiveness by focusing resources on a limited and more coherent set of goals and objectives, reducing overhead expenses, exploiting synergies among similar activities, and eliminating the risk of possible duplication of effort.

The program receives appropriations from both the Energy and Water Development and the Interior and Related Agencies subcommittees. Energy and Water Development activities focus on developing advanced technologies for producing transportation fuels and power using biomass feedstocks. Interior activities focus on developing advanced technologies for more energy efficient industrial processes and high-value industrial products. In addition, the program invests in technical program and market analysis and performance assessment in order to direct effective strategic planning.

The program is organized into the following areas of activity:

- Biomass and Biorefinery Systems R&D (Interior)
  - Advanced Biomass Technologies R&D: Products Development
  - Systems Integration and Production

- Biomass and Biorefinery Systems R&D (Energy and Water Development)
  - Advanced Biomass Technologies R&D
  - Systems Integration and Production

Products Development (formerly the **Agriculture Industries of the Future**). The biobased products industries use biomass from agricultural crops and crop residues, forest resources and residues, lumber and wood wastes, animal wastes, and municipal solid waste to produce industrial products and consumer goods such as chemicals, plastics, coatings, lubricants, and composite materials, which are currently usually made with petroleum feedstocks. Unlike petroleum-based chemicals, biomass products are derived from renewable carbohydrates, lignin, protein, and plant oils. Use of bio-based industrial products will enable biomass resources to substitute for fossil-fuel resources as economically and environmentally warranted, thus helping to serve national goals for economic growth, energy, and the environment. These new biobased product technologies, when integrated into the next generation of biorefineries producing fuels, chemicals, and/or power, can help reduce manufacturing energy intensity relative to stand-alone petroleum-based processes.

The Products Development effort relies on strong partnerships with industry, including plant crop growers and processors, forest products companies, chemical companies, biotechnology providers, and a network of universities and national laboratories. Research projects are accomplished using competitive solicitations targeted toward multi-disciplinary teams through collaborative, cost-shared contracts. The research develops process technologies for the extraction, production, and use of chemicals and materials from biomass.

For example, in the early 1990s, EERE began supporting research for technology to produce polylactic acid (PLA) – a biodegradable plastic derived from corn. Cargill Dow recently started up its first PLA plastics manufacturing plant in Blair, Nebraska, with a capacity of 300 million pounds per year. The potential market for this new plastic is more than 8 billion pounds per year in 2020, which would save 190 trillion Btu of fossil fuels per year. These savings would be accomplished through the use of corn in place of petroleum as the feedstock.

An important focus today is the production of organic chemicals, which can be used as building blocks for a myriad of industrial and consumer products (plastics, paints, adhesives, solvents, cleaners, etc.). In the future, biomass might also be used to manufacture other industrial products that are today made solely from oil, natural gas, and minerals. Like petroleum-based plastics, biobased plastics and composites can be used to augment the use of materials such as aluminum, steel, and glass.

Products Development is closely coordinated with related efforts in other parts of the Department and other Federal and State agencies such as USDA. It is also closely coordinated with private efforts, notably chemical companies who are focusing on biomass. The forest products industry is pursuing efforts in sustainable forestry for the production of biomass and has created a new focus area on

biobased products from forestry resources. The Department's Office of Science and the National Science Foundation support basic research in plant and microbial science that is highly relevant, and the USDA has a long-standing program on new uses for agricultural crops. Breakthroughs resulting from relevant, related work will benefit the Products Development activities.

Program decisions about research directions and priorities are guided by inputs obtained from biomass science and technology experts and energy and industrial practitioners from outside of the U.S. Department of Energy. The perspectives of these individuals helps to assure that Program activities reflect the perspectives of manufacturers, utilities, farmers, foresters, State agencies, consumers, environmental organizations, and other stakeholders. These inputs have been obtained using technology roadmaps and peer reviews, several of which have been accomplished in the last two years.[a]

Industrial Gasification (formerly the industrial gasification part of the **Combustion Crosscutting Program** and the gasification projects from the **Forest Products Industry of the Future Program**). Because funding of technology development and validation appears to be within industry's capability, the FY 2004 budget request does not seek funding for this activity in accordance with the Administration's R&D Investment Criteria (R&DIC) (directing funding to long-term, high-risk research that industry is unlikely to undertake without Federal support).

Technical Program Management Support focuses on strategic and operating plans, feasibility studies, trade-off analyses, and evaluation of program performance. These efforts support EERE management's overall objectives of increasing program efficiency and targeting future resources to the most productive program efforts.

Program Benefits

Each year, EERE estimates the benefits of program activities to support Government Performance and Results Act (GPRA) reporting. Methods are complex and vary by program. A complete explanation of methodology and assumptions will be posted this spring on line at www.eren.doe.gov/eere/budget.html. An overview of the methods and results for the Biomass Program is provided below.

EERE's benefits estimate modeling starts with the Energy Information Administration's (EIA's) National Energy Modeling System (NEMS) and modifies it to create NEMS-GPRA04. The Baseline for the Biomass Program is essentially the EIA's Annual Energy Outlook (AEO) 2002 reference case, which already includes some additional penetration of biomass energy use. The program goals for biomass Gasification Combined Cycle (BGCC) are modeled in NEMS-GPRA04 as improved capital costs and generating efficiency. Because the AEO baseline already reflects these EERE R&D goals, the benefits of these technology improvements are largely not reflected in the estimates below. Program goals for biobased products cannot be directly represented in NEMS-GPRA04 because the model does not represent in detail the displacement of petroleum feedstocks in the production of various chemical products. The energy savings for new biobased products are estimated separately based on an assumed

[a]Agenda 2020, EPRI's annual Gasification Technology Conference, the American Forest and Paper Association's annual Technology Forum, and the EPRI-led Biomass Interest Group which meets twice a year to review technology progress.

market penetration rate of about 15 percent per year. The resulting reduction in the demand for oil is then incorporated in the NEMS-GPRA04 program case.

Initial estimates of the energy impacts of program goals for reducing the cost of cellulosic ethanol were developed utilizing EERE's ethanol analytic model, assuming feedstock costs of about $30 per dry ton. The resulting estimated demand for ethanol was then included in NEMS-GPRA04, which adjusts the overall level of ethanol purchased by accounting for changes in the price of biomass feedstocks resulting from competition among ethanol and biobased products. Biomass capacity to satisfy green power demand is introduced as planned additions based on analysis of green power markets undertaken by Princeton Energy Resources International.

FY 2004 GPRA Benefits Estimates for Biomass Program (NEMS-GPRA04)			
	2005	**2010**	**2020**
Electricity Capacity (GW)[c]	0.0	0.2	0.5
Electricity Generation (BkWh)[c]	0.3	1.3	3.7
Cellulosic Ethanol Production (Bil. gallons)	0.00	0.11	0.82
Non-Renewable Energy Savings (quads)	0.06	0.10	0.33
Oil Savings (quads)	0.02	0.07	0.33
Carbon Savings (MMT)	0.6	0.8	3.6
Energy Expenditure Savings (B2000$)	0.0	0.6	1.9

Estimates for additional electricity capacity and generation, energy savings, oil savings, carbon emission reductions, and energy expenditure savings resultant from realization of Program goals are shown in the table through 2020.[a] By 2020, annual demand for oil will be reduced by about 59.6 million barrels/year, primarily through reduced use of petrochemical feedstocks.[b] The reduced need for petrochemical feedstocks and fossil energy in chemical production and lower prices resulting from the lower demand both contribute towards the energy expenditure savings. Benefits grow substantially in the post-2020 time frame, due to continued reductions in biorefinery costs and continued market adoption of these new products. These estimates do not take into account some of the potential synergies between biomass and hydrogen markets (which are largely in the post-2020 time frame). These estimates reflect EIA reference case assumptions about future energy markets. The development of these biomass technologies would provide the Nation with additional opportunities to utilize domestic fuels for transportation and electricity generation in the event that oil or electricity markets are more constrained than expected, or if changes in environmental requirements result in increased use of ethanol or other biobased products.

In addition to the benefits quantified above, the clean-burning nature of biomass in vehicles is already being used to help mitigate emissions affecting regional air quality and maintain Clean Air Act (CAA) compliance, a role which may grow as State and local governments seek additional means of meeting

[a] Benefits reported are annual, not cumulative, for the year given for the entire Biomass Program (both Interior and EWD portions). Estimates reflect the benefits associated with program activities from FY 2004 to the benefit year or to program completion (whichever is nearer), and are based on program goals developed in alignment with assumptions in the President's Budget.

[b] Additional use of cellulosic ethanol primarily replaces corn ethanol in gasoline blends.

these requirements. Because biomass resources are widely available, the development of a biorefinery industry will provide economic growth opportunities for rural communities throughout the country.

Program Strategic Performance Goals

The Program Strategic Performance Goals represent the Program in its entirety, and thus encompass efforts under both the Energy and Water Appropriation and the Interior Appropriation. The program has the following overall performance goals:

1) By 2020, develop and verify gasification technologies which enable the increased efficiency of biopower systems from the current 20 percent efficiency to 30-35 percent; with a unit cost reduction of 50 percent from the 11 cents per kWh baseline in 2000 to 5.5 cents per kWh (as stand-alone systems outside of the biorefinery) ; 2) by 2010, develop the bioconversion technologies necessary for reducing the production cost of cellulosic ethanol from $1.40 to $1.22 per gallon, and, by 2020, to $1.00 per gallon, through technology improvements for the co-production of ethanol, electricity, and bio-based chemicals (this cost is equivalent to the cost of high-value petroleum-based additives that refineries must pay in order to produce gasoline that satisfies octane and emission requirements specified by EPA and the automobile manufacturers) ; 3) by 2010, through collaborative research projects with industry, universities and national laboratories, develop and verify cost competitive, energy efficient, process technologies for bio-based products that will enable, by 2020, a domestic market of at least 50 billion lbs per year of bio-based products — an increase of more than three-fold — from current sales of about 15 billion lbs/yr.

The Interior section focuses on products development R&D, and addresses sub-program goal (3) in the stated performance goal. The respective performance indicators and technology baselines are stated below:

Performance Indicators:

(Broken down by PSPG Sub-goal; the goal shown below is for the Interior and Related Agencies appropriation; those funded by the Energy and Water Development appropriation are not shown)

(3) Products Development -- By 2010, through collaborative research projects with industry, universities and national laboratories, develop and verify cost competitive, energy efficient, process technologies for bio-based products that will enable, by 2020, a domestic market of at least 50 billion lbs per year of bio-based products — an increase of more than three-fold — from current sales of about 15 billion lbs/yr.

Performance Indicators

Number of new biobased product process technologies demonstrated at the pilot scale. The number of biobased products process technologies being developed that are compatible with, and being integrated into, biofuels and/or biopower research for biorefineries as evidenced in biorefinery research projects. Growth statistics of biobased product market.

Annual Performance Results and Targets: Products Development

FY 2002 Results	FY 2003 Proposed Target	FY 2004 Proposed Target
Cargill Dow LLC started up the first full-scale PLA plastic manufacturing facility (300 million lbs./yr.) based on corn sugar as the feedstock. 200 trillion Btu fossil fuel savings by 2020. DOE's technology development contributions prior to plant construction enabled this success. Two new biobased polymer technologies advanced to scale-up with industry partners who are committed to commercialization within two to three years.	In partnership with industry, complete pilot scale demonstration of two new biobased product technologies for economic, technical, and product performance. A 2-cycle engine oil derived from soy oil is commercialized for the emerging bioproducts industry (target slipped from FY02 because obtaining the engine for testing took longer than originally planned).	Complete validation of one new biobased product technology, with long-term potential of greater than 2 B lbs./yr. sales, at the pilot scale for economic, technical, and product viability in partnership with industry. With industry partners, a new biobased product technology advances to scale-up with partners' intention to commercialize in a new industrial biorefinery by 2008. The biorefinery will be at pilot scale.

Significant Program Shifts

Products Development (formerly the Industries of the Future Specific, Agriculture Program) efforts are now administered under the Biomass and Biorefinery Systems R&D Program's Advanced Biomass Technologies R&D category. The Industrial Gasification activity (formerly the Industrial Gasification portion of the Office of Industrial Technologies' Combustion Crosscutting Program) will be closed out in FY 2003. No new funding is requested for this activity in FY 2004 in view of industry's ability to pursue further technology development and validation without Federal support. The synergy and increased efficiency and productivity resulting from the new management structure will help the Program meet its challenging milestones.

Funding Profile[a]

(dollars in thousands)

	FY 2002 Comparable Appropriation	FY 2003 Amended Request	FY 2004 Request	$ Change	% Change
Biomass and Biorefinery Systems R&D					
Total, Biomass and Biorefinery Systems R&D	24,779	23,939	8,808	-15,131	-63.2%

Public Law Authorizations:

P.L. 94-163, "Energy Policy and Conservation Act" (EPCA) (1975)
P.L. 94-385, "Energy Conservation and Production Act" (ECPA) (1976)
P.L. 95-91, "Department of Energy Organization Act" (1977)
P.L. 95-618, "Energy Tax Act of 1978"
P.L. 95-619, "National Energy Conservation Policy Act" (NECPA) (1978)
P.L. 95-620, "Powerplants and Industrial Fuel Use Act of 1978"
P.L. 96-294, "Energy Security Act" (1980)
P.L. 100-12, "National Appliance Energy Conservation Act of 1987"
P.L. 100-615, "Federal Energy Management Improvement Act of 1988"
P.L. 101-218, "Renewable Energy and Energy Efficiency Technology Competitiveness Act of 1989"
P.L. 101-549, "Clean Air Act Amendments of 1990"
P.L. 101-575, "Solar, Wind, Waste, and Geothermal Power Production Incentives Act of 1990"
P.L. 106-224, "Biomass Research and Development Act of 2000"
P.L. 93-577, "Federal Non-nuclear Energy Research and Development Act of 1974"
P.L. 102-486, "Energy Policy Act of 1992"

[a] SBIR/STTR funding in the amount of $472,000 was transferred to the Science appropriation in FY 2002.

Funding by Site[a]

(dollars in thousands)

	FY 2002	FY 2003	FY 2004	$ Change	% Change
Albuquerque Operations Office					
National Renewable Energy Laboratory	200	300	300	0	0.0%
Sandia National Laboratories	527	500	0	-500	-100.0%
Total, Albuquerque Operations Office	727	800	300	-500	-62.5%
Chicago Operations Office					
Argonne National Laboratory	496	321	0	-321	-100.0%
Total, Chicago Operations Office	496	321	0	-321	-100.0%
Idaho Operations Office					
Idaho National Engineering and Environmental Laboratory	1,309	525	350	-175	-33.3%
Total, Idaho Operations Office	1,309	525	350	-175	-33.3%
National Energy Technology Laboratory	6,489	8,000	0	-8,000	-100.0%
Oak Ridge Operations Office					
Oak Ridge National Laboratory	1,728	1,600	300	-1,300	-81.3%
Total, Oak Ridge Operations Office	1,728	1,600	300	-1,300	-81.3%
Richland Operations Office					
Pacific Northwest National Laboratory	500	650	700	+50	7.7%
Total, Richland Operations Office	500	650	700	+50	7.7%
Washington Headquarters	13,530	12,043	7,158	-4,885	-40.6%
Total, Biomass and Biorefinery Systems R&D	24,779	23,939	8,808	-15,131	-63.2%

[a] "On December 20, 2002, the National Nuclear Security Administration (NNSA) disestablished the Albuquerque, Oakland, and Nevada Operations Offices, renamed existing area offices as site offices, established a new Nevada Site Office, and established a single NNSA Service Center to be located in Albuquerque. Other aspects of the NNSA organizational changes will be phased in and consolidation of the Service Center in Albuquerque will be completed by September 30, 2004. For budget display purposes, DOE is displaying non-NNSA budgets by site in the traditional pre-NNSA organizational format."

Site Descriptions

National Renewable Energy Laboratory

The National Renewable Energy Laboratory (NREL), located in Golden, Colorado, is the lead laboratory in support of biomass R&D. NREL is responsible for the development of advanced analytical methodologies (chemical and life-cycle) that are used to facilitate industry commercialization, including complete economic assessments of the relevant biomass technologies. NREL works with industry and academia to arrive at consensus points on technology costs and environmental performance. NREL also developed and operates two user facilities, the Thermochemical Users Facility (TCUF) and the Alternative Fuels Users Facility (AFUF).

Sandia National Laboratories

In support of the Program, SNL in 2002 provided technical expertise on the combustion processes involving biomass. These activities will be no longer conducted in FY 2004.

Argonne National Laboratory

Argonne National Laboratory (ANL) conducts R&D for the program's Industrial Gasification activity and will no longer be funded in FY 2004.

Idaho National Engineering and Environmental Laboratory

INEEL provides biomass-related R&D services and support for the feedstock infrastructure development effort.

National Energy Technology Laboratory

The National Energy Technology Laboratory (NETL) conducts R&D for the Industrial Gasification activity.

Oak Ridge National Laboratory

Oak Ridge National Laboratory (ORNL) conducts biomass technologies R&D and develops improved harvesting technology for biomass feedstocks.

Pacific Northwest National Laboratory

The Pacific Northwest National Laboratory conducts R&D in support of the development of the syngas platform and related products. Major program components include thermocatalysts for fuels and chemicals and wet biomass for syngas production.

Washington Headquarters

The Office of Energy Efficiency and Renewable Energy (EERE) provided funding to regional offices for the Regional Biomass Energy Program in FY 2002 (currently no longer funded), provides funding at DOE Headquarters for various procurements and interagency agreements as needed, provides programmatic oversight of biomass activities conducted at the Golden Field Office and National Laboratories, and works with advisory panels and stakeholders on roadmaps and related activities for biomass technologies development.

