Office of Energy Efficiency and Renewable Energy
Energy Supply

Executive Summary

Mission

The Mission of the Office of Energy Efficiency and Renewable Energy (EERE) is to strengthen America's energy security, environmental quality, and economic vitality through public-private partnerships that:

- promote energy efficiency and productivity;
- bring clean, reliable, and affordable energy technologies to the marketplace; and
- make a difference in the everyday lives of Americans by enhancing their energy choices and quality of life.

The energy efficiency and renewable energy initiatives in this budget impact both energy supply and demand markets, all sectors of the U.S. economy, and all regions of the country. These efforts directly support the conservation, environmental, critical infrastructure, and security goals and recommendations in the National Energy Policy (NEP). This budget also directly supports the Secretary's mission of enhancing the Nation's energy security, and the President's FreedomFuel, weatherization, and climate change goals and initiatives. Specifically, EERE's portfolio helps achieve the Department of Energy's Energy Resources business-line goal to:

> *Increase global energy security, maintain energy affordability and reduce adverse environmental impacts associated with energy production, distribution, and use by developing and promoting advanced energy technologies, policies, and practices that efficiently increase domestic energy supply, diversity, productivity, and reliability.*

Goals and Objectives

EERE fulfills its mission through the pursuit of 3 objectives, directly tied to implementation of the National Energy Policy:

- ***Modernize conservation***. EERE energy efficiency programs constitute the majority of Federal efforts to improve the energy performance of the American economy by improving the productivity with which we use energy in our homes, vehicles, factories, and energy production and delivery systems.

  Objective: Through public-private partnerships:

  - Reduce U.S. energy intensity by 29 percent in 2020, compared to expected reductions of 26 percent without EERE Conservation programs. (Interior)

- Complete the weatherization of 753,000 low-income households from 2003 through 2008.

P ***Increase energy supplies.*** Accounting for some 9 percent of domestic energy production (including hydropower), America's vast domestic renewable energy resource base provides substantial opportunity for increasing and diversifying domestic production. EERE focuses on promoting technological improvements necessary to allow the private sector to develop these domestic resources.

Objective: Through public-private partnerships, increase renewable energy production by 70 percent in 2020, compared to an increase of 28 percent without EERE programs, including provision of about 22 percent of the expected 240 GW of additional electricity capacity installed between 2005 and 2020 with the EERE portfolio.[a] (EWD)

P ***Modernize our critical energy infrastructure.*** EERE's portfolio employs an integrated supply and demand systems approach to reducing the stress on our Nation's energy infrastructure by reducing peak demand for energy, developing on-site energy resources, and improving the efficiency with which energy is provided and distributed.

Objective: Through public-private partnerships, help ensure the adequacy of our electricity generation and transmission system through the development by 2020 of:

- 56 GW of distributed generation (compared to 38 GW without EERE programs)[b] and technologies facilitating an improvement in the operating efficiency of existing transmission capacity. (EWD)

- Demand and load management techniques and practices which allow an approximately 9 percent reduction in the expected 949 GW projected peak electricity demand, and provide the opportunity to reduce peak loads on an emergency basis. (Interior)

Expected Benefits

EERE's three objectives directly support three types of energy benefits for the United States: increased energy security, improvements in environmental quality, and economic gains. Pursuant to GPRA, EERE annually estimates the expected energy and oil savings, and related reductions in carbon emissions and energy expenditures, associated with market adoption of EERE program technologies under expected energy market conditions. Although these estimates clearly do not cover the full range of resulting benefits (*e.g.*, security and reliability benefits are not quantified), and reflect only one set of assumptions about future energy prices and markets, they do provide a sense of the level of short- and mid-term benefits associated with these programs.

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[a] This amount is smaller than the base due to efficiency improvements; these calculations were performed for the years 2015-2020.

[b] This difference is smaller than the reported capacity increase for the DEER Program, due to integration effects with the other programs.

A summary of the methods and models used in developing these benefit estimates is provided below. For further details about the models used to calculate the EERE benefits estimates, as well as information on the technology and market assumptions relevant to particular EERE programs, visit www.eren.doe.gov/eere/budget.html.

P ***Increased energy security.*** The efficiency, renewable, and infrastructure improvements described above would enhance both fuel and infrastructure security for the United States:

- U.S. oil consumption would be about 1.8 million barrels per day (b/d) lower in 2020 than otherwise expected, resulting in reductions in oil imports of about 1.5 million b/d, depending upon the response of international oil markets. Reductions in the energy intensity of the U.S. economy, combined with the development of more diverse domestic energy resources, would reduce the vulnerability of our economy to volatility in fuels prices.

- The development of distributed generation, load control options, and improved transmission operating flexibility would reduce the vulnerability of our electricity infrastructure to natural or man-made events, and increase the ability to cope with, and recover from, electricity emergencies.

P ***Accelerated protection and improvement of the environment.*** The energy efficiency and renewable energy technology improvements supported by this budget provide the U.S. with additional, longer-term flexibility in responding to current and potential future environmental needs. The efficiency, renewable, and infrastructure improvements described above would reduce a variety of emissions associated with energy production and use:

- EERE programs will contribute to the President's Clear Skies Initiative by reducing expected emissions of nitrogen oxide (NOx) and mercury (Hg) from electricity generation in 2020 by 3.7 percent and 1.5 percent, respectively, while contributing to reductions in particulate matter (PM) as well.

- EERE programs will reduce 2020 carbon dioxide (CO_2) emissions by 151 metric tons of carbon equivalents (MMTCE). This contributes to the President's goal of an 18 percent reduction in greenhouse gas (GHG) emissions intensity by 2012.

P ***Improved economic performance and energy affordability.*** The efficiency, renewable, and infrastructure improvements developed by EERE provide economic benefits to individual families and businesses, and to our economy as a whole:

- EERE programs have the potential to reduce energy bills by $102 billion in 2020, a reduction of 11 percent of the expected total U.S. energy expenditures in 2020 under business-as-usual market and policy conditions,

- Reductions in the demand for conventional energy resources reduce natural gas prices by about $0.50 per thousand cubic feet (mcf) in 2020.

EERE's programs are designed to provide the Nation with more energy efficient technologies and greater availability of domestic renewable energy resources. Taken together, these new technologies and energy sources provide the U.S. with unprecedented opportunities to respond to our future energy-related, economic, environmental, and security challenges.

The development of substantially more efficient vehicles, capable of operating on domestically-produced hydrogen, affords the Nation an important opportunity to reduce, and potentially eliminate, its dependence on imported oil. The development of more reliable, high-quality electricity supports our increasingly information-based economy. The development of substantially more efficient buildings and factories, combined with new means of producing electricity on-site, often from locally available renewable resources, will help the Nation address growing electricity infrastructure and reliability problems. The development of locally-available sources of electricity that can provide emergency services even in the event of power or fuel losses can improve our homeland security.

Energy efficient technologies and renewable energy resources also provide important tools and flexibility in responding to environmental issues, from local air quality to global climate change. On the economic front, new energy efficiency and renewable energy technologies can increase the competitiveness of U.S. companies in the global marketplace, as well as creating new domestic job opportunities.

The extent to which these technologies and resources are adopted depend in large part on the extent to which future economic, environmental, and security needs warrant their adoption. Although the largest benefits of efficient technologies and domestic renewable resources may come in response to energy, security, or environmental issues, significant benefits also occur in a business-as-usual future scenario.

GPRA 2004 Benefits Estimates

	Primary Non-Renewable Energy Savings (Quads)		Oil Savings (Quads)		Consumer Energy Expenditure Savings (Billion $2000)		Carbon Emission Reductions (MMT)	
	2010	2020	2010	2020	2010	2020	2010	2020
Biomass Program	0.10	0.33	0.07	0.33	0.6	1.9	0.8	3.6
Building Technologies Program	0.41	1.33	0.05	0.13	5.5	16.3	6.9	22.7
Distributed Energy & Electricity Reliability Program	0.19	0.46	0.01	0.02	3.1	9.0	3.4	8.5
FEMP	0.03	0.07	0.00	0.01	0.4	0.8	0.6	1.3
FreedomCAR & Vehicle Technologies Program	0.32	1.58	0.34	1.51	9.4	25.5	6.4	29.8
Geothermal Technologies Program	0.10	0.40	0.01	0.02	0.6	1.8	1.7	7.5
Hydrogen, Fuel Cells & Infrastructure Technologies Program	0.00	0.10-0.24	0.00	0.23	0.1	3.9	0.0	4.6
Industrial Technologies Program	0.56	2.13	0.13	0.46	4.4	20.2	9.9	36.3
Solar Energy Technology Program	0.07	0.12	0.00	0.01	0.5	1.4	1.3	2.4
Weatherization & Intergovernmental Program	0.68	1.42	0.14	0.60	6.0	14.7	8.9	26.3
Wind & Hydropower Technologies Program	0.20	1.15	0.01	0.08	1.4	5.4	3.2	20.9
Total, Individual Sums	2.66	9.09	0.76	3.4	32.0	100.9	43.1	163.9
Total, Integrated[a]	2.27	8.66	0.70	3.29	31.2	101.8	38.9	151.0

[a] EERE's portfolio approach to RD&D impacts benefits and the way they are calculated. The total benefits reported for EERE's entire portfolio are usually less than the sum of the individual programs due to competition between these technologies and the resulting tradeoffs. For instance, efficiency improvements reduce the future need for new electricity generating capacity, including the potential size of the renewable electric market. In addition, a research failure in one area will not necessarily reduce the technology's overall benefits, as the lack of market penetration by the failed technology may create a market opportunity elsewhere in the EERE portfolio. An integrated benefit total may be higher than the individual sums because of the additive impact of multiple EERE programs.

This budget reports the levels of savings for 2005 (short-term), 2010, and 2020 (mid-term), covering about 15 years of budget impacts.[a] EERE is completing analysis of impacts through 2050 (long-term), which will provide a more complete picture of EERE program benefits, especially for programs such as the Hydrogen, Fuel Cells & Infrastructure Technologies Program, which will require both significant R&D and market infrastructure changes to fully realize.

The estimates reported are based on the mid-term program goals identified in this budget, along with some longer-term goals identified in program roadmaps, where necessary to capture longer research time horizons. Technologies are often introduced into the models over time, since R&D tends to produce a series of price or performance improvements which gradually expand the available market for the technology.

In order to help standardize analysis across EERE's portfolio, roughly level FY 2004 funding amounts are presumed for future years, unless otherwise noted in individual program chapters. This analysis is undertaken pursuant to guidelines developed for EERE which specify common assumptions, methodologies, and approaches for use in estimating resulting benefits, although there remain to date some variations, sometimes substantial, in how the guidelines are implemented within and between specific areas. The guidelines are updated annually to reflect changes in the Energy Information Administration's (EIA) expectations about future energy markets, including energy prices and improvements in conventional technologies against which EERE technologies would compete in the marketplace. EERE's reorganization during FY 2002 consolidates analytical efforts and will facilitate improved consistency in the application of these guidelines to program benefit estimates in the future.

The NEMS-GPRA04 model is currently used to estimate benefits through the year 2020 (to be extended to 2025 starting with next year's analysis) and is the basis of the benefit estimates reported here. The EERE-2050 model (EERE's version of MARKAL, calibrated to NEMS) estimates benefits through 2050, with analyses available as completed. The models compare technologies against one another, resulting in projected market penetration estimates for each technology and associated levels of energy consumption and production, energy expenditures, and emissions. One requirement of this competition is that program technologies must provide additional value to consumers, or be available at lower costs, in order to produce benefits.

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[a] Benefits for 2005 are only presented at the program level in individual program chapters, not as integrated across the EERE portfolio.

Not all programs could be modeled individually this year. The FreedomCAR & Vehicle Technologies Program and the Hydrogen, Fuel Cells & Infrastructure Program were modeled jointly, as were the Wind and Hydropower Technologies Program; the Geothermal Technologies Program; the Solar Energy Technology Program; and the biopower portion of the Biomass Program. The benefit estimates for these individual programs would likely be somewhat higher if it were possible to model them without the program interactions.

In order to ensure that reported benefits do not include energy savings and other results that would have occurred without the EERE programs, the models are run twice – once with and once without the results of the EERE programs included. The net benefits of EERE programs reported in the above table are the differences between the "EERE Case" and the "No-EERE Case". The No-EERE Case is developed by removing explicit representation of EERE program effects from EIA's *Annual Energy Outlook 2002* Reference Case.

In the EERE Case, program outputs are represented using EERE's versions of two widely-used energy-economic models. The goals or outputs of R&D programs are typically represented in these models as improvements in technology cost and performance, while outputs of market transformation programs are represented by enhanced market penetration of energy technologies or practices. In some cases where the technology or intended market is not well represented in NEMS, benefit levels must be initially estimated off-line based on available market analysis to develop realistic estimates of market adoption. Assumptions currently used reflect the results of reviews by A.D. Little, Inc. over the last five years of the market adoption assumptions utilized in EERE benefit analyses (no review was undertaken in FY 2002). Off-line analyses are currently reduced across the board by 30 percent as a way of conservatively accounting for likely economic interactions within markets that often cannot be specifically identified without fuller modeling. Identifying a better approach for taking these effects into account is a high priority for future analyses. The results are then included in NEMS in order to account for feedback effects with other markets.

The models also keep track of changes in prices when new technologies change the level of demand for fuels. Efficiency and renewable technologies tend to place downward pressure on energy prices, resulting in part in an increase in uses of energy services such as lighting or travel. These price effects are accounted for in the benefit estimates reported. More difficult to assess is the extent to which improved technology characteristics will increase the sale of new technologies. Consumers often place a value on the cleaner, more reliable, higher quality, and more controllable nature of many of EERE's technologies that are not reflected in model comparisons with conventional technologies. In only a few cases, such as green power markets, was the market information available to take these technology attributes into account. In other cases, the positive impact of preferential consumer choice on EERE technologies are likely understated, especially with regard to the value of distributed generation and building efficiency improvements. Finally, and perhaps most importantly, the societal value of energy technologies that improve national security or reduce environmental impacts are not reflected in the modeled market choices. While excluding these factors provides a truer picture of the extent to which these technologies will be purchased in current markets, it understates the potential value of the products to society as a whole.

Management Strategies

Managing for Results – EERE's New Business Model. Excellence in business management is essential to accomplishing EERE's mission and objectives. In March 2002, EERE initiated a complete reorganization of its programmatic and business functions, implementing the President's Management Agenda and lessons learned from EERE's Strategic Program Review. The new EERE business model is based on using 11 programs to accomplish its mission and; centralizing business administration functions into a single EERE organization focused on supporting the 11 programs–this eliminated many inefficient overlapping functions and reduced layers between Program Managers and "top management,"thereby increasing the authority and accountability of the Program Managers. The new business model replaced the old organizations with the following:

- A DAS for Technology Development responsible for managing 11 Headquarters Program Management Offices and the 6 EERE Regional Offices.
- A DAS for Business Administration responsible for managing three Headquarters offices (Program Execution Support; Planning, Budget Formulation and Analysis; and Information and Business Management Systems) and the Golden Field Office.
- A Board of Directors (chaired by the Assistant Secretary for EERE) to provide expert advice and counsel with respect to the full range of EERE issues and activities.
- An Office of Communication and Outreach.

The Focus on Program Management. The DAS for Technology Development institutes program management standards and represents the Program Managers' interests to the Assistant Secretary and EERE Board of Directors. Each Program Manager is now much more prominent, accessible, accountable, responsible, and empowered. In addition, the Program Manager now has full use of—but does not have to manage—a "one-stop shop" Program Execution Support team dedicated to the program. This allows the Program Manager to focus primarily on program management rather than internal business management. EERE's previous 31 programs were restructured into 11 programs that address eight of nine EERE priorities that are based on EERE's mission and the energy policy goals and objectives (described below). The ninth priority -- "change the way we do business" -- is fulfilled by adopting and implementing the new business model.

Centralized Business Administration. Building on the Strategic Management System (SMS) adopted by EERE in January 2000, the creation of a single business office provides EERE with the opportunity to further integrate its planning, budget formulation, budget execution, and program analysis and evaluation functions. This new structure will allow EERE to "change the way we do business" by streamlining administrative functions, implementing consistent means of getting our work done, and improving the performance basis of our portfolio and management decisions.

The President's Management Agenda provides a blueprint for more efficient and effective government operations. EERE has pursued this agenda internally through its reorganization and with its participation and application of the OMB R&D Investment Criteria (R&DIC) and participation in the OMB Program Assessment Rating Tool (PART) process.

EERE is implementing the President's Management Agenda by:

- Management of Human Capital. EERE's reorganization reduces supervisory levels from eight to four, reduces five DAS-level positions to two, eliminates five ADAS-level positions, reduces the number of offices from 19 to 14 (including consolidation of 31 programs to 11) emphasizes core programs and management and facilitates workforce analysis.
- Expanded E-Government. The consolidation of business systems into a single office facilitates development of an EERE corporate procurement request and authorization system; a single EERE program/project management system; improved inter- and intranet services, data sharing, and streamlined IT policies and procedures to ensure alignment with DOE information systems. These efforts complement and support the Departmental-wide I-Manage system.
- Budget and Performance Integration. EERE included the Administration's R&D Investment Criteria (R&DIC) in its FY 2004 budget planning and will continue to integrate these criteria and those of the PART into program and corporate level planning, management and evaluation efforts. EERE is applying criteria from R&DIC and PART to its multi-year planning process currently underway. All of the EERE programs participated in the R&DIC and six of the programs/subprograms (Buildings, Geothermal, Hydrogen [subprogram], Solar, Weatherization [subprogram] and Wind [subprogram]) participated in the PART review as well. Individual programs are planning and acting upon the review findings that are programmatic in nature. On a corporate level in DOE and EERE, OMB's review recognized the difficulty of applying some of the original PART criteria to R&D programs, and EERE is working with OMB and others in the R&D community to make that process and EERE programs more able to achieve the intent of budget and performance review and integration in FY 2005. EERE is using the experience gained from the application of the R&DIC and PART in FY 2004 to work with OMB to develop an integrated and more effective review process for the FY 2005 budget from its inception. EERE is integrating the performance measures and benefits estimates to facilitate the performance based budgeting as described in the expected benefits section above and in the individual programs sections.
- Improved Financial Performance. EERE is working to improve program planning and implementation to more effectively obligate and cost appropriated funds. These improvements will reduce EERE's end-of-year uncosted obligations by $100 million within one year of final appropriations compared to fiscal year 2002 balance of $725 million. By more effectively implementing our programs, results are achieved sooner to the benefit of the American public.
- Competitive Sourcing. EERE is participating in a Departmental effort to competitively outsource 15 percent of all commercial activities.

Expected Near- and Long-Term Results: EERE's flattened structure will make it more responsive; increase its focus on results, not processes; directly link its budget to performance; end overlapping functions and resulting inefficiencies; and make the most of its people, and their knowledge, skills, and abilities.

Applied R&D Investment Criteria. All EERE applied R&D efforts were reviewed for FY 2004 using the OMB R&DIC developed in accordance with the President's Management Agenda by the Office of Management and Budget (OMB). The programs conducted internal reviews using the questionnaires, which

were then reviewed and ultimately screened by OMB. The Department continues to work with OMB to improve consistency and accuracy in reporting.

Strategic Program Review. EERE's Strategic Program Review (SPR), developed at the direction of the President's National Energy Policy and released in March 2002, found that EERE research, in the aggregate, generates significant public benefits and generally exhibits technical excellence. These findings have significant independent external support. For example, the National Academy of Sciences/National Research Council's recent review of $1.6 billion worth of EERE R&D identified $30 billion in net realized economic benefits and an additional $3-$20 billion in environmental benefits.[a] EERE-supported R&D is also a top recipient of the coveted "R&D 100" awards. The SPR further concluded, however, that there are significant areas needing improvement. This budget request seeks to implement these improvements. EERE utilized preliminary findings in helping to shape its FY 2003 budget request. With the final report in hand, EERE is moving forward on the specific recommendations for the closure, redirection, expansion, or provision for further review ('watch list') of specific efforts, along with the EERE-wide adoption of identified best-practices. In this regard, EERE is conducting oversight and evaluation through technical program management and support of individual programs' 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.

2002 Strategic Plan. EERE's FY 2004 budget request reflects the energy policy needs and opportunities identified in its 2002 Strategic Plan. This plan, which considers the potential for efficiency, renewable, and infrastructure benefits under expected future market and policy conditions also considers options in which energy markets or policy needs do not evolve as expected. The Strategic Plan recognizes the need to prioritize investments to make the largest possible contribution to DOE's energy resources goal along with our mission and objectives. Based on the NEP, the Secretary's Departmental mission, and recent analyses of potential future energy markets, EERE has identified nine priorities, eight of which are programmatic and used to identify needed programmatic shifts:

1. Dramatically reduce or even end dependence on foreign oil.
2. Reduce the burden of energy prices on the disadvantaged.
3. Increase the viability and deployment of renewable energy.
4. Increase the reliability and efficiency of electricity generation, delivery and use.
5. Increase the efficiency of buildings and appliances.
6. Increase the efficiency/reduce the energy intensity of industry.
7. Create the new domestic bioindustry.
8. Lead by example through the government's own actions.
9. Change the way we do business.

This budget reflects a large number of programmatic shifts since EERE reorganized the elements of 31 programs into 11 new programs that directly support the eight strategic programmatic priorities:

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[a] National Academy of Sciences / National Research Council. Energy Research at DOE: Was it Worth It? 2001.

STRATEGIC PRIORITY	PROGRAM
1. Dramatically reduce or even end dependence on foreign oil	Hydrogen, Fuel Cells & Infrastructure Technologies Program
	FreedomCAR & Vehicle Technologies Program
	Biomass Program
	Industrial Technologies Program
	Building Technologies Program
2. Reduce the burden of energy prices on disadvantaged	Weatherization and Intergovernmental Program
	Building Technologies Program
3. Increase the viability and deployment of renewable energy	Solar Energy Technologies Program Wind Energy and Hydropower Technologies Program Geothermal Technology Program
4. Increase the reliability and efficiency of electricity generation, delivery and use	Distributed Energy & Electricity Reliability Program
5. Increase the efficiency of buildings and appliances	Building Technologies Program
6. Increase the efficiency/reduce the energy intensity of industry	Industrial Technologies Program
7. Create the new domestic bioindustry	Biomass Program
8. Lead by example through government's own actions	Federal Energy Management Program

Complementary Appropriations

EERE's budget is appropriated in bills managed by two Congressional Appropriation Subcommittees. The Energy and Water Development (EWD) Appropriations Subcommittee supports EERE's work on renewable energy under the Energy Supply appropriation account. In FY 2004, the request in the EWD account totals $444,207,000, or 34 percent of EERE's budget. In addition, the Interior and Related Agencies (Interior) Appropriations Subcommittee supports EERE's energy efficiency efforts under the Energy Conservation appropriation account. The FY 2004 request in the Interior account totals $875,793,000 or 66 percent of EERE's budget. Six programs are jointly funded: Hydrogen, Fuel Cells, and Infrastructure Technologies Program; Weatherization and Intergovernmental Program; Distributed Energy and Electricity Reliability Program; Building Technologies Program; Biomass Program; and Federal Energy Management Program.

The complementary nature of these appropriations jointly facilitate making America more energy productive. In our modern economy, distinctions between energy supply increases and energy efficiency improvements increasingly are blurred. For example:

- Fuel cells increase energy efficiency while simultaneously providing a new way to power automobiles on fuels other than petroleum (Hydrogen, Fuel Cells, and Infrastructure Technologies Program).
- Technical assistance, consumer information, and other market enhancement efforts can be more effective when consumers can obtain a range of efficiency and renewable information in "one stop" (Weatherization and Intergovernmental Program).
- Distributed generation systems provide a new way to produce electricity supplies, while also affording improvements in efficiency by reducing transmission line losses and capturing and using otherwise wasted heat produced when electricity is generated (Distributed Energy and Electricity Reliability Program).
- Buildings designed to include both advanced efficiency and renewable energy features can achieve greater overall energy savings and even potentially produce as much or more energy on-site than they use on average over the course of a year (Building Technologies Program).
- Federal procurement can "lead by example" in purchasing cost-effective energy efficient products and renewable energy power supplies (Federal Energy Management Program).

Combined, both funding sources contribute to meeting our Nation's energy challenges and goals and to providing enhanced public benefits that could not otherwise be realized in this time frame.

Major External Influences

The following legislative requirements are major drivers of EERE activities:

P.L. 93-275	Federal Energy Administration Act of 1974
P.L. 93-409	Solar Heating and Cooling Demonstration Act (1974)
P.L. 93-410	Geothermal Energy Research, Development and Demonstration Act (1974)
P.L. 93-577	Federal Non-nuclear Energy Research and Development Act of 1974
P.L. 94-163	Energy Policy and Conservation Act (EPCA) (1975)
P.L. 94-385	Energy Conservation and Product Act (ECPA) (1976)
P.L. 94-413	Electric and Hybrid Vehicle Research, Development and Demonstration Act of 1980
P.L. 95-238	Automotive Propulsion Research and Development Act of 1978
P.L. 95-618	Energy Tax Act of 1978
P.L. 95-619	National Energy Conservation Policy Act (NECPA) (1978)
P.L. 95-620	Powerplant and Industrial Fuel Use Act of 1978
P.L. 95-91	Department of Energy Organization Act (1977)
P.L. 96-294	Energy Security Act (1980)
P.L. 96-512	Methane Transportation Research, Development and Demonstration Act of 1980
P.L. 100-12	National Appliance Energy Conservation Act of 1987
P.L. 100-494	Alternative Motor Fuels Act of 1988
P.L. 100-615	Federal Energy Management Improvement Act of 1988

P.L. 100-697	Superconductivity and Competitiveness 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. 101-566	Hydrogen Research, Development, and Demonstration Act of 1990
P.L. 101-575	Solar, Wind, Waste, and Geothermal Power Production Incentives Act of 1990
P.L. 102-486	Energy Policy Act of 1992 (EPACT)
P.L. 104-271	Hydrogen Future Act of 1996
P.L. 106-224	Biomass Research and Development Act of 2000

Major Program Changes

EERE achieves its energy efficiency, renewable energy, and infrastructure objectives through a mix of research, development, demonstration, and deployment (RD3) efforts. EERE's research is increasingly undertaken in the field with private sector partners in order to facilitate more rapid market adoption than is typical of the traditional, linear approach to RD3. EERE's RD3 efforts are also increasingly focused on realizing the cost savings and improved energy performance achievable with an overall systems approach to designing energy efficient and renewable energy use into homes, factories, vehicles, and transmission systems. This systems approach generates greater energy savings and use of renewable energy than is possible by improving the individual components alone.

Resources provided in the FY 2002 budget allowed for a number of significant accomplishments towards the development of clean, competitive, and reliable renewable energy and power delivery technologies. Sample indicators of recent progress and FY 2003 and FY 2004 activity changes by program funded by Energy Supply appropriations include:

Biomass and Biorefinery Systems R&D

P In FY 2002, a life-cycle assessment of a distributed biopower system, including determination of the benefits of avoiding transmission and distribution infrastructure and losses, was completed. In bioconversion, a second industrial partner achieved two-fold enzyme improvements. In bioconversion product integration, the program conducted experiments to refine the kinetic model and process configuration and evaluate residues from an interim process configuration. The program supported a cost-share competitive solicitation to initiate industrial biorefinery work in collaboration with industry, including the current corn ethanol industry.

P In FY 2003, efforts will continue testing of cleanup and conditioning technologies and catalysts needed for coupling biomass gasifiers to fuel cells. The program will have formed at least two partnerships with industry to establish fermentation organisms that can meet the performance goals established for the industrial biorefinery. In bioconversion product integration, the program will identify the best process options through process simulation analysis using the latest energy and material information and conceptual equipment cost estimates.

P In FY 2004, efforts will continue on the testing of clean-up and conditioning technologies and catalysts needed for biomass gasifiers. An industrial partner will validate the performance of an

organism capable of fermenting multiple biomass sugars for ethanol production. The program will continue funding biorefinery R&D projects until 2005.

Geothermal Technology

P In FY 2002, the program worked to understand complex natural geothermal processes and developed technology to facilitate producing geothermal resources in an economical manner. Research activities included improving reservoir models, studying fracture dynamics, developing tracers, and conducting geochemical research. The program completed preliminary designs for five competitively selected projects employing enhanced geothermal systems (EGS) technology. The Geothermal Technologies Program also selected a second round of cost-shared exploration projects and continued other multi-phase projects to find and confirm new geothermal resources.

P In FY 2003, the program seeks to understand complex natural geothermal processes and developing technology to facilitate geothermal resource production in an economical manner. Research activities include improving reservoir models, studying fracture dynamics, developing tracers, and conducting geochemical research. The Geothermal Technologies Program will increase the number of cost-shared, competitively-selected exploration projects initiated with industry to ten.

P In FY 2004, the program will conduct research to understand complex natural geothermal processes and develop technology to facilitate geothermal resource production in an economical manner. It will also step up work on EGS cost-shared projects at three competitively-selected sites. The program will maintain at least five cost-shared, competitively-selected, exploration projects initiated with industry to find and confirm new geothermal resources within the United States.

Hydrogen Technology

P In FY 2002, the Hydrogen, Fuel Cells & Infrastructure Technologies Program organized a comprehensive hydrogen roadmapping effort that used key stakeholders to assist in identifying challenges and paths forward to move the U.S. towards a hydrogen economy. Hydrogen storage development efforts culminated in validation and certification of 5000 psi hydrogen tanks suitable for short-range fleet vehicles. The program completed the construction of a hydrogen refueling station in Las Vegas, Nevada.

P In FY 2003, the program will fund a balanced research program for the development of small, mass-produced natural gas reformers; biomass systems that can use a range of feedstocks to co-produce hydrogen and other valuable products; and processes that produce hydrogen from water using sunlight. The program will test further the Las Vegas refueling station to validate production technologies.

P In FY 2004, the program will support the President's FreedomCAR and FreedomFuel initiatives

by accelerating development of low-cost, small-scale reformers and separation technology to enable hydrogen generated from distributed natural gas to achieve $3.00 per gasoline gallon equivalent by 2005 and to be competitive with gasoline by 2010 ($1.50 per gasoline gallon equivalent, delivered, pre-tax). It will also accelerate and expand research on the production of hydrogen from renewable resources, as well as continuing development of on-board hydrogen storage technologies, based on solid state materials, to enable achievement of 2010 goals of 2.0 kWh/kg (6 percent by weight hydrogen storage capacity), 1.5 kWh/l and $4/kWh. The program will conduct operations of Las Vegas fueling station to determine emissions and system efficiency and will initiate design and construction of hydrogen refueling stations to support limited "learning" demonstrations of fuel cell fleet vehicles.

Hydropower

P In FY 2002, Hydropower issued two RFPs for large turbine testing, one for designs/turbine manufacturers, and one for sites. The program initiated pilot-scale biological and hydraulic testing of a large turbine design. Based on initial test results, the program began planning for full-scale prototype testing.

P In FY 2003, Hydropower will begin large turbine testing activities. Successful testing is providing industry with additional turbine options for retrofit or new development, and will help to attain the 2 percent fish mortality goal by 2010. The program will also complete pilot-scale proof-of-concept testing of the Alden turbine design.

P In FY 2004, Hydropower will develop and test full scale (greater than 1 MW) prototypes of retrofit and new environmentally friendly designs under competitively selected public private partnerships. The program will also conduct full-scale prototype testing of the previously selected Alden Research Laboratory innovative turbine.

Solar Energy

P In FY 2002, the Solar Energy Technology Program continued to identify efficiency-limiting defects to advance the fundamental understanding of both PV materials and devices using state-of-the-art characterization techniques. Funding was continued for university basic research and analysis that improves the understanding of fundamental properties of novel materials and cell devices. The program began the first year of new Thin-Film Partnership three-year cost-shared contracts with industry to develop thin film technologies.