Funding Schedule

(dollars in thousands)

	FY 2002 Comparable Appropriation	FY 2003 Amended Request	FY 2004 Request	$ Change	% Change
Advanced Biomass Technology R&D					
Thermochemical Conversion R&D - Products	2,754	3,304	3,304	0	0
Bioconversion R&D - Products	4,355	4,955	5,104	+149	+3.0%
Subtotal, Advanced Biomass Technology R&D	7,109	8,259	8,408	+149	+1.8%
Systems Integration and Production	17,140	14,680	0	-14,680	-100.0%
Technical Program Management Support	530	1,000	400	-600	-60.0%
Total, Biomass and Biorefinery Systems R&D	24,779	23,939	8,808	-15,131	-63.2%

Detailed Program Justification

(dollars in thousands)

	FY 2002	FY 2003	FY 2004
Advanced Biomass Technologies R&D - Products Development	**7,109**	**8,259**	**8,408**

The Products Development subprogram relies on partnerships with industry, universities and National Laboratories to develop process technologies for producing chemicals and materials from biomass. As R&D proceeds, the Program will continue to leverage and coordinate with efforts in other EERE and DOE programs, USDA, and other agencies.

FY 2002: Projects funded by Agriculture Industries of the Future (IOF) solicitations in prior years will continue to focus on innovative technology for the use of biomass as feedstock for chemicals and materials. These efforts include novel separations technologies, bio-based plastics, novel products from oils, and lower cost and energy use in biomass harvesting, pre-processing and storage. Supported the 18 active Agriculture IOF R&D projects, and the 8 university grants to enhance graduate education programs, helping to ensure well-focused efforts and achievement of key milestones.

DOE's technology development contributions prior to plant construction enabled the successful start-up of Cargill Dow's first large-scale (300 Mlbs./yr.) polylactic acid (PLA) plastics plant in Blair, Nebraska, based on corn sugar as the feedstock. This facility was expanded to include the fermentation of the lactic acid required as well. Two projects advanced to scale-up with industry partners with a target to commercialize biobased polymers within 2-3 years. SBIR/STTR funding in the amount of $150,000 was transferred from this subprogram to the Science Appropriation.

Participants include: National Corn Growers Association, American Soybean Association / United Soybean Board, National Association of Wheat Growers, American Forest and Paper Association, Corn Refiners Association, National Association of Land-Grant Colleges, Cargill, ADM, Dow Chemical Co., Dupont, BF Goodrich, Rohm and Haas Co., Amalgamated Research Inc., Biomass Agricultural Products (B/MAP), Genencor International, Cargill Dow LLC, PNNL, INEEL, ANL, ORNL, NREL, and a wide array of colleges and universities.

FY 2003: Projects funded from the Agriculture Industries of the Future solicitations in FY 2000 and 2001 will continue to focus on innovative technology for the use of biomass as feedstock for chemicals and materials. These efforts include novel separations technologies, bio-based plastics, novel products from oils, and lower cost and energy use in biomass harvesting, pre-processing and storage.

An analytical effort will be initiated to determine a list of top chemical targets to be pursued through competitive research. The criteria for inclusion in this list will be based on economics and superior performance over the existing fossil-based technologies. Expect the commercial introduction of a soy-oil based 2-cycle engine oil. It is expected that 2 of these current and/or past projects will include successful pilot scale validation with industry partners and the commercialization of at least one new

biobased polymer or solvent. Initial technology breakthroughs are expected in novel, lower cost, less energy-intensive harvesting and storage technology.

The existing university grants sought to create multi-disciplinary curricula at the graduate level. It was hoped that participating students would join the workforce of a new bio-based industry. The first generation of these grants will be ending in 2003, making this year an appropriate time to evaluate and possibly rescope this effort.

Participants include: National Corn Growers Association, American Soybean Association / United Soybean Board, National Association of Wheat Growers, American Forest and Paper Association, National Association of Land-Grant Colleges, Cargill, ADM, Dow Chemical Co., Dupont, BF Goodrich, Rohm and Haas Co., Genencor International, Cargill Dow LLC, Metabolix, B/MAP, Vertec Biosolvents, BCI, Amalgamated Research Inc., PNNL, INEEL, ANL, NREL, and a wide array of colleges and universities.

FY 2004: The Products Development effort will attain full integration into the Biomass Program and continue with development of the integrated biorefinery. The program will focus on the previously identified top chemical targets, through a competitive solicitation. In addition, work selected in 2000 and 2001 Industries of the Future solicitations will continue, including novel separations technologies, bio-based plastics, novel products from oils, and lower cost and energy use in biomass harvesting, pre-processing and storage.

It is expected that one of these current and/or past projects, with significant market opportunity (>2 B lbs. by 2020), will include scale-up of the technology to successful pilot-scale demonstration with industry partners, and new product technology for a new industrial biorefinery will move into pilot-scale demonstration.

Recommendations from the 2003 evaluation of the education grant initiative will be implemented.

Participants include: National Corn Growers Association, Iowa Corn Promotion Board, American Soybean Association / United Soybean Board, American Forest and Paper Association, National Association of Land-Grant Colleges, Cargill, ADM, Dow Chemical Co., Dupont, Cargill Dow LLC, Metabolix, B/MAP, Vertec Biosolvents, Amalgamated Research Inc., Ashland Chemical, Arkenol, CNH, Castor Oil Inc., USDA Western Regional Laboratory, PNNL, INEEL, ANL, NREL, and a wide array of colleges and universities.

(dollars in thousands)

FY 2002	FY 2003	FY 2004

Systems Integration and Production 17,140 14,680 0

These activities focus on new technologies for the integrated production of power from solid wood waste and black liquors from the pulping processes.

FY 2002: Continued engineering design and cost projections for biomass gasification demonstration (DeRidder, LA). Initiated construction for the Big Island, VA, demonstration of black liquor gasification. Conducted research and development on sulfur management, gas clean-up, materials, systems integration, and other gasification-related studies. Continued development of corrosion-resistant materials for use in black liquor gasifiers. Research continued on advanced nozzles for black liquor injectors. SBIR/STTR funding in the amount of $322,000 was transferred from this subprogram to the Science Appropriation.

Participants include: Georgia Pacific, Boise Cascade, GTI, Thermo-Chem, Fluor-Daniel, Nexant, ORNL, INEEL, NETL, and Georgia Institute of Technology.

FY 2003: Complete appropriate subtasks related to the engineering design and cost projections for biomass gasification demonstration (DeRidder, LA). Procurement and construction will be completed for the Big Island, VA, mill demonstration of black liquor gasification. Conduct research and development on sulfur management, gas clean-up, materials, systems integration, and other gasification-related studies. Complete current work on engineering design and cost projections for Kraft black liquor gasification demonstration. Complete current work on development of corrosion-resistant materials for use in black liquor gasifiers. Complete research on advanced nozzles for black liquor injectors and document results.

Participants include: Georgia Pacific, Boise Cascade, GTI, Thermo-Chem, Fluor-Daniel, Nexant, ORNL, INEEL, SNL, ANL, NETL, Georgia Institute of Technology, University of Utah, University of Missouri/Rolla, Institute of Paper Science and Technology, and University of Maine.

FY 2004: No activity.

Technical Program Management Support 530 1,000 400

FY 2002: Conducted activities related to technical program management support to increase program efficiency. This included trade-off analysis and the assessment of technical barriers.

FY 2003: Conduct activities related to technical program management support to increase program efficiency. This will include option studies on the needs and opportunities for biobased products; syngas platform options; and biobased oil options.

(dollars in thousands)

FY 2002	FY 2003	FY 2004

FY 2004: Conduct strategic planning and analyses that will be used as decision tools for the biobased products portfolio. This will include trade-off, technical, and cost analysis.

Total, Biomass/Biorefinery Systems R&D	**24,779**	**23,939**	**8,808**

Explanation of Funding Changes

	FY 2004 vs. FY 2003 Request
Advanced Biomass Technologies R&D	
■ Increase in bio-based products conversion research	+149
Systems Integration and Production	
■ Project funding appears to be within industry's capability. Close out in alignment with the Administration's R&D Investment Criteria	-14,680
Technical Program Management Support	
■ Reduction reflects reduced need for support because of closeout of Systems Integration and Production activity	-600
Total, Biomass and Biorefinery Systems R&D	**-15,131**

Federal Energy Management Programs

Program Mission

Federal Energy Management Programs (FEMP) promotes energy efficiency and water conservation, use of distributed and renewable energy, and sound utility management decisions at Federal sites.

The Federal government is the Nation's single largest energy consumer. It uses almost one quadrillion Btus of energy annually or about 1.41 percent of the Nation's energy consumption. In fiscal year 2000, the Federal government spent about $4 billion on energy to heat, cool, light, and conduct operations in its 500,000 buildings.

The Federal government spends about $200 billion annually on all products and services, including those that use energy such as lights, computers, copiers, and heating and cooling equipment. Buying power of this magnitude has a strong effect on private sector manufacturing and design decisions throughout the economy. For example, Executive Order 13221, which requires the Federal government to purchase products that use minimal standby power, offers a compelling example of how, by working with industrial partners, the Federal government's purchasing decisions can pull the market for energy efficient products. In response to E.O. 13221, office product manufacturers are introducing significant design changes that dramatically reduce the standby power of products used by consumers and businesses throughout the world. Through prudent product specifications and purchasing criteria, the Federal government can encourage the development of more energy efficient and renewable energy products and services.

In FY 2002, FEMP estimates that the Federal government was appropriated at least $6 billion for new construction and renovation projects for buildings and facilities. Through information exchange, technical guidance and assistance, FEMP can influence architectural designs, engineering, and building construction practices to ensure cost-effective energy efficiency and renewable energy technologies and practices are used.

Federal agencies have energy management opportunities in: building construction, renovation, retrofit, operations and maintenance; energy consuming product and equipment procurement; and utility service acquisition and utility load management. FEMP employs a variety of approaches to assist agencies in realizing energy, environmental and cost savings potentials, including: interagency coordination committees, direct technical assistance, education and training, information and outreach programs, targeted project financial support, and assistance in accessing alternative private sector funding. Success occurs when FEMP and its agency and private sector partners enable Federal energy managers to make better energy management choices that result in a more efficient, effective and energy secure government.

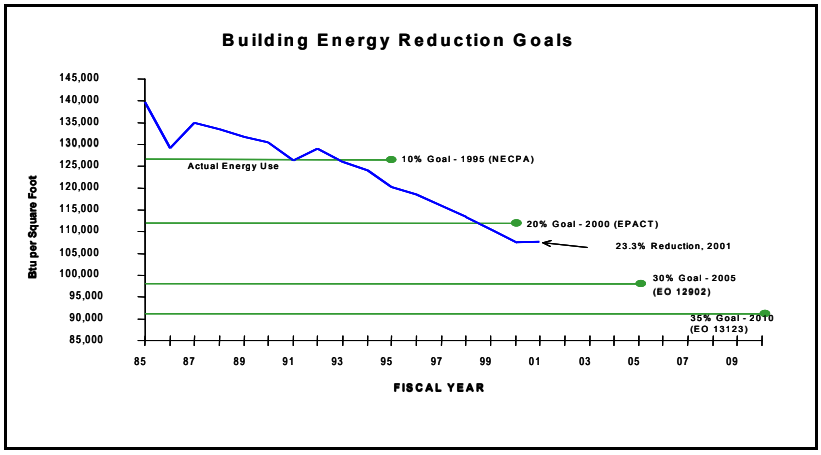
Strategic Context

Accomplishing this mission contributes to several national energy and environmental priorities. For example, on May 3, 2001, President Bush said that "The Federal government should set a good example of conservation by reducing its own energy use." The President's National Energy Policy calls for America to modernize conservation efforts, increase energy supplies, "accelerate the protection and

improvement of the environment, and increase our Nation's energy security." It directs heads of executive departments and agencies to "take appropriate actions to conserve energy use at their facilities to the maximum extent consistent with the effective discharge of public responsibilities."

Accomplishing this mission fulfills the statutory requirements of the National Energy Conservation Policy Act (NECPA); provisions under the Energy Policy Act of 1992 (EPACT); and Executive Order 13123 (Efficient Energy Management).

In 2001, the Federal government saved $1.38 billion (in 2001 constant dollars) over its 1985 energy bill for buildings due in part to energy improvements. This represents a 25.9 percent reduction in energy costs from the base year. Energy management is one of the most challenging tasks facing today's Federal facility manager. Sound energy management includes using energy efficiently, ensuring reliable supplies, and reducing costs wherever possible. As illustrated in the following graphic *Building Energy Reduction Goals*, the Federal government reduced its site energy intensity (Btu per gross square foot) at Federal facilities by 23.3 percent in 2001 compared to 1985 levels.



Compared to 2000, the Federal government experienced an increase in its energy bill for buildings of $488.6 million, a 14.2 percent increase. Energy consumption increased only 1 percent in 2001 compared to the previous year. In order to reach the 35 percent goal in 2010, as outlined in Executive Order 13123, Federal agencies must reduce their energy use by an additional 51 trillion BTUs.

Energy management is not explicitly part of the mission of most Federal agencies, thus challenging energy managers to make energy efficiency or renewable energy improvements at Federal facilities a top priority. In addition, within the Federal budgeting process, funding for capital purchases for new lighting, heating and cooling systems, or major construction and remodeling projects, can be difficult to obtain. Gaining access to private sector financing for Federal energy projects is often the only way for agencies to proceed. Towards this end, FEMP has developed the Super Energy Savings Performance Contracting (ESPC) program, enabling agencies to obtain financing through energy services companies, and assisting agencies in obtaining utility financing in its Federal Utility Partnership.

Congress has authorized the use of ESPC and Utility Energy Service Contracts (UESC) to enable Federal agencies to implement energy improvement projects without direct appropriations. These contract mechanisms are designed to access private sector financing. Accelerated progress toward improving the energy efficiency of Federal facilities can be made by expanding the use of these alternative financing mechanisms for energy efficiency and renewable energy projects. However, these ESPC provisions are statutorily scheduled to expire at the end of September, 2003, which will require a program closure unless Congress amends the sunset provision.

The Federal government is a major user of electricity, and its purchasing power can have a significant effect on electric utilities and markets. For example, several utilities and States now offer "green power" programs for boosting the use of renewable power generation. FEMP provides information and assistance to agencies to identify and participate in green power programs, State public benefit fund programs, and aggregated electricity purchase opportunities.

Federal agencies can lower their costs and environmental impacts by becoming more active participants in the increasingly competitive electricity and natural gas markets. Federal facilities can also contribute to improving local electric system reliability conditions through better peak demand management and pursuing opportunities for installing renewable and distributed energy technologies such as photovoltaics, microturbines, fuel cells, and combined heat and power (CHP) equipment. For example, to address the risk of power outages posed by local electricity supply constraints, the main Post Office (with FEMP assistance) in Anchorage, Alaska, installed a fuel cell to serve onsite power needs. When construction at the airport caused an outage to occur, one week before Christmas, the Post Office was able to continue normal business operations, while their neighbors sat in the dark. The Post Office processed more than 11.4 million letters and parcels on one of the busiest days on record.

Management Strategy

FEMP has developed a straight forward and effective approach for assisting Federal agencies in achieving national energy and environmental policy objectives.

It starts with having clear goals and plans. These are spelled out in legislation and executive orders and are backed by Administration energy policy guidance and Presidential support. The next step is implementation. Towards this end, FEMP chairs the Federal Energy Management Advisory Committee and facilitates the Federal Energy Policy Committee and the Interagency Energy Management Task Force. These committees, along with associated working groups, make decisions regarding needs, priorities, and guidance to Federal facility managers for energy efficiency projects. FEMP supports Federal agencies through education and outreach, technical support, and project financing. The next step is to measure progress. This is accomplished by compiling Federal energy statistics, measuring and verifying ESPC savings, and conducting case studies. The next step is to report and disseminate accomplishments. This is done through extensive outreach in newsletters, web sites, and the Annual Report to Congress on Federal government Energy Management. The final step is to reward excellence. FEMP honors numerous individuals, teams, and organizations for their outstanding achievements through the Federal Energy and Water Management Awards, Presidential Awards for Energy Management Success, and the Annual Federal Energy Saver Showcase Awards.

FEMP's approach has evolved as energy managers at Federal facilities have become more knowledgeable about energy efficiency technologies and practices. Early emphasis on raising awareness about energy consumption patterns has evolved into a more balanced approach that includes technical and financial assistance to provide energy efficiency solutions and reduce barriers. For example, FEMP held regional workshops on distributed energy resources and combined heat and power systems. These workshops assist Federal energy managers with decision making and equipment selection. Limited financial assistance for promising projects is based on specific criteria, such as return-on-investment, ability to replicate results at other Federal facilities, extent of cost-sharing, and the magnitude of the energy efficiency or renewable energy improvements.

FEMP receives appropriations from both the Interior and Related Agencies and the Energy and Water Development subcommittees. Interior activities cover the entire Federal government. Energy and Water Development activities focus on energy management in the Department of Energy.

Federal Energy Management Programs (Interior)
- Project financing
- Technical guidance and assistance
- Planning, reporting, and evaluation
-

Departmental Energy Management (Energy and Water)
- Energy management project support
- Energy management model program development

FEMP's management strategy parallels the three major components of the Interior budget request. First, to obtain financial, project, and operational expertise of private sector partners, FEMP helps Federal agencies obtain alternative project financing from utility and energy service companies. For example, ESPCs can be used by Federal agencies to make major investments in energy efficiency and renewable energy projects. All of the FEMP's ESPCs have been pre-competed allowing agencies to place delivery orders in a greatly condensed timeframe. Agencies that use FEMP's ESPC project facilitators reimburse FEMP for related expenses. These funds, in turn, are used to support further development of energy and cost-saving projects under the ESPC program.

Second, FEMP provides technical support to Federal agencies through the expertise of the department's regional offices and national laboratories, and collaborates with the Office of Energy Efficiency and Renewable Energy's R&D programs to facilitate the deployment of energy efficiency and renewable technologies. FEMP also leverages university programs in support of initiatives such as Green Energy Parks (this is a partnership between the Office of Energy Efficiency and Renewable Energy and the National Park Service that implements energy efficiency and renewable energy technologies while educating the visiting public about these technologies). FEMP uses a competitive process to allocate funds in a number of program areas. Agency requests for technical assistance, including distributed energy projects, are ranked against criteria, including ability to cost share potential for replication, impact on energy consumption, and implementation feasibility.

Lastly, through planning, market analysis, performance assessment, reporting and evaluation, FEMP coordinates extensively with other Federal agencies and non-governmental organizations to plan, implement, and measure the effectiveness of Federal energy management efforts. Additionally, FEMP reports agency performance against goals to Congress and the Office of Management and Budget, and conducts program and project management oversight of FEMP's extensive set of contractors. FEMP's program evaluation process includes a potential in-depth customer survey to ensure that the program evolves in a way that is consistent with market and agency needs.

Program Benefits

Each year, EERE estimates the benefits of program activities to support Government Performance and Results Act (GPRA) reporting. Methods are complex and vary by program. A complete explanation of methodology and assumptions will be posted this spring on line at www.eren.doe.gov/eere/budget.html.

An overview of the methods and results for the FEMP Program is provided below.

EERE's benefits estimate modeling starts with the Energy Information Administration's (EIA's) National Energy Modeling System (NEMS) and modifies it to create NEMS-GPRA04. The Baseline for the FEMP program is essentially the commercial building component of EIA's Annual Energy Outlook (AEO) 2002 reference case, which already includes some penetration of more efficient building technologies.

Because it encompasses a broad technological scope, while targeting a specific and relatively unique market segment not represented in NEMS-GPRA04, FEMP energy savings are initially estimated by PNNL based on the program goals and extensive information from required agency reporting. These estimates are represented in NEMS-GPRA04 as reductions in commercial energy use, since this is the sector in NEMS which most closely mirrors Federal energy patterns. NEMS-GPRA04 is then able to account for market feedbacks and interactions resultant from these Federal investments. The model also computes the other GPRA benefits metrics of primary energy savings, carbon emission reductions, and energy expenditure savings.

In order to reflect the fact that some improvements in efficiency would occur independently of FEMP activities, only one-half of these off-line estimates are included here. Because FEMP is a relatively small program, it is modeled in NEMS-GPRA04 in conjunction with the Weatherization and Intergovernmental Program and the resulting benefits estimates are allocated to FEMP based on the input assumptions.

FY 2004 GPRA Benefits Estimates for FEMP (NEMS-GPRA04)			
	2005	**2010**	**2020**
Non-Renewable Energy Savings (quads)	0.01	0.03	0.07
Oil Savings (quads)	0.00	0.00	0.01
Carbon Savings (MMT)	0.2	0.6	1.3
Energy Expenditure Savings (B2000$)	0.1	0.4	0.8

Estimates for energy savings, oil savings, carbon emission reductions, and energy expenditure savings resultant from realization of the FEMP Program goals are shown in the table above for the 2020 time frame.[1] FEMP activities over the course of the next 15 years are expected to reduce our annual Federal energy bill by about $800 million, given EIA expectations of future energy prices. Reported benefits do not include indirect market impacts associated with encouraging the development of energy efficient building practices in local markets served by Federal buildings. These estimates, undertaken at the program level, include both the DEMP and FEMP subpgrograms of the Federal Energy Management Program.

[1] Benefits reported are annual, not cumulative, for each year given for the entire FEMP (including Energy Conservation funded portions). Estimates reflect the benefits associated with program activities from FY 2004 to the benefit year or to program completion (whichever is nearer), and are based on program goals developed in alignment with assumptions in the President's Budget.

In addition to the benefits quantified here, improved Federal energy management increases the ability of the Federal government to manage its energy loads during emergencies and facilitates coordination of Federal energy use with local authorities in the event of local energy supply constraints or emergencies, a program benefit provided to California and other western States during their recent electricity shortages.

Program Strategic Performance Goals

FEMP has the following overall performance goals: (1) By 2005, FEMP activities will support Federal agency efforts to decrease energy intensity in standard Federal facilities by 30 percent and, by 2010, 35 percent, relative to the 1985 statutory baseline levels of 138,610 Btus per gross square foot ; (2) Departmental Energy Management Program Team activities will decrease the energy consumption intensity in DOE facilities by 40 percent by 2005, relative to the 1985 baseline levels of 473,126 Btus per square foot thus saving $100 million annually in avoided costs.

The Interior section addresses sub-program goal (1) in the stated performance goal. The respective performance indicators and technology baselines are stated below:

Performance Indicators:
(Broken down by PSPG sub-goal)

(1) FEMP -- By 2005, FEMP activities will support Federal agency efforts to decrease energy intensity in standard Federal facilities by 30 percent and, by 2010, 35 percent, relative to the 1985 statutory baseline levels of 138,610 Btus per gross square foot.

Performance Indicators

Site energy use per gross square foot in standard and energy intensive Federal buildings. Federal building use of energy produced by renewable resources. Greenhouse gas emissions attributable to Federal buildings.

Annual Performance Results and Targets

FY 2002 Results	FY 2003 Targets	FY 2004 Targets
Continued efforts to reduce energy intensity in Federal buildings by 24 percent by the end of FY 2002 as compared to 1985 energy use.[1] Reported the results achieved through the end of FY 2000. Supported the Federal goal of obtaining 2.5 percent of Federal facilities' electrical needs from renewable energy sources by 2005.		
Achieved between $80 and $120 million in private sector investment through Super ESPCs, which contributed to national energy security.	Achieve between $80 and $120 million in private sector investment through Super ESPCs, contributing to national energy security.	Will achieve between $70 and $110 million in private sector investment through Super ESPCs, contributing to national energy security. The typical delivery order project generates approximately 8,000 Btu annually ($2 over the life of the measure) in energy savings for each dollar invested.
	Provide technical and design assistance for 70 energy efficiency, renewable energy, and water conservation projects; 10 will be large-scale distributed energy resources and combined heat and power projects. Report the resulting impacts achieved through the end of FY 2001.	Will provide technical and design assistance for 75 energy efficiency, renewable energy, O&M, and DER/CHP, and water conservation projects and report resulting impacts (e.g. energy intensity reduction inputs) achieved through the end of FY 2002.

FY 2002 Results	FY 2003 Targets	FY 2004 Targets
Completed at least 60 energy assessments including ALERTS, SAVEnergy audits, industrial facility assessments, and operation and maintenance assessments that identified energy and cost saving opportunities.	Complete at least 80 energy assessments including ALERTS, SAVEnergy Audits, industrial facility assessments and operation and maintenance assessments to identify energy and cost saving opportunities.	Will conduct 25 SAVEnergy Audits and industrial facility assessments to identify energy and cost saving opportunities.
Published initial listing of products that use minimal standby power by 12/31/01 in accordance with E.O. 13221.	Integrate information on standby power into Defense Logistics Agency and General Services Administration's product schedules in accordance with E.O. 13221.	
Trained 4,000 Federal energy personnel in best practices that supported National Energy Policy education goals.	Train 4,000 Federal energy personnel in best practices supporting National Energy Policy education goals.	Will train 4,000 Federal energy attendees in energy management best practices supporting National Energy Policy education goals.

Funding Profile

(dollars in thousands)

	FY 2002 Comparable Appropriation	FY 2003 Amended Request	FY 2004 Request	$ Change	% Change
Federal Energy Management Program					
Project Financing	8,700	8,690	8,227	-463	-5.3%
Technical Guidance and Assistance	7,000	11,042	8,242	-2,800	-25.4%
Planning, Reporting and Evaluation	2,340	2,803	2,603	-200	-7.1%
Technical/Program Management Support	860	890	890	0	0.0%
Total, Federal Energy Management Programs	18,900	23,425	19,962	-3,463	-14.8%

Public Law Authorizations:

P.L. 94-163, "Energy Policy and Conservation Act" (EPCA) (1975)
P.L. 94-385, "Energy Conservation and Product Act" (ECPA) (1976)
P.L. 95-91 DOE Organization Act (1977)
P.L. 95-619, "National Energy Conservation Policy Act" (NECPA) (1978)
P.L. 100-615, "Federal Energy Management Improvement Act of 1988"
P.L. 102-486, "Energy Policy Act of 1992"

Funding by Site[1]

(dollars in thousands)

	FY 2002	FY 2003	FY 2004	$ Change	% Change
Albuquerque Operations Office					
National Renewable Energy Laboratory	4,218	5,227	4,454	-773	-14.8%
Sandia National Laboratories	292	362	308	-54	-14.9%
Total, Albuquerque Operations Office	4,510	5,589	4,762	-827	-14.8%
Oakland Operations Office					
Lawrence Berkeley National Laboratory	2,190	2,714	2,313	-401	-14.8%
Total, Oakland Operations Office	2,190	2,714	2,313	-401	-14.8%
Oak Ridge Operations Office					
Oak Ridge Operations Office	2,920	3,619	3,084	-535	-14.8%
Total, Oak Ridge Operations Office	2,920	3,619	3,084	-535	-14.8%
Richland Operations Office					
Pacific Northwest National Laboratory	2,012	2,493	2,124	-369	-14.8%
Total, Richland Operations Office	2,012	2,493	2,124	-369	-14.8%
Washington Headquarters	7,268	9,010	7,679	-1,331	-14.8%
Total, Federal Energy Management Programs	18,900	23,425	19,962	-3,463	-14.8%

[1] "On December 20, 2002, the National Nuclear Security Administration (NNSA) disestablished the Albuquerque, Oakland, and Nevada Operations Offices, renamed existing area offices as site offices, established a new Nevada Site Office, and established a single NNSA Service Center to be located in Albuquerque. Other aspects of the NNSA organizational changes will be phased in and consolidation of the Service Center in Albuquerque will be completed by September 30, 2004. For budget display purposes, DOE is displaying non-NNSA budgets by site in the traditional pre-NNSA organizational format."

Site Descriptions

Albuquerque Operations Office

The Albuquerque Operations Office (AO), located in Albuquerque, NM, provides financial processing for obligating funds through the Golden Field Office, EERE Regional Offices, National Renewable Energy Laboratory (NREL), and Sandia National Laboratories (SNL).

National Renewable Energy Laboratory

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

Sandia National Laboratories

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

Oak Ridge Operations Office

The Oak Ridge Operations Office (OR), located in Oak Ridge, TN, provides procurement services and oversight of funding for the Oak Ridge National Laboratory (ORNL).

Oak Ridge National Laboratory

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

Oakland Operations Office

The Oakland Operations Office (OAK), located in Oak Ridge, NT, provides procurement services and oversight of funding for the Lawrence Berkeley National Laboratory (LBNL).

Lawrence Berkeley National Laboratory

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

Richland Operations Office

The Richland Operations Office (RO), located in Richland, WA, provides procurement services and oversight of funding for the Pacific Northwest National Laboratory (PNNL).

Pacific Northwest National Laboratory

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

Funding Schedule

(dollars in thousands)

	FY 2002	FY 2003	FY 2004	$ Change	% Change
Federal Energy Management Program					
Project Financing	8,700	8,690	8,227	-463	-5.3%
Technical Guidance and Evaluation	7,000	11,042	8,242	-2,800	-25.4%
Planning, Reporting and Evaluation	2,340	2,803	2,603	-200	-7.1%
Technical/Program Management Support	860	890	890	0	0.0%
Total, Federal Energy Management Program	18,900	23,425	19,962	-3,463	-15.0%

Detailed Program Justification

	(dollars in thousands)		
	FY 2002	FY 2003	FY 2004
Project Financing	**8,700**	**8,690**	**8,227**
▪ **Energy Savings Performance Contracts (ESPCs)**	**6,920**	**6,910**	**6,447**

FY 2002: Continued efforts to deliver FEMP services to award Super ESPC delivery orders, which included identifying and screening projects, preparing delivery orders and site data packages, evaluating proposals, reviewing and documenting projects. Conducted workshops to help prepare agency technical, contracting, budget, legal, administrative, and management personnel to use the Super ESPC contracting vehicle. Implement Super ESPC delivery orders between $80-$120 million. FEMP estimated other Federal agency reimbursements at $1.1 million in from in FY 2002 for technical assistance and business development. Participants included: LBNL, NREL, PNNL, ORNL, NETL, McNeil Technologies, Aspen Systems.

FY 2003: Continue efforts to deliver FEMP services to award Super ESPC delivery orders, which includes identifying and screening projects, preparing delivery orders and site data packages, evaluating proposals, reviewing and documenting projects. Conduct workshops to help prepare agency technical, contracting, budget, legal, administrative, and management personnel to use the Super ESPC contracting vehicle. Implement Super ESPC delivery orders valued between $80-$120 million. FEMP estimates other Federal agency reimbursements at $800,000 in FY 2003. Participants included: LBNL, NREL, PNNL, ORNL, NETL, McNeil Technologies, Aspen Systems.

FY 2004: Deliver FEMP services to award Super ESPC delivery orders, which will include communications and outreach, identifying and screening projects, preparing delivery orders and site data packages, evaluating proposals, reviewing and documenting projects. Will conduct workshops to help prepare agency technical, contracting, budget, legal, administrative, and management personnel to use the Super ESPC contracting vehicle. Will assist agencies to implement Super ESPC delivery orders with estimated value between $70 and $110 million. If market analysis justifies, develop a CHP tech-specific Super ESPC; identify and implement CHP ESPC projects. FEMP estimates other Federal agency reimbursements at $ 700,000 in FY 2004. Participants included: LBNL, NREL, PNNL, ORNL, NETL, McNeil Technologies, Aspen Systems.

(dollars in thousands)

FY 2002	FY 2003	FY 2004

- **Utilities Program 1,780 1,780 1,780**

FY 2002: Maintained the Federal Utility Partnership Working Group (FUPWG) to assist Federal customers in developing energy-saving projects. Provided training for Federal agencies to maximize energy and cost savings and project effectiveness. Provide direct technical assistance to Federal agencies not familiar with the identification, design, and implementation of projects under utility programs. Provided information and assistance to Federal agencies on changes taking place in the energy industry to enable Federal decision-makers to make well informed decisions regarding energy project implementation and commodity purchases; provided assistance in gaining an understanding of the impacts of utility restructuring on: energy costs, security issues at Federal sites, and the impact Federal sites have on reliability. Participants included: LBNL, NREL, PNNL, ORNL.

FY 2003: Lead the Federal Utility Partnership Working Group (FUPWG) in two meetings and track Federal Utility Energy Services Contracting (UESC) projects and provide support through: workshops for Federal agencies, guidance documents and direct projects support for project. Enable Federal decision-makers to make well informed decisions regarding energy project implementation and commodity purchases; provide assistance in gaining an understanding of the impacts of utility restructuring on: energy costs, security issues at Federal sites, and the impact Federal sites have on reliability. Participants include: LBNL, NETL, NREL, PNNL, ORNL.

FY 2004: Lead the Federal Utility Partnership Working Group (FUPWG) and establish strategic partnerships with targeted utilities which have both a large concentration of Federal customers and a commitment to assist those customers. Use these partnerships to leverage private sector resources and expertise to assist in the early adoption of EERE technologies at Federal sites. Track Federal Utility Energy Services Contracting (UESC) projects and provide support through: workshops for Federal agencies, development and distribution of guidance documents, and direct assistance for projects. Enable Federal decision-makers to make well informed decisions regarding energy project implementation and commodity purchases; provide information, communications, outreach, training, and technical assistance on the impacts of utility restructuring, including energy cost, security, and reliability. Participants will include: LBNL, NETL, NREL, PNNL, ORNL.

Technical Guidance and Evaluation 7,000 11,042 8,242

- **Direct Technical Assistance 4,984 8,699 6,242**

FY 2002: Provided support for at least 60 agency projects in the design, review, and implementation of energy efficiency, water conservation , and renewable projects which included facility construction and renovation that identified energy and cost saving opportunities.

Distributed call for projects to agencies and selected up to 4 projects meeting criteria which included agency support for project, cost effectiveness and value, agency funding available, cost

(dollars in thousands)

sharing/project partners, implementation time-frame, strategic value, and large potential impact.

Provided customers with at least 60 energy assessments including Assessment of Load and Energy Reduction Techniques (ALERTS), SAVEnergy Audits, industrial facility assessments, and operation and maintenance assessments that identified energy and cost saving opportunities. Assessment teams identified feasible means to implement these measures at the site, and provided follow-up assistance to facilities that received assistance in prior years. Participants included: LBNL, NREL, PNNL, ORNL, SNL, McNeil Technologies, Aspen Systems.

FY 2003: Provide support for at least 60 agency projects in the design, review, and implementation of energy efficiency, water conservation , and renewable projects which include facility construction and renovation that identify energy and cost saving opportunities.

Provided technical assistance and direct funding to facilities to implement 10 large-scale DER/CHP projects. FEMP is developing information to help other agencies use combined heat and power and other distributed energy technologies.

Provide customers with at least 80 energy assessments including Assessment of Load and Energy Reduction Techniques (ALERTS), SAVEnergy Audits, industrial facility assessments, and operation and maintenance assessments that identified energy and cost saving opportunities. Assessment teams are identifying feasible means to implement these measures at the site, and provided follow-up assistance to facilities that received assistance in the prior year. Participants included: LBNL, NREL, PNNL, ORNL, SNL, McNeil Technologies.

FY 2004: Will provide support for at least 75 agency projects to identify energy and cost saving opportunities in the design, review, and implementation of energy efficiency, water conservation, sustainable, operations and maintenance, DER/CHP, and renewable projects, including facility construction and renovation. (However, no specific funds will be reserved for 10 DER/CHP projects and 55 Assessment of Load and Energy Reduction Techniques (ALERTS), peak load assessments, and operation and maintenance assessments).

FEMP will provide agencies 25 energy assessments including SAVEnergy Audits and industrial facility assessments that identify energy and cost saving opportunities.