P In FY 2003, the solar program will begin a new PV Science Initiative with universities to develop next-generation PV materials and devices that have the potential for dramatic cost reductions. This activity will continue funding the most promising university projects under the Beyond the Horizon and Future Generation solicitations to accelerate their development. In the Thin-Film Partnership activity, the solar program will provide full funding for most promising thin film technologies and continue industry cost-shared contracts on technologies making the greatest achievements.

- In FY 2004, the solar program will begin second year of three-year contracts under the PV Science Initiative with universities to develop next-generation PV materials and devices that have the potential for dramatic cost reductions. The PV Science Initiative will more fully develop new ideas and concepts that can replace conventional technologies with a new generation of lower-cost, easier-to-manufacture technologies. In the Thin Film Partnership, the program will continue funding the most promising industry cost-shared contracts on technologies making the greatest achievements.

Wind Energy

- In FY 2002, the wind subprogram shifted away from cooperative research and testing of wind turbines designed for high-wind-speed (Class 6) areas, and concentrated on low-wind-speed (Class 4) turbine (LWST) technology, which could increase the land area usable for wind power by a factor of twenty. The subprogram competitively selected and commenced two conceptual design studies, two component development, and two full system development projects under the Phase I LWST solicitation. In addition, the wind efforts performed design review, analysis and testing to ensure that industry wind turbine research efforts in aero and structural dynamics, materials, wind characteristics, systems and components took full advantage of wind program technology developments and capabilities.

- In FY 2003, the wind subprogram will fabricate one near-term LWST full turbine system targeting a milestone of 4.5 cents per kilowatt-hour in Class 4 winds by 2005. The subprogram will complete design and beginning fabrication of advanced drive train and blade projects under WindPACT industry partnerships. The wind effort will complete conceptual design studies, and initiating multi-year, component and full system development projects competitively selected in FY 2002 under the Phase I LWST solicitation. In addition, the wind effort will provide research, design review, analysis, and testing support to industry wind turbine research partnership efforts using wind program expertise, technology developments, and capabilities.

- In FY 2004, the wind subprogram will select and commence 6-9 new industry partnership projects for concept studies, component development, and/or full system development under Phase II LWST competitive solicitation issued in 2003. It will also conduct research efforts in wind turbine aerodynamics, structures, materials, advanced components, and wind characteristics to support development of new and improved tools for low wind speed technology system design and applications. Performance in FY 2004 will be measured for Supporting Research & Testing activities using analytically-established targets linking contributions from each activity to meeting the program's low wind speed technology goals for large and small systems.

Electricity Reliability

- In FY 2002, in the area of high-temperature superconductivity (HTS), the electricity reliability

efforts completed design and construction of the prototype reciprocating magnetic materials separator with DuPont, and began testing. These activities included operation of Los Alamos and Oak Ridge National Laboratories "industrial research parks" for joint laboratory/industry research using state-of-the-art equipment to scale up processes for second generation HTS wire manufacture. In addition, the subprogram completed previously selected multi-year projects with industry to develop first-of-a-kind high temperature superconducting electrical transmission cables, HTS generators, and HTS transformers which demonstrated great improvements in efficiency and capacity for application to the U.S. electric grid. Industrial consortia worked with National Laboratories to develop high performance, low-cost, second-generation, high temperature superconducting wire.

P In FY 2003, the HTS subprogram will complete additional and final testing and evaluation for the prototype 100-MW, 3-phase, HTS cable installed in downtown Detroit. The subprogram will complete final testing and evaluation for the prototype reciprocating magnetic separator and the HTS-bearing, energy-storage flywheel, as well as competitively select public-private partnerships to provide DOE fifty-percent cost-share to multi-year projects with industry to develop first-of-a-kind HTS electrical systems using the latest HTS wire. Advanced, cost-shared, fundamental research activities will be conducted to better understand relationships between the microstructure of HTS materials and their ability to carry large electric currents over long lengths.

P In FY 2004, the subprogram will begin testing of a 100 MVA superconducting generator using groundbreaking design that is applicable to upgrading rebuilt generators in the 100 MW to 1200 MW sizes, as well as in new equipment. The HTS industry will work collaboratively with program-funded national laboratories to develop high-performance, low-cost, second-generation, high temperature superconducting wire. The subprogram will also conduct fundamental research activities that provide better understanding of relationships between the microstructure of HTS materials and their ability to carry large electric currents over long lengths.

Zero-Energy Buildings

In FY 2002, prototype designs were completed and construction was started on the initial first generation net zero-energy building (ZEB) homes, which are designed to cut homeowner utility bills by 50 percent.

In FY 2003, ZEB teams will finalize prototype designs for additional homebuilders. The program will complete design and analysis of climate-specific ZEB homes; evaluate ZEB construction methods and materials for their suitability in particular climates; and monitor prototype homes.

In FY 2004, ZEB efforts will focus on completing evaluation and monitoring of first generation ZEB homes, built by leading homebuilders, to verify a 50 percent reduction in annual utility bills to $600 per year for an average sized home in a temperate climate. The program will evaluate its activities to ensure no duplication or overlaps with Interior-funded efforts in the Buildings Technology Program exist.

Funding Summary (Energy Supply)

(dollars in thousands)

	FY 2002 Comparable Appropriation	FY 2003 Amended Request	FY 2004 Request	$ Change	% Change
Hydrogen Technology					
Production & Delivery R&D	11,148	11,760	23,000	+11,240	+95.6%
Storage R&D	6,125	11,335	30,000	+18,665	+164.7%
Infrastructure Validation	5,696	10,000	13,160	+3,160	+31.6%
Safety, Codes & Standards, and Utilization	4,486	4,786	16,000	+11,214	+234.3%
Education and Cross-Cutting Analysis	1,437	2,000	5,822	+3,822	+191.1%
Total, Hydrogen Technology	28,892	39,881	87,982	+48,101	+120.6%
Solar Energy					
Concentrating Solar Power	13,025	1,932	0	-1,932	-100.0%
Photovoltaic Energy Systems	70,855	73,693	76,693	+3,000	+4.1%
Solar Building Technology	3,227	4,000	3,000	-1,000	-25.0%
Total, Solar Energy	87,107	79,625	79,693	+68	+0.1%
Zero-Energy Buildings					
Zero Energy Building Design	1,367	8,000	4,000	-4,000	-50.0%
Total, Zero-Energy Buildings	1,367	8,000	4,000	-4,000	-50.0%
Wind Energy					
Technology Viability	23,411	29,800	29,800	+0	+0.0%
Technology Application	14,800	14,200	11,800	-2,400	-16.9%
Total, Wind Energy	38,211	44,000	41,600	-2,400	-5.5%

(dollars in thousands)

	FY 2002 Comparable Appropriation	FY 2003 Amended Request	FY 2004 Request	$ Change	% Change
Hydropower					
Technology Viability	3,886	5,089	5,589	+500	+9.8%
Technology Application	1,100	2,400	1,900	-500	-20.8%
Total, Hydropower	4,986	7,489	7,489	0	0.0%
Geothermal Technology					
Geoscience and Supporting Technologies	6,916	7,700	10,200	+2,500	+32.5%
Exploration and Drilling Research	8,084	12,100	11,500	-600	-5.0%
Energy Systems Research and Testing	12,035	6,700	3,800	-2,900	-43.3%
Total, Geothermal Technology	27,035	26,500	25,500	-1,000	-3.8%
Biomass/Biorefinery Systems R&D					
Advanced Biomass Technology R&D	38,373	37,430	31,000	-6,430	-17.2%
Systems Integration and Production	49,310	48,575	38,750	-9,825	-20.2%
Total, Biomass/Biorefinery Systems R&D	87,683	86,005	69,750	-16,255	-18.9%
Intergovernmental Activities					
International Renewable Energy Program	2,840	6,500	6,500	0	0.0%
Tribal Energy Activities	2,840	8,307	6,000	-2,307	-27.8%
Total, Intergovernmental Activities	5,680	14,807	12,500	-2,307	-15.6%
Electricity Reliability					
High-Temperature Superconducting R&D	31,991	47,838	47,838	0	0.0%

(dollars in thousands)

	FY 2002 Comparable Appropriation	FY 2003 Amended Request	FY 2004 Request	$ Change	% Change
Transmission Reliability R&D	18,257	7,720	10,720	+3,000	+38.9%
Distribution and Interconnection R&D	10,791	7,249	7,249	0	0.0%
Energy Storage R&D	9,098	7,640	5,000	-2,640	-34.6%
Renewable Energy Production Incentive	3,787	4,000	4,000	0	0.0%
Electricity Restructuring	2,840	2,059	2,059	0	0.0%
Total, Electricity Reliability	76,764	76,506	76,866	+360	+0.5%
Departmental Energy Management Program					
Energy Management Project Support	1,068	2,250	1,800	-450	-20.0%
Energy Management Model Program Development	353	750	500	-250	-33.3%
Total, Departmental Energy Management Program	1,421	3,000	2,300	-700	-23.3%
NCCTI	0	0	15,000	+15,000	NA
Program Direction	18,673	16,187	16,577	+390	+2.4%
Facilities and Infrastructure					
Operations and Maintenance	4,070	4,200	4,200	0	0.0%
Construction	800	800	750	-50	-6.3%
Total, Facilities and Infrastructure	4,870	5,000	4,950	-50	-1.0%
Total, Energy Efficiency and Renewable Energy - Energy Supply	382,689	407,000	444,207	+37,207	+9.1%

(dollars in thousands)

	FY 2002 Comparable Appropriation	FY 2003 Amended Request	FY 2004 Request	$ Change	% Change
Additional net budget authority to cover the cost of fully accruing retirement (non-add)	(817)	(720)	(720)	(0)	(0.0%)

Public Law Authorization:

P.L. 93-409, "Solar Heating and Cooling Demonstration Act" (1974)
P.L. 93-410, "Geothermal Energy Research, Development and Demonstration Act" (1974)
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, "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, "Powerplant 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. 104-271, "Hydrogen Future Act of 1996"
P.L. 106-224, "Biomass Research and Development Act of 2000"

Federal Staffing Requirements (FTEs)

	FY 2002 Actual	FY 2003 Budgeted	FY 2004 Budgeted
Renewable Energy Resources			
Golden Field Office	18	18	18
Idaho Operations Office	1	1	1
Headquarters	97	83	82
Total FTE, Renewable Energy Resources	116	102	101
Energy Conservation Programs			
Headquarters	274	274	270
Golden Field Office	37	37	38
Operations Office			
Chicago Operations Office	4	5	5
Idaho Operations Office	6	7	6
Oak Ridge Operations Office	1	1	1
Total, Operation Offices	11	13	12
Regional Offices			
Atlanta Regional Office	25	23	23
Boston Regional Office	17	16	16
Chicago Regional Office	18	18	18
Denver Regional Office	24	25	25
Philadelphia Regional Office	14	17	17
Seattle Regional Office	22	20	20
Total, Regional Offices	120	119	119
Total FTE, Energy Conservation Programs	442	443	439
Total FTE, Energy Efficiency and Renewable Energy	558	545	540

Institutional General Plant Projects

(dollars in thousands)

	FY 2002	FY 2003	FY 2004	$ Change	% Change
National Renewable Energy Laboratory	1,970	2,100	2,100	0	0.0%

Office of Energy Efficiency and Renewable Energy
Funding Summary by Program

(dollars in thousands)

	FY 2002 Comp Approp	FY 2003 Amended Request	FY 2004 Request to Congress	FY 2004 vs. FY 2003 $ change	FY 2004 vs. FY 2003 % change
Hydrogen, Fuel Cells & Infrastructure Technologies					
Hydrogen Technology	28,892	39,881	87,982	+48,101	+120.6%
Fuel Cell Technologies	46,682	57,500	77,500	+20,000	+34.8%
Total, Hydrogen, Fuel Cells & Infrastructure	75,574	97,381	165,482	+68,101	+69.9%
FreedomCAR and Vehicle Technologies	181,352	153,563	157,623	+4,060	+2.6%
Weatherization and Intergovernmental					
Intergovernmental Activities	5,680	14,807	12,500	-2,307	-15.6%
Weatherization Assistance Grants	230,000	277,100	288,200	+11,100	+4.0%
State Energy Program Grants	45,000	38,798	38,798	——	——
State Energy Activities	8,230	2,353	2,353	——	——
Gateway Deployment	40,951	41,195	27,609	-13,586	-33.0%
Total, Weatherization and Intergovernmental	329,861	374,253	369,460	-4,793	-1.3%
Solar Energy Technology	87,107	79,625	79,693	+68	+0.1%
Wind and Hydropower Technologies					
Wind Energy	38,211	44,000	41,600	-2,400	-5.5%
Hydropower	4,986	7,489	7,489	——	——
Total, Wind and Hydropower	43,197	51,489	49,089	-2,400	-4.7%
Geothermal Technologies	27,035	26,500	25,500	-1,000	-3.8%
Distributed Energy & Electricity Reliability					
Electricity Reliability	76,764	76,506	76,866	+360	+0.5%
Distributed Energy Resources	55,137	54,784	51,784	-3,000	-5.5%
Total, Distributed Energy & Electricity Reliability	131,901	131,290	128,650	-2,640	-2.0%

Building Technologies					
Zero Energy Buildings	1,367	8,000	4,000	-4,000	-50.0%
Building Technologies	63,082	52,563	52,563	——	——
Total, Building Technologies	64,449	60,563	56,563	-4,000	-6.6%
Industrial Technologies	100,909	91,477	64,429	-27,048	-29.6%
Biomass					
Biomass & Biorefinery Systems R&D (EWD)	87,683	86,005	69,750	-16,255	-18.9%
Biomass & Biorefinery Systems R&D (INT)	24,779	23,939	8,808	-15,131	-63.2%
Total, Biomass	112,462	109,944	78,558	-31,386	-28.5%
Federal Energy Management					
Departmental Energy Management Program	1,421	3,000	2,300	-700	-23.3%
Federal Energy Management Program	18,900	23,425	19,962	-3,463	-14.8%
Total, Federal Energy Management	20,321	26,425	22,262	-4,163	-15.8%
National Climate Change Technology Initiative (NCCTI) Competitive Solicitation					
NCCTI (EWD)	——	——	15,000	+15,000	N/A
NCCTI (INT)	——	20,000	9,500	-10,500	-52.5%
Total, NCCTI Competitive Solicitation	——	20,000	24,500	+4,500	+22.5%
Facilities and Infrastructure	4,870	5,000	4,950	-50	-1.0%
Program Direction					
Program Direction (EWD)	18,673	16,187	16,577	+390	+2.4%
Program Management (INT)	81,442	74,954	76,664	+1,710	+2.3%
Total, Program Direction	100,115	91,141	93,241	+2,100	+2.3%
Total, Energy Efficiency and Renewable Energy	**1,279,153**	**1,318,651**	**1,320,000**	**+2,100**	**0.2%**

Hydrogen Technology

Program Mission

The Hydrogen Technology Subprogram 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 Hydrogen Technologies Subprogram is a key component of the Administration's FreedomCAR and the new FreedomFuel 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. FreedomFuel 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 FreedomFuel 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 FreedomFuel 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 FreedomFuel initiative.

To accomplish the mission, activities are carried out under the FreedomFuel 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.

Budget and Performance Integration

To implement the budget and performance integration portion of the President's Management Agenda the Hydrogen Technology Subprogram participated in both the OMB R&D Investment Criteria (R&DIC) and the OMB Program Assessment Rating Tool (PART) process. The 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 Hydrogen Technology Subprogram FY 2004 budget proposal specifically:

- Fully supports the new FreedomFuel Initiative focused on overcoming challenges to economically producing, transporting, distributing and storing hydrogen for use as a consumer fuel. In implementing FreedomFuel, the DOE will partner with oil, energy and power companies. FreedomFuel and FreedomCAR will accelerate development of hydrogen and transportation-related fuel cell technologies, and the Nation's transition to a hydrogen-based economy.

- Expands and focuses high-risk R&D on hydrogen production from renewable resources and on hydrogen storage technologies.

- Incorporates five new long-term Program Specific Performance Goals (PSPGs) that now include all the key Subprogram activities and commits to improving annual performance indicators..

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, FreedomFuel has yet to establish specific technical targets. FreedomCAR has nine 2010 technology specific goals that are divided between two EERE program offices. FreedomFuel 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 (2001dollars).
- 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 FreedomFuel 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

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

Production and delivery of hydrogen will be expanded in the near-term by working with hydrogen producers and other industry partners to improve efficiency, reduce criteria emissions, and lower the cost of technologies that generate hydrogen from natural gas (near-term source) and renewable resources (long-term). Hydrogen production from natural gas focuses on small scale, distributed production not undertaken by the new Fossil Energy hydrogen program. Producing hydrogen from renewable sources comprises the majority of hydrogen spending, and includes research and development of shift reactors and related processes that can use a range of renewable feedstocks to produce hydrogen. Other key renewable research includes development and evaluation of sunlight absorbing semi-conductor components for photoelectrochemical water splitting to make hydrogen.

Long-term hydrogen storage activities will be expanded with increased emphasis on research and development of materials that will enable low-cost and low weight/volume storage systems for vehicles, such as advanced hydrides and carbon nanotubes. For the near-term, compressed hydrogen tanks will be demonstrated and certified. Compressed tanks provide a storage option for shorter-range fleet vehicles and for fuel cell buses, which do not have the volume constraint of compact light-duty automobiles. Due to a recent assessment of hydrogen storage needs, technology goals were revised and are currently under review. The Hydrogen Technology subprogram performance goal and indicator, and the detailed budget justification for storage reflect the revised technology goals. A safe, low-cost hydrogen storage system will be developed and validated for use on-board a vehicle to achieve more than a 300 mile range in one or two light-duty vehicle platforms by 2010, and in all light-duty platforms by 2015.

Infrastructure validation activities will be carried out in partnership with industry to develop and validate the feasibility of hydrogen generation stations that derive hydrogen from both renewable and fossil-fuel feed stocks for stationary and transportation fuel cell systems. Hydrogen production from natural gas, and related dispensing equipment, to achieve 70 percent well-to-pump energy efficiency and costs of $3.00 per gallon of gasoline equivalent by 2008 when produced in quantity will be developed and validated.

In addition, under infrastructure validation activities, Power Park Systems to co-produce hydrogen for fuel cell vehicles and stationary fuel cells will be validated at user facilities and with real world operations. The objective (2010) is to achieve a capital cost of $400-800/kW (depending on application) for stationary fuel cells, that would provide electricity at the station and a hydrogen production cost at the station of $1.50 per gallon of gasoline equivalent untaxed at 5000 psi for vehicles.

Safety, codes/standards and utilization activities are focused on ensuring the safety of hydrogen technologies and developing widely accepted codes and standards. Code developers will be assisted by experimental data from hydrogen refueling demonstration sites. The program will participate in development of uniform codes and standards at an international level to ensure that the U.S. industry can compete globally.

Education and cross-cutting analyses will focus on life cycle cost, emissions, and efficiency of a broad array of options for hydrogen infrastructure in the near (2015), mid (2030), and long term (post 2050). In addition, the program invests in technical program and market analysis and performance assessment in order to direct effective strategic planning.

Activities within the Hydrogen Technology Subprogram are conducted through competitive, cost-shared contracts with industry, and through pre-competitive R&D carried out by national laboratories and universities. Activities are merit reviewed and closely coordinated with those supported within the Fuel Cell Technology subprogram (under the Interior Appropriations), to develop and demonstrate highly efficient, integrated hydrogen-powered fuel cell systems for stationary and transportation applications.

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 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 basecase. 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

[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.

threats, or new environmental concerns, and the opportunity for oil demand to fall more rapidly than basecase 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:

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).

P 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 of vehicles.

The goals, performance indicators, and results for the Hydrogen Technology Subprogram (organized by goal) are:

Production and Delivery (Non-Renewable) - 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.

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

Performance Indicator

Cost of hydrogen produced in large quantities by renewable and nonrenewable fuel sources.

Annual Performance Results and Targets

FY 2002 Results	FY 2003 Targets	FY 2004 Targets
Completed construction of a prototype hydrogen generator with ceramic membrane for production and purification of hydrogen from natural gas.	Complete the design of a distributed natural gas-to-hydrogen production and dispensing system.	Develop a distributed natural gas-to- hydrogen production and dispensing system that can produce 5,000 psi hydrogen for $3.00 per gallon gasoline equivalent (untaxed) at the station, when produced in large quantities.

Model cost of hydrogen from renewables projected at $5.00 per gallon of gasoline equivalent (untaxed) at the station, when produced in large quantities.

Storage - 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.

Performance Indicator

Storage system specific energy and energy density.

Annual Performance Results and Targets

FY 2002 Results	FY 2003 Targets	FY 2004 Targets
Tanks: Completed certification of a 5000 psi hydrogen storage tank achieving 1.7 kWh/kg and 0.8 kWh/l.	Complete development of the 5,000 psi cyro-gas tank and 10,000 psi compressed gas tank achieving 1.3 kWh/kg and 1.0 kWh/l.	Complete testing and validation of 10,000 psi hydrogen storage tank achieving 1.3 kW/kg and 1.0 kWh/l.
Solid State: Developed materials enabling system targets of 0.8 kWh/kg and 0.5 kWh/l.	Engineer sub-scale solid state system meeting targets of 0.8 kWh/kg and 0.5 kWh/l.	Identify materials with the potential to meet 2015 targets of 3.0 kWh/kg (9 weight percent), 2.7 kWh/l, and $2/kWh.

Infrastructure Validation - validate infrastructure and vehicle interface technologies in 2008 with a cost of $3.00 per gallon gasoline equivalent.

Performance Indicator

Refueling Stations validating projected cost.

FY 2002 Results	FY 2003 Targets	FY 2004 Targets
Completed hydrogen refueling station from renewable sources.	Complete development of an integrated refueling station that can produce 5,000 psi hydrogen from natural gas for $3.60 per gallon of gasoline equivalent (including co-production of electricity), untaxed at the station, when produced in large quantities.	Complete validation of an integrated refueling station that can produce 5,000 psi hydrogen for $3.60 per gallon of gasoline equivalent (including co-production of electricity), untaxed at the station, when produced in large quantities.

Safety, Codes & Standards and Utilization - draft the technical specifications for a U.S. agreement on a global technical regulation for hydrogen fuel cell vehicles and infrastructure by 2007.

Performance Indicator

Development of technical specifications for hydrogen fuel cell vehicle and infrastructure regulations worldwide

Annual Performance Results and Targets

FY 2002 Results	FY 2003 Targets	FY 2004 Targets
No activities	No activities	Complete the harmonized regulation (i.e. incorporating the various standards of different countries into a single regulation) for hydrogen storage. Complete the technical draft for vehicular safety standards.

Education and Cross-Cutting Analysis - 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).

Performance Indicator

Percentage of each target audience that understands the concept, and how it may affect them, of a hydrogen economy.

Annual Performance Results and Targets

FY 2002 Results	FY 2003 Targets	FY 2004 Targets
No activities	No activities	Determine the baseline level of knowledge and develop a plan for educating target audiences (students and teachers, State and local governments, and large-scale end users nationwide)

Significant Program Shifts

The FY 2004 request more than doubles the FY 2003 request for the Hydrogen Technology Subprogram to support the President's new FreedomFuel Initiative.

The FY 2004 budget request represents a significant consolidation and realignment in the Hydrogen, Fuel Cells, and Infrastructure Technologies Program when compared to the FY 2003 budget request. This budget request reflects the functional priorities of the program: hydrogen production and delivery, hydrogen storage, hydrogen infrastructure validation, safety and codes/standards related to hydrogen and its infrastructure, and education and cross-cutting analysis. The new budget structure consolidates all electrolyzer research and development under production and delivery.

In addition, the FY 2004 request proposes that all fuel cell activities be performed under Interior and Related Agencies Appropriation. This is a change since some fuel cell work was requested under Energy and Water Development Appropriation in FY 2003. Also, all hydrogen production, delivery, and storage work is proposed to be under the Energy and Water Development Appropriation request in FY 2004. This is a change since some hydrogen storage and off-board natural gas reforming work was requested under Interior and Related Agencies in FY 2003. Along with this, work such as hydrogen feedstock analysis has been more properly placed under production and delivery. See the section of this request titled "Explanation of Funding Changes" for more specifics.

The increase in funding for FY 2004 compared to the FY 2002 request enables hydrogen production, storage, and infrastructure technology goals to be accelerated to enable commercialization of hydrogen-powered fuel cell vehicles by 2015 versus 2030.

Funding Profile[a]

(dollars in thousands)

	FY 2002 Comparable Appropriation	FY 2003 Amended Request	FY 2004 Request	$ Change	% Change
Hydrogen Technology					
Operating Expenses	28,892	39,881	87,982	+48,101	+120.6%
Total Hydrogen Technology	28,892	39,881	87,982	+48,101	+120.6%

Public Law Authorization:

P.L. 95-91, "Department of Energy Organization Act" (1977)
P.L. 96-294, "Energy Security Act" (1980)
P.L. 104-271, "Hydrogen Future Act of 1996"
P.L. 104-271, "Hydrogen Future Act of 1996"
P.L. 100-494, "Spark M. Matsunaga, Hydrogen Research, Development, and Demonstration Act of 1990"

[a] SBIR/STTR funding in the amount of $ 273,000 was transferred to the Science appropriation in FY 2002. Estimates for SBIR/STTR budgeted in FY 2003 and FY 2004 are $376,835 and $ 831,340 respectively. The FY 2002 Supplemental appropriation reduced this program by $ 777,000 for transfer to the Electricity Reliability program. The FY 2002 rescission reduced this program by $ 18,000. This program was reduced by a General Reduction of $ 1,040,000 in FY 2002.

Funding by Site[a]

(dollars in thousands)

	FY 2002	FY 2003	FY 2004	$ Change	% Change
Albuquerque Operations Office					
Golden Field Office	10,165	14,060	53,697	+39,637	+281.9%
Los Alamos National Laboratory	760	415	1,000	+585	+141.0%
National Renewable Energy Laboratory	6,628	7,445	14,890	+7,445	+100.0%
Sandia National Laboratory	2,945	2,900	3,900	+1,000	+34.5%
Atlanta Regional Office	140	200	200	0	0.0%
Boston Regional Office	80	200	200	0	0.0%
Chicago Regional Office	320	1,100	1,100	0	0.0%
Denver Regional Office	80	200	200	0	0.0%
Philadelphia Regional Office	115	200	200	0	0.0%
Seattle Regional Office	265	900	900	0	0.0%
Albuquerque Operations Office	1,998	5,195	0	-5,195	-100.0%
Total, Albuquerque Operations Office	23,496	32,815	76,287	+44,822	+136.6%
Chicago Operations Office					
Argonne National Laboratory	0	400	1,000	+600	+150.0%
Total, Chicago Operations Office	0	400	1,000	+600	+150.0%
Idaho Operations Office					
Idaho National Engineering and Environmental Laboratory	250	750	1,500	+750	+100.0%
Total, Idaho Operations Office	250	750	1,500	+750	+100.0%

[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."

	FY 2002	FY 2003	FY 2004	$ Change	% Change
National Energy Technology Laboratory	1,702	1,800	2,200	+400	+22.2%
Nevada Operations Office					
Nevada Operations Office	725	750	750	0	0.0%
Total, Nevada Operations Office	725	750	750	0	0.0%
Oakland Operations Office					
Lawrence Livermore National Laboratory	1,650	1,650	2,000	+350	+21.2%
Oakland Operations Office	300	115	0	-115	-100.0%
Total, Oakland Operations Office	1,950	1,765	2,000	+235	+13.3%
Oak Ridge Operations Office					
Oak Ridge National Laboratory	507	350	1,000	+650	+185.7%
Office of Scientific and Technical Information	10	0	25	+25	NA
Total, Oak Ridge Operations Office	517	350	1,025	+675	+192.9%
Richland Operations Office					
Pacific Northwest National Laboratory	50	100	220	+120	+120.0%
Total, Richland Operations Office	50	100	220	+120	+120.0%
Savannah River Operations Office					
Savannah River Operations Office	150	300	1,000	+700	+233.3%
Total, Savannah River Operations Office	150	300	1,000	+700	+233.3%
Washington Headquarters	52	851	2,000	549	+64.5%
Total, Hydrogen Technology	28,892	39,881	87,982	+48,101	+120.6%

Site Description

Golden Field Office

The Golden Field Office provides procurement services and technical oversight of the work conducted by the recipients of Cooperative Agreements. This includes research and development in the areas of production, storage and utilization, codes and standards, and validation of these technologies integrated into subscale systems.

Los Alamos National Laboratory

The Los Alamos National Laboratory (LANL) is conducting research and development of advanced hydrogen storage concepts such as polymer micro-spheres.

National Renewable Energy Laboratory

The National Renewable Energy Laboratory (NREL), located in Golden, CO, serves as the lead laboratory in research and development of technologies using renewable resources that will offer longer-term solutions to the production and storage of hydrogen. NREL is conducting research and development on material systems for the storage of hydrogen using carbon nanotubes and the photoelectrochemical production of hydrogen using semiconductors. NREL is also conducting research and development to engineer biological organisms and photoelectrochemical systems to split water into hydrogen and oxygen and the conversion of biomass to hydrogen. Additionally, NREL designs new processes and facilities to produce and use hydrogen through engineering calculations and cost evaluations, and provides key technical expertise for codes and standards development.

Sandia National Laboratory

The Sandia National Laboratory (SNL) in California serves as the lead laboratory in the research and development of metal hydride storage materials and systems for various end use applications. SNL is capable of producing metal hydride materials for use in research and validation projects. SNL also serves as the lead for the design, implementation, and testing of hydrogen systems to verify building codes and equipment standards for many applications.

Regional Offices

The six EERE Regional Offices located in Atlanta, Boston, Chicago, Denver, Philadelphia, and Seattle administer grants to regional, State and local organizations, both public and private.

Albuquerque Operations Office

Administered cooperative agreements.

Argonne National Laboratory

The Argonne National Laboratory (ANL) is conducting research and development of advanced hydrogen storage concepts such as nanostructured materials.

Idaho National Environmental and Engineering Laboratory

The Idaho National Environmental and Engineering Laboratory (INEEL), is performing research in the area of high temperature steam electrolysis using high temperature waste heat from next generation nuclear reactor technology. This technology can achieve significantly higher energy efficiencies than standard water electrolysis for the production of hydrogen. INEEL is also involved in hydrogen storage research and development.

National Energy Technology Laboratory

In accordance with a Memorandum of Agreement with the Office of Fossil Energy, NETL co-manages hydrogen research and development efforts to improve the efficiency and lower the cost of fossil-based hydrogen production processes. Collaboration also occurs with the Office of Fossil Energy and NETL for producing hydrogen from coal. Specifically, NETL researchers are developing separation and purification methods critical to producing high quality hydrogen used in fuel cells.

Nevada Operations Office

Nevada Operations Office provides technical and management assistance to develop an integrated hydrogen refueling station in Nevada, including coordination with the Department of Transportation.

Lawrence Livermore National Laboratory

The Lawrence Livermore National Laboratory (LLNL) serves as the lead laboratory in research and development of a high temperature solid oxide electrolyzer and two different systems for pressurized gas storage of hydrogen. LLNL is developing a solid oxide electrolyzer that will simultaneously reform natural gas to hydrogen using the waste heat for a higher round trip efficiency. LLNL is capable of producing composite storage tanks for environmental testing to verify the advantages of various engineering concepts to increase the storage capacity while reducing the cost of manufacturing.

Oakland Operations Office

Administered cooperative agreements.

Oak Ridge National Laboratory

The Oak Ridge National Laboratory (ORNL) performs research and development activities in photobiology and storage in support of the lead labs, NREL and SNL, respectively. ORNL has developed a collaboration with NREL and UC Berkeley to develop a microalgae system for the production of hydrogen. ORNL is using

their expertise to integrate engineered biological systems from NREL and UC Berkeley into a base organism that directly produces hydrogen.