FEMP will continue to develop technical information and assistance to help agencies deploy these technologies on a broader basis and conduct communications and outreach activities. These projects demonstrate leading-edge technologies with energy and cost savings. FEMP will assist agencies in identifying low-cost/no-cost improvements in the ways they maintain and operate their energy systems. FEMP will continue to provide training, technology assessments, and evaluations.. Participants included: LBNL, NREL, PNNL, ORNL, SNL, McNeil Technologies.

▪ **Training and Information**	**2,016**	**2,343**	**2,000**

(dollars in thousands)

FY 2002	FY 2003	FY 2004

FY 2002: Provided technical information, and tools and trained 4,000 personnel to support a greater number of projects than FEMP can assist directly. Developed and published 12 technical information products. Through the Procurement Challenge, helped agencies acquire the most energy efficient and water conserving products. Continued to coordinate with the Energy Star program. Assisted agencies in amending their guide specifications to incorporate requirements for energy efficient products. Maintained essential software such as the Building Life Cycle Cost tool that implements requirements for Life Cycle Costing project analysis. Participants will include: LBNL, NREL, PNNL, ORNL, SNL, McNeil Technologies.

FY 2003: Provided technical information, and tools and trained 4,000 personnel to support a greater number of projects than FEMP can assist directly. Developed and published 12 technical information products. Through the Procurement Challenge, help agencies acquire the most energy efficient and water conserving products, including the list of lower standby power products. Continue to develop and update product energy efficiency recommendations, and coordinate with the EPA/DOE Energy Star program. Assisted agencies in amending their guide specifications to incorporate requirements for energy efficient products. Maintained essential software such as the Building Life Cycle Cost tool that implements requirements for Life Cycle Costing project analysis. Participants include: LBNL, NETL, NREL, PNNL, ORNL, SNL, McNeil Technologies.

FY 2004: FEMP will and provide technical information, and tools and train 4,000 attendees to enable agency action on a greater number of projects than FEMP can assist directly to meet statutory Federal energy and water savings goals. FEMP may potentially develop and publish technical information products. FEMP will help agencies acquire the most energy efficient and water conserving products through procurement training, communications and outreach, and assisting agencies in amending their guide specifications to incorporate requirements for energy efficient products. Publish revised or new product energy efficiency recommendations, and coordinate energy efficiency criteria with the EPA/DOE Energy Star program, Consortium for Energy Efficiency (CEE) and others. FEMP will maintain essential software such as the Building Life Cycle Cost tool that implements requirements for Life Cycle Costing project analysis. Participants will include: LBNL, NETL, NREL, PNNL, ORNL, SNL, McNeil Technologies.

Planning, Reporting and Evaluation	**2,340**	**2,803**	**2,603**

FY 2002: Developed a strategic plan for targeting FEMP services at key remaining opportunities in the Federal sector. Updated Secretarial performance plan and status reports. Facilitated two meetings with senior officials and the 656 Committee and the Presidential Management Council, and provided support for the Federal Energy Management Advisory Committee. Collected and published data for the Annual Report to Congress, responded to inquiries and provided support to ensure accuracy in reporting and analysis of trends. Produced and disseminated technical and non-technical energy management material, distributed through FEMP-sponsored events (e.g., technical assistance and training workshops), EERE's information clearinghouse, and non-Federal conferences, workshops and seminars and individual requests from Federal agencies, State and local governments and the private sector. Participants included: LBNL, NREL, PNNL, ORNL, SNL, McNeil

Technologies. Awarded $500,000 in grants to States under the Special Project State Grants program which provided local support to Federal installations and sites. Participants included: California, Idaho, Maryland, New Hampshire and New Mexico.

FY 2003: Implement a strategic plan for targeting FEMP services at key remaining opportunities in the Federal sector. Update Secretarial performance plan and status reports. Promote the "whole building" design approach in the Federal community to increase energy security. Facilitate one or two meetings with senior officials and the 656 Committee and provide support for the Federal Energy Management Advisory Committee. Collect and publish data for the Annual Report to Congress, respond to inquiries and provide support to ensure accuracy in reporting and analysis of trends. Conduct awareness campaigns and Federal awards program. Enhance FY 2002 strategic communication activities that target Federal and non-Federal organizations by replicating projects and partnerships conducted on a broader scale. As a result, FEMP will coordinate the exchange of energy management information on a wide scale with the intent that such interactions become practice in the Federal government. Award $500,000 in grants to States under the Special Project State Grants program to provide local support to Federal installations and sites. Participants include: LBNL, NETL, NREL, PNNL, ORNL, SNL, McNeil.

FY 2004: Targeting FEMP services at key emerging opportunities in the Federal sector. Update Secretarial performance plan and status reports. Promote building energy security through the whole building design approach in the Federal community. (However, no new Energy Star pilot projects will be pursued at Federal agencies). Facilitate one or two meetings with senior Federal energy officials and provide support for the Federal Energy Management Advisory Committee. Collect and publish data for the Annual Report to Congress, respond to inquiries and provide support to ensure accuracy in reporting and analysis of trends. Conduct awareness campaigns and Federal awards program. Enhance FY 2003 strategic communication activities that target Federal and non-Federal organizations by replicating on a broader scale successfully completed projects and partnerships. FEMP will facilitate the wide dissemination of validated energy management information, with the goal of establishing known channels for this information. Will award $500,000 in grants to States under the Special Project State Grants program to provide local support to Federal installations and sites for energy efficiency, renewable energy, and other program mission related projects. Participants will include: LBNL, NETL, NREL, PNNL, ORNL, SNL, McNeil Technologies.

- **Technical/Program Management Support 860 890 890**

FY 2002: Provided critical technical and program management support services such as the Federal registry of solar projects, agency energy management profiles, and reports/analyses on Federal energy use. (Including McNeil Technologies, TMS and Energetics)

FY 2003: Provide critical technical and program management support services. (Including McNeil Technologies, TMS and Energetics)

FY 2004: Provide critical technical and program management support services. (Including McNeil

	(dollars in thousands)		
	FY 2002	FY 2003	FY 2004
Technologies and TMS)			
Total, Federal Energy Management Programs	**18,900**	**23,425**	**19,962**

Explanation of Funding Changes

	FY 2003 vs. FY 2004 ($000)
Project Financing	
▪ Decrease in Energy Savings Performance Contract continuous improvement such as a Combined Heat and Power alternative financing mechanism	-463
Technical Guidance and Assistance	
Direct Technical Assistance	
▪ Decrease in agency Distributed Energy Resources/Combined Heat and Power projects receiving direct technical assistance and significant decrease in comprehensive energy assessments (Assessment of Load and Energy Reduction Techniques (ALERTS), SAVEnergy Audits, etc.) Reduction of ALERTS due to revising towards more O&M, and commissioning.	-2,457
Training and Information	
▪ FEMP may cut technical information publishing. FEMP will provide the same courses but may slightly decrease the number of offerings	-343
Planning, Reporting and Evaluation	
▪ Elimination of Energy Star pilot projects at Federal agencies and decrease in technology transfer outreach efforts. Energy Star pilots for hospitals were completed in 2003	-200
Total Funding Change, FEMP	**-3,463**

National Climate Change Technology Initiative

Program Mission

The Competitive Solicitation Program is a component of the President's National Climate Change Technology Initiative (NCCTI). The program is intended to promote innovative applied research, via a series of open competitive solicitations, aimed at exploring concepts, technologies and advanced technical approaches that could, if successful, contribute in significant ways to:

- future reductions in, or avoidances of, greenhouse gas (GHG) emissions;
- GHG capture and sequestration;
- conversion of GHG to beneficial use; and/or
- enhanced monitoring and measuring of GHG emissions, inventories and fluxes in a variety of settings.

The Program would augment in unique and valued-added ways the base of ongoing Federal Research and Development which, by design, balances multiple objectives. Projects supported by this Program will be those that optimize climate change benefit per dollar spent.

Strategic Context

Existing R&D programs at the Department of Energy are already factored into current projections of U.S. GHG emissions. The NCCTI competitive solicitations are intended to build upon that foundation.

President Bush set the context for Federal leadership in climate-change activities in two major policy addresses, on June 11, 2001, and February 14, 2002. The President set America on a path to slow the growth of our greenhouse gas emissions and, as science justifies, to stop and then reverse the growth of emissions. He reaffirmed America's commitment to the United Nations Framework Convention on Climate Change (UNFCCC) and its central goal "to stabilize atmospheric greenhouse gas concentrations at a level that will prevent dangerous human interference with the climate." Although the UNFCCC goal does not indicate a specific level that might be seen as dangerous interference – an issue that remains open to scientific inquiry – nor does it specify a deadline by which the goal must be met, it does establish a long-term strategic planning context, with important implications for related R&D program planning and technology.

The President took note of the U.S. tradition of world leadership in science, technology and innovation, and tasked the Federal R&D agencies to provide leadership in developing the advanced technology that would likely be required in order to meet his near- and long-term climate change goals. U.S. climate-change policy is based upon voluntary action and incentives, rather than intrusive government regulation. A key enabler for voluntary action is the availability and cost-effectiveness of technologies and products that can substitute for current ones, but with significantly reduced GHG emission characteristics.

The Competitive Solicitation Program is different from other Department of Energy R&D Programs in two important ways. While many the Department's R&D programs contribute to climate change goals,

the missions of most of these R&D programs are aligned primarily with other national goals, such as energy security, energy efficiency, U.S. competitiveness, and pollution reduction. As a result the existing Departmental R&D portfolio, from the sole perspective of climate change, is less focused on climate change and more targeted toward multiple objectives.

In addition, although many Departmental programs are routinely subjected to competition and peer review, this competition is often constrained within a single topical area or purpose, dictated by a particular program's mission. As a result, from the perspective of climate change, the field of competition among ideas may be narrower than would otherwise be desired and the proposals themselves may be less innovative than would be expected from an unconstrained competitive process. This program's projects will be judged solely on their ability to contribute to climate change goals.

Management Strategy

The Competitive Solicitation Program will be managed as a NCCTI component under the purview of an interagency coordinating body, known as the Climate Change Technology Program (CCTP). The CCTP, headed by a designated Assistant Secretary of Energy, will supervise the process and report to the Chair of an Interagency Working Group (IWG) on Climate Science and Technology. The Chair of the IWG, in turn, reports to a Cabinet-level Committee on Climate Science and Technology Integration (CCCSTI). All awards will be subject to competition, and the solicitations will be open to any innovative technology that can demonstrate potential for significant climate change benefit. Projects will be required to identify a clear path to commercialization, clear decision-points and "off-ramp" criteria, and will be selected in accord with criteria agreed upon by the interagency process described above.

NCCTI Funding by DOE Office

(dollars in thousands)

Department of Energy Office	FY 2003	FY 2004
Energy Efficiency and Renewable Energy (EERE)		
EERE (END)	0	15,000
EERE (Interior)	15,000	9,500
Subtotal, EERE	15,000	24,500
Fossil Energy (Interior)	0	13,200
Nuclear Energy (END)	0	2,300
Total, NCCTI, Department of Energy	15,000	40,000

Long Term Goals and Benefits

- Accelerate the development of advanced technologies having greatest potential for significant climate change benefit.

- Increase research productivity through more open and broadened competition.

- Increase climate change technology portfolio rate of return (long-term climate change benefit per dollar of research invested), by competitively selecting better and bolder (riskier) projects with higher expected potential for large long-term payoff.

Program Strategic Performance Goal

Reduce carbon emissions by 20 MMTCE below projected emissions in 2020 (based upon EIA's baseline reference case).

Performance Indicators

GHG Performance: U.S. carbon-equivalent emissions reduced, avoided, sequestered, or otherwise converted to beneficial use.

Program Effectiveness: Percentage improvement in the above GHG performance measure on a per-dollar basis compared to the portfolio averages of existing applied R&D programs.

Annual Performance Results and Targets

FY 2002 Target	FY 2003 Proposed Target	FY 2004 Proposed Target
Proposed reprogramming of $10 million to begin the NCCTI solicitation process. (Rejected by Congress.)	Develop standardized assessment criteria and methods to evaluate GHG reductions generated by NCCTI projects, so that they may be compared to other DOE projects in EE, FE, and NE. Complete development of methodology to consistently assess the potential impacts of NCCTI technologies. Solicit projects and award 100 percent of funds available. Announce a second round solicitation for NCCTI, contingent on future funding.	Solicit further projects and award any carry-over balances plus at least 75 percent of FY 2004 appropriations. Develop assessment criteria and methods to evaluate the GHG reductions generated by NCCTI projects compared to each other and to other DOE projects in EE, FE, and NE.

Profile[a]

(dollars in thousands)

	FY 2002 Comparable Appropriation	FY 2003 Amended Request	FY 2004 Request	$ Change	% Change
National Climate Change Technology Initiative Competitive Solicitation					
Total, National Climate Change Technology Initiative	0	20,000	9,500	-10,500	-52.5%

Public Law Authorizations:

P.L.95-91, "Department of Energy Organization Act" (1977)

Funding by Site[b]

(dollars in thousands)

	FY 2002	FY 2003	FY 2004	$ Change	% Change
Washington Headquarters	$0	20,000	9,500	-10,500	-52.5%
Total, NCCTI	$0	20,000	9,500	-10,500	-52.5%

[a] SIR/STAR is estimated to be $530,000 in FY 2003 and $266,000 in FY 2004.

[b] "On December 20, 2002, the National Nuclear Security Administration (NASA) disestablished the Albuquerque, Oakland, and Nevada Operations Offices, renamed existing area offices as site offices, established a new Nevada Site Office, and established a single NASA Service Center to be located in Albuquerque. Other aspects of the NASA organizational changes will be phased in and consolidation of the Service Center in Albuquerque will be completed by September 30, 2004. For budget display purposes, DOE is displaying non-NASA budgets by site in the traditional pre-NASA organizational format."

Detailed Program Justification

(dollars in thousands)

	FY 2002	FY 2003	FY 2004
Technology Initiative	**0**	**19,800**	**9,000**

FY 2002: No activities.

FY 2003: Initiate a broad competitive solicitation using $20 million in combined EE/FE funding in the amended budget.

The focus of the solicitation will be on innovative technologies that have not been supported up to now by the existing DOE applied R&D programs.

The overall strategy of the program will be established by an interagency committee under the leadership of the Secretaries of Energy and Commerce, as the President stated on Feb 14, 2002.

FY 2004: Issue a new competitive solicitation for technologies that offer large savings of GHG emissions and that have good prospects for adoption by consumers or industry. The focus of the solicitation will be on innovative technologies that augment in unique and value-added ways the base of ongoing Federal R&D. Solicit further projects and award any carry-over balances plus at least 75 percent of FY 2004 appropriations. Develop assessment criteria and methods to evaluate the GHG reductions generated by NCCTI projects compared to each other and to other DOE projects in EE, FE, and NE.

Funding in Energy Conservation is decreased because in FY 2004 funds are requested in other accounts, including $15,000 in the Energy Efficiency and Renewable Energy portion of Energy Supply.

Technical Program Management Support	**0**	**200**	**500**

FY 2002: No activities.

FY 2003: Develop a multi-disciplinary, multi-program proposal review process. Define goals for an analytical process to compare projected greenhouse-gas (GHG) reduction performance of NCCTI projects with other projects in DOE research programs.

FY 2004: Develop the analytical process and models defined in FY 2003 to allow GHG performance comparisons between NCCTI proposals and between the NCCTI portfolio and the portfolios of other DOE research programs. Provide needed support to the solicitation and project selection processes.

Total, National Climate Change Technology Initiative	**0**	**20,000**	**9,500**

Explanation of Funding Changes

	FY 2004 vs. FY 2003 ($000)
NCCTI Solicitations	
▪ New appropriation to fund a second round of projects, if FY 2003 budget amendment is accepted, or to initiate the solicitations if no funds are appropriated in FY 2003. Funding in the Energy Conservation account is decreased because for FY 2004 funds are requested in other supporting accounts, including $15,000 in the Energy Efficiency and Renewable Energy portion of Energy Supply.	-10,500
Total Funding Change, NCCTI	**-10,500**

Program Management

Energy Conservation

Program Mission

The Energy Conservation Program Management budget component provides executive and technical direction, information, analysis, and oversight required for efficient and productive implementation of those programs funded by Energy Conservation appropriations in the Office of Energy Efficiency and Renewable Energy (EERE) of the United States Department of Energy (DOE). In addition, Program Management supports all Headquarters staff, six Regional Offices, the Golden Field Office in Colorado and several DOE employees at three Operations Offices to plan and implement EERE activities as well as facilitate delivery of applied R&D and grant programs to Federal, regional, State, and local customers.

Program Goal and Benefits

Program Management provides staffing, resources, and administrative support for the planning and implementation of energy conservation activities at Headquarters, the Golden Field Office, Energy Efficiency and Renewable Energy's Regional Offices, as well as direct funding for Information & Communications and Planning, Evaluation & Analysis functions.

Program Management is divided into Federal and contractual activities. Federal includes activities that directly support EERE staff and their expenses. DOE commonly refers to this budget as Program Direction. Contractual includes two related activities, the Information and Communications Program and Planning, Evaluation and Analysis, conducted by technical contractors.

Program Direction

Headquarters

Requested FY 2004 funding supports 270 Full-Time Equivalents (FTE) and contracted resources necessary for efficient and effective technical management, as well as corporate oversight and leadership. EERE faces four major institutional management challenges: (1) EERE programs are numerous and diverse, making management and integration at the corporate level very complex; (2) EERE complies with multiple external requirements, such as the Government Performance Results Act (GPRA), that require a broad spectrum of information to be delivered at different times of the year; (3) EERE's customer base is very diverse and therefore information preparation and delivery is complicated; and (4) the EERE research, development and deployment (RD&D) programs depend heavily on contractors managing subcontractors. Prior to 1999, EERE received criticism from both external and internal sources concerning its business practices and overall management. In addressing these criticisms, the Assistant Secretary obtained independent evaluations on the effectiveness of management within EERE, including a review by the National Academy of Public Administration (NAPA). One criticism common to all of the independent reviews was that EERE did not have a

systematic, disciplined approach to the fundamental business of planning, budget development, program execution, and program evaluation.

Subsequently, in FY 2001, EERE's Strategic Program Review (SPR) identified a need to strengthen the focus on programs and program management. In addition, EERE is vigilantly pursuing opportunities to incorporate the President's Management Agenda into its internal policies and procedures.

In response to outside recommendations and its own continuing self-assessments, EERE has initiated numerous reforms to address these identified shortcomings, including:

- Developing and implementing a new streamlined and integrated program and business model in FY 2002 designed for better performance. EERE consolidated its technical programs into eleven technology development programs and it centralized its business administration functions into a single EERE organization focused on supporting the eleven TD programs. The new business model will remove sources of myopic "stovepipes" and fragmentation; eliminate artificial organizational layers; enhance competitive sourcing, fiscal accountability and information technology services through the centralized BA organization; focus on "programs"; empower the program manager and increase their accountability; concentrate program manager attention on "results" rather than "processes"; assign EERE executives, especially former Deputy Assistant Secretaries, to roles better aligned with their expert skills; integrate performance planning and budgeting; provide the Assistant Secretary for Energy Efficiency and Renewable Energy more direct accessibility for improved program and business operation oversight.

- Updating in FY 2002 the EERE-wide Strategic Plan, which set forth goals, objectives and strategies for the entire organization.

- Implementing a formal Program Management Initiative in FY 2002, training that provides knowledge-based systems for all program managers. As a result, EERE intends to have a fully certified and trained program management corps.

- Implementing a Strategic Management System (SMS) in January 2000 that provides an integrated corporate approach toward planning, budget development and program evaluation across EERE.

Budgeted staff, facilities as well as contracted services and supplies support five functional areas that are essential for productive operation of the EERE enterprise:

(1) Technical Program and Project Management. Supplies the critical expertise needed to organize, plan, direct and monitor RD&D activities associated with energy efficiency programs at Headquarters and in the field. In addition to these technical responsibilities, program managers must also review and approve program plans, strategies and priorities; actively participate in corporate planning, budget development, and contract execution; and evaluate programs for achievement of optimal performance results by the overall EERE organization.

(2) Program Execution Support. Provides a full spectrum of program execution business activities for EERE managers from a single integrated organization. These services include all

actions associated with program execution; funding allocation, acquisition, reporting and analysis steps that make appropriation intentions reality. They also encompass human resources, business information systems, travel, training, space, security activities (except cyber security) and other management operation requirements.

(3) Planning, Budget Formulation and Analysis. Provides relevant and timely planning and analysis to support executive decision-making in the areas of resource allocation, budget formulation, performance measurement, and technology assessment. It also provides analyses of performance, planning, and budget issues. The function manages development and evaluation of EERE's annual Government Performance and Results Act (GPRA) metrics and updates of the EERE Strategic Plan; coordinates the inclusion of program performance measures in the EERE budget; represents EERE in the development of the annual DOE Performance Plan, Secretary's Performance Agreement with the President, and Accountability Report, DOE's Strategic Plan, the National Energy Policy, and other DOE or administration documents. These functional skills were employed to coordinate the EERE Strategic Program Review recommended by the National Energy Policy Development Group in its May 2001 report.

(4) Information and Business Management Systems. Develops and manages corporate level information and business management systems to insure consistent, efficient and effective business policies and practices for EERE's Headquarters and field organizations. These information systems serve all of the business activities associated with planning and budget formulation, budget execution, analyses and evaluation. This function also addresses other headquarters and field business systems; information technology and associated cyber security; environmental, safety and health; the coordination of audit activities and national laboratory evaluations as well as identifying field facility needs.

(5) Communications and Outreach. Communicates the EERE mission, program plans, accomplishments, and technology capabilities to a variety of stakeholder audiences including Congress, the public, educational institutions, industry, and other government and non-government organizations. In addition, writes testimony and prepares briefing books; coordinates answers to congressional questions (between 600 and 1,000 per year); prepares speeches and presentations by the Assistant Secretary and others when requested; manages the Energy Efficiency and Renewable Energy Network website, (EREN), and the Energy Efficiency and Renewable Energy Clearinghouse, (EREC); manages official correspondence; and coordinates reviews of EERE-related statements by other DOE offices and Federal agencies.

Golden Field Office

The Golden Field Office (GO), with 50 FTE's budgeted for FY 2004, supports EERE energy conservation efforts through field project management of R&D partnerships, laboratory contract administration, and a variety of professional, technical, and administrative functions. Federal staff expenditures are funded by both of EERE's Energy Supply and Energy Conservation appropriations. GO provides management support for approximately 450 agreements and some 300 active projects in nearly every State and in several other nations to support the Weatherization & Intergovernmental Program; Federal Energy Management Program; Distributed Energy Resources; Building Technologies Program; Industry Technologies Program; and the FreedomCAR & Vehicle Technologies Program. Key activities include:

- Administering the management and operating contract for the National Renewable Energy Laboratory (NREL).
- Managing the Federal Energy Management Program (FEMP) Super Energy Savings Performance Contracts and serving as the focal point for FEMP finance and procurement activities.
- Providing procurement, legal, business management, information resource management, and technical support to the six EERE Regional Offices.
- Supporting the Inventions and Innovations Program and the National Industrial Competitiveness through Energy, the Environment and Economics Program (NICE3).
- Partnering with industry and academia in joint R&D projects to further develop and facilitate delivery of applied R&D.

For FY 2004, 13 FTE's previously supporting EERE at 3 operations offices will be consolidated at GO. This consolidation of expertise dedicated to EERE field management is expected to increase productivity because of focus on a single DOE program and adaption of unified business practices.

Operations Offices

In FY 2003, EERE intends to complete the transfer of 13 FTE's at the Department's Idaho Falls, Chicago and Oak Ridge Operations Offices to GO. The FTE's provide project management, acquisition and financial support for energy efficiency activities primarily in the areas of Industrial Technologies, Distributed Energy Resources and Vehicle Technologies.

Regional Offices

EERE's 6 Regional Offices (ROs), located in Atlanta, Boston, Chicago, Denver, Philadelphia, and Seattle, catalyze the implementation of energy-efficient and renewable energy strategies at the State and local level by working with States and communities to promote EERE programs; identifying and engaging community and State partners; and integrating EERE programs with public and private sector activities. The ROs, with 119 FTE's budgeted for FY 2004, represent over a quarter of EERE's Federal workforce, and administer nearly $0.4 billion in program funding to States, localities, and regional organizations.

The RO's play a key role in implementing EERE's mission in administering grants, managing projects, and delivering programs that accelerate market penetration of energy efficiency and renewable energy technologies, plays a key role in implementing EERE's mission. Key activities include:

- Administering EERE's principal technology deployment grant programs, including the Weatherization Assistance Program and the State Energy Program;
- Delivering EERE's principal technical assistance programs, including Clean Cities, Rebuild America, and the Federal Energy Management Program;
- Serving as EERE's liaison to State Energy Offices, other State agencies, regional organizations of the National Governors' Association, and other stakeholders involved in energy and environmental quality issues;
- Providing EERE's national program managers at Headquarters with customer feedback on how to make their programs more effective and efficient;
- Supporting and helping deliver special initiatives of the President, Secretary, and Assistant Secretary;
- Creating local, State, and regional partnerships—and leveraging local, State, and regional resources—to maximize the impact of EERE's technologies and programs; and
- Helping EERE's end-use sectors deliver their programs to State and local stakeholders.

The following is a crosscut of FY 2004 Regional Office budget estimates by EERE's major Energy Conservation programs: Federal Energy Management Program; Weatherization & Intergovernmental Program; Industrial Technologies Program; Distributed Energy Resources; as well as support activities:

FY 2004 Regional Office Budget Estimates

(dollars in thousands)

Regional Offices	FEMP	Weatherization & Intergov'l Program	Industrial Tech.	Distributed Energy Resources	Crosscutting	Mgmt & Admin.	Totals
Atlanta	338	1,017	282	339	394	453	2,823
Boston	183	900	140	284	228	593	2,328
Chicago	236	965	108	644	53	140	2,146
Denver	345	1,279	179	282	534	719	3,338
Philadelphia	304	1,006	227	251	0	730	2,518
Seattle	296	1,018	123	267	339	478	2,521
Totals	1,702	6,185	1,059	2,067	1,548	3,113	15,674

Federal Energy Management Program (FEMP)

The ROs serve as liaisons and regional assistance centers for other Federal agencies seeking FEMP technical assistance in meeting the goals of E.O. 13123. This includes providing facility reviews and audits, and promoting sustainable design, practices, procedures, and standards in Federal offices, labs, industrial facilities, and in agencies' local transportation policies. ROs are instrumental in working with regional Federal agencies to sign FEMP delivery orders that commit those agencies to decrease energy consumption through the use of EE/RE technologies. In 2001 alone, ROs played a major role in securing $120 Million in private investments through FEMP's Super ESPC program. Emphasis has increased on Federal industrial facilities, and the ROs team with the Offices of Industrial Technology and Distributed Energy and Electricity Reliability (which covers cogeneration and combined-heat-and-power technologies as well as power-quality and peak-management technologies) to provide an integrated technology transfer mechanism to Federal industrial facilities. ROs also have the lead role in working with regional Federal agencies on the facilitation of Federal renewable power purchases, such as wind and biomass.

Weatherization and Intergovernmental Programs (WIP)

State Grants (WAP and SEP). The Regional Offices are the principal outreach arm of the WIP, and have a long historical role in the implementation of the State grant programs. The ROs help award and administer Weatherization Assistance Program (WAP) grants to 50 States, Washington DC, and Native American tribes. Those grants provided funding to weatherize 105,000 homes in FY 2002, with funds requested for 123,000 home in FY 2003 and about 128,000 homes in FY 2004. The ROs also award and administer the State Energy Program (SEP) grants, which go to all 50 States, Washington, DC, and 5 Territories. Similarly, they help award SEP Special Project grants to States, DC, and Territories on a cost-shared, competitive basis. ROs also work with States to leverage State dollars for these programs. In 2000, the WAP leveraged over $117 Million in State funds, while in 2001 the SEP leveraged over $395 Million in State funds.

Gateway Deployment. The ROs coordinate State, contractor, public, private and DOE employee teams to implement the Rebuild America program for the Building Technologies program, and serve as regional program and project managers for the Energy Star and Building America activities. ROs manage over 400 partnerships throughout the country for the Rebuild America program. They have also promoted awareness of, and interest in, the NICE3 and Inventions and Innovations activities among regional businesses and entrepreneurs.

The ROs are a central component of the Clean Cities activity, promoting the use of alternative fuels and alternative-fuel vehicles by coalitions of Federal, State, and local agencies and regional businesses. RO staff participate in each of the Clean City coalitions, helping the Clean Cities Regional Coordinators to build self-sustaining coalitions. They provide the coalitions with technical assistance in preparing program plans and Memoranda of Understanding, provide assistance in creating outreach materials, participate in the program's strategic planning, and serve as resources for each region's coalitions for detailed information on regulations, legislation, and incentives.

Industrial Technologies. The ROs participate in the Office of Industrial Technology's (OIT's) State Industries of the Future coalitions and deployment activities, and are active promoters of OIT's Industrial Assessment Center and Best Practices activities. They work with industry leaders, State and local environmental and economic development officials, and with private industry to build awareness of OIT's portfolio of enabling technologies and technical assistance programs.

Distributed Energy Resources. The ROs provide general and region-specific support of distributed energy resource (DER) technology deployment programs by facilitating partnerships, projects, and technical assistance, and through outreach to regional stakeholders and interaction with headquarters program managers.

Crosscutting and Assistant Secretarial Support. The ROs work in partnership with State energy offices and other State organizations to identify energy issues and develop solutions through technical and financial assistance, voluntary partnerships, and other mechanisms. This includes working with State air-quality officials to help integrate EE technologies into their air-quality State Implementation Plans.

ROs collect, analyze, and convey State input and market information to EE planning efforts, and represent EE at the State and regional levels in speeches, meetings, and conferences. The ROs organize over 150 meetings, workshops and conferences per year across all EE/RE technologies. The Crosscutting portion of the RO budget also provides logistical support and briefing materials for high-profile/VIP events and visits for senior EE and DOE management.

The ROs also play an important role in implementing Memoranda of Understanding between DOE and other Federal agencies, such as the Environmental Protection Agency, General Services Administration, Federal Emergency Management Agency (FEMA), and the Department of the Interior (DOI), to implement joint projects where the whole portfolio of EE technologies is relevant. This includes the Green Parks initiative with the DOI National Park Service and coordination with FEMA to promote the use of green and energy-efficient technologies when communities respond to natural disasters and rebuild afterwards.

Management and Administration. The ROs provide budget formulation and execution, procurement, and human resource management for their 119 FTEs, process the financial plan modifications and program letters to implement the program-support activities above, and provide IT support and integration with headquarters IT systems. RO administration also includes development of regional strategic plans with stakeholders and EE management and identification of new opportunities to link DOE and regional resources for deployment of EE technologies.

Information and Communications Program

The Information and Communications Program (ICP) supports the Office of Communication & Outreach at DOE Headquarters by disseminating information about the benefits of energy efficiency and renewable energy technologies to stakeholders and consumers at the Federal, State, local, and individual level. The objectives of the program are: (1) provide accurate information on energy efficiency and renewable energy technologies to the public so EERE's customers can make informed decisions in the marketplace, resulting in an increase in the adoption of EERE efficiency technologies and efficient energy practices; and (2) raise the general awareness of state-of-the-art energy efficiency technologies and practices. These objectives are accomplished through a variety of mechanisms including the complimentary Energy Efficiency and Renewable Energy Clearinghouse (EREC) and the Energy Efficiency and Renewable Energy Network (EREN). In FY 2001, the Office of Energy Efficiency and Renewable Energy reached more than 1.4 million people and provided access to more than 81,000 resources through its information outreach system.

EREC is our nation's primary source for free, unbiased information about energy efficiency and renewable energy technologies. With a toll-free number and trained staff, EREC reaches individuals – including those who don't have Internet access – who need personalized assistance in obtaining energy information products. In FY 2002, ICP streamlined EREC by providing more functionality through its website and beginning to move to a print-on-demand environment.

EREN connects EERE with Internet users through about 70 program Web sites and hundreds of resource links. In FY 2002, ICP made visual and functional changes to the EREN website to reflect the recent restructuring of the EERE organization. EREN also began an assessment of total website content to reduce redundancies and improve access by EREN users.

Planning, Evaluation and Analysis

Planning, Evaluation and Analysis provides for a well conceived and efficiently managed program pathway that leads to the achievement of EERE goals in the most cost-effective manner possible. A solid analytical foundation is basic to understanding the potential for increasing the penetration of energy-efficient and renewable technologies, and for achieving the correct balance and direction of programmatic activities. In addition, these analytical activities are required to ensure continued program alignment with the NEP goals and objectives, as well as the President's Management Agenda.

Planning, Evaluation and Analysis is also collects data, develops analytical tools and models, and conducts analyses essential for program planning, prioritization, and management. EERE maintains strong capabilities in data analysis and model development to ensure that decisions regarding program direction and resource allocation are guided by the best possible information. Analytical capabilities and supporting databases are continually refined and strengthened to improve the information available for program guidance decisions and to better evaluate the energy, economic, and environmental impacts of programmatic alternatives.

The FY 2004 funding for this area is the same as the combined total requested under the same heading in FY 2003 in the Industry, Transportation, and Buildings sectors and Distributed Energy. The funds have been consolidated under the EE reorganization in order distribute them among all Energy Conservation programs in a manner consistent with EERE's annual corporate analytical agenda.

Communications and Outreach

Communicates the EERE mission, program plans, accomplishments, and technology capabilities to a variety of stakeholder audiences including Congress, the public, educational institutions, industry, and other government and non-government organizations. In addition, writes testimony and prepares briefing books; coordinates answers to congressional questions (between 600 and 1,000 per year); prepares speeches and presentations by the Assistant Secretary and others when requested; manages the Energy Efficiency and Renewable Energy Network website, (EREN), and the Energy Efficiency and Renewable Energy Clearinghouse, (EREC); manages official correspondence; and coordinates reviews of EERE-related statements by other DOE offices and Federal agencies.

Staffing

The organization has been actively recruiting from industry, universities, and other DOE offices or Federal agencies, as well as offering positions to talented new graduates. These efforts are beginning to pay off as EERE benefits from the inflow of fresh and diverse ideas and perspectives.

Funding Profile[a]

(dollars in thousands, whole FTE's)

	FY 2002 Comparable Appropriation	FY 2003 Amended Request	FY 2004 Request	$ Change	% Change
Program Management					
Program Direction	74,965	68,399	70,109	+1,710	+2.5%
Information and Communication	1,550	1,550	1,550	0	0.0%
Planning, Evaluation, and Analysis	4,927	5,005	5,005	0	0.0%
Total, Program Management	81,442	74,954	76,664	+1,710	+2.3%
Additional net budget authority to cover the cost of fully accruing retirement (non-add)	(2,665)	(2,653)	(2,653)	(0)	(0.0%)
Staffing (FTE)					
Headquarters [b]	274	274	270	-4	-1.5%
Golden Field Office	37	37	50	+13	+35.1%
Operations Offices	11	13	0	-13	-100.0%
Regional Offices	120	119	119	0	0.0%
Total, Staffing	442	443	439	-4	-0.9%

Public Law Authorizations:

P.L. 94-163, "Energy Policy and Conservation Act" (EPCA) (1975)
P.L. 94-385, "Energy Conservation and Production Act" (ECPA) (1976)
P.L. 95-91, "Department of Energy Organization Act" (1977)
P.L. 95-618, "Energy Tax Act of 1978"
P.L. 95-619, "National Energy Conservation Policy Act" (NECPA) (1978)
P.L. 96-294, "Energy Security Act" (1980)
P.L.102-486, "Energy Policy Act of 1992"

[a] SBIR/STTR funding in the amount of $ 23,000 was transferred to the Science appropriation in FY 2002. Estimates for SBIR/STTR budgeted in FY 2003 and FY 2004 are $ 21,168 and $ 22,046 respectively.