Office of Scientific and Technology Information

The Office of Scientific and Technology Information (OSTI), located in Oak Ridge, TN, performs standard distribution of information for programs including Hydrogen Technology. This distribution consists of publishing and maintaining on-line full text of electronic current awareness publications and the production of CD-ROM disks containing reports.

Pacific Northwest National Laboratory

For the Hydrogen Technology Subprogram, the Pacific Northwest National Laboratory (PNNL) is the lead laboratory in the development of safety materials and systems for various end use applications. PNNL performs research and development tasks and other technical support to address safety issues involved with various technologies, including underground storage, pipeline transmission and hydrogen sensing .

Savannah River Technology Center

The Savannah River Technology Center (SRTC), is evaluating high temperature, chemical cycle water splitting to produce hydrogen using high temperature waste heat. SRTC is also involved in hydrogen storage research and development.

Funding Schedule

(dollars in thousands)

	FY 2002	FY 2003	FY 2004	$ Change	% Change
Hydrogen Technology					
Production and Delivery	11,148	11,760	23,000	+11,240	+95.6%
Storage	6,125	11,335	30,000	+18,665	+164.7%
Infrastructure Validation	5,696	10,000	13,160	+3,160	+31.6%
Safety, Codes & Standards, and Utilization	4,486	4,786	16,000	+11,214	+234.3%
Education and Cross-Cutting Analysis	1,437	2,000	5,822	+3,822	+191.1%
Total, Hydrogen Technology	28,892	39,881	87,982	+48,101	+120.6%

Detailed Program Justification

(dollars in thousands)

	FY 2002	FY 2003	FY 2004
Total, Production and Delivery R&D	**11,148**	**11,760**	**23,000**
P **Production and Delivery R&D**	**9,268**	**11,790**	**23,000**

The subprogram includes research and development of advanced technologies for producing and delivering hydrogen. Activities encompass a diversity of feedstocks such as natural gas, petroleum, and renewable sources including biomass and solar, to convert to hydrogen, with the majority of funding focused on renewables. Work involving other feedstocks are largely funded by, and coordinated with, other offices (i.e. Fossil Energy and Nuclear Energy). Technology areas include an array of processes and techniques such as reforming, separating, purifying, compressing, and delivering hydrogen.

FY 2002: The Department organized a comprehensive hydrogen roadmapping effort that used key stakeholders to assist in identifying challenges and paths forward to move the U.S. towards a hydrogen economy. Hydrogen will initially be produced from natural gas - the development of reforming technology that can produce hydrogen with higher efficiency, lower emissions, and lower cost is fundamental to our success. In support of these goals, the subprogram completed construction and testing of a prototype ceramic hydrogen membrane generator to produce hydrogen from natural gas, and the development and testing of electrolysis systems that decreased the capital cost by 50 percent (from $2500/kW to $1200/kW). SBIR/STTR funding in the amount of $273,000 was transferred from this subprogram to the Science Appropriation.

FY 2003: The subprogram will continue to fund a balanced research program for the development of small, mass-produced natural gas reformers; biomass systems that can use a range of feedstocks to co-produce hydrogen and other valuable products; and processes that produce hydrogen from water using sunlight. Several second generation electrolyzer systems will be awarded through a competitive procurement to lower the capital cost.

FY 2004: Accelerate and expand research on the production of hydrogen from renewable resources including conversion of biomass, photolytic and fermentative micro-organism systems, photoelectrochemical systems, and water electrolysis with the long term goal for these production technologies to produce hydrogen that is cost competitive with gasoline. Demonstrate biomass based production of hydrogen at a projected cost of $2.60/kg at the plant gate in 2008. Develop advanced electrolyzer concepts that address cost, energy efficiency, and durability issues that will demonstrate $600/kWe projected to10,000 electrolyzers/yr at 10,000 scfpd. Electrolysis development activities will include using low quality water and higher temperature operations.

Conduct research in high and ultra-high temperature water splitting chemical cycles using solar

concentrators. Conduct economic analyses and technical assessments for technologies being developed. Analysis activities will focus on diverse energy feedstocks for hydrogen production in the near (2015), mid (2030) and long term (post 2050). These energy sources will be evaluated based upon economic, environmental, and technological factors to identify viable pathways for producing and delivering hydrogen. Evaluate new technologies to produce hydrogen from non-carbon emitting approaches.

Accelerate development of low-cost, small-scale reformers and separation technology to enable hydrogen generated from distributed natural gas to achieve $3.00 per gasoline gallon equivalent by 2005 and to be competitive with gasoline by 2010 ($1.50 per gasoline gallon equivalent, delivered). Focus on critical reformer research activities to lower materials costs, improve reliability through higher activity catalysts with longer life, reduce unit production costs, and reduce unit size. In collaboration with the Office of Fossil Energy, evaluate more compact and energy efficient oxygen and hydrogen membranes and other separation and purification technology for applicability to distributed reforming as well as for the production of hydrogen in large scale central production facilities.

In conjunction with the DOE Office of Fossil Energy and the Department of Transportation, initiate analysis and research on lower cost transport and delivery of hydrogen from central production facilities to the point of use at refueling stations and stationary power operations. This will include initiating research on lower cost and more energy efficient hydrogen compression and liquefaction, lower costs and better materials for hydrogen pipelines, and new liquid or solid carriers for hydrogen transport.

P	**Congressionally Directed**	**1,880**	**0**	**0**

Funding for the following projects was directed by Congress to be included in this subprogram: The ITM Syngas project (FY 2001 $800,000, FY 2002 $1,410,000, FY 2003 $0) and the Gasification of Iowa Switchgrass project (FY 2001 $250,000, FY 2002 $470,000, FY 2003 $0).

Storage	**6,125**	**11,335**	**30,000**

The subprogram will develop and demonstrate compressed hydrogen tanks for near-term storage of hydrogen, and advanced materials for long-term hydrogen storage systems. Performance targets reflect revised technology goals currently under review.

FY 2002: Development efforts culminated in validation and certification of 5000 psi hydrogen tanks suitable for short-range fleet vehicles. Research efforts focused on complex metal hydrides that demonstrated hydrogen storage capacity twice that of conventional metal hydrides in laboratory tests (5 percent vs 2.5 percent).

FY 2003: Efforts include: 1) development of 10,000 psi hydrogen tanks to enable achievement of 2005 targets of 1.5 kWh/kg (4.5 weight percent), 1.2 kWh/l, and $6/kWh; and 2) research and development of reversible

(dollars in thousands)

storage materials - metal hydrides and carbon nanotubes - to enable achievement of 2010 targets of 2.0 kWh/kg (6 weight percent), 1.5 kWh/l, and $4/kWh.

FY 2004: Complete validation of high-pressure (10,000 psi) and cryogenic tanks as a near-term approach, enabling achievement of 2005 targets of 1.5 kWh/kg (4.5 weight percent), 1.2 kWh/l (tank upper limit), and $6/kWh. Investigate materials that allow novel tank geometries for low-volume tank design and technologies that enable safe, "smart" tanks to predict and communicate performance and potential failure.

Continue development of on-board hydrogen storage technologies, based on solid state materials, to enable achievement of 2010 goals of 2.0 kWh/kg (6 percent by weight hydrogen storage capacity), 1.5 kWh/l and $4/kWh. Enhance existing R&D in reversible storage materials, such as carbon nanotubes, metal hydrides, and address regeneration issues related to chemical hydrides, such as sodium borohydride. Explore options for hybrid approaches that combine compressed gas storage with reversible materials to reduce pressure requirements and increase vehicle range. Develop vehicle interface technologies, for example dispensing equipment and communications software, to reduce refueling times and ensure safety.

Expansion of hydrogen storage activity will focus on innovative chemistries and novel materials approaches in collaboration with the DOE Office of Science - through university, national laboratory, and industry R&D - to work toward 2015 goals of 3.0 kWh/kg (9 percent by weight hydrogen storage capacity), 2.7 kWh/l and $2/kWh. Advanced concepts include novel carbon nanostructures (other than nanotubes), polymer microspheres, and biometric materials

Complete development of a standardized test facility to compare the potential of hydrogen storage materials.

Focus analysis activities on advanced storage options for hydrogen with special attention to the energy required to get the hydrogen in and out of the storage medium. Assess regenerative chemical storage for efficiency, emissions, and the cost of chemical regeneration, and carbon nanotube storage for economic and technological potential to provide the needed breakthrough in hydrogen storage technology. The storage activity will also be expanded to include intermediate bulk storage needs within hydrogen transport/delivery infrastructure and at the point of use at refueling stations and stationary power operations. Hydrogen storage analysis will assist the programmatic decision process in 2006 to down-select to storage options that have the potential to meet long-term targets.

Infrastructure Validation	**5,696**	**10,000**	**13,160**

This activity includes the validation of advanced hydrogen technologies using full-scale demonstrations. Hydrogen technologies researched and developed by EERE are then verified for performance against established R&D goals and include high pressure storage tanks, production and delivery processes, and

(dollars in thousands)

hydrogen refueling station technologies.

FY 2002: A number of technology validation projects were completed. This includes the completion of the construction of the refueling station in Las Vegas, NV, completed certification of a commercial, 5000 psi composite wall high pressure storage tank, completion of an in-house certification of a high-pressure 3500 psi cryogenic gas tank.

FY 2003: Efforts will include further testing of the Las Vegas refueling station to validate production technologies to produce lower-cost distributed hydrogen and electricity, completing the validation of a 10,000 psi composite storage tank, and the certification of a 5000 psi cryogenic storage tank.

FY 2004: Conduct operations of Las Vegas fueling station to determine emissions and system efficiency. Initiate design and construction of hydrogen refueling stations to support demonstrations of hydrogen fuel cell fleet vehicles. For this vehicle/infrastructure demonstration, funding for the fuel cell vehicles will be requested in the Interior and Related Agencies budget. These refueling stations will utilize fossil and renewable-based hydrogen production technologies. The stations will address safety, cost, and standardization issues associated with a hydrogen infrastructure for fuel cell vehicles. Funding will continue for the demonstration of power park concepts that co-produce hydrogen and electricity for industrial complexes. Infrastructure validation analysis will examine data from integrated field projects to evaluate technologies against subprogram goals and milestones. In 2004, this will include analysis of cost and technical performance of hydrogen refueling stations and other infrastructure validation activities.

Total, Safety, Codes & Standards and Utilization	**4,486**	**4,786**	**16,000**
# Safety, Codes & Standards and Utilization	**867**	**4,786**	**16,000**

This activity includes accelerating the development of applicable codes and standards for hydrogen production and delivery processes as well as for hydrogen storage technologies for both transportation and stationary applications. Activities also include development of safety sensors and safety analysis.

FY 2002: The Department initiated safety testing of storage tanks and fuel delivery systems in support of efforts by the International Code Council and National Fire Protection Association to draft amended building codes for hydrogen and fuel cell applications. Two new sensor technologies were demonstrated in a laboratory setting that had no loss in accuracy due to interaction with other non-hydrogen gases.

FY 2003: Amended codes will be presented to the full voting body of the ICC. If successful, all of the

(dollars in thousands)

hydrogen codes will be included in all future versions of the model building code. One of the sensors will be installed in vehicles in Las Vegas for field verification and testing.

FY 2004: Begin development of a top-down safety analysis of all hydrogen-related processes and equipment for transportation and stationary applications. Collaborate with NASA and DOT to implement a comprehensive safety testing and evaluation program for hydrogen fuel cell vehicles that will result in a performance and certification specification for the National Highway Traffic Safety Administration. With industry, provide failure mode tests in each subsystem within the vehicle and identify design requirements to support FreedomCAR goals. Coordinate and develop new building codes and equipment standards for hydrogen technologies. Assist code developers by providing experimental data from hydrogen refueling demonstration sites. Conduct safety experiments and necessary analysis to determine adequacy of current distribution piping and bulk storage standards for hydrogen and provide design requirements for future above and below ground bulk storage systems used at refueling stations. Support development of international codes and standards by working with developing organizations such as International Codes Council and the National Fire Protection Association. Continue fundamental R&D of hydrogen combustion for internal combustion engines in coordination with the of FreedomCAR and Vehicle Technologies Program. Develop accurate, efficient, and lower cost sensors for leak detection, process control and safety measurements.

#	**Congressionally Directed . . . . . .**	**3,619**	**0**	**0**

The following projects were directed by Congress in FY 2002 to be included in this subprogram: Big Sky Development Corp demonstration of fuel cells in Montana. (FY 2000 $294,000, FY 2001 $350,000, FY 2002 $329,000, FY 2003 $0); Gallatin County Fuel Cell Demo (FY 2001 $0, FY 2002 $1,410,000, FY 2003 $0); Demonstration of Hydrogen-powered Underground Mining Locomotive and an Earth Loader (FY 2001 $2,000,000 FY 2002 $940,000, FY 2003 $0) and University of Alabama Fuel Cell technology assessment and demonstration (FY 2001 $0, FY 2002 $940,000, FY 2003 $0).

Education and Cross-Cutting Analysis	**1,437**	**2,000**	**5,822**

The subprogram includes development and distribution of training and education materials including films, manuals, and instruction books/booklets for hydrogen production, delivery, storage, and safety processes. Cross-cutting analysis will be used to assess the potential impact and benefits of hydrogen technology in society.

FY 2002: Two new educational films were completed. The first was a new safety film to be used to educate building code officials and Fire Marshals on the properties of hydrogen. The second film was produced as a

supplement to the educational curriculum developed for high school students. Both films were validated by industry stakeholders, educators and National Laboratory experts.

FY 2003: New education films will be used and further developed into training modules to be used by local code inspectors and other State government officials on the use of fuel cells and hydrogen technologies.

FY 2004: In collaboration with industry stakeholders, a cross-cutting planning model capable of analyzing options and trade-offs for the transition from liquid hydrocarbons to a hydrogen-based transportation system will be developed. This will include modeling of: 1) infrastructure - energy sources, conversion technologies, distribution and retailing options; 2) demand - representing vehicle manufacturing decisions, consumer demand for vehicles including vehicle-stock evolution and resulting hydrogen fuel demand; and 3) time-space economics - a methodology for integrating the infrastructure strategy and market demand in specific locations and times.

This model will be used, in collaboration with industry, to provide insight into important issues regarding timing of infrastructure investment, large-scale versus small-scale hydrogen production facilities for transition to hydrogen infrastructure, and decisions to facilitate initial hydrogen availability at retail outlets.

Educational materials will be developed to introduce hydrogen and fuel cell systems, and clearly communicate the hydrogen vision to potential end users, local governments, and others. This supports the National Energy Policy recommendation to communicate hydrogen benefits, safety, and utilization information to key stakeholders. In collaboration with industry and education organizations, create a curriculum and training program for elementary and secondary school teachers. The effort will pair teachers with local industry experts and involve practicing teachers in the development of a usable curriculum for education about hydrogen and fuel cells, as well as a training program for teachers to use the curriculum. Building on current Department efforts, university programs will be expanded to provide more students opportunities to research hydrogen and fuel cell technologies.

Regional, State, and local networks will be established to involve code officials, building engineers, energy regulators, and consumers in regional hydrogen technology demonstrations including education on installation, codes and standards, and safety issues. These regional programs will provide information exchange and networking to seek solutions to local hydrogen implementation barriers.

Total, Hydrogen Technology	**28,892**	**39,881**	**87,982**

Explanation of Funding Changes

	FY 2004 vs. FY 2003 ($000)
Production and Delivery	
P Accelerate and expand research on production from renewable resources (e.g. photoelectrochemical). Accelerates development of distributed natural gas reformers and separation technology	+11,240
Storage	
P Expands current storage R&D (carbon nanotubes, advanced hydrides, etc.) and initiates advanced storage concepts (polymer microspheres, biometric materials, etc.)	+18,665
Infrastructure Validation	
P Increase for hydrogen refueling stations for new fuel cell vehicle/infrastructure validation demonstration ($8,101). Decreases hydrogen internal combustion engine work for vehicles and eliminates funding for fuel cells (-$4,941)	+3,160
Safety, Codes & Standards and Utilization	
P Increases focus on Codes & Standards and hydrogen safety and expands R&D efforts to develop critical engineering data needed to complete and submit a global regulation for hydrogen storage and finalize a vehicle safety standard acceptable to the National Traffic Safety Administration (NHTSA)	+11,214
Education and Cross-Cutting Analysis	
P Initiates national education campaign to communicate the benefits and barriers of hydrogen technology. This activity includes only cross-cutting life cycle analysis; all other analysis activities shifted to other key activities.	+3,822
Total Funding Change, Hydrogen Technology	**+48,101**

Solar Energy Technology Program

Program Mission

Sunlight is an abundant, domestic energy resource. It can be used in every region of the country. The mission of the Solar Energy Program is to find ways to help meet America's energy needs through the development of solar energy devices and systems that are more efficient, reliable, and affordable.

Solar energy involves the conversion of sunlight into useful products such as electric power, process heat, hot water, and lighting. This can be accomplished on scales ranging from kilowatts to megawatts and can be used by electric utilities, manufacturing plants, commercial buildings, and residences. The Solar Energy Program currently includes development of photovoltaic systems, concentrating solar power troughs and dishes, solar hot water heaters, and fiber optic lights. It also includes balance-of-system (BOS) components such as DC to AC power inverters and battery charge controllers.

The Solar Energy Program mission addresses national priorities for energy, environmental, and security policies. The technologies developed by this Program will provide the Nation with a domestic energy resource that helps meet peak electricity needs, reduces the stress on our critical electricity infrastructure, and helps to mitigate peak electricity price vulnerabilities. As a result, customers can have more choices for meeting their energy needs; utilities can have more choices for operating feeder lines, substations, transmission lines, and central-station power plants; and the Nation can have more flexibility in responding to potentially higher energy prices, growing peak electricity demand, future environmental concerns, or changes in security assessments.

Federal solar energy research began in the 1970s in response to oil price shocks. At that time the cost of solar electricity was about $2/kWh. Technological advances over the last two decades have significantly reduced solar electricity costs. The Solar Energy Program is building on these advances by focusing research on new and advanced types of solar devices, including ones that use recent breakthroughs in advanced materials such as semi-conductors.

Today's solar energy technologies provide reliable and flexible power in high-value applications for homes, offices, and factories. In addition, their small scale, transportability, and lack of fuel requirements make them ideal sources of electricity for remote power and certain types of military uses. As one-fourth of the world's population is not currently served by an electric grid, solar technologies are being used in remote areas around the world to make electricity for refrigerating food and medical supplies and for supplying lighting to schools and hospitals. In addition, solar technologies power highway signs and portable electronics throughout the United States.

Sunlight could be harnessed to a much greater extent if solar energy technologies were more fully developed and affordable. This is especially true if the higher cost of providing peak electricity supplies is not reflected in the prices paid by consumers. To reduce costs, efficiencies for converting sunlight into electricity need to increase, system lives need to be longer to reduce replacement costs, and energy storage devices need to have

greater efficiency and lower costs. These accomplishments will require fundamentally different technological approaches than those used in current applications. In addition, manufacturers, utilities, builders, and consumers will need to have more experience with the installation, operation, costs, and benefits of solar energy systems.

To achieve these ends, the Solar Energy Program has directed its efforts towards three interrelated research areas and determined recently that one of them (concentrating solar power) no longer warrants support:

Photovoltaics (PV) - PVs are semi-conducting materials which directly convert sunlight into electricity. Modular by nature with no moving parts, they can be placed almost anywhere solar light is available. The current state-of-the-art crystalline silicon cells, with the ability to support high-value applications at 20 to 25 cents/kWh, cannot achieve the significant additional cost-savings required for widespread applications. To help realize the additional cost savings that are needed, the PV subprogram is developing various types of "thin-film" PV cells and exploring other advanced "leap-frog" technologies. The subprogram is also developing improved "inverters" that turn the DC electricity solar systems generate into AC power that can be used to run equipment, as well as technologies to improve unit interconnections with the electric grid.

Solar Buildings - Although solar water heaters have been around for some time, their glass-and-copper configuration make them costly to manufacture, difficult to install and maintain, and inflexible in their applications. The Solar Buildings subprogram is modernizing solar water heating by using lightweight polymer materials. The subprogram is also assessing an entirely new application of solar power in buildings through the development of fiber optic systems that bring sunlight into interior rooms of commercial buildings, which reduces energy requirements for artificial light and improves the quality of indoor lighting.

Concentrating Solar Power (CSP) - CSP systems use dishes for smaller, decentralized systems or troughs for larger, centralized systems to redirect and concentrate sunlight. The concentrated sunlight is used to boil water, which creates steam for generating power. CSP systems currently offer the least expensive source of solar electricity ($0.11 to $0.14/kWh wholesale for multi-megawatt, centralized power plants). However, the National Academy of Sciences reviewed the program in 2000 and determined that "arguments for continued research in this area are not very compelling because the technology is already essentially deployable." This activity will be terminated in accordance with the Administration's R&D investment criteria and Program Assessment Rating Tool (PART) assessments.

To ensure that these activities are within the realm of technical feasibility and properly aligned with market forces, the Solar Program routinely obtains substantial input from solar energy experts outside of the U.S. Department of Energy. The perspectives of solar energy practitioners help assure that the Program's research directions and priorities address the needs of manufacturers, utilities, State agencies, consumers, and other stakeholders. Technology Roadmaps and Peer Reviews have been completed within the last two years for

each of the primary Program areas—PV, CSP, and Solar Buildings.[a] These program areas are also closely coordinated with related efforts elsewhere in the Department, particularly those that develop Zero Energy Buildings and integrate distributed energy into our critical infrastructure. In addition, the program invests in technical program and market analysis and performance assessment in order to direct effective strategic planning.

The Solar Energy Program encompasses technology development from the seminal idea, through basic and applied research, to engineering development and technical readiness validation. For example, basic research develops non-conventional, breakthrough materials and technologies. Applied research develops nearer-term technologies such as thin films in partnership with industry. Engineering development produces techniques for advanced manufacturing, systems engineering, and module and system reliability to bring the technologies to the point of demonstration.

Budget and Performance Integration

To implement the budget and performance integration portion of the President's Management Agenda, the Solar Energy Program participated in both the Administration's R&D Investment Criteria (R&DIC) evaluation process and the OMB Program Assessment Rating Tool (PART) process. Both exercises guided program budget planning, management decisions, and performance goals and targets. As a result of program management and the PART review the Solar Energy Program FY 2004 budget specifically:

- Terminates the CSP subprogram
- Redirects requested funding from earmarked activities in FY 2002 to R&D that better contributes to the program's performance goals

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

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[a] PV: 2001 Peer Review of the DOE Photovoltaic Program, September 14, 2001; Solar Electric Power: The U.S. Photovoltaic Industry Roadmap, 2001; Photovoltaics, Energy for the New Millennium: The National Photovoltaics Program Plan 2000-2004, 2000.

CSP: 2001 Concentrating Solar Power Peer Review: Final Report, November 2001; Concentrating Solar Power: An Industry Vision for the New Millennium, 2001; Concentrating Solar Power: Paths to the Future, 1998; Parabolic-Trough Technology Roadmap: A Pathway for Sustained Commercial Development and Deployment of Parabolic-Trough Technology, January 1999; Concentrating Solar Power Dish Roadmap, March 2000; Draft: Central Receiver Technology Roadmap: A Pathway for Sustained Commercial Development and Deployment of Central Receiver Technology, April 2001; "Assessment of Parabolic Trough and Power Tower Solar Technology Cost and Performance Forecasts," October 2002.

Solar Buildings: 2001 Peer Review of the U.S. Department of Energy's Solar Buildings Technology Research Program, December 2001; Technology Pathways for the DOE Zero Energy Buildings Program, June 8, 2002; Zero Energy Homes Roadmap, May 2002

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 Solar Energy Program is provided below.

EERE's benefits estimate modeling starts with the Energy Information Administration's (EIA) National Energy Modeling System (NEMS) and modifies it to create NEMS-GPRA04. The baseline for renewable programs is essentially the EIA's Annual Energy Outlook (AEO) 2002 reference case, which already includes a small amount of penetration of solar technologies. The program goals for PV are modeled directly in NEMS-GPRA04 by incorporating these capital cost, operations and maintenance (O&M) cost, technology performance, and capacity factor improvements in NEMS-GPRA04 for the program case. The specifications for the costs and efficiencies of the solar water heaters in NEMS-GPRA04 are similarly improved to reflect the program goals. Because NEMS does not directly model water heating applications for pools, these savings estimates are developed separately based on market penetration analysis performed by Princeton Energy Resources International and then incorporated into NEMS-GPRA04 (with the pool estimates reduced by 30 percent to improve consistency with technologies modeled directly in NEMS). For both the baseline and program cases, the maximum share for intermittent generation and the short-term cost multipliers that indicate how quickly the industry can increase without cost penalties are modified based on analysis undertaken by the National Renewable Energy Laboratory, Lawrence Berkeley National Laboratory, and Princeton the Energy Resources International.

Consumers can exhibit preferences for different sources of electricity. Because NEMS-GPRA04 cannot directly address demand for green power, PV capacity to satisfy this market is estimated based on market analyses undertaken by Princeton Energy Resources International and introduced into NEMS-GPRA04 as planned additions. NEMS-GPRA04, however, does not reflect the additional demand consumers may have for solar energy because it provides increased reliability of service, an emergency source of power, and/or an improvement in load management capabilities. As a result, the benefits reported here understate the likely demand for solar energy.

FY 2004 GPRA Benefits Estimates for Solar Energy Program (NEMS-GPRA04)

	2005	2010	2020
Electricity Capacity (GW)	0.2	1.0	5.0
Electricity Generation (BkWh)	0.4	1.7	8.9
Non-Renewable Energy Savings (quads)	0.02	0.07	0.12
Oil Savings (quads)	0.00	0.00	0.01
Carbon Savings (MMT)	0.3	1.3	2.4
Energy Expenditure Savings (B2000$)	0.2	0.5	1.4

Estimates for electricity capacity and generation additions, energy savings, oil savings, carbon emission reductions, and energy expenditure savings that result from the realization of Solar Energy Program goals are

shown in the table above through 2020.[a] In the 2020 time frame, the technology improvements developed by this program provide nearly 9 GW of new electricity generating capacity under base case market assumptions, accounting for almost 3 percent of the additional electricity generating capacity needed over the next 15 years. Benefits for PV systems in particular are expected to grow beyond 2020 as the research is completed, market penetration grows, and the equipment stock turns over. These estimates reflect EIA reference case assumptions about future energy markets and would be larger if future electricity markets prove to be more constrained than expected or policy changes encourage the greater use of non-fuel, domestic electricity sources. In particular, estimated benefits would be sensitive to assumptions about the structure of future electricity prices and markets, particularly in the areas of peak pricing and load management market opportunities.

The Solar Energy Program provides additional types of public benefits in the areas of reliability, security, and environment not reflected in the quantified benefits reported above. Solar PV and thermal technologies, like other sources of distributed generation, provide local and flexible sources of critical infrastructure improvements, an important consideration given uncertainties regarding where and when specific infrastructure improvement will be most needed. Solar energy is particularly valuable in reducing the need for new generating and transmission capacity because its availability matches daily and seasonal electricity peaks. Solar energy provides additional energy security in the form of local power and hot water availability during emergencies which is not dependent on fuel deliveries or overhead wires that are subject to disruption and which will not contribute to local air pollution during a protracted emergency. Finally, because solar energy displaces electricity demand the most during the hottest, sunniest days of the year when electricity usage for space cooling is high, it is particularly effective at reducing Clean Air Act criteria pollutants when air pollution levels are at their highest and non-attainment status is most at risk.

Program Strategic Performance Goals

The Solar Program has the following overall performance goals: 1) by 2006, reduce the cost of grid-tied (battery-free) photovoltaic systems to the end user (including operation and maintenance costs) to $4.50 per Watt, from a median value of $6.25 per Watt in 2000, which requires a reduction in the cost of the PV module itself to $1.75 per Watt, compared with a cost of $2.50 per Watt in 2000 and would reduce the average cost of electricity generated by PV systems from a current $0.25/kWh to $0.18/kWh; and 2) by 2005, reduce the cost of solar water heating from $0.08/kWh in 2001 to $0.04/kWh. The long-term goal for PV systems is $0.06/kWh.

[a] Benefits reported are annual, not cumulative, for the year given. 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.

Performance Indicators:
(Identified by PSPG Sub-goal)

- Cost of electricity from photovoltaics (cents per kilowatt-hour)
- Cost of solar water heating (cents per kilowatt-hour)

In order to assess opportunities for more advanced solar systems, an additional program goal is to, by 2006, identify and begin prototype development of the two most promising PV leapfrog technologies, for example, nanotechnologies or plastic cells. They will be selected from the initial eight to ten candidates undergoing exploratory research that have the potential for dramatic cost reduction.

Annual Performance Results and Targets

FY 2002 Results	FY 2003 Targets	FY 2004 Targets
Reduced manufacturing cost of crystalline silicon PV modules to $2.25 per Watt (equivalent to a range of $0.20 to $0.25 per kWh price of electricity for an installed solar system). Reduced the projected cost of megawatt-scale CSP systems from $0.13 per kWh to $0.11 per kWh in 2001.	Reduce manufacturing cost of PV modules to $2.10 per Watt (equivalent to a range of $0.19 to $0.24 per kWh price of electricity for an installed solar system).	Reduce manufacturing cost of PV modules to $1.95 per Watt (equivalent to a range of $0.18 to $0.23 per kWh price of electricity for an installed solar system). Test the polymer-based balance-of-system components for solar water heating in order to validate their applicability to cold climates.

Funding Profile[a]

(dollars in thousands)

	FY 2002 Comparable Appropriation	FY 2003 Amended Request	FY 2004 Request	$ Change	% Change
Solar Energy	87,107	79,625	79,693	+68	+0.1%
Total, Solar Energy	87,107	79,625	79,693	+68	+0.1%

Public Law Authorizations:

P.L. 93-409, "Solar Heating and Cooling Demonstration Act" (1974)
P.L. 94-163, "Energy Policy and Conservation Act" (EPCA) (1975)
P.L. 94-385, "Energy Conservation and Product Act" (ECPA) (1976)
P.L. 95-91, "Department of Energy Organization Act" (1977)
P.L. 95-619, "National Energy Conservation Policy Act" (NECPA) (1978)
P.L. 96-294, "Energy Security Act" (1980)
P.L. 101-218, "Renewable Energy and Energy Efficiency Technology Competitiveness Act of 1989"
P.L. 101-575, "Solar, Wind, Waste, and Geothermal Power Production Incentives Act of 1990"

[a] SBIR/STTR funding in the amount of $ 870,000 was transferred to the Science appropriation in FY 2002. Estimates for SBIR/STTR budgeted in FY 2003 and FY 2004 are $ 829,094 and $ 829,802 respectively. The FY 2002 Supplemental appropriation reduced this program by $ 2,381,000 for transfer to the Electricity Reliability program. The FY 2002 rescission reduced this program by $ 61,000. This program was reduced by a General Reduction of $ 3,177,000 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	64,417	63,192	63,442	+250	+0.4%
Golden Field Office	1,230	1,250	1,950	+700	+56.0%
Sandia National Laboratory	12,189	7,000	6,918	-82	-1.2%
Atlanta Regional Office	50	50	50	0	0.0%
Boston Regional Office	50	50	50	0	0.0%
Chicago Regional Office	50	50	50	0	0.0%
Philadelphia Regional Office	50	50	50	0	0.0%
Seattle Regional Office	50	50	50	0	0.0%
Albuquerque Operations Office	3,931	1,900	1,900	0	0.0%
Total, Albuquerque Operations Office	82,017	73,592	74,460	+868	+1.2%
Chicago Operations Office					
Brookhaven National Laboratory	330	400	400	0	0.0%
Chicago Operations Office	80	0	0	0	0.0%
Total, Chicago Operations Office	410	400	400	0	0.0%
Oakland Operations Office					
Oakland Operations Office	750	750	750	0	0.0%
Total, Oakland Operations Office	750	750	750	0	0.0%
Oak Ridge Operations Office					
Office of Scientific and Technical Information	20	20	20	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.

	FY 2002	FY 2003	FY 2004	$ Change	% Change
Oak Ridge Operations Office	500	800	0	-800	-100.0%
Total, Oak Ridge Operations Office	520	820	20	-800	-97.6%
Washington Headquarters	3,410	4,063	4,063	0	0.0%
Total, Solar Energy	87,107	79,625	79,693	+68	+0.1%

Site Description

National Renewable Energy Laboratory

The National Renewable Energy Laboratory (NREL) is the lead laboratory for the National Photovoltaic R&D Program. NREL conducts fundamental and applied materials research on photovoltaic devices, photovoltaic module reliability and systems development, data collection and evaluation on solar radiation, and implementation of cost-shared government/industry partnerships. Basic research teams investigate a variety of photovoltaic materials, such as amorphous silicon, polycrystalline thin films, high-efficiency materials and concepts, and high-purity silicon and compound semiconductors. NREL conducts simulated and actual outdoor tests on photovoltaic cells, modules, and arrays. The test results are used in developing standards and performance criteria for industry and to improve reliability. NREL also serves as the lead laboratory for the Solar Buildings subprogram. NREL supports this by managing technical tasks subcontracted to universities and industry and the development of low-cost solar collectors for water or space heating. In addition, NREL coordinates related technical activities with the Sandia National Laboratory.

Golden Field Office

The Golden Field Office (GO) administers the Solar Rating and Certification Corporation grant for the Solar Buildings subprogram. This grant enables the solar industry to develop voluntary standards on the performance and reliability of solar water heaters. GO also administers contracts for two projects for the Photovoltaic Energy Systems subprogram. GO utilizes cooperative agreements and requests for proposals to help industry realize the benefits of using photovoltaic systems and devices.

Sandia National Laboratory

Sandia National Laboratory (SNL) supports the Photovoltaic Energy Systems subprogram with the principal responsibility for systems and balance-of-systems technology development and reliability. Indoor and outdoor measurement and evaluation facilities provide support to industry for cell, module, and systems measurement, evaluation and analysis. Systems-level work concentrates on application engineering reliability, database development, and technology transfer.

Regional Offices

The six EERE Regional Offices located in Atlanta, Boston, Chicago, Denver, Philadelphia, and Seattle provide support to the R&D programs by administering grants and cooperative agreements to regional, State and local organizations, both public and private.

Albuquerque Operations Office

The Albuquerque Operations Office administers the cooperative agreements for the southeast and southwest regional experiment stations (RESs).

Brookhaven National Laboratory

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

Chicago Operations Office

The Chicago Operations Office assists in administering the Million Solar Roofs program.

Oakland Operations Office

The Oakland Operations Office assists in administering the Million Solar Roofs program.

Office of Scientific and Technology Information

The Office of Scientific and Technology Information (OSTI) publishes and maintains on-line full text of eight electronic current awareness Solar Energy Program publications and produces CD-ROM disks containing photovoltaic reports.

Oak Ridge Operations Office

The Oak Ridge Operations Office conducts research on fiber optic systems to enhance day lighting using sunlight.

Funding Schedule

(dollars in thousands)

	FY 2002	FY 2003	FY 2004	$ Change	% Change
Solar Energy					
Photovoltaic Energy Systems	70,855	73,693	76,693	+3,000	+4.1%
Solar Building Technology	3,227	4,000	3,000	-1,000	-25.0%
Concentrating Solar Power	13,025	1,932	0	-1,932	-100.0%
Total, Solar Energy	87,107	79,625	79,693	+68	+0.1%

Detailed Program Justification

(dollars in thousands)

	FY 2002	FY 2003	FY 2004
Photovoltaic Energy Systems	**70,855**	**73,693**	**76,693**
# Fundamental Research	**21,065**	**30,400**	**30,400**

Fundamental research is key to continued advancement of photovoltaic technology that is necessary to meet long-term goals of $0.06/kWh electricity by 2020. Industry and university researchers are working in partnership with National Laboratories to improve the efficiency of cell materials and devices by investigating their fundamental properties and operating mechanisms. This teamed research approach works to identify efficiency limiting defects in cell materials and analyzes their electrical and optical properties.

Fundamental research is also used to investigate innovative ideas and leap-frog technologies. This high-risk research opens the door to non-conventional concepts that could dramatically improve cost effectiveness in the long term. For example, the PV Science Initiative, which starts in FY 2003, is used to more fully develop ideas and concepts for replacing conventional technologies with a new generation of lower-cost, easier-to-manufacture technologies. In support of thin films, basic science of polycrystalline thin films based on cadmium telluride (CdTe) and copper indium diselenide (CIS) alloys will also be conducted to provide a broader understanding of stability and degradation issues associated with fabricating materials on a larger scale.

The High Performance Initiative, started in FY 2001, supports research to substantially increase the efficiency of two key technologies: 1) large-area, monolithically interconnected multi-junction thin films and 2) super high efficiency multi-junction concentrating cells. Fundamental research is aimed at increasing the conversion efficiency of thin films from their current 8 to10 percent to 15 to 20 percent, and to increase multi-junction cell efficiency from the current 30 percent to 40 percent. Both approaches have the potential to substantially reduce the costs of photovoltaic cells.

FY 2002: Continued to identify efficiency-limiting defects to advance the fundamental understanding of both PV materials and devices using state-of-the-art characterization techniques. Only the most critical research in support of industry was conducted in FY 2002. Continued funding for university basic research and analysis that improve the understanding of fundamental properties of novel materials and cell devices. Continued full funding for the High Performance Initiative to reach goals of doubling efficiencies for thin film modules and developing a commercial 40-percent concentrating cell device by 2010. SBIR/STTR funding in the amount of $635,000 was transferred from this subprogram to the Science appropriation.

(dollars in thousands)

FY 2002	FY 2003	FY 2004

FY 2003: Begin a new PV Science Initiative with universities to develop next-generation PV materials and devices that have the potential for dramatic cost reductions. This activity will continue funding the most promising university projects under the Beyond the Horizon and Future Generation solicitations to accelerate their development. The new PV Science Initiative will be initiated to more fully develop new ideas and concepts that can replace conventional technologies with a new generation of lower-cost, easier-to-manufacture technologies. Continue measurement and characterization research in support of industry and the High Performance Initiative.

FY 2004: Begin second year of three-year contracts under the PV Science Initiative with universities to develop next-generation PV materials and devices that have the potential for dramatic cost reductions. The PV Science Initiative will more fully develop new ideas and concepts that can replace conventional technologies with a new generation of lower-cost, easier-to-manufacture technologies. In support of thin films, research will focus on roles of semiconductor solid phases, defects, and impurities to optimize and improve performance. Processing methods and devices will be investigated to improve large-area deposition techniques and growth mechanisms such as non-vacuum deposition processes that can achieve better uniformity and higher deposition rates. Under measurements and characterization, continue efforts to identify efficiency limiting defects to advance the fundamental understanding of both PV materials and devices using state-of-the-art characterization techniques. Continue full funding for the High Performance Initiative to reach goals of doubling efficiencies for thin film modules and developing a validated 40-percent-efficient concentrating cell device by 2010. Performance will be measured by demonstrating a 35-percent-efficient device by the end of 2004.

P	**Advanced Materials and Devices . . . . . .**	**26,839**	**29,793**	**29,793**

The Advanced Materials and Devices activity has three sub-activities: thin film R&D, crystalline silicon R&D, and advanced manufacturing R&D.

Development of thin films is a major thrust of the program and receives strong industry support. Most PV technologists agree that thin film technologies have the best chance for attaining the subprogram's long-term goal of $0.06/kWh by 2020. The Thin Film Partnership has formed strong research teams to focus R&D on promising thin film candidates, such as amorphous silicon, copper indium diselenide, and thin film silicon. These research teams are comprised of laboratory, industry, and university researchers who work to solve generic issues as well as industry specific problems.

Crystalline silicon (c-Si) is the workhorse of the U.S. industry, which comprises just under 90 percent of the modules sold in the market today. Most of the commercial modules are 12 to 14 percent efficient. Goals are to use a small amount of subprogram funding to leverage continued industry research to improve module efficiencies from 14 to 18 percent and lower vendor systems cost to $4.50 per Watt by 2006.

In Advanced Manufacturing R&D, strong partnerships with the U.S. PV industry have been formed with the goal of retaining and enhancing the industry's leadership in the development and manufacture of PV modules. Many areas of manufacturing R&D are critical to further reduce the cost of PV. In collaboration with university researchers and industry, the National Laboratories will apply fundamental physics and chemistry principles to identify nanostructure deficiencies in photovoltaic materials and develop solutions that will improve sunlight-to-electricity conversion efficiencies, while lowering manufacturing costs. Three of the most important barriers are yield, throughput rate, and the ability to consistently produce more efficient modules. Better, more reliable, and faster processes are required, and these in turn require improvements such as more intelligent processing, in-situ diagnostics, and less expensive methods of assembly.

FY 2002: Began first year of new thin film partnership three-year cost-shared contracts with industry to develop thin film technologies. Aggressive goals have been established to transition at least two of the technologies from pilot plant status to multi-megawatt production. Performance of ongoing research is measured by validating a 19-percent-efficient small-area thin film cell (laboratory bench scale) and 12-percent-efficient large area module (pre-production prototype). Due to the maturity of silicon technology, funding was reduced to support only the most innovative research on silicon crystal growth methods with improved throughput and conversion efficiency and lower energy and materials cost as compared to current methods. In advanced manufacturing R&D, a new solicitation was issued in 2001 to develop in-situ process diagnostics and intelligent processing needed for integrated module manufacturing scale-up. All industry contracts have 50-percent minimum cost sharing. The Advanced Manufacturing R&D activity is focused on high-throughput, large-area thin films and next-generation, high-throughput thin wafer silicon technologies not addressed in prior years.

FY 2003: In the Thin Film Partnership, fund the most promising thin film technologies and continue industry cost-shared contracts on technologies making the greatest achievements. Performance will be measured by completing the transition of at least one thin film technology from prototype production to multi-megawatt scale production. Efforts will focus on the most innovative research on silicon crystal growth methods with improved throughput, conversion efficiency, and lower energy and materials cost as compared to current methods. Support the highest priority module reliability research. In Advanced Manufacturing R&D, begin second year of three-year cost-shared industry contracts to develop in-line diagnostics and intelligent processing needed for manufacturing scale-up, increased yield, higher efficiencies, and reduced

cost. Performance will be measured by achieving module manufacturing process capable of $2.10 per Watt direct manufacturing cost with 50 megawatt production capacity.

FY 2004: In the Thin Film Partnership, continue full funding for most promising industry cost-shared contracts on technologies making the greatest achievements. Support the most innovative research on silicon crystal growth methods with improved throughput, conversion efficiency, and lower energy and materials cost as compared to current methods. In Advanced Manufacturing R&D, begin third year of three-year cost-shared industry contracts to develop in-line diagnostics and intelligent processing needed for manufacturing scale-up, increased yield, higher efficiencies, and reduced cost. Performance will be measured by achieving module manufacturing processes capable of $1.95 per Watt direct manufacturing cost with 50 megawatt production capacity in FY 2004.

P **Technology Development** **17,555** **13,500** **16,500**

The Technology Development activity involves three sub-activities: systems engineering and reliability; building integrated PV R&D; and outreach and analysis.

Systems engineering and reliability research focuses on the critical need to improve reliability of the entire PV system, including balance-of-system components such as DC to AC power inverters and battery charge controllers. This work is led by Sandia National Laboratory and is implemented in close partnership with industry and the Southeast and Southwest Regional Experiment Stations. Emphasis is placed on four technical objectives: 1) reducing life-cycle costs; 2) improving reliability of systems and system components; 3) increasing and assuring the performance of fielded systems; and 4) removing barriers to the use of the technology. To help remove barriers, the engineering and reliability activity supports development of standards and codes, and procedures for certifying performance of commercial systems.

Building integrated photovoltaics (BIPV) is a rapidly growing solar application in which PV modules serve the dual purpose of replacing conventional building materials and generating electricity. While traditional applications such as remote telecommunications and rural infrastructure will continue to grow, industry's new emphasis is BIPV. By offering more than one functionality, BIPV systems will help cross the profit threshold that holds the key to significant growth in distributed, grid-connected electricity markets. This effort will be coordinated with the Building Technologies Program to develop Zero Energy Buildings.

Outreach and analysis activities are necessary for a national R&D program to remain viable in a rapidly changing energy sector. Activities include testing, verification, and deployment activities for

(dollars in thousands)

grid-connected applications and analyzing private sector commercialization options to better target R&D pathways.

FY 2002: Maintained viable system engineering and reliability program at Sandia National Laboratory and the Southeast and Southwest Regional Experiment Stations. Completed standard reliability database and conducted analysis to identify failure mechanisms impeding the 30-year lifetime goal and focused design improvements where they were needed most. Published inverter status report that describes R&D requirements for a high-performance, long-life inverter. Continued outreach activities to energy providers and assessed deployment needs. Continued data collection and analysis from deployed systems. Increased funding for peer reviewed analysis studies aimed at improving program decisions. Continued to distribute Million Solar Roofs funding to DOE regional offices to provide technical assistance to the partnerships at the State and local level. Began transfer of Million Solar Roofs activities to the private sector.

FY 2003: Reduce systems engineering and reliability research to only the most critical needs. Continue work through Regional Experiment Stations to improve reliability of distributed grid-tied systems, especially in the buildings sector. Continue core BIPV research to more fully integrate PV into buildings. Continue core technology analysis and outreach activities. Million Solar Roofs activity completed and transferred to the private sector.

FY 2004: Increase funding for critical systems engineering and reliability research, with emphasis on inverter reliability. Work through Regional Experiment Stations to improve reliability of distributed grid tied systems, especially in the buildings sector. Continue BIPV research to more fully integrate PV into buildings and to support the Zero Energy Home activity. Maintain core technology analysis and outreach activities.

P	**Southwest Resource Opportunity . . . . . .**	**3,083**	**0**	**0**

FY 2002: Congress directed funding in FY 2002 to provide technical analysis, technical assistance, and harmonization of multi-program activities that address the resource opportunities in electric power needs of the southwestern United States. Funding to support this directive was derived proportionately from the three solar subprograms.

P	**Navajo Electrification Project**	**2,313**	**0**	**0**

FY 2002: Congress directed funding in FY 2002 to assist the Navajo Nation to provide electric power to homes in the Navajo Nation that lack electric power. Although $800K was used for solar

(dollars in thousands)

systems on some homes, most of the funding was for power line extensions. Funding to support this directive was derived proportionately from the three solar subprograms.

		FY 2002	FY 2003	FY 2004
Solar Building Technology Research		**3,227**	**4,000**	**3,000**
P	**Solar Water and Space Heating**	**2,922**	**4,000**	**3,000**

The Solar Water and Space Heating research activity develops solar technologies that provide hot water and space heating for residential and commercial buildings, in collaboration with industry partners. The research emphasizes low-cost, polymer-based solar water heaters to cut the cost of solar water heating by 50 percent to an equivalent of $0.04/kWh by 2005, which is expected to expand the market. The initial emphasis is on systems designed for mild climates, gradually shifting to systems for hard-freeze climates. In addition, the same polymer-based technology developed for low-cost water heaters will be adapted to provide space heating.

The Hybrid Solar Lighting research activity develops lighting systems that could increase the productivity of workers by bringing sunlight into interior rooms (top two floors) of commercial and industrial buildings. A collector dish and tracking system concentrate sunlight onto large-core optical fibers to transfer the sunlight into interior rooms.

FY 2002: Built full-scale prototypes of polymer-based solar water heaters in conjunction with industry partners. Continued accelerated testing of glazing, durability testing of polymers, and measurement of scale in heat exchanger tubes. The subprogram's cost-shared partnerships with industry-developed manufacturing processes amenable to the new polymer and existing materials used in solar water heaters. A half-scale model of a hybrid lighting system was built and tested in a laboratory, proving the basic feasability of the concept. SBIR/STTR funding in the amount of $78,000 was transferred from this subprogram to the Science appropriation.

FY 2003: Based on field tests, the low-cost solar water heaters will be redesigned and modified as required. In collaboration with industrial partners the redesign will be evaluated by their potential for reducing the cost of energy to $.04/kWh by 2005. Initiate development of a low-cost solar water heater capable of operation in cold climates with potential sales of 100,000 units per year by 2010 (compared to current U.S. sales of 6,000 to 8,000 units per year). Develop and test polymer-based balance-of-system components (storage tanks, heat exchangers, pumps) for solar thermal systems. A full-scale model of the hybrid lighting system will be built and tested.

FY 2004: Evaluate field data from the low-cost water heating systems deployed in FY 2002. Continue development of a polymer water heater capable of operation in cold climates. Test the polymer-based

balance-of-system components needed for the cold-climate system. Begin design of a polymer system that can provide space heating and contribute to space cooling. Continue working with other DOE programs to accomplish the goals of the Zero Energy Building activity. Install a hybrid solar lighting system at a commercial site and begin data collection.

P **Southwest Resource Opportunity** **174** **0** **0**

FY 2002: Congress directed funding in FY 2002 to provide technical analysis, technical assistance, and harmonization of multi-program activities that address the resource opportunities in electric power needs of the southwestern United States. Funding to support this directive was derived proportionately from the three solar subprograms.

P **Navajo Electrification Project** **131** **0** **0**

FY 2002: Congress directed funding in FY 2002 to establish a five-year program to assist the Navajo Nation to provide electric power to homes in the Navajo Nation that lack electric power. Although $800,000 was used to fund solar systems on some homes, most of the funding was used for power line extensions. Funding to support this directive was derived proportionately from the three solar subprograms.

Concentrating Solar Power **13,025** **1,932** **0**

Several years ago the Department asked the National Research Council to conduct a review of its renewable energy programs. The Council findings cast doubt over the potential of large-scale CSP plants to achieve the technology advances required to penetrate broad domestic energy markets. This led to DOE's request that the CSP subprogram begin phase-out in FY 2003 and be terminated in FY 2004.

P **Distributed Power System Development** **5,224** **1,932** **0**

This activity focused on solar dish/engine systems ranging in size from 10 kW for remote power applications (e.g., water pumping) to 25 kW for grid-connected applications (e.g., utility end-of-line).

FY 2002: As directed by Congress, the CSP subprogram issued a request for proposals for a 1.0 MW Nevada Solar Dish Project and contractors were selected for possible awards. Installation of the approximately 40 dishes that make up the project would, if funded, occur over a two- to three-year period and would allow industry to reach the required reliability targets for market entry. A 10 kW

remote dish was readied for installation on a Native American reservation where it will be used to pump water.

FY 2003: The subprogram will evaluate the 25 kW dish systems at the University of Nevada. All other dish R&D activities will be terminated, postponed, or maintained at minimum levels.

FY 2004: No activity.

P **Dispatchable Power System Development** **3,559** **0** **0**

Large-scale CSP technologies have been operating successfully in the California desert for 15 years.

FY 2002: Continued development of both near-term and long-term storage technologies, e.g., single-tank thermocline system and eutectic salts. Advanced receiver and concentrator components were tested at the operating trough plants in California. Technical support was provided to U.S. industry for evaluating next-generation components. A study was completed evaluating the feasibility of producing hydrogen from high-temperature, high-solar-concentration processes. SBIR/STTR funding in the amount of $157,000 was transferred from this subprogram to the Science Appropriation.

FY 2003: No activity.

FY 2004: No activity.

P **Advanced Component Research** **3,386** **0** **0**

This subprogram is focused on opportunities to combine advances in CSP and PV systems into an integrated system.

FY 2002: The National Solar Thermal Test Facility conducted additional advanced trough component testing. R&D for concentrating photovoltaics and free-piston Stirling systems continued, as two university projects continued and several industry partners tested prototype hardware designed to prove the feasibility of the concepts.

FY 2003: No activity.

FY 2004: No activity.

		(dollars in thousands)		
		FY 2002	FY 2003	FY 2004
P	**Southwest Resource Opportunity**	**489**	**0**	**0**

FY 2002: Congress directed FY 2002 funding to provide technical analysis, technical assistance, and harmonization of multi-program activities that address the resource opportunities in electric power needs of the southwestern United States. Funding to support this directive was derived proportionately from the three solar subprograms.

P	**Navajo Electrification Project**	**367**	**0**	**0**

FY 2002: Congress directed FY 2002 funding to establish a 5-year program to assist the Navajo Nation to provide electric power to homes in the Navajo Nation that lack electric power. Although $800,000 was used to fund solar systems on some homes, most of the funding was for power line extensions. Funding to support this directive was derived proportionately from the three solar subprograms.

Total, Solar Energy	**87,107**	**79,625**	**79,693**

Explanation of Funding Changes

		FY2004 vs. FY2003 ($000)
Photovoltaic Energy Systems		
P	Technology Development. Increase to support module and systems reliability improvements. In thin film modules, increase funding for accelerated lifetime testing and diagnostics to determine failure modes in pre-commercial products. In systems, increase funding for inverter initiative to accelerate attainment of next-generation grid-tied inverter with greater than twenty-year lifetime	+3,000
Solar Building Technology Research		
P	Reduced funding for hybrid daylighting R&D, as full scale model is being built and tested	-1,000
Concentrating Solar Power		
P	Distributed Power System Development. Complete program phase-out in accordance with National Academy of Science recommendations	-1,932
Total Funding Change, Solar Energy		**+ 68**

Zero Energy Buildings

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 integrate renewable energy systems into building designs and operations, the focus of which is the Zero Energy Building concept. These are buildings that use solar and other renewable energy sources so that the buildings produce as much energy as they consume on an annual basis.

The program's portfolio also includes activities 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 buildings codes and equipment standards. These efforts facilitate the development of technologies, tools, and techniques for Zero Energy Buildings.

Accomplishing this mission contributes to several national energy and environmental policies. For example, the President's National Energy Policy (NEP) calls for "modernizing energy conservation" and relieving congestion on the Nation's electricity transmission and distribution system. It also calls for "establishing a national priority for improving energy efficiency." Additionally, the NEP specifically 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.

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 reduces environmental emissions, including greenhouse gases.

It is possible that within the next decade, new homes and commercial buildings built in America will be able to produce as much energy as they use. These buildings can be designed so that they are affordable, durable, healthy, comfortable, and more conducive to higher productivity. This is the basis of a vision statement that has been developed in partnership with industry in 2001 for the Zero Energy Buildings concept. The Zero Energy Buildings activities facilitates the whole building optimization and integration of advanced energy efficiency and site generation technologies never before considered for mainstream construction.

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 space conditioning in buildings is the key driver of peak electricity demands. Development of buildings that produce as much energy as they consume, along with improving the energy efficiency of buildings and equipment, contributes to reduced consumption of electricity during peak demand periods. Zero Energy Buildings involve the integration of renewable energy technologies, which are capable of producing energy to reduce peak demands.

Buildings are exceptionally long-lived capital assets. Buildings in existence today represent more than 85 percent of the buildings that will exist in 2010. Development of Zero Energy Buildings, and improvements in the energy efficiency of existing and new buildings, thus have the capability of helping to alleviate demands on the energy supply system over the near-, mid-, and long-terms. The economic impacts of reductions in energy use can be enormous, since the Nation's annual energy bill for buildings is about $240 billion.

There are several factors which interfere with the private sector making R&D investments in buildings 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.

In addition, participants in the buildings industries view energy efficiency or the application of renewable energy systems as a top priority, only when customers demand it do the developers, manufacturers, and construction trades respond.

Another factor is the compartmentalization of the building professions, in which architects and designers, developers, construction companies, engineering firms, and energy services providers are not typically required to apply integrated strategies for siting, construction, operations, and maintenance. This fragmentation and the fact that even the largest homebuilder has less than 3 percent of market share means there is an appropriate Federal role as facilitator in building consensus on research directions and priorities, industry-wide codes and standards, technology transfer, and education, outreach, and information exchange.

The management strategy for developing affordable Zero Energy Buildings requires a high level of coordination with other programs in the Office of Energy Efficiency and Renewable Energy. These include Solar Energy, Distributed Energy and Electricity Reliability, and Hydrogen Technology, Fuel Cells, and Infrastructure. In addition, the Biomass and Biorefinery Systems R&D, Wind, and Geothermal Technology Programs have important technologies to contribute. In addition, the program invests in technical program and market analysis and performance assessment in order to direct effective strategic planning.

A number of Zero Energy homes have been built to date – largely serving the off-grid market. The goal is to expand the applicability of these homes by making them more affordable so that home buyers and commercial building owners in most parts of the country can participate.

The opening phases of the Zero Energy Buildings activities will emphasize development of residential markets, as several of the major national home builders have been spearheading the concept, and because residential dwellings are often simpler to construct, offer mass market opportunities, and are more homogeneous than commercial buildings. Specific overall goals are to integrate solar technology and energy efficient buildings resulting in an annual energy bill of less than $600 for an average size home by 2004, and a "net-zero" bill by 2010.

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 Administration's R&D Investment Criteria (R&DIC) evaluation process and the OMB Program Assessment Rating Tool (PART) process. Both exercises guided program budget planning, management decisions and performance goals and targets. As a result of program management and the PART review, the Building Technologies Program FY 2004 budget proposal specifically:

- Improves integration of Zero Energy Buildings and Analysis Tools and Design Strategies activities, which will result in improved efficiency of these distinct but related R&D activities.
- Supports the Solid State Lighting Initiative by redirecting funds within the lighting technologies R&D budget and from Technology Roadmaps and appliance standards.

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. The estimates provided are for the entire Buildings Technologies Program and are inclusive of ZEB benefits.

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.

[a] Benefits reported 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.

Program Strategic Performance Goals

The Program Strategic Performance Goal (PSPG) 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 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 20 final rules enhancing product minimum efficiency 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 Energy and Water section focuses on zero net energy buildings, and addresses subprogram goal (5) in the stated performance goal. The respective performance indicators and technology baselines are stated below:

Performance Indicators:

(Broken down by PSPG Sub-goal)

(5) Zero Energy Building Technologies Research -- 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.

Performance Indicators:

The amount of energy generation in residences and commercial buildings.
The net amount of utility bills for residences and commercial buildings.
The number of available cost-effective, marketable ZEB design packages.

Annual Performance Results and Targets

FY 2002 Results	FY 2003 Targets	FY 2004 Targets
Developed industry-led teams to build and monitor first-generation Zero Energy homes.	Expand ZEB teams to include more climates and continue partnership with industry to more fully integrate solar electric and thermal energy into buildings.	Research, document, and complete a strategic framework for the integration of solar technology into energy efficient homes to achieve marketable Zero Energy Homes.

Significant Program Shifts

Zero Energy Buildings activities have recently moved from the Solar Energy Program to the Buildings Technologies Program. This shift will enable more effective access to the residential and commercial building industries for Zero Energy Buildings technology developers and expand the range of opportunities for industry participation and cost sharing. The program will evaluate its activities to ensure no duplications or overlaps with Interior-funded efforts in the Building Technologies Program. The ZEB activities will continue to maintain effective technical coordination with the Solar Energy Program is paramount, and is a top priority of management strategies of both.

Funding Profile

(dollars in thousands)

	FY 2002 Comparable Appropriation	FY 2003 Amended Request	FY 2004 Request	$ Change	% Change
Zero Energy Buildings					
Zero Energy Buildings Design . . .	1,367	8,000	4,000	-4,000	-50.0%
Total, Zero Energy Building Technology Research	1,367	8,000	4,000	-4,000	-50.0%

Public Law Authorization:

P.L. 93-410, "Geothermal Energy Research, Development and Demonstration Act" (1974)
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. 101-218, "Renewable Energy and Energy Efficiency Technology Competitiveness Act of 1989"
P.L. 101-575, "Solar, Wind, Waste, and Geothermal Power Production Incentives Act of 1990"

Funding by Site[a]

(dollars in thousands)

	FY 2002	FY 2003	FY 2004	$ Change	% Change
Albuquerque Operations Office					
National Renewable Energy Laboratory	1,367	8,000	4,000	-4,000	-50.0%
Total, Albuquerque Operations Office	1,367	8,000	4,000	-4,000	-50.0%
Total, Zero Energy Buildings	1,367	8,000	4,000	-4,000	-50.0%

[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."

Site Description

National Renewable Energy Laboratory

The National Renewable Energy Laboratory (NREL) conducts research and development for the Building Technology Program, including Building America and Zero Energy Building Consortia.

Funding Schedule

(dollars in thousands)

	FY 2002	FY 2003	FY 2004	$ Change	% Change
Zero-Energy Buildings					
Zero Energy Building Design	1,367	8,000	4,000	-4,000	-50.0%
Subtotal, Zero-Energy Building Design	1,367	8,000	4,000	-4,000	-50.0%

Detailed Program Justifications

(dollars in thousands)

	FY 2002	FY 2003	FY 2004
Zero Energy Building Design	**1,367**	**8,000**	**4,000**

Zero Energy Buildings (ZEB), both residential and low-rise commercial, will be designed to optimally combine very energy-efficient building envelopes, appliances, lighting, advanced controls, and heating/cooling systems with renewable energy systems, including solar water/space heating and solar electric systems, to require on an annual basis zero offsite energy. Initially, the program will focus on marketable homes that are designed, constructed and monitored in conjunction with leading homebuilders, to achieve an annual energy bill by 2004 of $600 for the average size home, a 50 percent reduction. R&D will be needed to achieve a true net-zero energy goal based on the initial evaluation of home types and recommendations by homeowners, builders, architects, and engineers. The Department believes that effective management of building loads and use of renewable energy at the point of use, has the potential to relieve summer peak demand by about 90 percent, making possible a zero energy bill by the year 2010. All activities under this program are conducted under the joint leadership of the Building Technologies and Solar Energy Programs.

FY 2002: Completed prototype designs and started construction of the initial first generation ZEB homes designed to cut homeowner utility bills by 50 percent. Conducted market analysis to determine homeowner requirements for ZEB homes. Developed analytical tools to optimize the mix of energy efficiency and solar energy technologies. Evaluated and modified the proof-of-concept hybrid solar light prototype into a full-scale system. SBIR/STTR funding in the amount of $37,000 was transferred from this subprogram to the Science Appropriation.

FY 2003: ZEB teams will finalize prototype designs for additional homebuilders. Complete design and analysis of climate-specific ZEB homes; evaluate ZEB construction methods and materials for their suitability in particular climates; and monitor prototype homes. Select and develop prototype designs for broader geographic and economic market diversity; disseminate results and lessons learned from each ZEB team to move toward true net-Zero Energy homes with the costs and overall economics necessary for production home builders; develop a whole house energy controller for ZEB homes; and develop designs to fully integrate solar technologies into the building envelope. Test prototype hybrid solar lighting system suitable for Zero Energy buildings, and evaluate potential Zero Energy building designs.

FY 2004: Complete evaluation and monitoring of first generation ZEB homes, built by leading homebuilders, to verify a 50 percent reduction in annual utility bills to $600 per year for an average sized home in a temperate climate. Initiate development of advanced optimization methods for second-generation ZEB houses; initiate designs to cut utility bills to a dollar-a-day or $365 per year and significantly reduce peak loads by FY 2007; and identify key R&D areas to significantly reduce remaining household loads. Analyze and maximize demand reduction capabilities of ZEB homes during utility peak periods in order to achieve zero summer electric peak loads thereby reducing stress on the distribution system in growth markets. Develop designs to fully integrate solar electric and thermal technologies into the building envelope, and integrate and optimize energy supply and demand reduction technologies.