[b] Includes FTE's at National Energy Technology Laboratory (NETL).

Funding By Site[a]

(dollars in thousands)

	FY 2002	FY2003	FY 2004	$ Change	% Change
Albuquerque Operations Office					
Golden Field Office	6,193	5,501	7,417	+1,916	+34.8%
National Renewable Energy Laboratory	2,861	2,900	2,900	0	0.0%
Regional Offices					
Atlanta	3,091	2,704	2,823	+119	+4.4%
Boston	2,550	2,230	2,328	+98	+4.4%
Chicago	2,350	2,056	2,146	+90	+4.4%
Denver	3,659	3,198	3,338	+140	+4.4%
Philadelphia	2,757	2,412	2,518	+106	+4.4%
Seattle	2,762	2,415	2,521	+106	+4.4%
Total, Albuquerque Operations Office	26,223	23,416	25,991	+2,575	+11.0%
Chicago Operations Office					
Argonne National Laboratory	1,039	1,000	1,000	0	0.0%
Chicago Operations Office	742	790	0	-790	-100.0%
Total, Chicago Operations Office	1,781	1,790	1,000	-790	-44.1%
Idaho Operations Office	395	556	0	-556	-100.0%
Oakland Operations Office					
Lawrence Berkeley National Laboratory	330	300	300	0	0.0%
Oak Ridge Operations Office					
Oak Ridge National Laboratory	2,496	2,500	2,500	0	0.0%

[a] "On December 20, 2002, the National Nuclear Security Administration (NNSA) disestablished the Albuquerque, Oakland, and Nevada Operations Offices, renamed existing area offices as site offices, established a new Nevada Site Office, and established a single NNSA Service Center to be located in Albuquerque. Other aspects of the NNSA organizational changes will be phased in and consolidation of the Service Center in Albuquerque will be completed by September 30, 2004. For budget display purposes, DOE is displaying non-NNSA budgets by site in the traditional pre-NNSA organizational format."

(dollars in thousands)

	FY 2002	FY2003	FY 2004	$ Change	% Change
Oak Ridge Operations Office	119	117	0	-117	-100.0%
Total, Oak Ridge Operations Office	2,615	2,617	2,500	-117	-4.5%
Richland Operations Office					
Pacific Northwest National Laboratory	2,208	2,200	2,200	0	0.0%
Washington Headquarters	47,890	44,075	44,673	+598	+1.4%
Total, Program Management	81,442	74,954	76,664	+1,710	+2.3%

Site Descriptions

Albuquerque Operations Office

Provide program guidance, direction, and support. All operations office work will be transferred and consolidated in the Golden Field Office starting in FY 2004.

Golden Field Office

Provide program guidance, direction, and support. All operations office work will be transferred and consolidated in the Golden Field Office starting in FY 2004.

National Renewable Energy Laboratory

Provide global analytical support for major crosscutting issues.

Regional Offices

Provide program guidance, direction, and support.

Argonne National Laboratory

Provide global analytical support for major crosscutting issues.

Chicago Operations Office

Provide program guidance, direction, and support. All operations office work will be transferred and consolidated in the Golden Field Office starting in FY 2004.

Idaho Operations Office

Provide program guidance, direction, and support. All operations office work will be transferred and consolidated in the Golden Field Office starting in FY 2004.

Lawrence Berkeley National Laboratory

Provide global analytical support for major crosscutting issues.

Oak Ridge National Laboratory

Provide global analytical support for major crosscutting issues.

Oak Ridge Operations Office

Provide program guidance, direction, and support. All operations office work will be transferred and consolidated in the Golden Field Office starting in FY 2004.

Pacific Northwest National Laboratory

Provide global analytical support for major crosscutting issues.

Washington Headquarters

Provide program guidance, direction, and support.

Funding Schedule

(dollars in thousands, whole FTE's)

	FY 2002	FY 2003	FY 2004	$ Change	% Change
Program Direction					
Headquarters					
Salaries and Benefits	31,183	32,717	32,300	-417	-1.3%
Travel	1,962	1,500	2,000	+500	+33.3%
Contractual Services					
Working Capital Fund	4,960	5,052	5,195	+143	+2.8%
Support Services and Other Related Expenses	12,242	7,151	7,523	+372	+5.2%
Subtotal, Contractual Services	17,202	12,203	12,718	+515	+4.2%
Subtotal, Headquarters	50,347	46,420	47,018	+598	+1.3%
Full Time Equivalents	274	274	270	-4	-1.5%
Golden Field Office					
Salaries and Benefits	3,752	3,686	5,267	+1,581	+42.9%
Travel	165	125	200	+75	+60.0%
Rent	500	515	530	+15	+2.9%
Support Services and Other Related Expenses	1,776	1,175	1,420	+245	+20.9%
Subtotal, Golden Field Office	6,193	5,501	7,417	+1,916	+34.8%
Full Time Equivalents	37	37	50	+13	+35.1%
Operations Offices					
Salaries and Benefits	1,156	1,388	0	-1388	-100.0%
Travel	100	75	0	-75	-100.0%
Subtotal, Operations Offices	1,256	1,463	0	-1463	-100.0%
Full Time Equivalents	11	13	0	-13	-100.0%
Regional Offices					
Salaries and Benefits	10,623	10,914	11,196	+282	+2.6%
Travel	979	834	1,000	+166	+19.9%
Rent	1,750	1,775	1,828	+53	+3.0%
Support Services and Other Related Expenses	3,817	1,492	1,650	+158	+10.6%
Subtotal, Regional Offices	17,169	15,015	15,674	+659	+4.4%
Full Time Equivalents	120	119	119	0	0.0%

(dollars in thousands, whole FTE's)

	FY 2002	FY 2003	FY 2004	$ Change	% Change
Subtotal, Program Direction	74,965	68,399	70,109	+1,710	+2.5%
Information and Communications Program					
Energy Efficiency and Renewable Energy Clearinghouse (EREC)	1,150	1,150	1,150	0	0.0%
Energy Efficiency and Renewable Energy Network (EREN)	400	400	400	0	0.0%
Subtotal, Information and Communications Program	1,550	1,550	1,550	0	0.0%
Planning, Evaluation and Analysis	4,927	5,005	5,005	0	0.0%
Total, Program Management	81,442	74,954	76,664	+1,710	+2.3%
Total, Full Time Equivalents	442	443	439	-4	-0.9%
Additional net budget authority to cover the cost of fully accruing retirement (non-add)	(2,665)	(2,653)	(2,653)	0	0.0%

Detailed Program Justification

	(dollars in thousands)		
	FY 2002	FY 2003	FY 2004
Program Direction	**74,965**	**68,399**	**70,109**
■ **Headquarters**	**50,347**	**46,420**	**47,018**
• Salaries and Benefits	31,183	32,717	32,300

FY 2002: The FY 2002 budget supported 274 FTEs to provide for the continued executive management activities at HQ including the implementation of Workforce 21 plans. Activities included: liaison with senior officials in Congress, the White House, OMB, and other agencies as well as State and local governments, and the private sector.

These activities also provided for the continued formulation and operation of the EERE programs including: establishing goals and objectives for the programs; assessing performance and effectiveness; and supporting the FY 1992 Energy Policy Act requirements and the Government Performance and Results Act. SBIR/STTR funding in the amount of $23,000 was transferred from this subprogram to the Science Appropriation.

FY 2003: The FY 2003 Request supports 274 FTEs to provide for the continued executive management activities at HQ including the implementation of the President's Management Agenda and Workforce 21 plans. In an effort to flatten the EERE organization, remove intervening bureaucracy and place focus on program management, a major staff restructuring took place during late FY 2002. As a result of this dramatic move, best business practices are being identified and implemented during this fiscal year. Routine HQ activities also include: technical program and project management; liaison with senior officials in Congress, the White House, OMB, and other agencies as well as State and local governments, and the private sector.

These activities also provide for the continued formulation and operation of the EERE programs including: establishing goals and objectives for the programs; assessing performance and effectiveness; and supporting the FY 1992 Energy Policy Act requirements and the Government Performance and Results Act.

FY 2004: The FY 2004 Request will support 270 FTEs to provide for the continued executive management activities at HQ including further implementation of the President's Management Agenda and Workforce 21 plans. The Department expects developments such as integrated business management systems; heavier reliance on performance based indicators; and the identification of revised staffing mix requirements within the context of a relatively advanced age work force, emerging program demands and technology changes. Routine activities also encompass: technical program and

(dollars in thousands)

project management; liaison with senior officials in Congress, the White House, OMB, and other agencies as well as State and local governments, and the private sector.

These activities will also provide for the continued formulation and operation of the EERE programs including: establishing goals and objectives for the programs; assessing performance and effectiveness; and supporting the FY 1992 Energy Policy Act requirements and the Government Performance and Results Act.

•	Travel	1,962	1,500	2,000
•	Contractual Services	17,202	12,203	12,718
▸	Working Capital Fund (WCF)	4,960	5,052	5,195

FY 2002: The budget supported $4,960,000 for WCF activities such as administrative services, rent ($2,712), automated office support, contract close out, telephone services, postage, printing, graphics, and similar services.

FY 2003: The request supports $5,052,000 for WCF activities such as administrative services, rent ($2,805), automated office support, contract close out, telephone services, postage, printing, graphics, and similar services.

FY 2004: The request will support $5,195,000 for WCF activities such as administrative services, rent ($2,909), automated office support, contract close out, telephone services, postage, printing, graphics, and similar services.

▸	Support Services and Other Related Expenses	12,242	7,151	7,523

FY 2002: Performed analytical services and independent reviews in support of cross-cutting program objectives and program performance measures. Helped plan a dramatic organizational restructuring. Peer reviewed EERE program performance to provide feedback to research staff. Program management support for information technology, outreach, communication, procurement, financial and human resources management.

FY 2003: Perform analytical services and independent reviews in support of cross-cutting program objectives and program performance measures. Develop an integrated business management system that replaces several former program specific data bases. Peer review EERE program performance providing feedback

(dollars in thousands)

to research staff. Program management support for information technology, outreach, communication, procurement, financial and human resources management.

FY 2004: Expect to perform analytical services and independent reviews in support of cross-cutting program objectives and program performance measures. Will help implement President Management Agenda driven improvements into routine practice. Plan to peer review EERE program performance providing feedback to research staff. Continue to provide program management support for information technology, outreach, communication, procurement, financial and human resources management.

■	**Golden Field Office**	**6,193**	**5,501**	**7,417**
•	Salaries and Benefits	3,752	3,686	5,267

FY 2002: The budget supported the continued operation of the Golden Field Office including 37 FTEs for program management activities such as monitoring and evaluating laboratory work and reviewing and funding research proposals, contract and technical management of projects with universities, and commercial vendors, and field administration of the Management and Operating contract for NREL.

FY 2003: The request supports the continued operation of the Golden Field Office including 37 FTEs for program management activities such as monitoring and evaluating laboratory work and reviewing and funding research proposals, contract and technical management of projects with universities, and commercial vendors, and field administration of the Management and Operating contract for NREL.

FY 2004: The request will support the continued operation of the Golden Field Office including 50 FTEs for program management activities such as monitoring and evaluating laboratory work and reviewing and funding research proposals, contract and technical management of projects with universities, and commercial vendors, and field administration of the Management and Operating contract for NREL.

During FY 2004, an additional 13 FTEs will be reassigned from other DOE operations office to Golden. This consolidation of expertise dedicated to EERE field management support is expected to increase staff effectiveness because of focus on a single DOE program and adaption of unified best practices.

•	Travel	165	125	200

	(dollars in thousands)		
	FY 2002	FY 2003	FY 2004
• Rent	500	515	530
• Support Services and Other Related Expenses	1,776	1,175	1,420

FY 2002: The budget provided for landlord activities to support infrastructure and supplies to maintain the operation of the Golden Field Office and help in the implementation of the EERE mission.

FY 2003: The request provides for landlord activities to support infrastructure and supplies to maintain the operation at Golden and help in the implementation of the EERE mission.

FY 2004: The request will provide for landlord activities to support infrastructure and supplies to maintain the security and operation at Golden and help in the implementation of the EERE mission.

During FY 2004, EERE field management support will be consolidated at Golden by reassigning an additional 13 FTE from three other DOE operations offices.

■ **Operations Offices**	**1,256**	**1,463**	**0**
• Salaries and Benefits	1,156	1,388	0

FY 2002: Sponsored DOE staff at Idaho Falls, Chicago and Oak Ridge Operations Offices to respectively support Industrial Technologies, Distributed Energy Resources and Vehicle Technologies. (11 FTE)

FY 2003: Support DOE staff at Idaho Falls (7 FTE), Chicago (5 FTE) and Oak Ridge (1 FTE) Operations Offices to respectively implement Industrial Technologies Program; Distributed Energy Resources; and FreedomCAR & Vehicle Technologies Program project contracts.

FY 2004: In FY 2004, 13 FTE's that were previously located at the Idaho Falls, Chicago, and Oak Ridge Operations Offices will be consolidated and relocated.

• Travel	100	75	0
■ **Regional Offices**	**17,169**	**15,015**	**15,674**

	(dollars in thousands)		
	FY 2002	FY 2003	FY 2004
• Salaries and Benefits	10,623	10,914	11,196
• Travel	979	834	1,000
• Rent	1,750	1,775	1,828
• Support and Other Related Expenses	3,817	1,492	1,650
Regional Office Subtotals			
Atlanta	3,091	2,704	2,823
Boston	2,550	2,230	2,328
Chicago	2,350	2,056	2,146
Denver	3,659	3,198	3,338
Philadelphia	2,757	2,412	2,518
Seattle	2,762	2,415	2,521
Total, Regional Offices	**17,169**	**15,015**	**15,674**

(dollars in thousands)

	FY 2002	FY 2003	FY 2004
Information and Communications Program	**1,550**	**1,550**	**1,550**
■ **Energy Efficiency and Renewable Energy Clearinghouse (EREC) . . . . . .**	**1,150**	**1,150**	**1,150**

FY 2002: Provided technical assistance in response to 110,000 public inquiries.

FY 2003: Provide technical assistance in response to 110,000 public inquiries.

FY 2004: Will provide technical assistance in response to 110,000 public inquiries.

■ **Energy Efficiency and Renewable Energy Network (EREN) 400 400 400**

FY 2002: Web-based information and technical assistance services were provided to EERE stakeholders.

FY 2003: Web-based information and technical assistance services provided to EERE stakeholders. EREN plans for increase usage over the previous year (8 million internet hits per month) while maintaining a 95+ percent customer satisfaction rating.

FY 2004: Provide web-based information and technical services to EERE stakeholders. In FY 2004, EREN will complete its redesign to reflect the current EERE organizational structure and reduce redundancies throughout the web site.

	(dollars in thousands)		
	FY 2002	FY 2003	FY 2004
Planning, Evaluation and Analysis	**4,927**	**5,005**	**5,005**

FY 2002: Conducted program evaluation and planning by developing, interpreting and disseminating the basic data required to implement energy policy and manage and evaluate energy efficiency programs, including continued collaboration with EIA on energy use data; responsible for the execution of NAPA Implementation Plan; tracked program objectives and goals as required under the Government Performance and Results Act (GPRA), focusing program elements on maximum measurable benefits; analyzed new starts and technology commercialization to document program quality metrics; published and distributed Edition 22 of the *Transportation Energy Data Book* and included information on hybrid vehicle sales and prices.

FY 2003: Conduct program evaluation and planning by developing, interpreting and disseminating the basic data required to implement energy policy and manage and evaluate energy efficiency programs, including continued collaboration with EIA on energy use data; responsible for the execution of NAPA Implementation Plan; track program objectives and goals as required under the Government Performance and Results Act (GPRA), focusing program elements on maximum measurable benefits; analyzed new starts and technology commercialization to document program quality metrics; published and distributed Edition 23 of the *Transportation Energy Data Book* and included information on hybrid vehicle sales and prices. Develop the analytical capability to estimate the best pathways to making the U.S. transportation sector sustainable with respect to domestic fuels used and greenhouse gases emitted.

FY 2004: Conduct program evaluation and planning by developing, interpreting and disseminating the basic data required to implement energy policy and manage and evaluate energy efficiency programs, including continued collaboration with EIA on energy use data; responsible for the execution of NAPA Implementation Plan; track program objectives and goals as required under the Government Performance and Results Act (GPRA), focusing program elements on maximum measurable benefits; analyzed new starts and technology commercialization to document program quality metrics; published and distributed Edition 23 of the *Transportation Energy Data Book* and included information on hybrid vehicle sales and prices. Develop the analytical capability to estimate the best pathways to making the U.S. transportation, buildings and industry sectors sustainable with respect to domestic fuels used and greenhouse gases emitted.