Explanation of Funding Changes

	FY 2004 vs. FY 2003 ($000)
Zero Energy Buildings	
# Software development for ZEB integration postponed; commercial ZEB R&D and research design assistance deferred; funding for ZEB consortia reduced; the program will evaluate its activities to ensure no duplications or overlaps with Interior-funded efforts in the Building Technologies Program.	-4,000
Total Funding Change, Zero Energy Buildings	**-4,000**

Wind and Hydropower Technologies

Program Mission

The Wind and Hydropower Technologies Program conducts research and development to enhance the level of technology development and deployment of the Nation's fastest growing and the most widely used renewable energy resources.

Wind energy and hydropower have been used by people for centuries. Over the years, the technologies for extracting energy from the wind and the rivers have progressed from primitive wind machines and water wheels to advanced turbines. Even with today's sophisticated systems **S** involving highly-engineered materials, computer-assisted designs and control systems **S** only a small fraction of the available energy from these resources can be economically developed. Significant potential exists for further technology efficiency and environmental improvements, which has the potential to greatly expand the amount of wind energy and hydropower in the Nation's energy mix.

In accomplishing this, the Wind and Hydropower Technologies Program will be able to address national priorities for energy, environmental, and security policies. Hydropower and wind emit no air pollution or greenhouse gases and they do not use fuel from foreign sources. They are capable of producing large amounts of bulk power to meet America's growing need for clean sources of electricity. While they currently serve wholesale power markets primarily, smaller scale systems are capable of being deployed in a more distributed manner to better serve retail markets, or provide the power grid with ancillary services, and thus help to address the congestion problems currently being experienced with the Nation's electricity infrastructure.

America's wind and hydropower resources are extensive. Hydropower is the most widely used form of renewable energy in the world today and accounts for about 7 percent of total electricity generation in the U.S. (77 percent of domestic renewable electricity generation). Those regions of the country that rely on hydropower the most have among the lowest electricity prices. For example, hydroelectric dams on the Columbia River System generate up to 80 percent of the electricity used in the Pacific Northwest, where electricity prices have historically been up to one-third lower than the national average. However, if the environmental performance such as the rate of fish mortalities of existing hydroelectric turbines cannot be improved, the operational capacity of the Nation's fleet of hydropower facilities could be reduced. For example, as part of the relicensing process, a hydropower dam on the Snake River in the Pacific Northwest was dismantled to protect salmon fisheries.

Wind is the fastest growing form of renewable energy in America. For example, from 1991 to 2001, the production of electricity from wind turbines in the U.S. has more than doubled, a rate faster than any other form of power generation. However, unless wind technologies are developed that can generate electricity economically in areas with relatively low wind speeds (*e.g.*, Classes 3 and 4)[a], wind energy

[a] Class 3 wind resource areas exhibit an annual average wind speed of 12 miles per hour at 30 feet above the ground. Class 4 have an annual average wind speed of 13 miles per hour at 30 feet above the ground.

development could reach a plateau and be generally limited to those regions of the country with Class 6[a] wind resources. Class 6 areas are often found in some of the most remote regions of the country, far from the load centers which they are intended to serve.

The Department of Energy's wind energy research efforts have focused historically on the development of large wind turbines (greater than 100 kilowatts) suitable for Class 6 wind resource areas. Results of this research have been impressive as the cost of electricity generation from these systems has declined by a factor of twenty since 1982. The current focus is on the development of wind turbine designs that can operate economically in lower wind resource areas, which may significantly expand wind energy use in America. For example, developing wind turbines that can economically produce power in areas of the country with Class 4 wind resources would increase the total amount of available, cost-competitive wind energy resource in America by a factor of twenty.

The Department also supports development of small wind turbines (100 kilowatts or less) that can serve a range of high valued, distributed power applications. These applications include supplemental on-site power generation for grid-connected suburban and rural residences, farms, and businesses; stand-alone power supply in conjunction with hybrid system technologies to serve remote or island energy needs; and dedicated power for applications such as water pumping and icemaking. Substantial markets for residential and small business applications in the United States are expected to open with emerging State incentive programs, reduced institutional barriers, and improved technology, as detailed in the U.S. small wind turbine industry's roadmap.[b]

The Department's hydropower research has focused on the development of more environmentally-friendly technologies to maintain the Nation's existing hydropower capacity. While the current generation of hydroelectric turbines are highly efficient and cost competitive, their operational capacity will likely be reduced during upcoming relicensing proceedings before the Federal Energy Regulatory Commission if their environmental performance cannot be improved. The primary problem is fish mortality, which currently ranges from 5 to 30 percent. The research goals are: (1) increase fish survivability by reducing the rate of fish death and injury from traversing hydropower turbines; and (2) promote life-sustaining oxygen levels in the waters downstream of hydropower facilities. The best hydropower turbines operating today have measured fish mortality rates of 5 percent. The Department of Energy's goal for new turbine development is to reduce turbine-caused fish mortality by more than half, to less than 2 percent, which is comparable to that of dam spillways and other dam bypass features. With regard to oxygen levels in waters downstream of hydropower plants, the Department of Energy's goal is to develop technologies that boost oxygen levels to the Federal water quality standard of 6 milligrams per liter.

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[a] Class 6 wind resources have an annual average wind speed of 15 miles per hour at 30 feet above the ground.

[b] "The U.S. Small Wind Turbine Industry Roadmap: a 20-year industry plan for small wind turbine technology." American Wind Energy Association Small Wind Turbine Committee, June 2002.

The program conducts research, development, testing, and field verification of wind and hydropower systems through laboratory and public-private partnerships. In pursuing these activities, the program regularly obtains inputs from wind and hydropower experts from outside of the U.S. Department of Energy.[a] The perspectives of wind and hydropower practitioners helps to ensure that the program's research directions and priorities are properly aligned with the needs of equipment manufacturers, electric utilities, regional organizations, State and other Federal agencies, and other stakeholders and does not displace private sector investment (*i.e.*, investments should be long-term and high-risk to ensure an appropriate Federal role).

The Wind and Hydropower Technologies Program is being restructured for fiscal year 2004 to include two subprograms: 1) Wind Energy and 2) Hydropower. Each subprogram will have two key activities: 1) Technology Viability and 2) Technology Application. This change aligns the program with the Department's priorities for renewable energy technology, and will enable the program to strategically streamline activities and clarify linkages to program goals for enhanced performance-based management.

The Technology Viability key activity focuses on achieving the following goals:

P Reduce the cost of energy from large wind systems to 3 cents per kWh to enable wind to compete with conventional fuels in bulk electricity markets:

- in Class 6 wind resources by 2004 (2002 baseline - 4 cents)
- in Class 4 wind resources by 2012 (2002 baseline - 5.5 cents)

P Develop a class of small wind turbine systems designed for residential and small business applications by 2007 for Class 3 wind resources that achieve costs in the range of 10-15 cents per kWh (baseline is 17-22 cents per kWh in 2002).

P Complete testing that will lead to a commercially viable hydroelectric turbine technology capable of:

- reducing the rate of fish mortality to 2 percent or lower by 2010 (compared with turbine-passage mortalities of 5 to 30 percent for today's turbines); and
- ensuring compliance with seasonal downstream dissolved oxygen requirements by enabling levels of at least 6 mg/l to comply with water quality standards.

Having this technology commercially available will provide hydropower plants an option whereby they can improve environmental performance and possibly maintain electrical generation capacity during relicensing efforts.

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[a] "Final Report of the Department of Energy's Wind Program 2001 Annual Peer Review Meeting," Golden, Colorado, August 7-9, 2001. "AWEA R&D Committee Response to DOE Program Plan," July 2002.

The Technology Application key activity focuses on achieving the following program goals:

- Increase the number of States with more than 20 megawatts of installed wind power capacity from 12 to 32 by 2005, and the number of States with more than 100 megawatts from 8 to 16 by 2010.

- In coordination with the Federal Energy Management Program (FEMP), provide the technical assistance to increase the contribution of wind energy to supplying Federal electricity use to 5 percent (1,000 MW) by 2010.

- In 2004, complete assessment of undeveloped low head/low power hydropower resources across all U.S. hydrologic regions.

Budget and Performance Integration

To implement the budget and performance integration portion of the President's Management Agenda, the wind subprogram participated in both the Administration's R&D Investment Criteria (R&DIC) evaluation process and the OMB Program Assessment Rating Tool (PART) process. Both exercises guided program budget planning, management decisions and performance goals and targets. As a result of the program management and PART review the Wind Energy subprogram specifically:

- continues its emphasis on moderate speed wind; and
- added FY 2004 annual performance measures for Technology Acceptance activity.

Like many R&D programs, the Wind Energy subprogram experienced difficulty developing annual performance measures that satisfy the PART requirements. The program is committed to developing adequate annual measures to support the FY 2005 budget.

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 Wind and Hydropower 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 renewable energy programs is essentially the EIA's Annual Energy Outlook (AEO) 2002 reference case, which already includes some penetration of these technologies. The program goals for wind technologies are modeled directly in NEMS-GPRA04 by incorporating the capital costs, operations and maintenance (O&M) cost, and capacity factors consistent with the program's low wind speed technology goal of 3 cents per kWh by 2012 into the model. These goals are substantially more aggressive than those included in the NEMS-GPRA04 basecase.

New capacity in NEMS is selected based on each technology's relative capital and operating costs, its operating performance (i.e. availability), the regional load requirements, and existing capacity resources, as well as constraints on the rates at which new renewable technologies enter energy markets.[a]

FY 2004 GPRA Benefits Estimates for Wind & Hydropower Program (NEMS-GPRA04)			
	2005	**2010**	**2020**
Electricity Capacity (GW)	2.0	5.9	34.7
Electricity Generation (BkWh)	8.1	23.1	146.1
Non-Renewable Energy Savings (quads)	0.08	0.20	1.15
Oil Savings (quads)	0.01	0.01	0.08
Carbon Savings (MMT)	1.2	3.2	20.9
Energy Expenditure Savings (B2000$)	0.6	1.4	5.4

The program's hydropower technology goal of reducing the fishkill associated with hydropower production is largely intended to improve the potential for relicensing of existing facilities, so that this existing capacity is not lost. As such, this goal is effectively incorporated into the NEMS-GPRA04 program case as relicensed capacity: the AEO 2002 Reference Case assumes relatively constant hydroelectric capacity, which requires essentially all existing hydro-electric facilities to be successfully relicensed. Based on analysis undertaken for the Idaho National Engineering Laboratory, the Baseline is revised to remove 1.0 GW and 5 BkWh of hydroelectric power by 2007, increasing to 1.5 GW and 7 bkWh by 2020 to reflect the levels of expected loss of capacity due to concerns related to fish-kill. This hydropower is then re-introduced in the program case.

Because NEMS-GPRA04 cannot model green power demand directly, the amount of wind and hydropower capacity needed to satisfy green power demand is based on market analyses undertaken by Princeton Energy Resources International and modeled as planned additions. For both the Baseline and GPRA cases, the maximum share of electricity generation allowed from intermittent sources was raised from the 12 percent used by EIA to 30 percent, based on experience in other countries. Short-term cost multipliers that indicate how quickly the industry can increase production without driving up the production costs are modified as a result of consultation with NREL, LBNL, and PERI, based on world-wide experience. The expansion of wind energy without cost penalties associated with manufacturing constraints was increased from 50 percent of installed capacity to 100 percent to reflect the fact that the industry is global and has shown the capability to expand rapidly in the last several years. The benefits estimates are conservative because the wind resource curve in the NEMS model involves assumptions that significantly increase the capital cost of developing new wind resources in ways that are inconsistent with market conditions in nations that have already significantly expanded wind production.

[a] Benefits reported are annual, not cumulative, for the year given. 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.

Estimates for additions to electricity capacity and generation, energy savings, oil savings, carbon emission reductions, and energy expenditure savings resultant from realization of Wind and Hydropower Technologies Program goals are shown in the table above for the 2020 timeframe. The increased environmental and market attractiveness of wind and hydropower is expected to provide over 34.7 GW of needed new electricity generating capacity in 2020, or about 11 percent of the total new capacity expected to be required over the next 15 years.[a] The bulk of the estimated generation and energy savings is due to expansion of cost-effective wind power to areas with lower wind speed (class 4) as the costs of wind power are reduced and performance increased. These cost savings also expand the amount of wind that is cost-effective to develop in high-speed (class 6) wind areas. Because these electricity sources do not consume fuels, they also have the potential to save the Nation over 1 quad of energy and reduce carbon emissions by over 20 million metric tonnes. These estimates reflect EIA reference case assumptions about future energy markets. The development of these program technologies would provide additional opportunity for the Nation to expand renewable-based electricity capacity in the event that electricity or fuels markets are more constrained than expected, if additional environmental policies increase the value of these non-emissions electricity sources, or if additional transmission capacity is available to facilitate more remote wind locations.

Program Strategic Performance Goals

The Wind and Hydropower Technologies Program has the following overall performance goals: 1) by 2012, wind energy R&D activities will provide the technologies to reduce the cost of wind powered electricity generation in Class 4 wind moderate speed areas from 5.5 to 3 cents per kWh; and 2) by 2010, hydropower R&D activities will enable commercialization of a fish passage technology capable of reducing turbine-induced fish mortality from 5-30 percent to 2 percent or less.

Performance Indicator

Cost of wind powered electricity generation.

[a] This percentage is calculated from the GPRA renewable case. More capacity is needed than in the Reference Case because the wind and solar are intermittent.

Annual Performance Results and Targets

FY 2002 Results	FY 2003 Target	FY 2004 Target
Initiated development of an improved resolution national wind resource atlas, focusing first on new maps for high priority regions for commercial projects.	Complete low wind speed turbine conceptual design studies, and fabricate and begin testing advanced wind turbine components optimized for low wind speed application initiated under industry partnership projects.	Complete testing of prototypes for first advanced low wind speed technology components, and complete detailed designs under first two public-private partnership projects for full system low wind speed turbine development.

Performance Indicator

Percentage of fish mortality for turbines in the current stage of the testing and development process.

Annual Performance Results and Targets

FY 2002 Results	FY 2003 Target	FY 2004 Target
Pilot-scale biological and hydraulic testing initiated.	Completion of pilot-scale testing, providing the basis for future full-scale testing at an operational site. Successful testing will provide industry with a proven design, helping attain the 2 percent mortality goal.	Complete biological studies on the effects of blade strike on turbine-passed fish

Significant Program Shifts

In 2002, the program completed an R&D partnership under the Next Generation Turbine project that culminated in a field-tested 1.5 megawatt turbine on track for achieving the goal of 3 cents per kilowatt hour in Class 6 winds by 2004. Given this success, in 2002 the program decided to shift focus from its Class 6 targeted efforts and concentrate most of its R&D projects on technology for lower wind speed resource areas. This includes the Low Wind Speed Technology (LWST) project, which is focused on cost-effective large turbines in Class 4 wind areas which are on average five times closer to load centers, thus reducing transmission constraints. Cost-effective Class 4 technology would also increase the available area for wind energy development twenty fold relative to technology competitive in Class 6 resource areas.

The program is also shifting focus to low wind speed R&D for small wind systems, defined as turbines having a rated capacity of less than 100 kilowatts, deployed in a distributed manner in relatively close proximity to the point of use. The Distributed Wind Technology Project mirrors the LWST project for large wind systems and targets achieving cost-effective small wind technology for Class 3 and above wind areas, with primary

applications expected for residences and small businesses, including farms. In FY 2003, the program completed its R&D partnership for development of the high reliability 100 kW Cold Weather Turbines, with the industry partner assuming the lead for commercialization activities. Initial uses expected for this R&D 100 award winning turbine include power for the National Science Foundation's Antarctic Polar and McMurdo Research Stations.

Funding Profile

(dollars in thousands)

	FY 2002 Comparable Appropriation	FY 2003 Amended Request	FY 2004 Request	$ Change	% Change
Wind and Hydropower					
Wind Energy	38,211	44,000	41,600	-2,400	-5.5%
Hydropower Energy	4,986	7,489	7,489	0	0.0%
Total, Wind and Hydropower	43,197	51,489	49,089	-2,400	-4.7%

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. 95-619 National Energy Conservation Policy Act (NECPA) (1978)
P.L. 95-91 Department of Energy Organization Act (1977)
P.L. 101-218 Renewable Energy and Energy Efficiency Technology Competitiveness Act of 1989
P.L. 101-575 Solar, Wind, Waste, and Geothermal Power Production Incentives Act of 1990
P.L. 102-486 Energy Policy Act of 1992 (EPACT)

Wind Energy Funding by Site[a]

(dollars in thousands)

	FY 2002	FY 2003	FY 2004	$ Change	% Change
Albuquerque Operations Office					
Sandia National Laboratories	3,805	3,875	3,800	-75	-1.9%
Golden Field Office	1,522	5,550	3,000	-2,550	-45.9%
National Renewable Energy Laboratory	26,616	30,333	30,000	-333	-1.1%
Atlanta Regional Office	135	60	75	+15	+25.0%
Boston Regional Office	1,543	70	75	+5	+7.1%
Chicago Regional Office	619	100	75	-25	-25.0%
Denver Regional Office	528	225	250	+25	+11.1%
Philadelphia Regional Office	195	100	100	0	+0.5%
Seattle Regional Office	585	100	150	+50	+50.0%
Albuquerque Operations Office	445	350	350	0	0.0%
Total, Albuquerque Operations Office	35,993	40,763	37,875	-2,888	-7.1%
Idaho Operations Office					
Idaho National Engineering and Environmental Laboratory	75	125	100	-25	-20.0%
Total, Idaho Operations Office	75	125	100	-25	-20.0%
Oakland Operations Office					
Lawrence Berkeley National Laboratory	250	250	250	0	0.0%
Oakland Operations Office	1,174	1,174	0	-1,174	-100.0%
Total, Oakland Operations Office	1,424	1,424	250	-1,174	-82.4%

[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."

Oak Ridge Operations Office					
Oak Ridge National Laboratory	150	150	150	0	0.0%
Office of Scientific and Technical Information	11	10	10	0	0.0%
Total, Oak Ridge Operations Office	161	160	160	0	0.0%
Power Administration					
Bonneville Power Administration	51	200	300	+100	0.0%
Western Area Power Administration	125	230	400	+170	0.0%
Total, Power Administration	176	430	700	+270	0.0%
Washington Headquarters	382	1,098	2,515	+1,417	+129.1%
Total, Wind Energy	38,211	44,000	41,600	-2,400	-5.5%

Hydropower Funding By Site[a]

(dollars in thousands)

	FY 2002	FY 2003	FY 2004	$ Change	% Change
Albuquerque Operations Office					
Golden Field Office	10	0	3,263	+3,263	NA
Total, Albuquerque Operations Office	10	0	3,263	+3,263	NA
Idaho Operations Office					
Idaho National Engineering and Environmental Laboratory	291	965	965	0	0.0%
Idaho Operations Office	3,560	2,263	0	-2,263	-100.0%
Total, Idaho	3,851	3228	965	-2263	-70.1%
Oak Ridge Operations Office					
Oak Ridge National Laboratory	650	1,500	1,500	0	0.0%
Office of Scientific and Technical Information	11	11	11	0	0.0%
Total, Oak Ridge Operations Office	661	1,511	1511	0	0.0%
Richland Operations Office					
Pacific Northwest National Laboratory	450	1,500	1,500	0	0.0%
Total, Richland Operations Office	450	1,500	1,500	0	0.0%
Power Administrations					
Bonneville Power Administration	0	100	100	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."

Western Area Power Administration	0	100	100	0	0.0%
Total, Power Administrations	0	200	200	0	0.0%
Washington Headquarters	14	1,050	50	-1000	-95.2%
Total, Hydropower	4,986	7,489	7,489	0	0.0%

Site Description
(Wind Energy)

Sandia National Laboratories

The SNL Wind Energy Department staff work closely with counterparts at the National Renewable Energy Laboratory to provide the Wind Energy subprogram and the U.S. wind industry with engineering expertise to further the program's knowledge and goals.

Golden Field Office

The Golden Field Office will administer contracts for existing and new cooperative agreements for R&D and field verification projects for both small and utility size wind turbines, and interagency agreements under the Wind and Hydropower Technologies Program.

National Renewable Energy Laboratory

The National Renewable Energy Laboratory (NREL) is the lead laboratory for national wind R&D, performing research in aerodynamics, structural dynamics, and advanced components and control systems related to wind energy. The National Wind Technology Center (NWTC), located at NREL, provides research and testing facilities for fatigue testing of turbine blades, dynamometer testing of wind turbine drive trains and generators, atmospheric testing of turbines, and certification testing which is required for sales and operation in many overseas markets. NWTC staff also conducts the Department's cost-shared Wind Turbine Research partnerships with industry.

Regional Offices

The six EERE Regional Offices located in Atlanta, Boston, Chicago, Denver, Philadelphia, and Seattle administer grants and cooperative agreements to regional, State and local organizations, both public and private.

Albuquerque Operations Office

The Albuquerque Operations Office manages selected university research activities for the Wind subprogram that were formerly managed by the Sandia National Laboratories.

Idaho National Engineering and Environmental Laboratory

Idaho National Engineering and Environmental Laboratory (INEEL) provides technical support for the Wind Energy subprogram on government and military applications.

Lawrence Berkeley National Laboratory

Lawrence Berkeley National Laboratory (LBNL) performs analyses of opportunities for Wind Energy applications in the restructured electricity market and administers various utility restructuring activities under the new electricity reliability office. In support of utility restructuring, LBNL conducts policy and technical analyses on utility regulatory policies at the State and Federal levels. LBNL provides technical support to State organizations such as the public utility commissions and State energy offices on utility restructuring issues. LBNL provides guidance and support to the private and public market components of the utility industry, including the energy services industry, regional market transformation consortia, and public and private utilities.

Oakland Operations Office

The Oakland Operations Office has acted as the contracting point for outreach activities awarded under the EE-wide broad-based solicitation in 2000 and 2001. Each project lasted from 1 to 3 years. No broad-based solicitation is planned for FY 2004.

Oak Ridge National Laboratory

Oak Ridge National Laboratory (ORNL) provides analysis and support to wind integration studies and applications.

Office of Scientific and Technology Information

The Office of Scientific and Technology Information (OSTI) distributes information for the Wind Energy subprogram, including publishing and maintaining on-line full text of eight electronic current awareness publications.

Bonneville Power Administration

The Bonneville Power Administration is supporting the Wind Energy subprogram's integration and wind plant forecasting efforts by providing operational data on the integration of wind into its electric power grid.

Western Area Power Administration

The Western Area Power Administration is providing integration and transmission analysis of wind into its power system.

Site Description
(Hydropower)

Golden Field Office

The Golden Field Office will administer contracts for existing and new cooperative agreements for R&D and field verification projects for both small and utility size wind turbines, and interagency agreements under the Hydropower subprogram.

Idaho National Engineering and Environmental Laboratory

Idaho National Engineering and Environmental Laboratory (INEEL) performs research and development for the Hydropower subprogram. INEEL has been the principal DOE laboratory for the Hydropower subprogram since its inception. INEEL serves as the engineering technical monitor for the Advanced Hydro Turbine Technology subprogram and the Tribal Energy hydropower projects located in Alaska.

Regional Offices

The six EERE Regional Offices located in Atlanta, Boston, Chicago, Denver, Philadelphia, and Seattle administer grants and cooperative agreements to regional, State and local organizations, both public and private.

Office of Scientific and Technology Information

The Office of Scientific and Technology Information (OSTI) distributes information for the Hydropower subprogram, including publishing and maintaining on-line full text of eight electronic current awareness publications.

Oak Ridge National Laboratory

Oak Ridge National Laboratory (ORNL) provided the environmental analysis for the DOE Hydropower Energy environmental mitigation study, and the lab's environmental scientists and fisheries biologists perform hydropower environmental impact studies for the Federal Energy Regulatory Commission. Currently, ORNL has the primary responsibility for environmental analysis and as environmental technical monitor for the Advanced Hydro Turbine Technology program, including technical oversight of laboratory biological experiments on stresses experienced by turbine-passed fish.

Pacific Northwest National Laboratory

Pacific Northwest National Laboratory (PNNL) is providing biological testing support for the Advanced Hydro Turbine Technology program. PNNL has designed and fabricated test equipment to simulate turbine-induced physical stresses on fish, and is currently conducting experiments on shear stresses. These experiments are conducted under ORNL technical direction and oversight.

Bonneville Power Administration

The Bonneville Power Administration provides technical support and assistance for hydropower/ renewable integration studies.

Western Area Power Administration

The Western Area Power Administration provides technical support and assistance for hydropower/ renewable integration studies.

Wind Energy Funding Schedule

(dollars in thousands)

	FY 2002	FY 2003	FY 2004	$ Change	% Change
Wind Energy					
Technology Viability					
Low Wind Speed Technology	7,120	12,000	12,000	0	0.0%
Distributed Wind Technology	1,680	2,000	2,000	0	0.0%
Supporting Research and Testing	14,611	15,800	15,800	0	0.0%
Subtotal, Technology Viability	23,411	29,800	29,800	0	0.0%
Technology Application					
Systems Integration	3,500	3,200	3,200	0	0.0%
Resource Assessment	1,000	1,000	1,000	0	0.0%
Technology Acceptance	3,600	3,600	3,600	0	0.0%
Analysis and Industry Support	6,700	6,400	4,000	-2,400	-37.5%
Subtotal, Technology Application	14,800	14,200	11,800	-2,400	-16.9%
Total, Wind Energy[a]	38,211	44,000	41,600	-2,400	-5.5%

[a] SBIR/STTR funding in the amount of $369,000 was transferred to the Science appropriation in FY 2002. Estimates for SBIR/STTR budgeted in FY 2003 and FY 2004 are $424,904 and $401,727 respectively. The FY 2002 Supplemental appropriation reduced this program by $1,028,000 for transfer to the Electricity Reliability program. The FY 2002 rescission reduced this program by $18,000. This program was reduced by a General Reduction of $1,364,000 in FY 2002.

Detailed Program Justification

(dollars in thousands)

	FY 2002	FY 2003	FY 2004
Wind Energy	**38,211**	**44,000**	**41,600**
P **Technology Viability**	**23,411**	**29,800**	**29,800**

The Technology Viability key activity integrates most elements of the former Applied Research and Turbine Research key activities to increase focus on achieving the program goals for improving the cost effectiveness of large and small wind energy systems by increasing the linkage of the program's applied research efforts and public/private partnerships. Technology Viability consists of competitively selected public/private partnership projects (Low Wind Speed Technology and Distributed Wind Technology projects) closely coordinated with Supporting Research and Testing.

• Low Wind Speed Technology (Large Systems)	7,120	12,000	12,000

The Low Wind Speed Technology (LWST) project supports public-private partnerships for multiple large wind system (turbines over 100 kilowatts) technology pathways to achieve the Program Strategic Performance Goal of 3 cents per kilowatt-hour in Class 4 winds by 2012. The LWST strategy includes continuing industry partnerships initiated under the Wind Partnerships for Advanced Component Technologies (WindPACT) and Next Generation Turbine projects, which provide initial progress on low wind speed technology pathways. New partnerships to catalyze industry adoption of component technology developments and emerging innovation are supported through a series of three LWST competitive solicitations - Phase I initiated in FY 2002, Phase II planned for FY 2004, and Phase III planned for FY 2007 - for projects under three technical areas: 1) conceptual design studies, 2) component development and testing, and 3) full turbine prototype development and testing. The LWST portfolio and related Supporting Research and Testing activities will be continuously coordinated to facilitate technology transfer and transition conceptual design and component projects into full system development. LWST projects will be periodically reviewed against analytically-established performance measures to provide the basis for funding and planning adjustments needed to optimize the portfolio for success.

• Distributed Wind Technology (DWT - Small Systems)	1,680	2,000	2,000

The Distributed Wind Technology (DWT) project supports public-private partnerships for multiple small wind system (turbines #100 kilowatts) pathways for achieving the program goal of 10-15 cents per kilowatt-hour in Class 3 resources by 2007. The DWT strategy builds upon industry partnerships initiated under the Small Wind Turbine and Cold Weather Turbine projects, and is patterned after the LWST project in its low wind speed focus and project structure. Public-private partnerships selected through a DWT project competitive solicitation in FY 2003 for concept studies, component

(dollars in thousands)

development, and full turbine prototype development will be coordinated with Supporting Research and Testing activities, and periodically reviewed against established project milestones to assure performance.

FY 2002: (Formerly called Small Wind Turbine - $1,500,000) Continued support for industry efforts to complete designs and fabricate prototypes of advanced small wind turbines ranging from 5 to 50 kilowatts. Performed field testing of 50 kW prototype turbine.

(Formerly called Cold Weather Turbine - $180,000) Supported public-private partnership for high reliability, direct drive 100 kW wind turbine intended for use in extreme environment applications. Completed performance and reliability field-testing of prototype turbines at the National Wind Technology Center, including confirmation of stand-alone power system operation in the Hybrid Power Test Bed, and began testing in an actual remote community in Alaska for extreme environment service.

FY 2003: Field-testing prototypes of advanced small wind turbines to confirm performance and reliability. Initiating new competitively selected industry partnerships for achieving Class 3 (12 mph/30 feet) wind resource cost effectiveness for smaller wind systems (≤100 kilowatts), targeted for use in residential and small business applications.

FY 2004: For those public-private partnerships competitively selected in 2003, complete preliminary designs, fabricate and test components, and complete detailed designs. Begin fabrication of proof-of-concept turbines.

• Supporting Research and Testing (SR&T)	14,611	15,800	15,800

Supporting Research and Testing is composed of two elements that directly support development of Low Wind Speed Technology. The first, formerly called Core Research, includes research in wind characteristics, aerodynamics, structural dynamics, materials, and advanced components that provide the technical improvements needed to support Low Wind Speed Technology projects. Characterization of the design environment and improved computer codes are the main products. The second element involves laboratory support for Low Wind Speed Technology design review, analysis and testing required to support the technology development process. Outputs of this activity include periodic design reviews and conduct of tests at industry and laboratory locations.

FY 2002: Performed design review, analysis and testing to ensure that industry wind turbine research efforts in aero and structural dynamics, materials, wind characteristics, systems and components took full advantage of wind program technology developments and capabilities. Supported project testing requirements using world-class testing facilities at the National Wind Technology Center, and provided close technical oversight to monitor and direct project performance.

(dollars in thousands)

FY 2002	FY 2003	FY 2004

(Formerly called University Research - $1,000,000) Competitively selected new projects for advanced wind turbine and systems research, and completed funding for several ongoing wind energy research activities with universities on a range of topics, including wind turbine aerodynamics, structures, materials, advanced components, and wind characteristics.

(Formerly called Core Research - $9,200,000) Activities included completion of one year of data collection under the Long-Term Inflow and Structures Test and completion of design code validation using wind tunnel test data obtained in FY 2000. Continued highest priority research efforts in wind turbine aerodynamics, structures, materials, advanced components, and wind characteristics to support development of new and improved tools for advanced wind energy system design and applications. Core research efforts focused on the primary program thrust to develop low wind speed turbine technology. SBIR/STTR funding in the amount of $369,000 was transferred from this subprogram to the Science Appropriation.

(Portion of former National Wind Technology Center Operations - $650,000) Operated the National Wind Technology Center facilities at the National Renewable Energy Laboratory to support laboratory and industry research activities.

FY 2003: Providing research, design review, analysis, and testing support to industry wind turbine research partnership efforts using wind program expertise, technology developments, and capabilities.

(Formerly called University Research - $1,000,000) Continuing multi-year university projects competitively selected in FY 2002 for advanced wind turbine technology and systems research.

(Formerly called Core Research - $9,000,000) Continuing research efforts in wind turbine aerodynamics, structures, materials, advanced components, and wind characteristics to support development of new and improved tools for advanced wind energy system design and applications. Core research also includes providing technical information and assistance to industry for mitigating avian issues and Small Business Innovation Research (SBIR) support. Core research efforts are focusing on supporting development of low wind speed turbine technology. Performance in FY 2003 is being measured for core research activities using analytically-established targets linking contributions from each activity to meeting low wind speed technology program goals.

(Portion of former National Wind Technology Center Operations - $900,000) Operating the National Wind Technology Center facilities at NREL to provide testing and certification support to industry.

(dollars in thousands)

FY 2002	FY 2003	FY 2004

FY 2004: Conduct research efforts in wind turbine aerodynamics, structures, materials, advanced components, and wind characteristics to support development of new and improved tools for low wind speed technology system design and applications. Provide design review, analysis, and testing support to public/private partnership R&D efforts using wind program expertise, technology developments, and capabilities. SR&T includes funding required for operation of the National Wind Technology Center, including specialized engineering test facilities and equipment critical for low wind speed technology development. Performance in FY 2004 will be measured for SR&T using analytically-established targets linking contributions from each activity to meeting the program's low wind speed technology goals for large and small systems.

P **Technology Application** **14,800** **14,200** **11,800**

The Technology Application key activity addresses opportunities and barriers concerning use of wind energy systems. Activities include Systems Integration and Resource Assessment that require applied technical efforts, and Technology Acceptance which focuses on resolving institutional issues and outreach. Technology Application also includes Analysis and Industry Support activities that accelerate the appropriate introduction of wind energy systems in the energy sector through opportunities such as field verification projects, support for industry certification testing and standards development, and near-term technical support for emerging industry issues. (Includes the former Cooperative Research and Testing and some activities from the former Applied Research key activities.)

- Systems Integration, Total 3,500 3,200 3,200

  < Systems Integration 3,266 3,200 3,200

  Systems Integration includes the monitoring and analysis of existing wind systems in user settings to assess and validate factors such as energy savings, voltage stability, power regulation and other power system performance issues. The scope of the activity includes integration of large wind farms in utility grid systems, small wind turbines in standalone applications such as hybrid diesel systems, and wind turbines in distributed applications, often close to customers. Technical assistance is provided to electric utilities, regulators, and other stakeholders to address issues such as system impacts from wind plant power variations, and appropriate treatment for an intermittent source such as wind power to allow such plants to participate in the competitive marketplace.

(dollars in thousands)

FY 2002	FY 2003	FY 2004

FY 2002: (Formerly called Wind Integration - $2,400,000) Completed assessment of ancillary service requirements for wind energy in several regions, and collection of wind farm performance data required to support development of models for integrating wind energy into power delivery systems. Completed targeted studies of electric power transmission system barriers.

(Formerly called Distributed Wind Applications - $1,100,000) Completed technical support, data collection, and evaluation of three operating wind diesel hybrid projects in Alaska, and one congressionally directed project. Concluded design studies, testing, and analysis of wind hybrid systems conducted in FY 2001 based on industry success with system installation and performance in Alaska and other remote locations and transfer results to industry. Initiated small wind system field test to characterize small wind system design factors affecting performance and reliability.

FY 2003: (Formerly Wind Integration - $2,400,000) Continue focus on analytical support to facilitate integration of wind energy into power delivery systems, including targeted studies of electric power transmission system barriers and assessment of ancillary service requirements for wind energy.

(Formerly called Distributed Wind Applications - $800,000) Conduct monitoring and analysis of wind/diesel systems in Alaska, and systems engineering for other distributed small wind system applications. Complete targeted research activities to address small wind turbine acoustic issues.

FY 2004: Continue focus on analytical support to facilitate integration of wind energy into power delivery systems, including targeted studies of electric power transmission system barriers and assessment of ancillary service requirements for wind energy, improvements in wind plant forecasting to allow a wind plant operator to participate in next day market opportunities, and collection of the only publicly available high data rate wind farm performance information in the United States. Continue technical support for integration of small wind systems into residential and small business systems, and for applications such as water pumping and icemaking. Support coordinated assessment and analysis of integration with hydropower and other renewable energy systems, and production of hydrogen from wind systems.

(dollars in thousands)

	FY 2002	FY 2003	FY 2004
< Congressionally Directed Systems Integration	234	0	0

The following project was directed by Congress to be included in this program in FY 2002: Wind Generation Facility for St. Paul Island and Unalaska, Alaska (FY 2001 $0, FY 2002 $234,200, FY 2003 $0).

• Resource Assessment	1,000	1,000	1,000

Interest in wind energy development in the U.S. has increased the need for more detailed and accurate wind resource assessments for specific areas, particularly with State and Tribal organizations. Resource Assessment includes activities for increasing the data base of wind resource potential at turbine hub-heights in partnership with States, improving the understanding and analysis of the wind characteristics in areas where wind energy projects are established, and developing and validating updated high-resolution wind resource maps in cooperation with private industry. Cooperative research with National Oceanic and Atmospheric Administration (NOAA) Laboratories in adapting numerical weather prediction models for use in wind energy forecasting and wind mapping is also an important component of Resource Assessment.

FY 2002: (Portion of former Industry Support - $1,000,000) Activities focused on increasing the data base of wind characteristics at turbine hub-heights in partnership with States, improving the understanding and analysis of the wind characteristics in areas where wind energy projects are established, and developing updated high-resolution wind resource maps in cooperation with private industry. A major activity was the validation of updated wind resources maps for the Pacific Northwest and the Mid-Atlantic. Short-term statistical wind forecasting tools were developed, and cooperative wind forecasting research with NOAA/Forecast Systems Laboratory (FSL) was performed.

FY 2003: (Portion of former Industry Support - $1,000,000) Validate new wind resource maps of California and the rest of the southwestern United States. Support State projects for establishing tall-tower measurement sites to ensure that high-quality data is collected and added to the existing data base. Continue research with FSL on statistical and probabilistic wind forecasts.

FY 2004: Analyze and categorize tall tower data collected in FY 2003 to assess effectiveness for accurately simulating wind characteristics at hub-heights with numerical weather prediction models. Produce high-resolution wind resource maps at 100 m above ground, close to hub-height of the newer wind turbines. Continue support and research for wind energy forecasting programs with the emphasis on disseminating results to industry.

(dollars in thousands)

	FY 2002	FY 2003	FY 2004
• Technology Acceptance	3,600	3,600	3,600

Technology Acceptance includes activities to build on the national R&D investment in wind technology through work with national stakeholder groups to move the technology into the power generation market. The Wind Powering America component of Technology Acceptance addresses barriers to wind development at the national, State, and local levels. The focus is on facilitating the deployment of wind technology to bring economic benefits to the country, enhancing the use of domestic energy resources, enabling Federal sector compliance with renewable energy use goals, and stimulating sustainable Tribal energy sectors. Activities are conducted in partnership with utility generators, equipment manufacturers, project financiers and developers, public and private officials, regulators, industrial and public sector consumers, other agencies, and citizen stakeholder groups to provide technical support, guidance, information, and limited cost-shared funding to regional, State, and local efforts to explore and develop their wind energy resources. Technology Acceptance also supports cooperative activities with utility-based and other key stakeholder organizations to expand wind resource information on technical and institutional barriers to wind power development and other topical issues.

FY 2002: (Formerly called Wind Powering America - $3,100,000) Provided regionally- based technical support and outreach assistance to Federal, State, and local organizations, utilities, rural landowners, American Indian groups, and the wind industry to accelerate wind energy development. Conducted ten State workshops focusing on wind energy.

(Portion of former Industry Support - $500,000) Supported national utility and stakeholder forums to address critical technical and institutional barriers to wind power development, including environmental and siting issues, transmission and utility system integration, and emerging power market structures.

FY 2003: (Formerly Wind Powering America - $3,100,000) Conduct national effort to accelerate the use of wind energy in the United States through regionally-based technical assistance and coordinated outreach activities, in partnership with Federal, State, and local organizations, utilities, rural landowners, Native American groups, and the wind industry.

(Portion of former Industry Support - $500,000) Support cooperative activities with States and other stakeholder organizations to expand wind resource information to address technical and institutional barriers to wind power development in the United States.

FY 2004: Activities will focus on enhancing general technology awareness and exploring project development issues and ownership models, and on support for residential and small business applications of small wind systems. Support nationally-coordinated efforts with utilities and

(dollars in thousands)

stakeholders to resolve institutional issues and barriers impacting wind power development, and acceptance of wind by the electric power sector. Annual performance measures for this activity include: 25 States with over 20 MW installed; 12 States with over 100 MW installed; and 1 percent of Federal electricity use supplied by wind power.

• Analysis and Industry Support, Total	6,700	6,400	4,000
< Analysis and Industry Support	3,404	6,400	4,000

Analysis and Industry Support is comprised of several related but distinct activities: systems analysis to track improvements in wind technology in diverse applications; assessment of future improvements in cost performance of wind technology (i.e., technology characterization); market analyses leading to benefits assessments to support the Government Performance and Results Act; investigation of technical issues to address near-term barriers for industry; testing and design review support for the Underwriters Laboratories wind turbine certification program; and operation of the National Wind Technology Center to support overall Technology Application activities. Analysis and Industry Support also includes regional field verification, which supports industry needs for gaining initial field operation experience with advanced technology wind turbines and verifies the performance, reliability, maintainability, and cost of new wind turbines in a commercial environment. It also helps expand opportunities for wind energy in new regions of the United States by tailoring projects to meet unique regional requirements; and documents and communicates the experience from these projects for the benefit of others in the wind power development community.

FY 2002: (Portion of former Industry Support - $1,500,000) Focused on resolving near-term technical issues identified as high priority by industry, and developed targeted products for wind energy communications and outreach. Included analytical effort required for technology characterization and benefits assessment.

(Portion of former National Wind Technology Center Operations - $650,000) Operated the National Wind Technology Center facilities at the National Renewable Energy Laboratory, and provided support for Technology Application activities, including certification testing.

(Formerly called Regional Field Verification - $4,000,000) Provided technical, data collection, analysis, and reporting support to cost-sharing project hosts, and completed project development reports. Initiated competitively selected field verification project for small wind systems, and supported five congressionally directed projects.

(dollars in thousands)

FY 2002	FY 2003	FY 2004

(Formerly called Avian Research - $200,000) Supported industry research efforts to characterize and mitigate avian concerns associated with wind energy systems.

(Formerly called Certification - $350,000) Performed laboratory testing and design review services in support of U.S. wind turbine certification agent.

FY 2003: (Part of former Industry Support - $1,500,000) Assisting industry efforts in resolving near-term technical issues, developing targeted products for wind energy communications and outreach, and completing analysis activities required for technology characterization and benefits assessment.

(Portion of former National Wind Technology Center Operations - $900,000) Operate the National Wind Technology Center facilities at the National Renewable Energy Laboratory to provide testing and certification support to industry.

(Formerly called Regional Field Verification - $4,000,000) Providing technical, data collection, analysis, and reporting support to cost-sharing project hosts. Issue competitive select solution for field verification projects targeting machines emerging from Next Generation Turbine and Small Wind Turbine projects.

FY 2004: Provide near-term technical, standards development, and certification testing support to industry, including operation of the National Wind Technology Center. Support competitive solicitations for installing small, cost-shared wind projects to field verify performance of new wind turbine technology in a commercial operating environment. Document and communicate program activities and results to stakeholder audience. Complete analytic activities required for technology characterization and benefits assessment.

<	Congressionally Directed Analysis and Industry Support . . .	3,296	0	0

The following wind projects were directed by Congress to be included in this program: Kotzebue Wind Project - to complete the installation of a 2-4 MW wind farm at a remote village in northwestern Alaska, just north of the Arctic Circle (FY 2001 $1,000,000, FY 2002 $941,400, FY 2003 $0), Turtle Mountain Community College - for the installation of a wind energy system to provide power for a Native American college campus (FY 2001 $100,000, FY 2002 $471,000, FY 2003 $0), Vermont-Washington Electric Cooperative - to aid in the installation of a wind energy system to promote renewable energy use by an electric cooperative (FY 2001 $0, FY 2002 $941,400, FY 2003 $0), Vermont-Department of Public Service - for a public education and outreach project to reduce barriers to wind energy use in the State (FY 2001 $0, FY 2002 $471,000, FY 2003 $0), and Toledo Harbor Lighthouse for the installation of a wind energy

system to provide power for an offshore tourism facility (FY 2001 $0, FY 2002 $471,000, FY 2003 $0). No funding is requested for any of these projects in FY 2004.

Hydropower Funding Schedule[a]

(dollars in thousands)

	FY 2002	FY 2003	FY 2004	$ Change	% Change
Hydropower					
Technology Viability					
Advanced Hydro Turbine Technology	1,655	5,089	5,589	+500	+9.8%
Congressionally Directed Alaska Projects	2,231	0	0	0	0.0%
Subtotal, Technology Viability	3,886	5,089	5,589	+500	+9.8%
Technology Application					
Biologically-Based Criteria Development	1,000	1,500	1,500	0	0.0%
Low Head/Low Power Resource Assessment	100	900	400	-500	-55.6%
Subtotal, Technology Application	1,100	2,400	1,900	-500	-20.8%
Total, Hydropower	4,986	7,489	7,489	0	0.0%

[a] SBIR/STTR funding in the amount of $32,000 was transferred to the Science appropriation in FY 2002. Estimates for SBIR/STTR budgeted in FY 2003 and FY 2004 are $48,064 and $48,064 respectively. The FY 2002 Supplemental appropriation reduced this program by $ 134,000 for transfer to the Electricity Reliability program. This program was reduced by a General Reduction of $148,000 in FY 2002.

Detailed Program Justification

(dollars in thousands)

	FY 2002	FY 2003	FY 2004
Hydropower	**4,986**	**7,489**	**7,489**
P **Technology Viability**	3,886	5,089	5,589

The Technology Viability key activity focuses on R&D to develop advanced hydropower turbine designs that will be more environmentally-friendly, reducing the rate of fish mortality to 2 percent or lower, and available for industry use by 2010.

• Advanced Hydro Turbine Technology	1,655	5,089	5,589

This activity focuses on full-scale prototype testing of advanced turbine designs to determine biological and hydraulic performance. These designs include that developed by the Alden Research Laboratory, which has completed pilot-scale proof-of-concept testing, and four projects at three sites competitively selected in June 2002. Successful operation of these systems will significantly advance the fish passage and water quality goals of the Hydropower subprogram.

FY 2002: (Formerly called Large Turbine Testing - $1,464,000) Issued two RFPs for large turbine testing, one for designs/turbine manufacturers, and one for sites. SBIR/STTR funding in the amount of $32,000 was transferred from this subprogram to the Science Appropriation.

(Formerly called Advanced Turbine Pilot-Scale Testing - $223,000) Initiated pilot-scale biological and hydraulic testing of a large turbine design. Based on initial test results, begin planning for full-scale prototype testing.

FY 2003: (Formerly called Large Turbine Testing - $4,089,000) Begin large turbine testing activities. Successful testing is providing industry with additional turbine options for retrofit or new development, and will help to attain the 2 percent fish mortality goal by 2010.

(Formerly called Advanced Turbine Pilot-Scale Testing - $1,000,000) Complete pilot-scale proof-of-concept testing of the Alden turbine design. The funding request for FY 2003 is providing for the full-scale prototype testing at an operational hydropower site. Successful testing will provide industry with a proven design for retrofit or new development and helping attain the 2 percent mortality goal by 2010.

FY 2004: Activities planned under Advanced Hydro Turbine Technology will fall into two areas: 1) development and testing of full scale (greater than 1 MW) prototypes of retrofit and new environmentally friendly designs under competitively selected public private partnerships; and 2) full-scale prototype testing of the previously selected Alden Research Laboratory innovative turbine.

(dollars in thousands)

	FY 2002	FY 2003	FY 2004
• Congressionally Directed Alaska Projects	2,231	0	0

FY 2002: Congressionally directed funding for the Power Creek and Gustavus (Falls Creek) projects in Alaska. Historical funding for the Gustavus project is as follows: (FY 2001 $0, FY 2002 $388,000, FY 2003 $0). Legislation states that FY 2002 is the last year of funding for Power Creek Project (FY 2001 $0, FY 2002 $1,843,000, FY 2003 $0). No funding requested in FY 2004.

P	**Technology Application . . . . . .**	**1,100**	**2,400**	**1,900**

The Technology Application key activity addresses opportunities and barriers concerning the use of hydropower in the United States. Activities will focus on resource assessment and biological and environmental studies.

• Biologically-Based Criteria Development	1,000	1,500	1,500

This activity addresses the need to fill significant gaps in the understanding of how fish respond to physical stresses experienced in passage through turbines. Potential injury mechanisms are extremely difficult to measure inside a turbine, and this research addresses the need for this data in developing advanced turbine design criteria. Research on the effectiveness of hydropower environmental mitigation practices was identified as a priority R&D need at the hydro industry's R&D Forum in July 2001.

FY 2002: Developed biological experiments and instrumentation to establish biologically-based performance criteria.

FY 2003: Conduct additional biological criteria studies of the effects of strike and cavitation on turbine-passed fish. Complete fish passage and in stream flow mitigation studies.

FY 2004: Complete biological studies on the effects of strike on turbine-passed fish and start studies of the cumulative effects of shear, pressure, strike, cavitation and turbulence. Begin mitigation studies on the environmental effects of dam decommissioning, and studies on integrating hydropower with other renewables.

	(dollars in thousands)		
	FY 2002	FY 2003	FY 2004
• Low Head/Low Power Resource Assessment	100	900	400

Previous hydropower resource assessments have focused on potential projects with a capacity of 1 MW or greater. These assessments were also based on previously identified sites with varying development potential. This activity provides for an assessment of hydropower potential for low head (30 feet or less) and low power (1 MW or less) resources.

FY 2002: (Formerly called Mini-Hydro Research and Development - $100,000) Assessment of potential mini-hydro conducted through both cost-shared biological field verification of mini-hydro turbine systems to determine biological and hydraulic performance resource assessment and analysis activities. Continuing the on-going resource assessment activities as well as the investigation of promising turbine designs.

FY 2003: (Formerly called Low Head/Low Power Mini-Hydro Research and Development - $900,000). Complete low-head/low-power/mini-hydro resource assessment for the lower 48 States.

FY 2004: The assessment of potential small (low head/low power) hydro resources in the United States will be completed (Alaska & Hawaii to be added to the lower 48 assessments done in FY 2003), integrated into the program's analytic work, and made available to industry.

Total, Wind Energy and Hydropower	**43,197**	**51,489**	**49,089**

Explanation of Funding Changes

	FY 2004 vs. FY 2003 ($000)
Wind Energy	
P Technology Application: Analysis and Industry Support: Decrease reflects reduced funding for Regional Field Verification activity, based on anticipated funding requirements for projects initiated in 2003.	-2,400
Hydropower	
P Technology Viability: Advanced Hydro Turbine Technology: Increase supports testing of new prototype hydro turbines	+500
P Technology Application: Low-Head / Low-Power R&D: Decrease reflects shift in funding to higher-priority testing of new prototype hydro turbines	-500
Total, Hydropower	0
Total Funding Change, Wind Energy and Hydropower	**-2,400**

Geothermal Technology Program

Program Mission

The mission of the Geothermal Technology Program is to work in partnership with U.S. industry to establish geothermal energy as an economically competitive contributor to the U.S. energy supply. The technologies developed by this program will provide the Nation with new sources of electricity supply that are highly reliable and cost competitive and do not add to America's air pollution or the emission of greenhouse gases. Geothermal electricity generation is not subject to price volatility and supply disruptions from changes in global energy markets. Geothermal energy systems use a domestic and renewable source of energy and are not reliant on foreign sources of fuel.

America's geothermal resources include heat near the earth's surface, the hot water and steam reservoirs that are up to several miles further down, and the molten rock or magma which lie below that. However, hot rock is found everywhere below the Earth's surface at sufficient depths, and one day this energy may be included in the Nation's inventory of viable geothermal resources, provided cost-effective extraction technologies are developed.

About 60 percent of the Nation's existing geothermal resources lie beneath Federal lands, primarily in the Great Basin of the West. The President's National Energy Policy calls for increasing renewable energy production on Federal lands, and geothermal energy is one of the primary means of achieving this.

Today's geothermal energy facilities generate electricity or provide heat for various direct applications such as aquaculture, crop drying, and district heating, or use heat pumps to heat and cool buildings. Geothermal energy production is a $1.5 billion a year industry.

Geothermal energy currently accounts for about 0.3 percent of total U.S. electricity production. It represents about 17 percent of all renewable electricity production. Net installed geothermal power capacity in the U.S. has grown from about 500 to 2,800 MW between 1973 and today. Geothermal electric capacity is currently limited to a select number of sites in a few States, based on favorable geological circumstances that have made these areas relatively easy to exploit. For example, the Nation's first large-scale geothermal electric power plant began operations in 1960 at The Geysers in Sonoma County, California. This 1,000+ MW facility is the world's largest producer of geothermal electricity, and generates enough power to supply the needs of San Francisco, California. Today, geothermal sources provide 6 percent of California's total power needs.

Geothermal energy can also be used for direct uses requiring a low-to-moderate heat source. For example, the city of Klamath Falls, Oregon uses geothermal energy from hot reservoirs that lie beneath the city to supply heat for a large district heating system. In northern Nevada, one of the Nation's largest onion-drying facilities uses geothermal energy from a nearby resource to provide both process heat and electric power.

Locating, mapping, and drilling for geothermal energy are major cost drivers. For example, the capital costs

associated with developing a typical geothermal well field range from $200 to $800 per kilowatt of installed capacity. These costs can represent up to 50 percent of the total installed cost of the facility.

America's geothermal resources could be harnessed to a much greater extent, in many more locations, if geothermal energy technologies were more fully evolved and affordable. Improvements are needed in exploration and drilling techniques, methods for expanding the capacity and energy production of existing reservoirs, and novel techniques for using the hot rocks which lie everywhere beneath the surface.

Current technology relies on extracting energy in the form of hot water from geothermal reservoirs, and water is often used to cool geothermal power plants as well. Closed-loop systems have been developed that reduce water consumption by injecting used geothermal water back into the reservoir. Waste water, such as effluent from municipal treatment plants, can be injected into geothermal reservoirs to augment energy production as well as for disposal purposes.

The Federal Government has been supporting geothermal energy development since the 1970s. The focus has evolved from an early emphasis on sites where access to geothermal resources was readily available to the development of advanced systems for using geothermal resources at many more locations. This now requires the development of more sophisticated exploration, characterization, drilling, and energy conversion technologies. For example, the program supported the development of synthetic diamond drill bits for drilling. This technology development was recently honored as one of the top 100 scientific and technological accomplishments of the U.S. Department of Energy in its first 25 years.

Over the years, the Geothermal Technology Program has obtained substantial inputs from geothermal energy experts from outside of the U.S. Department of Energy. The perspectives of those experts, in meetings such as the peer reviews, held August 23-24, 2001, and March 25-27, 2002, help to assure that the program's research directions and priorities are properly aligned with the needs of geothermal energy developers, equipment manufacturers, utilities, State agencies, consumers, and other stakeholders. In addition, the program invests in technical program and market analysis and performance assessment in order to direct effective strategic planning.

Budget and Performance Integration

To implement the budget and performance integration portion of the **President's Management Agenda** the Geothermal Technology Program participated in both the OMB R&D Investment Criteria (R&DIC) and the OMB Program Assessment Rating Tool (PART) process. The 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 FY 2004 budget specifically:

- continues to redirect resources within the program to emphasize enhanced geothermal systems R&D; and
- terminates the program's "Industry Support" activity, largely composed of nearer-term, lower-risk activities within industry's capabilities.

Like many R&D programs the Geothermal Technology Program experienced difficulty in developing annual performance measures that satisfy the PART requirements. The program is committed to developing adequate annual measures to support the FY 2005 budget.

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 posted this spring on line at www.eren.doe.gov/eere/budget.html. An overview of the methods and results for the Geothermal 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 renewable programs is essentially the EIA's Annual Energy Outlook (AEO) 2002 reference case, which includes a limited amount of additional geothermal resource development. The program goals for geothermal technology improvements are modeled directly in NEMS-GPRA04 by incorporating the capital and operation and maintenance (O&M) cost reductions. The model also takes into account site availability and maximum development per site per year for conventional and Enhanced Geothermal Systems (EGS) geothermal capacity. The conventional geothermal characteristics modeled are from the EPRI/DOE Technology Characteristics report, and the EGS characteristics are developed by Princeton Energy Resources International (PERI). The NEMS model represents individual geothermal sites with different characteristics, with the lowest cost sites being developed first. Within each region, new capacity is selected based on its relative capital and operating costs, its operating performance (i.e., availability), the regional load requirements, and existing capacity resources. Because NEMS-GPRA04 cannot directly model green power demand, the impact of this demand on geothermal capacity is based on market analyses undertaken by PERI and included in NEMS-GPRA-04 as planned additions.

FY 2004 GPRA Benefits Estimates for Geothermal Technology Program (NEMS-GPRA04)

	2005	2010	2020
Electricity Capacity (GW)	0.0	1.8	6.7
Electricity Generation (BkWh)	0.4	14.6	53.8
Non-Renewable Energy Savings (quads)	0.00	0.10	0.40
Oil Savings (quads)	0.00	0.01	0.02
Carbon Savings (MMT)	0.1	1.7	7.5
Energy Expenditure Savings (B2000$)	0.0	0.6	1.8

Estimates for additional electricity capacity and generation, energy savings, oil savings, carbon emission reductions, and energy expenditure savings resultant from realization of Geothermal Technology Program goals are shown in the table above through 2020.[a] These geothermal power advances offer the opportunity for

[a] Benefits reported are annual, not cumulative, for the year given. 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.

nearly 7 GW of additional generating capacity in 2020, about 2 percent of the total additional generating capacity expected to be required by 2020. Because most of this capacity is in the western United States, where electricity infrastructure needs are greatest, development of these resources could provide larger regional contributions to electricity reliability. In addition to contributing to needed electricity capacity, the development of these geothermal resources would displace fuels otherwise required to provide this energy, and reduce associated emissions accordingly. These estimates reflect EIA reference case assumptions about future energy markets. These benefits would be larger if electricity markets prove to be more constrained than expected, or if the costs of siting and building transmission capacity to areas with geothermal resources are less than expected.

Program Strategic Performance Goals

The Geothermal Technology Program has the following overall performance goal: By 2010, the levelized cost of power generated from geothermal sources will be reduced from 5-8 cents in 2000, to 3-5 cents per kWh.

Performance Indicators:

The number of States with geothermal energy facilities.
The number of homes and businesses being supplied with geothermal energy.
The levelized cost of power in cents per kWH.

Annual Performance Results and Targets

FY 2002 Results	FY 2003 Target	FY 2004 Proposed Target
Completed design and environmental assessment of a small-scale geothermal power plant (300 kW to 1 MW) for field verification. An FY 2000 NREL study revealed considerable opportunity for small-scale geothermal in several western States.	Begin operation of a small-scale geothermal power plant in the State of New Mexico, adding a new State to those with commercial power facilities and providing field-verification of a new energy conversion system.	Create an initial Enhanced Geothermal System (EGS) with an industry partner and test associated technology needed to monitor and maintain the system.

Significant Program Shifts

The program has focused its efforts on expanding the number of exploitable geothermal sites. Although use for electric power generation is limited now to certain locations in the West, geothermal resources are available in every State, and the program, through increased emphasis on Enhanced Geothermal Systems, is developing new tools, techniques, and technologies for accessing these resources and is building partnerships with industry, universities, and the States to expand geothermal energy development.

Funding Profile[a]

(dollars in thousands)

	FY 2002 Comparable Appropriation	FY 2003 Amended Request	FY 2004 Request	$ Change	% Change
Geothermal Technology	27,035	26,500	25,500	-1,000	-3.8%
Total, Geothermal Technology	27,035	26,500	25,500	-1,000	-3.8%

Public Law Authorization:

PL 93-410, "Geothermal Energy Research, Development, and Demonstration Act of 1976"
P.L 95-91, "Department of Energy Organization Act" (1977)"
P.L 95-618, "Energy Tax Act of 1978"
P.L 96-294, "Energy Security Act" (1980)"
P.L 101-218, "Renewable Energy and Energy Efficiency Technology Competitiveness Act of 1989"
P.L 101-575, " Solar, Wind, Waste, and Geothermal Power Production Incentives Act of 1990"
P.L. 102-486, "Energy Policy Act of 1992"

[a]SBIR/STTR funding in the amount of $201,000 was transferred to the Science appropriation in FY 2002. Estimates for SBIR/STTR budgeted in FY 2003 and FY 2004 are $197,022 and $189,588 respectively. The FY 2002 Supplemental appropriation reduced this program by $727,000 for transfer to the Electricity Reliability program. The FY 2002 rescission reduced this program by $63,000. This program was reduced by a General Reduction of $974,000 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	3,140	3,300	2,190	-1,110	-33.6%
Golden Field Office	1,900	0	6,000	+6,000	NA
Sandia National Laboratories	5,900	6,600	6,600	0	0.0%
Albuquerque Operations Office	1,600	3,000	3,000	0	0.0%
Total, Albuquerque Operations Office	12,540	12,900	17,790	+4,890	+37.9%
Chicago Operations Office					
Brookhaven National Laboratory	950	1,000	1,000	0	0.0%
Total, Chicago Operations Office	950	1,000	1,000	0	0.0%
Idaho Operations Office					
Idaho National Engineering and Environmental Laboratory	3,100	3,400	3,500	+100	+2.9%
Idaho Operations Office	6,660	5,500	0	-5,500	-100.0%
Total, Idaho Operations Office	9,760	8,900	3,500	-5,400	-60.7%
Oakland Operations Office					
Lawrence Berkeley National Laboratory	880	900	900	0	0.0%
Lawrence Livermore National Laboratory	1,130	1,200	1,200	0	0.0%
Oakland Operations Office	1,230	1,100	1,100	0	0.0%
Total, Oakland Operations Office	3,240	3,200	3,200	0	0.0%
Oak Ridge Operations Office					
Office of Scientific and Technical Information	10	10	10	0	0.0%
Total, Oak Ridge Operations Office	10	10	10	0	0.0%
Washington Headquarters	535	490	0	-490	-100.0%
Total, Geothermal Technology	27,035	26,500	25,500	-1,000	-3.8%

[a] "On December 20, 2002, the National Nuclear Secruity 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) serves as the lead laboratory for the Geothermal Technology Program's Energy Systems Research and Testing. NREL provides on-going research and development in energy conversion technologies. The laboratory also supports the Geothermal Technology Program in the areas of education, outreach and systems analysis.

Golden Field Office

Golden Field Office provides management of research at NREL, administers University Research, and oversees projects in Enhanced Geothermal Systems, and contracts in energy conversion systems.

Sandia National Laboratories

Sandia National Laboratories (SNL) serves as the lead laboratory for coordination of geothermal drilling research. In cooperative projects with the U.S. geothermal industry, SNL performs research on advanced drilling systems including diagnostics-while-drilling, drilling measurement and control, drilling hardware development, and design and testing of high-temperature wellbore instrumentation. SNL coordinates the activities of universities and commercial research firms to rapidly bring promising geothermal drilling to commercial availability.

Albuquerque Operations Office

Albuquerque Operations Office administers the Geothermal Research Exploration and Definition program.

Brookhaven National Laboratory

Brookhaven National Laboratory supports research activities in Advanced Drilling and Advanced Heat and Power Systems, including innovative drilling materials, high temperature elastomers, and silica recovery from geothermal brines.

Idaho National Engineering and Environmental Laboratory

Idaho National Engineering and Environmental Laboratory (INEEL) serves as the lead laboratory for coordination of the Geothermal Technology Program's Geoscience and Supporting Technologies. In cooperative projects with the U.S. geothermal industry, INEEL performs research on fluid flow and solute transport modeling in hydrothermal reservoirs and conducts site investigations of geothermal resource potential. INEEL also conducts research on energy conversion systems and related technologies.

Idaho Operations Office

The Idaho Operations Office (ID) provides procurement services and oversight of funding for the Idaho National Engineering and Environmental Laboratory. ID also administers university research in geothermal energy and projects in Enhanced Geothermal Systems.