Total, Program Management	**81,442**	**74,954**	**76,664**

Explanation of Funding Changes

	FY 2004 vs. FY 2003 ($000)
Program Management	
■ Headquarters	
Salaries and Related Expenses - 2 percent decrease in expected FY 2004 salaries and related expenses due to reduction in Full-Time Equivalents from 274 to 270, offset by added within grade pay increases and increase for travel funding.	
Support Services and Other Related Expenses -4 percent increase in contract services. Contract assistance necessary to analyze energy efficiency technology potential, as well as implement EERE organizational restructuring and other presidential management agenda driven initiatives..	+598
■ Golden Field Office	
Salaries and Related Expenses - Consolidation of EERE field program management support staff from other DOE operation Offices, Full-Time Equivalents rise from 37 to 50.	
Support Services and Other Related Expenses - 21 percent increase in contract services to provide for landlord activities to support infrastructure and maintain security at Golden.	+1,916
■ Operations Offices	
Salaries and Related Expenses- Reflects reassignment of 13 FTE from Idaho Falls, Chicago and Oak Ridge Operations Office to the Golden Field Office	-1,463
■ Regional Offices	
Salaries and Related Expenses - Increase for anticipated within grade pay raises and travel of 119 FTE.	
Support Services and Other Related Expenses - 5 percent increase to support increase in cost of rent, supplies and support contracts..	+659
Total Funding Change, Program Management.	**+1,710**

Support Services

(dollars in thousands)

	FY 2002	FY2003	FY 2004	$ Change	% Change
Management Support	15,960	8,683	8,425	-258	-3.0%

Other Related Expenses

(dollars in thousands)

	FY 2002	FY2003	FY 2004	$ Change	% Change
Equipment Transport	75	75	75	0	0.0%
Rent to GSA	2,250	2,290	2,358	+68	+3.0%
Rent to Others	100	100	103	+3	+3.0%
Communications, Utilities	590	600	610	+10	+1.7%
Printing and Reproduction	160	160	160	0	0.0%
Supplies and Materials	310	85	110	+25	+29.4%
Equipment	640	175	190	+15	+8.6%
Working Capital Fund	4,960	5,052	5,915	+863	+17.1%
Total, Other Related Expenses	9,085	8,537	9,521	+984	+11.5%

Comparability Matrix

Energy Conservation

FY 2002 Funding

(dollars in thousands)

	FY 2004 Structure									
	Vehicle Tech	Fuel Cell Tech	WAP & Inter-gov't	Distributed Energy Resources	Building Tech	Industrial Tech	Biomass and Biorefinery R&D	FEMP	Program Mangt	**Total**
FY 2002 Structure										
Buildings Sector.....			301,100		63,082				12,737	376,919
FEMP.....								18,900	4,400	23,300
Industry Sector.....			9,062			100,909	24,779		9,377	144,127
Transportation Sector....	181,352	41,182	13,369						10,232	246,135
Power Sector.....		5,500		55,137					1,950	62,587
Policy and Management.....			650						42,746	43,396
Total.....	**181,352**	**46,682**	**324,181**	**55,137**	**63,082**	**100,909**	**24,779**	**18,900**	**81,442**	**896,464**

FY 2003 Funding

(dollars in thousands)

	FY 2004 Structure										
	Vehicle Tech	Fuel Cell Tech	WAP & Inter-gov't	Distributed Energy Resources	Building Tech	Industrial Tech	Biomass and Biorefinery R&D	FEMP	NCCTI Comp Solicitation Program	Program Mangt	**Total**
FY 2003 Structure											
Buildings Sector.....			344,488		52,563					11,740	408,791
FEMP.....								23,425		4,455	27,880
Industry Sector.....			5,308			91,477	23,939			7,635	128,359
Transportation Sector....	153,563	50,000	9,000							10,101	222,664
Power Sector.....		7,500		54,784						1,620	63,904
NCCTI Competitive Solicitation.....									20,000		20,000
Policy and Management.....			650							39,403	40,053
Total.....	**153,563**	**57,500**	**359,446**	**54,784**	**52,563**	**91,477**	**23,939**	**23,425**	**20,000**	**74,954**	**911,651**

Comparability Matrix
Building Technology, State and Community Sector
FY 2002 Funding

(dollars in thousands)

	FY 2004 Structure			
	Building Technologies	Weatherization & Intergovern-mental Activities	Program Management	**Total**
FY 2002 Structure				
Building Technology,				
State and Community Sector				
Buildings Research and Standards				
Technology Road Maps and Compet. R&D	6,718			6,718
Residential Buildings Integration	12,224			12,224
Commercial Buildings Integration	4,418			4,418
Equipment, Materials and Tools				
Lighting Appliance and Standards	8,251			8,251
All Other	29,512			29,512
Buildings Research and Standards	61,123			61,123
Building Technology Assistance				
Weatherization Assistance Program (Grants)		230,000		230,000
State Energy Program		45,000		45,000
Community Energy Program				
Rebuild America		11,938		11,938
Information Outreach		2,500		2,500
Training & Assistance (State/Federal Bldg Codes)		4,300		4,300
Technical/Program Management Support		50		50
Community Energy Program		18,788		18,788
Energy Star Program		3,000		3,000
Cooperative Programs with States		1,959		1,959
Energy Science Initiative	1,959			1,959
Management and Planning				
Evaluation & Planning		2,353	2,175	4,528
Program Direction				
Management and Planning			10,562	10,562
Total	63,082	301,100	12,737	376,919

(a) All of the new Office of Building Technology is represented in this table.
(b) Only part of Weatherization and Intergovt. Is represented in this table. See the "Weatherization and Intergovt. Table for complete coverage.

Comparability Matrix
Building Technology, State and Community Sector
FY 2003 Funding

(dollars in thousands)

	FY 2004 Structure			
	Buildings	Weatherization and Intergovernmental Activities	Program Mgmt	Total
FY 2002 STRUCTURE				
Building Technology, State and Community Sector				
Buildings Research and Standards	0	0		
Technology Road Maps and Compet. R&D	2,357	0		2,357
Residential Buildings Integration	13,478	0		13,478
Commercial Buildings Integration	5,010	0		5,010
Equipment, Materials and Tools	0	0		
Lighting Appliance and Standards	9,197	0		9,197
All Other	22,521	0		22,521
Building Technology Assistance	0	0		
Weatherization Assistance Program (Grants)	0	277,100		277,100
State Energy Program	0	38,798		38,798
Community Energy Program	0	0		
Rebuild America	0	12,723		12,723
Information Outreach	0	2,409		2,409
Training & Assistance (State/Federal Bldg Codes)	0	4,855		4,855
Technical/Program Management Support	0	50		50
Energy Star Program	0	6,200		6,200
Cooperative Programs with States	0	0		0
Energy Science Initiative	0	0		0
Management and Planning	0	0		
Evaluation & Planning	0	2,353	2,175	4,528
Program Direction	0	0	9,565	9,565
Total	52,563	344,488	11,740	408,791

Comparability Matrix

Industry Sector
FY 2002 Funding

(dollars in thousands)

	FY 2004 Structure				
	Biomass and Biorefinery R&D [a]	Industrial Technologies [b]	Weatherization & Intergovern-mental Activities [c]	Program Mgmt	Total
FY 2002 Structure					
Industry Sector					
Industries of the Future (Specific)					
Steel Vision		10,119			10,119
Aluminum Vision		7,948			7,948
Metalcasting Vision		5,247			5,247
Glass Vision		4,502			4,502
Chemicals Vision		14,158			14,158
Petroleum Vision		2,740			2,740
Mining Vision		5,014			5,014
Supporting Industries		1,570			1,570
Forest and Paper Products Vision	1,071	10,511			11,582
Agriculture Vision	7,109	0			7,109
Technical Program Mgmt Support	140	1,060			1,200
Industries of the Future (Crosscutting)					
Industrial Materials for the Future		13,423			13,423
Combustion					0
High Efficiency Combustion Systems		2,000			2,000
Industrial Gasification	16,069				16,069
Sensors and Controls		3,699			3,699
Inventions and Innovation			4,322		4,322
Industrial Technical Assistance		14,449			14,449
NICE3			2,681		2,681
Technical Program Mgmt Support	390	2,510	100		3,000
Energy Efficiency Science Initiative		1,959			1,959
Cooperative Programs with States			1,959		1,959
Management and Planning					
Evaluation and Planning				730	730
Program Direction				8,647	8,647
Total	24,779	100,909	9,062	9,377	**144,127**

(a) These columns include all of the new Biomass Program in Energy Conservation
(b) These columns include all of the new Industry Program.
(c) These columns include only part of the Weatherization and Intergov't. Program

Comparability Matrix
Industry Sector
FY 2003 Funding

(dollars in thousands)

	FY 2004 Structure				
	Biomass and Biorefinery R&D	Industrial Technologies	Weatherization and Intergovenmental Activities	Program Management	Total
FY 2002 STRUCTURE					
Industry Sector					
INDUSTRY					
Industries of the Future (Specific)					63,615
Steel Vision		7,329			7,329
Aluminum Vision		7,103			7,103
Metalcasting Vision		4,357			4,357
Glass Vision		3,572			3,572
Chemicals Vision		14,458			14,458
Petroleum Vision					
Mining Vision		5,119			5,119
Supporting Industries		1,600			1,600
Forest and Paper Products Vision	1,080	8,747			9,827
Agriculture Vision	8,259				8,259
Technical Program Mgmt Support	267	1,724			1,991
Industries of the Future (Crosscutting)					57,109
Industrial Materials for the Future		12,698			12,698
Combustion					
High Efficiency Combustion Systems		2,000			2,000
Industrial Gasification	13,600				13,600
Sensors and Controls		3,774			3,774
Inventions and Innovation			2,372		2,372
Industrial Technical Assistance		15,929			15,929
NICE3			2,736		2,736
Technical Program Mgmt Support	733	3,067	200		4,000
Management and Planning					7,635
Evaluation and Planning				730	730
Program Direction				6,905	6,905
Total	23,939	91,477	5,308	7,635	128,359

Comparability Matrix
Transportation Sector

FY 2002 Funding

(dollars in thousands)

	FY 2004 Structure				
	Vehicles Technologies	Fuel Cell Technologies	Weatherization & Intergovern-mental Activities	Management and Planning	Total
FY 2002 Structure					
Transportation Sector					
Vehicle Technology R&D					
Hybrid Systems R&D	45,749				45,749
Fuel Cell R&D		41,182			41,182
Advanced Combustion Engine R&D	47,731				47,731
Cooperative Automotive Research	500				500
Electric Vehicle R&D	6,887				6,887
Heavy Vehicle Systems R&D	9,980				9,980
Vehicle Technology R&D	110,847	41,182			152,029
Fuels Utilization R&D					
Advanced Petroleum Based Fuels	11,822				11,822
Alternative Fuels	13,570				13,570
Fuels Utilization R&D	25,392				25,392
Material Technologies					
Propulsion Materials Technology	8,765				8,765
Lightweight Materials Technology	25,337				25,337
Materials Laboratory (HTML)	5,502				5,502
Materials Technologies	39,604				39,604
Technology Deployment					
Testing and Evaluation	1,750				1,750
EPACT Replacement Fuels Program	1,000				1,000
Advanced Vehicle Competitions	800				800
Clean Cities	0		11,410		11,410
Technology Deployment	3,550		11,410		14,960
Cooperative Programs with States			1,959		1,959
Energy Efficiency Science Initiative	1,959				1,959
Management and Planning				10,232	10,232
Total	181,352	41,182	13,369	10,232	246,135

Comparability Matrix
Transportation Sector
FY 2003 Funding

(dollars in thousands)

	FY 2004 Structure				
	Vehicle Technologies	Fuel Cell Technology	Weatherization and Intergovernmental Activities	Program Management	Total
FY 2002 STRUCTURE					
Transportation Sector					
Vehicle Technology R&D					**149,280**
Hybrid Systems R&D					**42,600**
Light Vehicles Propulsion & Ancillary Subsystems	6,835				6,835
High Power Energy Storage	17,675				17,675
Advanced Power Electronics	13,690				13,690
Heavy Vehicle Propulsion Systems	4,038				4,038
Technical/Program Management Support	362				362
Fuel Cell R&D					**50,000**
Fuel Cell Systems		7,600			7,600
Stack Subsystem Components		14,900			14,900
Fuel Processor/Storage		24,100			24,100
Field Evaluation		3,000			3,000
Technical/Program Management Support		400			400
SBIR/STTR					
Advanced Combustion Engine R&D					**40,680**
Combustion and Emission Control R&D	17,571				17,571
Light Truck Engine	13,106				13,106
Heavy Truck Engine	6,979				6,979
Engine Boosting	500				500
Health Impacts	1,500				1,500
Off-Highway Engine R&D	500				500
Technical/Program Management Support	524				524
Cooperative Automotive Research					**1,000**
CARAT-Coop Auto Research	500				500
GATE	500				500
Electric Vehicle R&D					**3,500**
Advanced Battery Development	1,500				1,500
Exploratory Technology Research	1,935				1,935
Technical/Program Management Support	65				65
Heavy Vehicle Systems R&D					**11,500**
Vehicle Systems Optimization	10,314				10,314
Truck Safety Systems	400				400
Stimulate Truck Innovative Concepts & Knowledge	600				600
Technical/Program Management Support	186				186
Fuels Utilization R&D					**18,483**
Advanced Petroleum Based Fuels	13,658				13,658
Alternative Fuels	4,825				4,825
Material Technologies					**29,800**
Propulsion Materials Technology					**7,000**
Automotive Propulsion Materials	1,000				1,000
Heavy Vehicle Propulsion	5,850				5,850
Technical/Program Management Support	150				150
Lightweight Materials Technology					**22,800**
Automotive Lightweight Materials	9,600				9,600
Heavy Vehicle High Strength Weight Reduction Materials	8,950				8,950
Technical/Program Management Support	250				250
High Temperature Materials Laboratory (HTML)	4,000				4,000
Technology Deployment					**15,000**
Testing and Evaluation	3,000				3,000
EPACT Replacement Fuels Program	2,000				2,000
Advanced Vehicle Competitions	1,000				1,000
Clean Cities				9,000	9,000
Cooperative Programs with States					
Energy Efficiency Science Initiative					
Management and Planning					**10,101**
Evaluation & Planning				2,000	2,000
Program Direction				8,101	8,101
Total	153,563	50,000	9,000	10,101	222,664

Comparability Matrix
Power Technologies

FY 2002 Funding

(dollars in thousands)

	FY 2004 Structure			
	Distributed Energy Resources	Fuel Cell Technologies	Program Management	Total
FY 2002 Structure				
Power Sector				
Distributed Energy Resources				
Distributed Generation Technology Development				
Building Fuel Cells		5,500		5,500
Industrial Gas Turbines	4,500			4,500
Microturbines	11,000			11,000
Reciprocating Engines	11,000			11,000
Technology Based-				
Advanced Material and Sensors	6,997			6,997
Fuel Flexibility (oil heat)	500			500
Thermal Activated Technology	14,660			14,660
Technical/Program Management Support	480			480
End-Use Integration	6,000			6,000
Management and Planning				
Evaluation and Planning			322	322
Program Direction			1,628	1,628
Total	55,137	5,500	1,950	62,587

Comparability Matrix
Power Technologies
FY 2003 Funding

(dollars in thousands)

	FY 2004 Structure			
	Distributed Energy Resources	Fuel Cell Technology	Program Management	Total
FY 2002 STRUCTURE				
Power Sector				
Tecnology Development				
Building Fuel Cells		7,500		7,500
Industrial Gas Turbines	4,500			4,500
Microturbines	7,000			7,000
Reciprocating Engines	10,000			10,000
Technology Based- Advanced Material and Sensors	8,256			8,256
Fuel Flexibility (oil heat)	500			500
Thermal Activated Technology	4,660			4,660
Advanced Desiccant & Chillers				
Technical/Program Management Support	480			480
End-Use Integration				
All except Technical/Program Management Support	19,338			19,338
Technical/Program Management Support	50			50
Technical Management and Planning				
Evaluation and Planning			100	100
Program Direction			1,520	1,520
SBIR/STTR				
Total	54,784	7,500	1,620	63,904

Comparability Matrix
Policy and Management
FY 2002 Funding

(dollars in thousands)

	FY 2004 Structure			
	Weatherization and Intergovernmental Programs	Program Management		
	Gateway Deployment	Outreach and Communications	Program Direction	**Total**
FY 2002 Structure				
Policy and Management				
Program Direction			41,196	41,196
International Market Development				
Asian Pacific Economic Cooperation	600			600
Greenhouse Gas Technology Information Exchange	50			50
Outreach and Communication				
Information and Communications Program				
Energy Efficiency & Renewable Energy Clearinghouse		1,150		1,150
Energy Efficiency & Renewable Energy Network (EREN)		400		400
Total	**650**	**1,550**	**41,196**	**43,396**

Comparability Matrix
Policy and Management
FY 2003 Funding

(dollars in thousands)

	FY 2004 Structure		
	Weatherization and Intergovernmental Activities	Program Management	Total
FY 2002 STRUCTURE			
Program Direction		37,853	40,506
International Market Development			
Asian Pacific Economic Cooperation (APEC)	585		585
Greenhouse Gas Technology Information Exchange	65		65
Outreach and Communication			
Information and Communications Program			
Energy Efficiency & Renewable Energy Clearinghouse		1,150	1,150
Energy Efficiency & Renewable Energy Network (EREN)		400	400
Total	650	39,403	40,053

Comparability Matrix
Vehicle Technologies

FY 2002 Funding

(dollars in thousands)