Lawrence Berkeley National Laboratory

Lawrence Berkeley National Laboratory performs Core Research and develops exploration technology including studies of reservoir dynamics and seismic and electromagnetic exploration techniques.

Lawrence Livermore National Laboratory

Lawrence Livermore National Laboratory also performs Core Research and exploration technology development, including isotope and geochemical studies.

Oakland Operations Office

Oakland Operations Office administers financial assistance awards for geothermal outreach activities.

Office of Scientific and Technology Information

The Office of Scientific and Technology Information (OSTI) performs standard distribution of information for multiple EERE programs including Geothermal Technology. This distribution consists of publishing and maintaining on-line full text of eight electronic current awareness publications.

Funding Schedule

(dollars in thousands)

	FY 2002	FY 2003	FY 2004	$ Change	% Change
Geothermal Technology					
Geoscience and Supporting Technologies					
Core Research	2,136	3,000	3,000	0	0.0%
University Research	3,200	1,200	1,200	0	0.0%
Enhanced Geothermal Systems	1,580	3,500	6,000	+2,500	71.4%
Subtotal, Geoscience and Supporting Technologies	6,916	7,700	10,200	+2,500	32.5%
Exploration and Drilling Research					
Detection and Mapping	3,000	6,000	5,500	-500	-8.3%
Innovative Drilling Subsystems	4,784	6,000	6,000	0	0.0%
Near-Term Technology Development	300	100	0	-100	-100.0%
Subtotal, Exploration and Drilling Research	8,084	12,100	11,500	-600	-5.0%
Energy Systems Research and Testing					
Advanced Heat & Power Systems	3,300	3,300	2,400	-900	-27.3%
Systems Field Verification	811	1,000	0	-1,000	-100.0%
Industry Support	4,724	1,000	0	-1,000	-100.0%
GeoPowering the West	3,200	1,400	1,400	0	0.0%
Subtotal, Energy Systems Research and Testing	12,035	6,700	3,800	-2,900	-43.3%
Total, Geothermal Technology	27,035	26,500	25,500	-1,000	-3.8%

Detailed Program Justification

	(dollars in thousands)		
	FY 2002	FY 2003	FY 2004
Geoscience and Supporting Technologies	**6,916**	**7,700**	**10,200**

This area involves the improved understanding of the geological processes affecting the energy production capacity of geothermal reservoirs. The aim is to produce tools for assessing energy production, for optimizing reservoir management, and for increasing the geothermal resource base through a broad spectrum of laboratory and field studies.

P **Core Research**	**2,136**	**3,000**	**3,000**

Core Research addresses characterization and management of the geothermal resource via increased understanding of underground fractures, including flow through those fractures, and resource management, including reinjection of spent geothermal fluid. The research activities combine laboratory and analytical studies with field testing to produce innovative reservoir management techniques. There is cross fertilization with the petroleum, mining, and groundwater industries through critical examination of their techniques.

FY 2002: Worked to understand complex natural geothermal processes and developed technology to facilitate producing geothermal resources in an economical manner. Research activities included improving reservoir models, studying fracture dynamics, developing tracers, and conducting geochemical research. The funding provided for a continuation of projects in reservoir management that promised to give industry reliable tools for reservoir analysis and production.

FY 2003: Understand complex natural geothermal processes and developing technology to facilitate geothermal resource production in an economical manner. Research activities include improving reservoir models, studying fracture dynamics, developing tracers, and conducting geochemical research. The funding provides for increasing emphasis on projects supporting Enhanced Geothermal Systems (EGS).

FY 2004: Conduct research to understand complex natural geothermal processes and develop technology to facilitate geothermal resource production in an economical manner. Research activities include improving reservoir models, studying fracture dynamics, developing tracers, and conducting geochemical research. The funding provides for a continuation of projects supporting EGS (i.e., engineered reservoirs) technology that will result in improved means for understanding, predicting, and managing the performance of EGS.

P **University Research, Total**	**3,200**	**1,200**	**1,200**
• University Research	2,264	1,200	1,200

(dollars in thousands)

Fundamental knowledge about the formation, evolution, and behavior of geothermal systems in a broad geological context is provided through competitively-selected financial assistance awards to universities. This work complements and supports Core Research and Enhanced Geothermal Systems which are more directly focused on geothermal reservoir analysis.

FY 2002: Conducted competitively-selected research projects in earth science at universities to expand the geothermal knowledge base. Knowledge gained from this work resulted in better tools for finding, monitoring and understanding geothermal systems.

FY 2003: Fund ongoing, competitively-selected research projects in earth science at universities to preserve a strong geothermal knowledge base. Knowledge gained from this work is producing technology that will help to expand the resource base. The funding profile reflects the completion of multi-year grant awards and a realignment of some projects to complement Core Research.

FY 2004: Continue to fund competitively-selected research projects in earth science at key universities to preserve a strong geothermal knowledge base. Knowledge gained from this work will support expansion of the resource base.

• Congressionally Directed University Research	936	0	0

The following project was directed by Congress to be included in this program: University of Nevada-Reno Center for Geothermal Energy (FY 2001– $0, FY 2002 – $936,000, FY 2003 – $0).

P **Enhanced Geothermal Systems (EGS) . . . . . .**	**1,580**	**3,500**	**6,000**

EGS are engineered reservoirs that have been created to extract heat from economically unproductive geothermal resources. EGS technology includes those methods and equipment that enhance the removal of energy from a resource by increasing the productivity of the reservoir. Better productivity may result from improving the reservoir's natural permeability and/or providing additional fluids to transport heat. The Department estimates that the development of next-generation EGS technology can more than double the amount of economically viable geothermal resources in the West. This work comports well with the NEP recommendations to develop next-generation technology and increase geothermal energy production on Federal lands.

FY 2002: Completed preliminary designs for five competitively selected projects employing EGS technology. The results were documented and distributed to stakeholders, and one project was selected for full-scale development. Two additional projects were selected for preliminary analysis from a new solicitation.

(dollars in thousands)

FY 2002	FY 2003	FY 2004

FY 2003: Begin development of an enhanced reservoir with improved permeability in the Coso Hot Springs geothermal field at the U.S. Naval Weapons Air Station (China Lake, California). Complete conceptual design and feasibility studies at two other competitively selected sites: Desert Peak (Nevada) and Glass Mt. (California).

FY 2004: Step up work on EGS cost-shared projects at three competitively-selected sites. During FY 2004, drilling and reservoir stimulation experiments will be conducted at one site, while drilling of a production well will be completed at another site.

Exploration and Drilling Research **8,084** **12,100** **11,500**

Today, about one in five exploration wells succeeds in locating economic geothermal energy resources. Advances in exploration and drilling technologies have the potential to significantly increase our ability to locate and exploit America's geothermal resources. This area involves tools and techniques for detection and mapping of geothermal sites, studies in collaboration with the U.S. Geological Survey to confirm geothermal resources in the Great Basin of the western U.S., and research and development of advanced drilling components and subsystems. The objectives are to find and characterize undiscovered resources, reduce the number of wells needed to find and confirm resources, and reduce the cost of drilling wells.

P **Detection and Mapping** **3,000** **6,000** **5,500**

Detection and Mapping seeks to reduce the risks associated with discovering geothermal resources. Exploration research develops improved tools to find geothermal resources, particularly techniques that can locate resources not associated with surface manifestations such as hot springs. Detection and Mapping also includes an industry cost-shared Geothermal Resource Exploration and Definition program (GRED) involving field studies of potential sites. GRED will lead directly to the definition of new geothermal resources and ultimately greater use of them for generation of electricity and direct heat applications.

FY 2002: Selected a second round of cost-shared exploration projects and continued other, multi- phase projects to find and confirm new geothermal resources. Conducted geophysical, geological, and geochemical exploration research.

FY 2003: Increase the number of cost-shared, competitively-selected exploration projects initiated with industry to ten. Initiate studies to identify and confirm the geothermal resources of the Great Basin in collaboration with the U.S. Geological Survey. Conduct geophysical, geological, and geochemical exploration research. Performance is measured by confirming at least two new geothermal reservoirs in the United States.

(dollars in thousands)

FY 2004: Maintain at least five cost-shared, competitively-selected, exploration projects initiated with industry to find and confirm new geothermal resources within the United States. These projects are expected to bring new geothermal fields into production. Continue studies to identify and confirm the geothermal resources of the Great Basin in collaboration with the U.S. Geological Survey. Continue research to improve exploration technology with increasing emphasis on remote sensing, seismic and electromagnetic techniques. Performance will be measured by confirming at least two new geothermal reservoirs in the United States during FY 2004.

P	**Innovative Drilling Subsystems . . . . . .**	**4,784**	**6,000**	**6,000**

Drilling and completion of wells account for 30 percent through 50 percent of the cost of a geothermal power project. High up-front costs and probability of unsuccessful drilling can drive financial risk to unacceptable levels relative to anticipated project return on investment. Innovative Drilling Subsystems research aims to produce new technologies for reducing the cost of geothermal wells through an integrated systems approach that focuses on key subsystems. The research effort also draws on advancements from the petroleum, mining, and related industries where new technology can be adapted for geothermal applications.

FY 2002: Conducted proof-of-concept field tests of a prototype Diagnostics-While-Drilling (DWD) subsystem, for integration into an Advanced Drilling System. DWD research, listed as a separate subactivity in FY 2001, was included under the Innovative Drilling Subsystems subactivity. The change in funding was the result of channeling the majority of subsystem research into DWD development while de-emphasizing work on subsystems of lesser priority, such as acoustic telemetry. Work continued on other key subsystems such as advanced drill bits and high-temperature instrumentation.

FY 2003: The development of several major advanced drilling components, including the Diagnostics-While-Drilling subsystem, advanced drill bits, a bit vibration suppression subsystem, and an improved lost circulation subsystem continues at an accelerated pace. These elements will ultimately be integrated into a comprehensive advanced drilling system by FY 2008. Progress is measured by completing field verification of the Diagnostics-While-Drilling subsystem.

FY 2004: Conduct additional field tests of an improved Diagnostics-While-Drilling subsystem for reliability and durability. Integrate various subsystem components into a prototype advanced drilling system designed to reduce the overall cost of geothermal wells by an average of 25 percent by 2008 (i.e., $300 per foot in 2000 to $225 per foot in 2008). Progress will be measured by testing and confirming a high-speed telemetry package for the Diagnostics-While-Drilling subsystem in a geothermal well.

	(dollars in thousands)		
	FY 2002	FY 2003	FY 2004
P **Near-Term Technology Development . . . . . .**	**300**	**100**	**0**

Near-term R&D assists industry in solving immediate drilling-related problems through cost-shared projects, field testing and technology transfer. The approach involves incremental improvements to conventional technology rather than developing new technology.

FY 2002: Continued development of high temperature geothermal well cements in collaboration with industry. Research on other near-term drilling improvements, conducted under cost-shared contracts with industry, were completed.

FY 2003: Complete development of high-temperature well cements and transfer technology to industry.

FY 2004: No activities planned.

Energy Systems Research and Testing	**12,035**	**6,700**	**3,800**

Activities in this area focus on the development of improved technologies to more efficiently convert the heat of the earth into useful energy services like electricity and district heating. These include better heat exchangers and condensers, which are examples of technologies that enable exploitation of resources at lower temperatures. Use of advanced materials and innovative energy conversion technologies can substantially improve the economics of geothermal energy generation. To be effective, information about new technologies and other relevant matters must be widely disseminated to stakeholders as part of the technology transfer process. Activities in this area include outreach and analysis and partnership building efforts such as GeoPowering the West.

P **Advanced Heat and Power Systems . . . . . .**	**3,300**	**3,300**	**2,400**

Advanced heat and power systems research concerns reducing costs and improving the efficiency of surface plant systems. The work involves conversion-cycle improvements, advanced conversion cycles, better instrumentation and controls, scale and corrosion inhibition, enhanced operational performance, non-destructive testing techniques, and generation of fundamental data necessary for industry to solve problems.

FY 2002: Improved technology in heat conversion and power systems for application to a broad range of geothermal resources and environmental conditions. The subactivity involved laboratory research on innovative systems, including heat exchangers, air-cooled condensers, materials, monitoring equipment, and other power components, for both low and high temperature applications.

(dollars in thousands)

FY 2002	FY 2003	FY 2004

FY 2003: Maintain level of effort on innovative energy conversion systems, including heat exchangers, air-cooled condensers, and other components, for both low and high temperature applications. These advanced technologies enable the use of lower temperature resources for heat and power development. These activities contribute to the program objective of decreasing the capital costs of surface systems by 20 percent.

FY 2004: Focus research on the most promising innovative systems, such as air-cooled condensers. Improvements to these systems will have the highest likelihood of increasing efficiency while reducing costs. During FY 2004, an innovative air-cooled condenser will be tested at an operational geothermal power plant. Work in other areas, such as plant management and monitoring systems will be concluded.

P	**Systems Field Verification**	**811**	**1,000**	**0**

New surface equipment and systems typically require extensive field testing before the technology is accepted by industry. Such verification activities to establish the performance characteristics of improved technology is done through the operation of small power plants and direct-use facilities constructed with cost-sharing industry partners. The plants incorporate technology improvements, largely developed with Government funding, into prototype systems for full testing at a commercial scale.

FY 2002: Continued developmental work on three cost-shared small-scale electric power plants and five direct use projects selected by competitive solicitation. Project documentation of engineering designs was prepared for all projects, enabling industry to conduct comparative analyses of designs for future power plant developments.

FY 2003: Complete all system field verification projects and construct at least one small-scale power plant for operational testing.

FY 2004: No activities planned.

P	**Industry Support, Total**	**4,724**	**1,000**	**0**
	• Industry Support	978	1,000	0

Industry Support includes activities that address current barriers and problems that affect the use of geothermal resources. Studies and analyses are conducted on both technical and institutional issues which have been identified as relevant to the advancement of geothermal energy.

(dollars in thousands)

FY 2002	FY 2003	FY 2004

FY 2002: Provided technical, economic, and institutional analysis and outreach to industry on an ongoing basis. SBIR/STTR funding in the amount of $201,000 was transferred from this subprogram to the Science Appropriation.

FY 2003: Continue technical, economic, and institutional support to meet industry's needs. Reduced funding reflects completion of the Lake County Basin Pipeline Project and the Santa Rosa Pipeline Project.

FY 2004: No activities planned.

• Congressionally Directed Industry Support	3,746	0	0

Funding included support for the Lake County Basin Project (FY 2001 $2,000,000, FY 2002 $1,873,000, FY 2003 $0) and the Santa Rosa Pipeline Project (FY 2001 $0, FY 2002 $1,873,000, FY 2003 $0) with funds directed by Congress.

P **GeoPowering the West, Total . . . . . .**	**3,200**	**1,400**	**1,400**
• GeoPowering the West	859	1,400	1,400

GeoPowering the West (GPW) contributes to the overall use of domestic renewable energy resources through partnerships with the U.S. geothermal industry, power companies, industrial and residential consumers, and Federal, State and local officials. Increased use of geothermal energy is dependent upon many institutional and non-technical issues. GPW provides and institutional support and limited, cost-shared technical assistance to State-level activities which support geothermal energy. By demonstrating the benefits of this clean, abundant energy source, GPW increases State and regional awareness of opportunities to enhance local economies and strengthen our Nation's energy security while minimizing environmental impact.

FY 2002: Expanded outreach activities to address regional and State geothermal development opportunities and barriers. The results of those activities were shared in public meetings and other venues. The National Geothermal Collaborative brought together stakeholders from the public and private sectors to deal with institutional issues affecting geothermal development. Independent working groups were established for six States (NV, NM, ID, AZ, OR and WA) to address local issues.

FY 2003: Focus on highest priority outreach activities dealing with regional and State geothermal development barriers and opportunities. Add two new State working groups (AK and UT). Conclude lesser priority activities, document and disseminate results.

F**Y 2004:** Conduct outreach activities focused on key regional and State geothermal development barriers and opportunities. Continue support of work of National Geothermal Collaborative. Add two new State working groups (CA and HI).

• Congressionally Directed GeoPowering the West	2,341	0	0

Directed funding for GeoPowering the West was provided by Congress in FY 2002 (FY 2001 $0, FY 2002 $2,341,000, FY 2003 $0).

Total, Geothermal Technology	**27,035**	**26,500**	**25,500**

Explanation of Funding Changes

	FY 2004 vs. FY 2003 ($000)
Geoscience and Supporting Activities	
P Enhanced Geothermal Systems - The increase stems from the high priority of this program area and reflects budget projections supporting the field development phases of three cost-shared projects	2,500
Total, Geoscience and Supporting Activities	2,500
Exploration and Drilling Research	
P Detection and Mapping - The decrease is due to the completion of cost-shared exploration projects during the course of the fiscal year	-500
P Near-Term Technology Development - The decrease reflects a program decision to conclude work in this area and focus on the advanced drilling system needed to achieve program goals	-100
Total, Exploration and Drilling Research	-600
Energy Systems Research and Testing	
P Advanced Heat and Power Systems - The decrease reflects a program decision to begin an orderly phase out of work in this area in order to focus more attention on subsurface issues affecting geothermal development	-900
P Systems Field Verification - The decrease stems from the conclusion of field activities and a program decision to end further activities in this area	-1,000
P Industry Support - The decrease reflects a program decision to end further activities in this area, primarily nearer-term, lower-risk activities within industry's capabilities.	-1000
Total, Energy Systems Research and Testing	-2,900
Total Funding Change, Geothermal Technology	**-1,000**

Biomass and Biorefinery Systems R&D

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.

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.

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.

As a result of the organizational changes, the program can focus better on promising research pathways for converting biomass to useful output, including biorefinery processes. An industrial biorefinery benefits from the integration of technologies for processing biomass materials and converting them into gaseous, and liquid fuels, electric power, process heat, and industrial products and chemicals.

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.

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 help 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] In addition, the program invests in technical program and market analysis and performance assessment in order to direct effective strategic planning.

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 Integrated Gasification Combined Cycle (IGCC) 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 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.

[a] August 2002 Biomass Program Review, Washington, DC; August 2002 Biomass Advisory Committee Meeting; Washington, DC.; Documentation of Biopower Roadmapping Workshop, August 30-31, 2000, Washington, DC, attendance by Gas Technology Institute, EPRI, industry, DOE, TVA, NREL, and ORNL; Enzyme Sugar Platform Plan, July 2001, NREL and ORNL; Bio-ethanol Multi-Year Technical Plan, March 2001, NREL; Biomass Research and Development Technical Advisory Committee Recommendations, December 2001

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 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 (PSPG's) 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

[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.

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 Energy and Water section addresses sub-program goals (1) and (2) in the stated performance goal. The respective performance indicators and technology baselines are stated below:

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

(1) Biomass and Biorefinery Systems R&D -- 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).

Performance Indicators:

Cost of biopower systems in cents per kWh. Energy efficiency of the production of fuels and chemicals from gasification and other thermochemical processes.

(2) Biomass and Biorefinery Systems R&D -- 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).

Performance Indicators:

Ethanol production costs. System efficiency for the production of fuels and chemicals.

Annual Performance Results and Targets

FY 2002 Results	FY 2003 Target	FY 2004 Target
Initiated testing of Small Modular Biopower Systems, which have both domestic and international applications. Develop a prototype yeast capable of fermenting multiple biomass-derived sugars for ethanol production. (Delayed until FY 2004)	Establish testing program at three existing gasifiers at partners' sites for the development and application of technology components (e.g. gas clean-up, gas engines, fuel cells, etc.) that need to be integrated with the gasification components to produce power, fuels, and chemicals. Complete the thermochemical options analysis to assess various process pathways to fuels (e.g., F-T, gasoline, diesel, alcohols). Develop an improved enzyme preparation for reducing the cost of producing ethanol from biomass. Evaluate its impact on production costs using an updated computer model of the production process.	Develop a prototype yeast capable of fermenting multiple biomass-derived sugars for ethanol production. Initiate demonstration of the integration of biomass conversion and gas cleanup systems for advanced power cycle applications (microturbines and hybrid fuel cells). Complete testing of ethanol production from corn fiber in partnership with industry in order to achieve a 3 percent increase in ethanol production from each corn ethanol plant that successfully implements the technology without requiring additional corn feedstock .

Significant Program Shifts

The FY 2004 activities will include additional long-term, high-risk R&D in thermochemical conversion in support of biorefinery development.

The $14 million in FY 2004 mandatory biomass funding for United States Department of Agriculture will be jointly managed at the direction of the Biomass Research and Development Board established under the Biomass R&D Act of 2000.

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					
Advanced Biomass Technology R&D	38,373	37,430	31,000	-6,430	-17.2%
Systems Integration and Production	49,310	48,575	38,750	-9,825	-20.2%
Total, Biomass and Biorefinery Systems R&D	87,683	86,005	69,750	-16,255	-18.9%

Public Law Authorization:

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, "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, "Powerplant 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. 102-486, "Energy Policy Act of 1992"
P.L. 93-577, "Federal Non-nuclear Energy Research and Development Act of 1974"

[a]SBIR/STTR funding in the amount of $ 351,000 was transferred to the Science appropriation in FY 2002. Estimates for SBIR/STTR budgeted in FY 2003 and FY 2004 are $ 344,283 and $ 279,213 respectively. The FY 2002 Supplemental appropriation reduced this program by $ 2,344,000 for transfer to the Electricity Reliability program. The FY 2002 rescission reduced this program by $ 18,000. This program was reduced by a General Reduction of $ 2,604,000 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	27,558	27,800	27,800	0	0.0%
Golden Field Office	33,513	5,600	5,600	0	0.0%
Atlanta Regional Office	436	0	0	0	0.0%
Boston Regional Office	669	0	0	0	0.0%
Chicago Regional Office	280	0	0	0	0.0%
Denver Regional Office	331	0	0	0	0.0%
Seattle Regional Office	324	0	0	0	0.0%
Albuquerque Operations Office	394	0	0	0	0.0%
Sandia National Laboratories	250	30	30	0	0.0%
Total, Albuquerque Operations Office	63,755	33,430	33,430	0	0.0%
Chicago Operations Office					
Argonne National Laboratory	80	190	190	0	0.0%
Brookhaven National Laboratory	0	40	40	0	0.0%
Total, Chicago Operations Office	80	230	230	0	0.0%
Idaho Operations Office					
Idaho National Engineering and Environmental Laboratory	0	600	600	0	0.0%
Total Idaho Operations Office	0	600	600	0	0.0%
National Energy Technology Laboratory	4,366	2,000	0	-2,000	-100.0%

[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
Oakland Operations Office					
Lawrence Livermore National Laboratory	150	0	0	0	0.0%
Total, Oakland Operations Office	150	0	0	0	0.0%
Oak Ridge Operations Office					
Oak Ridge National Laboratory	3,600	2,200	2,200	0	0.0%
Office of Scientific and Technology Information	21	0	0	0	0.0%
Total, Oak Ridge Operations Office	3,621	2,200	2,200	0	0.0%
Richland Operations Office					
Pacific Northwest National Laboratory	350	2,200	2,200	0	0.0%
Total, Richland Operations Office	350	2,200	2,200	0	0.0%
Washington Headquarters	15,361	45,345	31,090	-14,255	-31.4%
Total, Biomass and Biorefinery Systems R&D	87,683	86,005	69,750	-16,255	-18.9%

Site Descriptions

National Renewable Energy Laboratory

The National Renewable Energy Laboratory (NREL) 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). The TCUF enables the private sector to cost-effectively test their power generating technologies in a fully-instrumented pilot facility. The Laboratory also conducts biotechnology research and engineering development of biological systems for the conversion of biomass to fuels and chemicals, such as ethanol. The AFUF includes laboratories, integrated bench scale process equipment, and a one-ton-per-day process development unit.

Golden Field Office

Golden Field Office (GO) administers and oversees day-to-day activities related to the Biomass and Biorefinery Systems R&D projects. These range from the Vermont gasifier project to advanced technologies that convert biomass-wood and agricultural crops and waste to electricity. Many of these projects target currently unused, rural farmland for growing dedicated energy crops.

Working with Headquarters program staff, GO administers and manages cooperative agreements for the Biomass and Biorefinery Systems R&D program's cellulose to ethanol demonstration projects. GO also competitively procures, administers, and manages projects designed to develop innovative technologies for the production of ethanol and co-products.

Regional Offices

The Regional Offices (RO's) administered funding and oversight of the Regional Biomass Energy Program in FY 2002. This activity will not be funded in FY 2004.

Albuquerque Operations Office

The Albuquerque Operations Office provides procurement services and oversight of funding for work being conducted at GO, NREL, SNL, and others.

Sandia National Laboratories

Sandia National Laboratories (SNL) provides technical and field management support to the small modular systems development task.

Argonne National Laboratory

Argonne National Laboratory (ANL) conducts environmental analysis for the program, including energy balance and emissions for biomass fuel cycles.

Brookhaven National Laboratory

Brookhaven National Laboratory (BNL) conducts analysis of biomass market penetration using integrated models.

Idaho National Engineering and Environmental Laboratory

The 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 gasification research for the program.

Lawrence Livermore National Laboratory

Lawrence Livermore National Laboratory (LLNL) conducted coordination of life-cycle analysis of ethanol and MTBE gasoline additives to evaluate environmental effects.

Oak Ridge National Laboratory

Oak Ridge National Laboratory (ORNL) conducts biomass technologies R&D and develops improved harvesting technology for biomass feedstock. ORNL conducts environmental research, residue and forests research, and resource economic analysis. These efforts are closely coordinated with NREL.

Office of Scientific and Technical Information

The Office of Scientific and Technical Information (OSTI) performs standard distribution of information for the program

Pacific Northwest National Laboratory

The Pacific Northwest National Laboratory provides research and development 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.

Funding Schedule

(dollars in thousands)

	FY 2002	FY 2003	FY 2004	$ Change	% Change
Biomass and Biorefinery Systems R&D					
Advanced Biomass Technology R&D					
Thermochemical Conversion R&D	14,486	16,625	14,000	-2,625	-15.8%
Bioconversion R&D	23,887	20,805	17,000	-3,805	-18.3%
Subtotal, Advanced Biomass Technology R&D	38,373	37,430	31,000	-6,430	-17.2%
Systems Integration and Production					
Thermochemical Production Integration	16,442	8,000	8,000	0	0.0%
Small Modular Biopower	4,000	5,000	4,000	-1,000	-20.0%
Feedstock Infrastructure	2,000	2,000	2,000	0	0.0%
Bioconversion Production Integration	20,543	28,825	20,000	-8,825	-30.6%
Crosscutting Biomass R&D	6,325	4,750	4,750	0	0.0%
Subtotal, Systems Integration and Production	49,310	48,575	38,750	-9,825	-20.2%
Total, Biomass and Biorefinery Systems R&D	87,683	86,005	69,750	-16,255	-18.9%

Detailed Program Justification

		(dollars in thousands)		
		FY 2002	FY 2003	FY 2004
Advanced Biomass Technologies R&D		**38,373**	**37,430**	**31,000**
P	**Thermochemical Conversion R&D, Total . . . . . .**	**14,486**	**16,625**	**14,000**
	• Thermochemical Conversion R&D	6,452	16,625	14,000

This effort conducts basic and applied research, testing, and feasibility studies in biomass gasification to provide the foundation for advanced and improved systems. This area demonstrates advanced gasification technologies that are suitable for combined heat and power generation in both large-scale and distributed applications, in biorefinery settings, and in the production of fuels and chemicals. Efforts will also validate more flexible use of a broader range of biomass feedstocks. This includes, for example, the examination of process development for a catalytic gasification technology to recover energy from wet biomass, and unconverted residuals from ethanol fermentation.

Research will also be conducted in thermochemical processes to produce biomass-derived fuels such as gasoline, diesel, hydrogen, and others. Efforts will focus on gasification as the processes for fuels/chemical products development. These processes will be integral to industrial biorefinery systems.

Gas turbines, microturbines, and fuel cells all require a clean biomass gas fuel to operate. Clean biomass fuels are also needed in catalytic processes to convert biomass-derived syngas into other fuels (such as methanol and hydrogen) and chemicals. One of the key R&D goals for biomass gasification is to complete development of gas cleanup technologies that will allow a wide variety of biomass feedstocks to be converted to clean products that meet the stringent fuel specifications for these advanced conversion systems.

Performance targets include the following: by 2004, begin evaluation of required technologies for advanced, multi-product industrial biorefineries; by 2010, complete testing of biomass-derived syngas and confirm gas conditioning and gas clean-up systems, and confirm 30-35 percent efficiency in the gasification process; by 2010, validate industrial biorefinery concept through a demonstration of the co-production of fuels, chemicals, and power via biomass gasification systems.

FY 2002: A life-cycle assessment of a distributed biopower system, including determination of

(dollars in thousands)

the benefits of avoiding transmission and distribution infrastructure and losses, was completed. Gas conditioning and gas clean up technologies were examined with a focus on gas production, hot gas cleanup, gas preparation, and innovative and productive uses of gasifier waste streams. Performance was measured through testing of mature advanced gas analysis instrumentation.

FY 2003: Continue testing of cleanup and conditioning technologies and catalysts needed for coupling biomass gasifiers to fuel cells. Thermochemical options analysis will be completed to assess the cost and efficiency of the various process pathways to fuels (Fischer Tropsch, gasoline, diesel, alcohols) as well as the gas cleanliness and composition required by these processes. The integration and emissions mapping testing of a microturbine coupled to a medium-Btu biomass gasifier will continue. Evaluation of the cost and efficiency of advanced gasification systems will continue. Testing aimed at developing a small, medium-Btu gasifier (offering higher efficiencies and lower emissions) will be continued in collaboration with industry. Evaluation of life cycle benefits and issues associated with biomass and competing systems will continue. A preliminary conceptual framework for industrial biorefineries will be developed and efforts will be undertaken leading to the production of liquid fuels via biomass gasification.

FY 2004: Efforts will continue on the testing of clean-up and conditioning technologies and catalysts needed for biomass gasifiers. Evaluation of the cost and efficiency of advanced gasification systems will be completed. Evaluation of life-cycle benefits and issues associated with biomass and competing systems will continue. In the longer-term, advanced gasification technology concepts with greater than 30-35 percent efficiency will be developed and demonstrated using advanced power cycles such as combustion turbines and fuel cells. Efforts that will lead to the production of liquid fuels from biomass gasification will continue. Researchers will examine the potential of producing hydrogen from gasification for power generation and chemical synthesis. The Program will identify and evaluate the most promising industrial biorefinery concepts that are capable of producing multiple products such as power, liquid fuels, and chemicals.

• Congressionally Directed Thermochemical Conversion R&D	8,034	0	0

The following projects were directed by Congress to be included in this program in FY 2002: Vermont Biomass Energy Center (FY 2002 $290,000, FY 2003 $0); McNeil Gasification Project - VT (FY 2002 $2,904,000, FY 2003 $0); Biorenewable Resource Consortium - IA (FY 2002 $1,936,000, FY 2003 $0); and Biomass Gasification Research Center - AL (FY 2002 $2,904,000, FY 2003 $0).

		(dollars in thousands)		
		FY 2002	FY 2003	FY 2004
P	**Bioconversion R&D, Total . . . . . .**	**23,887**	**20,805**	**17,000**
	• Bioconversion R&D	16,820	20,805	17,000

Collaborative efforts with industry and academia will continue to develop fermentation organisms that have increased stability, robustness, and lower cost. These organisms will have the ability to ferment mixed sugars from cellulosic wastes and agricultural residues. The approach is to collaborate with industry and universities on further development of organisms for the production of ethanol and chemicals. These organisms will be tested and required to meet the performance goals related to an economic industrial biorefinery. This multi-year effort in collaboration with industry will develop advanced genetic tools and manipulation of strains in order to convert available sugars to ethanol and chemicals. Prototypical hydrolyzate solutions will be used in attempting to make the micro-organisms capable of converting additional amounts of sugars to ethanol.