	FY 2004 Structure									
	Vehicle Systems	Innovative Concepts	Hybrid & Electric Propulsion	Advanced Combustion	Materials Tech.	Fuels Tech.	Tech. Intro.	Energy Efficiency Science Initiative	Tech/ Program Mgmt Supp't	**Total**
FY 2002 Structure										
Transportation Sector										
Vehicle Technology R&D										
Hybrid Systems R&D										
Light Vehicles Propulsion & Ancillary Subsystems										
Subsystems	5,100		3,900							9,000
High Power Energy Storage			17,295							17,295
Advanced Power Electronics			14,163							14,163
Heavy Vehicle Propulsion Systems			4,941							4,941
Technical/Program Management Support									350	350
Hybrid Systems R&D			40,299						350	45,749
Advanced Combustion Engine R&D										
Combustion and Emission Control R&D				19,515						19,515
Light Truck Engine				15,778						15,778
Heavy Truck Engine				9,396						9,396
Engine Boosting				500						500
Health Impacts				1,471						1,471
Off-Highway Engine R&D				500						500
Technical/Program Management Support									571	571
Advanced Combustion Engine R&D				47,160					571	47,731
Cooperative Automotive Research										
CARAT-Coop Auto Research		500								500
GATE		0								0
Cooperative Automotive Research		500								500
Electric Vehicle R&D										
Advanced Battery Development			4,447							4,447
Exploratory Technology Research			2,375							2,375
Tech/Program Management									65	65
Electric Vehicle R&D			6,822						65	6,887
Heavy Vehicle Systems R&D										
Vehicle Systems Optimization	9,369									9,369
Truck Safety Systems	400									400
STICK		100								100
Technical/Program Management Support									111	111
Heavy Vehicle Systems R&D	9,769	100							111	9,980
Vehicle Technology R&D	14,869	600	47,121						1,097	110,847
Fuels Utilization R&D										
Advanced Petroleum Based Fuels						11,326			496	11,822
Alternative Fuels						13,324			246	13,570
Fuels Utilization R&D						24,650			742	25,392
Material Technologies										
Propulsion Materials Technology										8,765
Automotive Propulsion Materials					2,914					2,914
Heavy Vehicle Propulsion					5,756					5,756
Technl/Program Management									95	95
Lightweight Materials Technology										25,337
Automotive Lightweight Materials					15,412					15,412
Heavy Vehicle High Strength Weight					9,574					9,574
Tech/Program Management									351	351
High Temperature Materials Laboratory (HTML)					5,502					5,502
Materials Technologies					39,158				446	39,604
Technology Deployment										
Testing and Evaluation							1,750			1,750
EPACT Replacement Fuels Program							900		100	1,000
Advanced Vehicle Competitions							800			800
Technology Deployment							3,450		100	3,550
Energy Efficiency Science Initiative								1,959		1,959
Total	14,869	600	47,121	47,160	39,158	24,650	3,450	1,959	2,385	181,352

Comparability Matrix
Vehicle Technology R&D
FY 2003 Funding

(dollars in thousands)

	FY 2004 Structure								
	Vehicle Systems	Innovative Concepts	Hybrid & Electric Propulsion	Advanced Combustion	Materials Tech.	Fuels Techn	Tech Intro	Technical Program Mgmt Supp't	Total
FY 2002 Structure									
Vehicle Technology R&D									
Hybrid Systems R&D									
Light Vehicles Propulsion & Ancillary Subsystems	3,700		3,135						6,835
High Power Energy Storage			17,675						17,675
Advanced Power Electronics			13,690						13,690
Heavy Vehicle Propulsion Systems			4,038						4,038
Tech/Program Management								362	362
Advanced Combustion Engine R&D									
Combustion & Emission Control R&D				17,571					17,571
Light Truck Engine				13,106					13,106
Heavy Truck Engine				6,979					6,979
Engine Boosting				500					500
Health Impacts				1,500					1,500
Off-Highway Engine R&D				500					500
Tech/Program Management								524	524
Cooperative Automotive Research									
CARAT-Coop Auto Research		500							500
GATE		500							500
Electric Vehicle R&D									
Advanced Battery Development			1,500						1,500
Exploratory Technology Research			1,935						1,935
Tech/Program Management								65	65
Heavy Vehicle Systems R&D									
Vehicle Systems Optimization	10,314								10,314
Truck Safety Systems	400								400
STICK		600							600
Tech/Program Management								186	186
Fuels Utilization R&D									
Advanced Petroleum Based Fuels						13,324		334	13,658
Alternative Fuels						4,675		150	4,825
Material Technologies									
Propulsion Materials Technology									
Automotive Propulsion Materials					1,000				1,000
Heavy Vehicle Propulsion					5,850				5,850
Tech/Program Management								150	150
Lightweight Materials Technology									
Automotive Lightweight Materials					9,600				9,600
Heavy Vehicle High Strength Wgt Reduction Materials					8,950				8,950
Tech/Program Management								250	250
High Temperature Materials Laboratory					4,000				4,000
Technology Deployment									
Testing and Evaluation							3,000		3,000
EPACT Replacement Fuels Program							1,900	100	2,000
Advanced Vehicle Competitions							1,000		1,000
Total	14,414	1,600	41,973	40,156	29,400	17,999	5,900	2,121	153,563

Comparability Matrix
Fuel Cell Technologies

FY 2002 Funding

(dollars in thousands)

	FY 2004 Structure					
	Transport. Systems	Distributed Energy Systems	Fuel Processor R&D	Stack Component R&D	Tech/ Program Mgmt Supp't	Total
FY 2002 Structure						
Transportation Sector						
Vehicle Technology R&D						
Fuel Cell R&D						
Fuel Cell Systems.....	7,466					7,466
Stack Subsystem Components.....				12,595		12,595
Fuel Processor/Storage.....			20,921			20,921
Technical/Program Management Support					200	200
Fuel Cell R&D.....	7,466	0	20,921	12,595	200	41,182
Power Sector						
Distributed Energy Resources						
Distributed Generation						
Technology Development						
Stationary Fuel Cell.....		5,500				5,500
Total.....	7,466	5,500	20,921	12,595	200	46,682

Comparability Matrix
Fuel Cell R&D
FY 2003 Funding

(dollars in thousands)

	FY 2004 Structure						
	Transport. Systems	Distributed Energy Systems	Fuel Processor R&D	Stack Component R&D	Technol. Validation	Technical Program Mgmt Supp't	Total
Power Sector							
Distributed Energy Resources							
Distributed Generation Technology Development							
Stationary Fuel Cell		7,500					7,500
Transportation Sector							
Vehicle Technology R&D							
Fuel Cell R&D							
Fuel Cell Systems	7,600						7,600
Stack Subsystem Components				14,900			14,900
Fuel Processor/Storage			24,100				24,100
Field Evaluation			1,200		1,800		3,000
Technical/Program Management Support						400	400
Total	7,600	7,500	25,300	14,900	1,800	400	57,500

Comparability Matrix

Weatherization and Intergovernmental Activities

FY 2002 Funding

(dollars in thousands)

	FY 2004 Structure					
	Intergovernmental Activities	Weatherization Assistance Program	State Energy Program Grants	State Energy Activities	Gateway Deployment	**Total**
FY 2002 Structure						
Building Technology, State, and Community Sector						
Building Technology Assistance						
Weatherization Assistance Program		230,000				230,000
State Energy Program			45,000			45,000
Community Energy Program						
Rebuild America					11,938	11,938
Information & Outreach					2,500	2,500
Building Codes Training and Assistance					4,300	4,300
Technical/Program Management Support					50	50
Energy Star					3,000	3,000
Cooperative Programs with States				1,959		1,959
Management and Planning						
Evaluation & Planning						
Evaluation Planning for Grant Programs				2,353		2,353
Industry Sector						
Industries of the Future (Crosscutting)						
Inventions and Innovation					4,322	4,322
NICE3					2,681	2,681
Cooperative Programs with States				1,959		1,959
Transportation Sector						
Technology Deployment						
Clean Cities					11,010	11,010
Tech Program Mgmt Support for Clean Cities					400	400
Cooperative Programs with States				1,959		1,959
Policy and Management						
International Market Development Program					650	650
Total	0	230,000	45,000	8,230	40,851	324,081

Comparability Matrix
Weatherization and Intergovernmental Activities
FY 2003 Funding

(dollars in thousands)

	FY 2004 Structure					
	Intergovernmental Activities	Weatherization Assistance Program (Grants)	State Energy Program (Grant)	State Energy Activities	Gateway Deployment	Total
FY 2002 STRUCTURE						
Multiple Sources in FY 2002 Structure						
Building Technology, State, and Community Sector						
Weatherization Assistance Program		277,100				277,100
State Energy Program			38,798			38,798
Community Energy Program						
Rebuild America					12,723	12,723
Information & Outreach					2,409	2,409
Building Codes Training and Assistance					4,855	4,855
Technical/Program Management Support					50	50
Energy Star					6,200	6,200
Cooperative Programs with States						
Evaluation Planning for Grant Programs				2,353		2,353
Industry Sector						
Industries of the Future (Crosscutting)						
Inventions and Innovation					2,372	2,372
NICE3					2,736	2,736
Technical/Program Management Support				200		200
Transportation Sector						
Technology Deployment						
Clean Cities					8,610	8,610
Tech Program Mgmt Support for Clean Cities					390	390
Cooperative Programs with States						
Conservation Policy and Management						
International Market Development Program					650	650
Total		277,100	38,798	2,553	40,995	359,446

Comparability Matrix
Distributed Energy Resources

FY 2002 Funding

(dollars in thousands)

	FY 2004 Structure			
	Technology Development	End-Use System Integration	Technical Program Management Support	Total
FY 2002 Structure				
Power Sector				
Distributed Energy Resources				
Distributed Generation Technology Development				
Industrial Gas Turbines	4,500			4,500
Microturbines	11,000			11,000
Reciprocating Engines	11,000			11,000
Technology Based-				
Advanced Material and Sensors	6,997			6,997
Fuel Flexibility (oil heat)	500			500
Thermal Activated Technology	4,660	10,000		14,660
Technical/Program Management Support			480	480
End-Use Integration		5,950	50	6,000
Total	38,657	15,950	530	55,137

Comparability Matrix
Distributed Energy Resources
FY 2003 Funding

(dollars in thousands)

	FY 2004 Structure				
	Technology Development	End-Use System Integration	Technical Program Management Support	SBIR/STR	Total
FY 2002 Structure					
Tecnology Development					
Building Fuel Cells					
Industrial Gas Turbines	4,500				4,500
Microturbines	7,000				7,000
Reciprocating Engines	10,000				10,000
Technology Based- Advanced Material and Sensors	8,256				8,256
Fuel Flexibility (oil heat)	500				500
Thermal Activated Technology	4,660				4,660
Advanced Desiccant & Chillers					
Technical/Program Management Support			480		480
End-Use Integration					
All except Technical/Program Management Support		19,338			19,338
Technical/Program Management Support			50		50
Technical Management and Planning					
Evaluation and Planning					
Program Direction					
Total	34,916	19,338	530		54,784

Comparability Matrix
Industrial Technologies

FY 2002 Funding

(dollars in thousands)

	FY 2004 Structure				
	Industries of the Future (Specific)	Industries of the Future (Crosscutting)	Technical Program Management Support	Energy Efficiency Science Initiative	Total
FY 2002 Structure					
Industry Sector					
Industries of the Future (Specific)					
Steel Vision	10,119				10,119
Aluminum Vision	7,948				7,948
Metalcasting Vision	5,247				5,247
Glass Vision	4,502				4,502
Chemicals Vision	14,158				14,158
Petroleum Vision	2,740				2,740
Mining Vision	5,014				5,014
Supporting Industries	1,570				1,570
Forest and Paper Products Vision	10,511				10,511
Technical Program Mgmt Support			1,060		1,060
Industries of the Future (Crosscutting)					
Industrial Materials for the Future		13,423			13,423
Combustion					
High Efficiency Combustion Systems		2,000			2,000
Industrial Gasification					
Sensors and Controls		3,699			3,699
Inventions and Innovation					
Industrial Technical Assistance		14,449			14,449
NICE3					
Technical Program Mgmt Support			2,510		2,510
Energy Efficiency Science Initiative				1,959	1,959
Total	61,809	33,571	3,570	1,959	100,909

Comparability Matrix
Industrial Technologies
FY 2003 Funding

(dollars in thousands)

	FY 2004 Structure				
	Industries of the Future (Specific)	Industries of the Future (Crosscutting)	Technical Program Management Support	Energy Eff. Science Initiative	Total
FY 2002 STRUCTURE					
Industry Sector					
INDUSTRY					
Industries of the Future (Specific)					
Steel Vision	7,329				7,329
Aluminum Vision	7,103				7,103
Metalcasting Vision	4,357				4,357
Glass Vision	3,572				3,572
Chemicals Vision	14,458				14,458
Petroleum Vision					
Mining Vision	5,119				5,119
Supporting Industries	1,600				1,600
Forest and Paper Products Vision	8,747				8,747
Agriculture Vision					
Technical Program Mgmt Support			1,724		1,724
Industries of the Future (Crosscutting)					
Industrial Materials for the Future		12,698			12,698
Combustion					
High Efficiency Combustion Systems		2,000			2,000
Industrial Gasification					
Sensors and Controls		3,774			3,774
Inventions and Innovation					
Industrial Technical Assistance		15,929			15,929
NICE3					
Technical Program Mgmt Support			3,067		3,067
SBIR					
Energy Efficiency Science Initiative					
Cooperative Programs with States					
Management and Planning					
Evaluation and Planning					
Program Direction					
Total	52,285	34,401	4,791		91,477

Comparability Matrix
Building Technologies

FY 2002 Funding

(dollars in thousands)

	FY 2004 Structure						
	Residential Buildings	Commercial Buildings Integration	Emerging Technologies	Equipment, Standards & Analysis	Energy Science Initiative	Tech/ Program Mgmt Supp't	**Total**
FY 2002 Structure							
Building Technology,							
State and Community Sector							
Buildings Research and Standards							
Technology Road Maps and Competitive R&D			6,658			60	6,718
Residential Buildings Integration	12,179					45	12,224
Commercial Buildings Integration		4,403				15	4,418
Equipment, Materials and Tools							
Lighting Appliance and Standards				8,251			8,251
All Other			28,312			1,200	29,512
Buildings Research and Standards	12,179	4,403	34,970	8,251	0	1,320	61,123
Energy Science Initiative					1,959		1,959
Total	12,179	4,403	34,970	8,251	1,959	1,320	63,082

Comparability Matrix
Building Technologies
FY 2003 Funding

(dollars in thousands)

	FY 2004 Structure						
	Residential Buildings	Commercial Buildings Integration	Emerging Technologies	Equipment, Standards & Analysis	Energy Science Initiative	Technical Program Management Support	Total
FY 2002 STRUCTURE							
Building Technology, State and Community Sector							
Buildings Research and Standards							
Technology Road Maps and Compet. R&D.....			2,297			60	2,357
Residential Buildings Integration.....	13,433					45	13,478
Commercial Buildings Integration.....		4,995				15	5,010
Equipment, Materials and Tools							
Lighting Appliance and Standards.....				9,197			9,197
All Other.....			20,321			2,200	22,521
Total.....	13,433	4,995	22,618	9,197		2,320	52,563

Comparability Matrix
Biomass & Biorefinery R&D

FY 2002 Funding

(dollars in thousands)

	FY 2004 Structure			
FY 2002 Structure	Advanced Biomass Technology R&D	Systems Integration and Production	Technical Program Management Support	Total
Industry Sector				
Industries of the Future (Specific)				
Forest and Paper Products Vision.....		1,071		1,071
Agriculture Vision.....	7,109			7,109
Technical Program Mgmt Support.....			140	140
Industries of the Future (Crosscutting)				
Industrial Materials for the Future				
Combustion				
Industrial Gasification.....		16,069		16,069
Technical Program Mgmt Support.....			390	390
Total.....	7,109	17,140	530	24,779

Comparability Matrix
Biomass and Biorefinery R&D
FY 2003 Funding

(dollars in thousands)

	FY 2004 Structure			
	Advanced Biomass Technology R&D	Systems Integration and Production	Technical Program Management Support	Total
FY 2002 STRUCTURE				
Industry Sector				
INDUSTRY				
Industries of the Future (Specific)				
Steel Vision				
Aluminum Vision				
Metalcasting Vision				
Glass Vision				
Chemicals Vision				
Petroleum Vision				
Mining Vision				
Supporting Industries				
Forest and Paper Products Vision		1,080		1,080
Agriculture Vision	8,259			8,259
Technical Program Mgmt Support			267	267
Industries of the Future (Crosscutting)				
Industrial Materials for the Future				
Combustion				
High Efficiency Combustion Systems				
Industrial Gasification		13,600		13,600
Sensors and Controls				
Inventions and Innovation				
Industrial Technical Assistance				
NICE3				
Technical Program Mgmt Support			733	733
Total	8,259	14,680	1,000	23,939

Comparability Matrix
Program Management

FY 2002 Funding

(dollars in thousands)

	FY 2004 Structure			
	Program Direction	Planning, Evaluation, & Analysis	Communications and Outreach	**Total**
FY 2002 Structure				
Buildings Sector				
Program Direction	10,562			10,562
Evaluation and Planning		2,175		2,175
FEMP	4,400			4,400
Industry Sector				
Program Direction	8,647			8,647
Evaluation and Planning		730		730
Transportation Sector				
Program Direction	8,532			8,532
Evaluation and Planning		1,700		1,700
Power Sector				
Program Direction	1,628			1,628
Evaluation and Planning		322		322
Policy and Management				
Outreach and Communications			1,550	1,550
Program Direction				
Headquarters	17,335			17,335
Golden Field Office	6,165			6,165
Regional Offices	17,696			17,696
Total	**74,965**	**4,927**	**1,550**	**81,442**

Comparability Matrix
Program Management
FY 2003 Funding

(dollars in thousands)

	FY 2004 Structure			
	Program Direction	Planning, Evaluation, & Analysis	Communications and Outreach	Total
FY 2002 STRUCTURE				
Buildings Sector				
Program Direction.....	9,565			9,565
Evaluation and Planning.....		2,175		2,175
FEMP	4,455			4,455
Industry Sector				
Program Direction.....	6,905			6,905
Evaluation and Planning.....		730		730
Transportation Sector				
Program Direction.....	8,101			8,101
Evaluation and Planning.....		2,000		2,000
Power Tech				
Program Direction.....	1,520			1,520
Evaluation and Planning.....		100		100
Outreach and Communications			1,550	1,550
Policy and Management				
Headquarters.....	16,673			16,673
Golden Field Office.....	6,165			6,165
Regional Offices.....	15,015			15,015
Ops Offices.....	(incl. in HQ)			
Total.....	68,399	5,005	1,550	74,954