Support will be provided to existing partnerships to develop more productive and lower-cost cellulase enzyme systems and additional partnerships will be developed with enzyme, biomass ethanol, and other biochemical producers to accelerate the use of commercially available cellulase systems. Cost-effective cellulase systems remain the most significant barrier to the commercialization of enzymatic hydrolysis technology. Second only to cellulase systems, pre-treatment methods remain the most challenging unit operation. Two leading enzyme companies are developing improved enzymes for hydrolysis of biomass cellulose into sugars. Evaluations of novel pre-treatment systems will continue. Past research and development has not yet led to cost-effective solutions. Through collaboration with universities and industry, efforts are now focusing on developing and understanding the fundamental principles of biomass de-polymerization to aid in developing novel pre-treatment systems that are necessary to improve process efficiency and reduce costs.

Performance will be measured in FY 2003 through testing of the two enzyme companies' prototype cellulase enzymes and economic evaluations will be conducted using realistic plant design parameters and results from the concurrent research on pre-treatment fundamentals. In FY 2004, the Program will work with industry to continue the development of technologies to meet the performance goals of the industrial biorefinery.

FY 2002: A second industrial partner achieved two-fold enzyme improvements.

FY 2003: The Program will have formed at least two partnerships with industry to establish fermentation organisms that can meet the performance goals established for the industrial biorefinery. Organisms will be improved and tested using hydrolysates with varying levels of inhibitory compounds, acidity, etc. This work will lead to higher fermentation yield and

(dollars in thousands)

FY 2002	FY 2003	FY 2004

improved conversion economics.

FY 2004: An industrial partner will validate the performance of an organism capable of fermenting multiple biomass sugars for ethanol production.

•	Congressionally Directed Bioconversion R&D	7,067	0	0

The following projects were directed by Congress to be included in this program in FY 2002: "continued funding for the Energy and Environmental Research Center at last years level"[a] (FY 2002 $477,000, FY2003 $0); Consortium for Plant Biotechnology Research (FY 2002 $940,000, FY 2003 $0); Prime LLC of South Dakota integrated ethanol complex (FY 2002 $2,830,000, FY 2003 $0), Michigan Biotechnology Initiative (FY 2002 $1,880,000, FY 2003 $0) and the switchgrass project of the Great Plains Institute for Sustainable Development in Minnesota (FY 2002 $940,000, FY 2003 $0).

Systems Integration and Production	**49,310**	**48,575**	**38,750**
P	**Thermochemical Production Integration, Total** . .	**16,442**	**8,000**	**8,000**
•	Thermochemical Production Integration	4,107	8,000	8,000

This element encompasses a number of thermochemical production and integration activities. Advanced R&D is being conducted to improve the selectivity, yield and longevity of syngas conversion catalysts and their use for the conversion of syngas to fuels and chemicals. In addition to technical advances needed to enable the cost-effective thermoconversion of feedstocks to liquid fuels, chemicals and materials, systems integration is a key component of technology utilization. Feedstock handling and conversion processes all need to be well-integrated within the biorefinery. Validation, verification, and demonstration of integrated bioprocessing systems will promote effective systems integration and reduce technical and financial risk for new biorefineries as it impacts both performance and profitability and ultimately implementation of technology.

FY 2002: The Program completed technical feasibility testing using closed-loop, short-rotation wood (fast-growing willows) as a dedicated fuel source for power generation at two retrofitted

[a] For the Energy and Environmental Research Center, $477,000 is included in Bioconversion R&D and $477,000 is included under Thermochemical Production Integration.

(dollars in thousands)

FY 2002	FY 2003	FY 2004

coal power plants in New York State.

FY 2003: Efforts will focus on testing and verifying syngas generated from various types of biomass feedstocks and determine the effect on catalytic performance. Determine gas treatment needs based on feedstock characteristics and target fuels/products.

FY 2004: Determine the effects of high moisture feedstocks on syngas generation and intermediate product formulation and target fuels/products.

- Congressionally Directed Thermochemical Production Integration 12,335 0 0

The following projects were directed by Congress to be included in this program in FY 2002: Tillamook Bay Port Authority (FY 2002 $726,000, FY 2003 $0); Iowa Switchgrass Project (FY 2002 $3,872,000, FY 2003 $0); A/D Methane Power Generation - CA (FY 2002 $2,420,000, FY 2003 $0); Winona, MS Biomass Project (FY 2002 $2,904,000, FY 2003 $0); Agricultural Mixed Waste Biorefinery - AL (FY2002 $1,936,000, FY2003 $0); and University of North Dakota Energy and Environmental Research Center (FY 2002 $477,000, FY 2003 $0).

P **Small Modular Biopower Total 4,000 5,000 4,000**

The program will develop, in partnership with industry, small modular biopower (SMB) systems that can use agricultural and urban waste streams as well as high-moisture feedstocks. Such systems improve energy conversion efficiencies and reduce air emissions. This effort will also investigate systems for efficient conditioning of the gases for coupling to advanced and clean power conversion devices. Funds are being leveraged with the U.S. Forest Service to demonstrate small modular systems in conjunction with the Forest Service's forest health/fire mitigation strategy by using thinnings and underbrush as fuels for power production.

Performance targets include the following: by 2004, complete field verification of systems in five to seven locations; award competitive contracts for field verification of small Biopower systems using high-moisture feedstocks; define limitations of enhanced methane recovery techniques for landfills applications; demonstrate integration of biomass conversion and gas cleanup systems for advanced power cycle applications (microturbines, hybrid fuel cells); and complete field validations of small Biopower systems that use animal residues/high-moisture feedstocks.

(dollars in thousands)

FY 2002	FY 2003	FY 2004

FY 2002: A detailed engineering design for a SMB system's modified turbine was completed; down selected to one project to proceed to Phase III.

FY 2003: The activity will focus on researching and developing systems that integrate small scale gasifiers, advanced power generating components such as internal combustion (IC) engines, microturbines and fuel cells. Performance will be measured through field verification R&D of systems that are being developed under current contracts. Efforts will include collaborative activities with the U.S. Forest Service utilizing SMB systems in forest management schemes. Begin investigations utilizing high moisture feedstocks and explore opportunities in landfill gas recovery.

FY 2004: Conduct innovative investigations utilizing high moisture feedstocks in order to enhance systems and reduce costs in spite of the moisture content. Evaluate attractive situations for using recovered landfill gas with SMB systems.

P **Feedstock Infrastructure 2,000 2,000 2,000**

The Feedstock Infrastructure Activity, which was formerly part of Energy and Water Development's Feedstock Production Activity (closed out in FY 2002), remains part of the Program's research portfolio because of the important role infrastructure plays in biomass feedstock production and conversion activities. Inherent in biomass systems is its bulk compared to other solid and liquid energy sources such as coal and oil. This disparity can lead to relatively higher costs for biomass harvesting and transport systems, and related storage considerations, when compared to fossil fuels. The requested level of support provides funds necessary to conduct systems level design studies. Overall analysis of biomass feedstock systems is included under this activity.

FY 2002: A database showing the availability (supply and cost) of biomass residues with high potential for competitive biopower markets was completed.

FY 2003: The program will continue to enhance its characterization of the physical and mechanical properties of crop residues and conduct additional analysis of alternative processes for increasing the bulk density of biomass to reduce volume, fire hazards, and decompositional losses. Continue efforts to explore infrastructure issues and complete the harvesting and logistic roadmap for agricultural residues in collaboration with industry and USDA. Develop novel harvesting equipment designs, storage, and logistics for agricultural wastes that will reduce feedstock costs.

(dollars in thousands)

FY 2002	FY 2003	FY 2004

FY 2004: The program will conduct work based on the harvesting and logistics roadmap, policy considerations and other relevant factors. The focus will be on biomass supply issues such as sustainable production management, or economic harvesting systems, and/or storage systems.

P	**Bioconversion Production Integration, Total . . . . . .**	**20,543**	**28,825**	**20,000**
P	Bioconversion Production Integration	9,691	28,825	20,000

This activity, previously called Cellulose to Ethanol Production, Renewable Diesel Alternatives, and Integrated Biorefinery Processes, includes the integration and optimization of industrial biorefinery process unit operations with a focus on ethanol production, biodiesel, and high-value chemicals. Work includes integrated testing of the hydrolysis process (i.e., handling, pretreatment, cellulose hydrolysis, and fermentation) to evaluate performance, efficiency, and costs for conversion of agricultural residues such as corn stover (stalks and fibrous components). This includes the validation of cost-effective processes for converting corn stover, and other residues, to ethanol (to support the integration of cellulosic conversion processes within existing starch-based commercial facilities). Performance tests will be conducted to validate alternatives for the diesel fuel pool (e.g., ethanol-diesel blends) and conduct research to reduce barriers to their expanded use.

FY 2002: The program conducted experiments to refine the kinetic model and process configuration and evaluate residues from an interim process configuration. The Program supported a cost-share competitive solicitation to initiate industrial biorefinery work in collaboration with industry, including the current corn ethanol industry. Made awards to six multi-year biorefinery R&D projects that are focused on new technologies for integrating the production of biomass-derived fuels and other products in a single facility. SBIR/STTR funding in the amount of $139,000 was transferred from this subprogram to the Science Appropriation.

FY 2003: The program will identify the best process options through process simulation analysis using the latest energy and material information and conceptual equipment cost estimates. Continue biorefinery R&D projects that are focused on new technologies for integrating the production of biomass-derived fuels and other projects in a single facility.

FY2004: The program will continue biorefinery R&D projects until 2005. Industry partners will continue to make progress in bench-scale and/or pilot-scale testing and other technology development activities. Economic analysis will improve with new data.

(dollars in thousands)

	FY 2002	FY 2003	FY 2004
• Congressionally Directed Bioconversion Production Integration	10,852	0	0

The following projects were directed by Congress to be included in FY 2002: Iroquois Project in Indiana (FY 2002 $2,820,000, FY 2003 $0); Micro-Combustion research at Oak Ridge National Laboratory (FY 2002 $940,000, FY 2003 $0); Oxygenated Diesel emissions testing (FY 2002 $940,000, FY 2003 $0); Sealaska (FY 2002 $1,880,000, FY 2003 $0), Black Belt Cooperative (FY 2002 $1,452,000, FY 2003 $0), and Gridley Project in California (FY 2002 $2,820,000, FY 2003 $0). . . . . .

P	**Crosscutting Biomass R&D . . . . . .**	**6,325**	**4,750**	**4,750**

This area of activity provides highly leveraged funds in crosscutting biomass research and development that directly supports P.L. 106-224, Title III, The Biomass Research and Development Act of 2000, and the Title IX of the Farm Bill. The activity enhances the integration of programs and partnerships with colleges, universities, national laboratories, and Federal and State research agencies with programs funding R&D in biobased products. These efforts include education, analysis, and research and development activities targeting an expanded number of participants and innovative technologies not presently supported in current portfolio of biomass R&D activities. For the purpose of this budget request, the Regional Biomass Energy Program was included here for FY 2002.

FY 2002: Conducted a broad-based solicitation that examines innovative concepts for application in the gasification process. Also supported efforts that are of a cross-cutting nature including education and analytical studies. Evaluated results of the projects to plan for FY 2003 follow-on activities. SBIR/STTR funding in the amount of $212,000 was transferred from this subprogram to the Science Appropriation.

FY 2003: Continue the projects initiated in FY 2002. The projects resulted from FY 2002 solicitations that targeted new participants and innovative crosscutting technologies. The funded activities, through applied research and testing of conversion processes and/or new organisms, will help establish biorefinery technologies.

FY 2004: Evaluate the current Federal portfolio and collaborate with USDA on Title IX of Farm bill. Complete phased activities initiated in FY 2002 where technical progress warranted.

Total Biomass/Biorefinery Systems R&D	**87,683**	**86,005**	**69,750**

Explanation of Funding Changes

		FY 2004 vs. FY 2003 ($000)
Advanced Biomass Technologies R&D		
P	Terminate activities associated with coupling gasification systems to fuel cells and microturbines for power generation	-2,625
P	Delay the development of genetic tools for the manipulation of fermentation organisms	-3,805
Total, Advanced Biomass Technologies R&D		-6,430
Systems Integration and Production		
P	Eliminate sugars platform process development activity	-8,825
P	Focus small modular biopower (SMB) work on forest residues and pursue only one demonstration. Complete Federal involvement and "graduate" commercialization efforts.	-1,000
Total, Systems Integration and Production		-9,825
Total Funding Change, Biomass and Biorefinery Systems R&D		**-16,255**

Intergovernmental Activities

Program Mission

The mission of the Weatherization and Intergovernmental Program is to develop, promote, and accelerate the adoption of energy efficiency, renewable energy, and oil displacement technologies and practices by a wide range of customers, including State and local governments, weatherization agencies, communities, companies, fleet managers, building code officials, technology developers, Native American tribal governments, and international agencies.

The Weatherization and Intergovernmental Program (WIP) funds activities that facilitate the movement of energy efficient and renewable energy products into the marketplace and helps match new energy technologies to markets for energy products and services, based on the needs and choices of State agencies and others responsible for determining how local needs are met.

Intergovernmental Activities support the program ,mission by providing consumers with improved choices for efficient and renewable energy products. Intergovernmental Activities are managed as part of the WIP, which is comprised of grant-related and technical assistance activities brought together through the reorganization of Energy Efficiency and Renewable Energy (EERE) in FY 2002. Combining these activities will improve the Department of Energy's effectiveness in deployment of efficient and renewable energy technologies by streamlining administration of program funding and consolidating management of competitive awards. The former Renewable Implementation and Support activities have been given stronger focus by inclusion in WIP.

As part of the Weatherization and Intergovernmental Program, Intergovernmental Activities support the President's National Energy Policy (NEP) recommendations for rapid deployment of clean energy technologies and energy efficient products. The NEP calls for "modernization of energy conservation," the promotion of market-based solutions to environmental concerns and the export of U.S. clean energy technologies. The Clean Energy Technology Exports initiative, which focuses on exporting clean energy technologies to developing and transitional countries, is in direct response to recommendations in the National Energy Policy.

The Office of Energy Efficiency and Renewable Energy's Strategic Program Review, prepared in response to the National Energy Policy, stresses the importance of international energy efficiency and renewable energy development for the U.S. economy. Specifically, the Strategic Program Review recommended expanding investments in the international deployment of advanced technologies in buildings, industry, power generation, transportation, agriculture, education, and health care. Expanding exports of energy efficiency and renewable energy products and services can also help drive down the costs for systems deployed domestically, while simultaneously boosting the development of a more financially sound energy efficiency and renewable energy industry for America.

International opportunities for energy efficiency and renewable energy products and services are substantial. About one-third of the world's population currently does not have access to electricity. In countries where the electricity infrastructure is underdeveloped or non-existent, distributed energy

systems such as photovoltaic arrays, small wind turbines, biomass power systems, or other renewable systems, have an advantage by avoiding the cost of construction of transmission and distribution facilities. U.S. equipment manufacturers rely on these markets abroad to sustain their business operations while domestic markets for these devices develop.

The Intergovernmental Activities subprogram receives appropriations from both the Energy and Water Development and the Interior and Related Agencies subcommittees. Interior activities focus on energy efficiency measures, while Energy and Water Development activities focus on maintaining working relationships with international and Native American tribal governments that inform and assist consumers with renewable and efficient energy options.

Weatherization (Interior)
- Weatherization Assistance
- Training and Technical Assistance

State Energy Assistance (Interior)

Other State Energy Activities (Interior)
- Cooperative Activities with States - Industry (program Closeout Only)
- Planning/Evaluation for State Activities

Gateway Deployment (Interior)
- Rebuild America
- Energy Efficiency Information and Outreach
- Building Codes Training and Assistance
- Clean Cities
- Energy Star
- National Industrial Competitiveness through Energy, Environment, and Economics NICE[3]) (program Closeout Only)
- Inventions and Innovations
- International Market Development
- Technical/Program Management Support

Renewable Support and Implementation (Energy and Water Development)
- International Renewable Energy
- Tribal Energy

International Renewable Energy activities and Tribal Energy activities, support bilateral and multilateral agreements and build partnerships with international energy organizations and Native American Tribal governments to foster information exchange on renewable energy and energy technology choices for consumers and businesses. These activities include information exchange, and technical and financial assistance projects. They are intended to promote better understanding and acceptance of energy efficiency and renewable energy technologies in other countries and on Native American Tribal lands, and to foster stronger public-private partnerships to expand domestic and overseas markets for U.S. manufacturers of these technologies. These efforts include field validation projects, which draw on cost sharing from the private sector and multilateral funding organizations,

whose primary purpose is to educate foreign energy decision makers about the merits of U.S. energy efficiency and renewable energy technologies and programs. Also important are the efforts to assist international educational institutions with the creation of renewable energy curricula, workshop development, and multi-year activity planning. This enables participating countries to understand the potential benefits of energy efficiency and renewable energy technologies, and develop plans for their appropriate application.

International Renewable Energy includes the following efforts: Support for Energy Efficiency and Sustainable Development Centers, comprised of nonprofit centers in six countries that are in a transition to a market economy to help them gain access to U.S. renewable energy and energy efficiency technologies. The Hemispheric Energy Initiative works with the energy ministers of member countries of the Organization of American States to support their renewable energy programs. The US-China Renewable Energy Cooperation supports business development for U.S. renewable and energy efficiency enterprises in China. Russian Programs cooperates with multilateral agencies on renewable energy projects and policy development in Russia. Eastern Europe looks for opportunities with specific Eastern European countries to contribute U.S. developed renewable energy and energy efficiency technologies. The Africa Project holds workshops and supports the Conference of Energy Ministers in Africa. The Competitive Solicitation Program issued a solicitation for feasibility studies in Fiscal Year 2000.

Title XXVI ("Indian Energy Resources") of the Energy Policy Act of 1992 authorized the Secretary of Energy to establish and implement a demonstration program to assist Indian Tribes in pursuing energy self-sufficiency and to promote the development of energy industries on Tribal lands. Since then, the Tribal Energy activity has focused on capacity building within Tribal leadership to build greater understanding of available Tribal energy resources needs, as well as technical assistance through competitively selected cost-shared field validation projects. This effort conducts consultations with Tribal representatives, resource assessments, and workshops and training in coordination with other Federal agencies, DOE Regional Offices, and State Energy Offices.

The strategy of the Tribal Energy activity is to build partnerships with Tribal governments to help assess Native American energy needs for residential, commercial, and industrial uses. Additionally, this subprogram provides technical and financial assistance in energy efficiency and renewable energy development. The activities provide the means for Tribal leaders to make knowledgeable choices regarding their Tribes' energy future, through resource assessments, workshops, training, and energy plan development assistance. Energy projects are competitively awarded on a cost-shared basis for Native American Tribes to implement comprehensive energy plans that incorporate energy efficiency and renewable energy technologies and resources. As a result, there are projects underway for the development of solar and wind energy resources and in the electrification of Tribal lands.

The Tribal Energy activities develop, implement, and manage technical and financial assistance projects to promote energy, environmental, and economic development policy objectives for Native Americans. This primarily involves the development of energy efficiency and renewable energy resources on Tribal lands. Working with Native American communities on Tribal lands and at Tribal Colleges, projects include resource assessments and development plans for energy efficient and renewable energy technologies on Tribal lands. Technical assistance helps Native American Tribes, communities on

Tribal lands, and Tribal Colleges develop culturally compatible energy and economic development plans and strategies reflecting Tribal priorities. In addition, the program invests in technical program and market analysis and performance assessment in order to direct effective strategic planning.

Economic development is an ongoing challenge facing America's Native American populations. Tribal governments work in partnership with the Federal Government and others to foster rural development and the elimination of poverty. Access to energy is a particular problem in this regard. Because of their remote locations and distance from transmission and distribution system points of delivery, many tribes have inadequate energy services, which interferes with economic development efforts and programs to promote rural education, public health, and safety. In many ways, the energy problems faced by these tribes resemble the energy problems faced by developing nations and remote populations around the world.

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 Weatherization and Intergovernmental 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 Weatherization and Intergovernmental Program is essentially the EIA's Annual Energy Outlook (AEO) 2002 reference case. This case already includes some penetration of cost-effective efficiency and renewable investments but generally limits market penetration based on observed current consumers and businesses market choices. These limits or "hurdle rates" included in the model can represent a range of market conditions, from lack of consumer information about a product to lack of available financing. Because this program provides information and other opportunities designed to accellerate market adoption of efficient and renewable technologies, its goals are generally represented in NEMS-GPRA04 as lowered hurdle rates or increased penetration rates for the effected markets. The extent to which consumer and businesses receptivity to these technologies is changed is based on analyses of the individual program activities and target markets.

Weatherization, State and Community grants, and NICE3 lead to greater adoption of energy efficiency largely in proportion to the size of the effort. Weatherization grants are represented in NEMS-GPRA04 by reducing energy consumption in the residential sector based on the number of households reached and typical savings per household. State and Community grants reductions are based on typical reported activities. A similar program-specified reduction in energy use is implemented in the industrial sector for the NICE3 program. The Clean Cities program is represented through improved CNG technology and greater consumer acceptance of CNG vehicles. It is modeled in conjunction with the FreedomCAR & Vehicle Technologies Program, and then the savings from CNG vehicles are allocated to WIP. The CNG vehicles are used a proxy for all alternative vehicles that are not part of the FreedomCAR or Hydrogen Programs. The Energy Star components of Gateway Deployment are represented by modifying the consumer coefficients indicating how consumers trade-off first cost expenditures with

annual energy savings, based on program goals for market penetration. The building codes activities are modeled under the Buildings Program, with a fraction based on program office estimates allocated to WIP.

The Inventions and Innovation Program is comprised of many individual grants for development of various technologies with intended application in different sectors of the economy. Those in the industrial sector were treated in the same manner as the NICE3 through incorporation in NEMS-GPRA04 of estimated resulting reductions in energy usage from the types of projects funded. The technologies with the largest expected benefits (aluminum head diesel engines for SUVs, high efficiency incandescent light bulbs, high efficiency air conditioners, and more efficient motors for air conditioners) were estimated with assistance from the I&I Program contractors and included in NEMS-GPRA04. The diesel engines were modeled as incremental to the FreedomCAR Program.

FY04 GPRA Benefits Estimates for WIP Program (NEMS-GPRA04)[a]			
	2005	2010	2020
Displaced Electricity Capacity (GW)	0.1	1.1	21.2
Non-Renewable Energy Savings (quads)	0.14	0.68	1.42
Oil Savings (quads)	0.02	0.14	0.60
Carbon Savings (MMT)	2.5	8.9	26.3
Energy Expenditure Savings (B2000$)	1.5	6.0	14.7

Estimates for reduced demand for peak electricity (displaced electricity capacity), energy savings, oil savings, carbon emission reductions, and energy expenditure savings resultant from realization of WIP Program goals are shown in the table above through 2020. About 1.4 quads of energy savings, associated with $14.7 billion in reduced energy bills, are expected annually by 2020 as a result of program efforts over the next 15 years. These estimates do not include savings from international activities, which are currently outside the scope of the integrated modeling framework. The Native American renewable initiative is also not being modeled for this year. These estimates reflect EIA reference case assumptions about future energy markets. The improved market for efficient and renewable energy products developed by this program will provide the nation with an increased ability to respond to higher or more volatile energy prices, increased public concern about environmental reliability, or security can increase the extent to which consumers respond to the information and other services provided by this program.

In addition to the benefits quantified above, this program provides a number of other types of benefits. The Low Income Weatherization Assistance Program, for instance, improves energy affordability for lower-income households who could not otherwise afford these improvements, increasing energy and housing affordability and reducing the impact of energy price changes on these households. The State Energy Program (SEP) grants, among many other activities, fund the development and maintenance of energy emergency planning at the State and local levels, a critical homeland security benefit. By improving the availability of cleaner and more efficient energy technologies, the SEP and other WIP

[a] Benefits reported are annual, not cumulative, for the year given for the entire Weatherization and Intergovernmental 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, efficiency and readiness with assumptions in the President's Budget.

program efforts helps metropolitan areas meet local Clean Air Act attainment requirements.

Program Strategic Performance Goal

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

The Weatherization and Intergovernmental Program has the following overall performance goals: 1) from 2003 to 2011, complete weatherization upgrades for a total of 1.2 million low income households; 2) by 2008, award cumulative total of 280 grants to 56 States and Territories; 3) cumulatively for the years 2003 through 2007, complete 15 or more State collaborative industrial research, development, and field testing cooperative agreements; 4) from 2003 to 2007, provide technical assistance to facilitate Rebuild America partners' retrofitting of an additional 280 million square feet of commercial and public/institutional space, with average efficiency improvement of 18 percent; 5) from 2003 through 2007, provide access to energy efficiency information for 20 million consumer contacts; 6) by 2008, facilitate adoption of upgraded model residential and commercial building energy codes (10 percent improvement) in 20 additional States, and by 2008, train 10,000 architects, engineers, builders and code officials to use and enforce upgraded energy codes; 7) By 2007, work with Clean Cities coalitions to increase the number of alternative fuel vehicles (AFV's) from 110,000 in 2001, to 233,000 in 2007, and 383,000 in 2010, leveraging an outcome of 983,000 AFV's, consuming one billion gallons of alternative fuel by 2010; 8) from 2001 to 2010, increase the market share for ENERGY STAR windows from 25 to 55 percent, and market share for ENERGY STAR appliances from 15 to 22 percent ;9) complete closeout of NICE^3; 10) from 2003 to 2008, competitively fund 75 or more inventors and small businesses to develop energy efficiency technologies;11) complete closeout of International Market Development initiated in 2003;12) support to the maximum extent practicable DOE international goals and specific commitments contained in bilateral and multilateral agreements; and support the Clean Energy Technology Exports (CETE) initiative for joint public-private cooperation to increase the export of U.S. products and services and the Asian Pacific Economic Cooperation (APEC) forum to support U.S. energy firms competing in markets abroad by working to implement a system of clear, open and transparent rules and procedures governing foreign investment, to level playing fields for U.S. companies overseas, and to reduce barriers to investment; and 13) from 2003 to 2008, fund technical assistance to Native American Tribes in support of 50 or more economic development projects, 15 or more feasibility studies, and 15 or more workshops to promote energy efficiency and renewable energy resource development on Tribal lands

The Energy and Water section addresses subprogram goals (12) and (13) in the stated performance goal. The respective performance indicators and annual targets are stated below:

> (12) International Programs -- Support to the maximum extent practicable DOE international goals and specific commitments contained in bilateral and multilateral agreements; and support the CETE initiative for joint public-private cooperation to increase the export of U.S. products and services and the Asian Pacific Economic Cooperation (APEC) forum to support U.S. energy firms competing in markets abroad by working to implement a system of clear, open and transparent rules and procedures governing foreign investment, to level playing fields for U.S.

companies overseas, and to reduce barriers to investment.

Performance Indicators

Number of bilateral and multilateral agreements supported and the successful completion of the tasks set forth in these agreements. Value of U.S. products and services deployed with the assistance of the CETE initiative per Federal dollars invested. Amount of funding leveraged from non-Federal sources to advance these activities.

Annual Performance Results and Targets

FY 2002 Results	FY 2003 Target	FY 2004 Target
Implemented energy efficiency and renewable energy provisions of DOE's bilateral and multilateral agreements with Mexico, China, the European Union, and other priority countries.	Expand support for DOE's priority agreements, including the harmonization of standards and labels in North America and the implementation of the U.S. Energy Efficiency for Sustainable Development and Global Village Energy Partnership initiatives.	Strengthen and broaden activities supporting priority agreements, e.g. expand the harmonization of standards to additional countries, ramp up implementation of the Energy Efficiency and Village Energy initiatives.
Supported the preparation of the Clean Energy Technology Exports (CETE) 5-year Strategic Plan, the multi-agency plan for expanding U.S. exports. Completed the U.S. Initiative on Joint Implementation that identified 52 projects that reduce greenhouse gas emissions.	Implement the CETE Strategic Plan through projects that deploy U.S. technologies in the largest and fastest growing international markets. Achieve major cost-sharing from public and private sources.	Fund 2-4 pilot projects under CETE initiative. Apply DOE's scientific and technical expertise into large-scale partnership projects that provide opportunities for expanded U.S. exports.

(13) Tribal Energy – From 2003 to 2008, fund technical assistance to Native American Tribes in support of 50 or more economic development projects, 15 or more feasibility studies, and 15 or more workshops to promote energy efficiency and renewable energy resource development on Tribal lands.

Performance Indicators

Number of technical assistance workshops.
Number of economic development projects.
Number of feasibility studies.
Percent of travel homes with power.
Annual global greenhouse gas emissions avoided as result of projects.

Annual Performance Results and Targets

FY 2002 Results	FY 2003 Target	FY 2004 Target
Funded technical assistance in the form of 4 feasibility studies and 14 economic development projects.	Fund technical assistance in the form of 5 workshops, 20 economic development projects and 4 feasibility studies.	Fund technical assistance in the form of 5 workshops, 15 economic development projects and 4 feasibility studies.

Significant Program Shifts

The funding has ended for the U.S. Country Studies Program which have completed its goal of showing how the U.S. could cost-effectively reduce global greenhouse gas emissions through energy efficiency and renewable energy exports and cooperative agreements with other countries. The funding has been shifted to support administration initiatives such as the Energy Efficiency for Sustainable Development and the Global Village Energy Partnership Initiatives announced at the World Summit for Sustainable Development. DOE expects to get ten-to-one leverage from its investments in these initiatives, which are expected to attract loans and private investments and lead to significant energy savings for the host countries and governments.

Funding Profile[a]

(dollars in thousands)

	FY 2002 Comparable Appropriation	FY 2003 Amended Request	FY 2004 Request	$ Change	% Change
Intergovernmental Activities	5,680	14,807	12,500	-2,307	-15.6%
Total, Intergovernmental Activities.	5,680	14,807	12,500	-2,307	-15.6%

Public Law Authorizations:
P.L. 95-91, "DOE Organization Act" (1977)
P.L. 102-486, "Energy Policy Act of 1992"

[a]The FY 2002 Supplemental appropriation reduced this program by $ 152,000 for transfer to the Electricity Reliability Program. This program was reduced by a General Reduction of $ 168,000 in FY 2002.

Funding by Site[a]

(dollars in thousands)

	FY 2002	FY 2003	FY 2004	$ Change	% Change
Albuquerque Operations Office					
..... Golden Field Office	972	6,000	5,400	-600	-10.0%
National Renewable Energy Labora	923	1,471	1,471	0	0.0%
.....Sandia National Laboratories	125	225	225	0	0.0%
Total, Albuquerque Operations Office	2,020	7,696	7,096	-600	-7.8%
Idaho Operations Office					
.....Idaho Operations Office	2,840	0	0	0	0.0%
Total, Idaho Operations Office	2,840	0	0	0	0.0%
Oak Ridge Operations Office					
..... Oak Ridge National Laboratory	215	475	475	0	0.0%
Total, Oak Ridge Operations Office	215	475	475	0	0.0%
Oakland Operations Office					
Lawrence Berkeley National Labora	225	399	399	0	0.0%
Total, Oakland Operations Office	225	399	399	0	0.0%
Richland Operations Office					
Pacific Northwest National Laborat	375	550	550	0	0.0%
Total, Richland Operations Office	375	550	550	0	0.0%
Washington Headquarters.....	5	5,687	3,980	-1,707	-30.0%
Total, Intergovernmental Activities	5,680	14,807	12,500	-2,307	-15.6%

[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

Golden Field Office

Golden Field Office (GO) is responsible for the management of awards to Native American Tribes for renewable energy projects. GO also manages SEP special project grants a crosscutting Gateway activity.

National Renewable Energy Laboratory

The National Renewable Energy Laboratory (NREL), located in Golden, Colorado, provides technical assistance to the transfer of renewable energy and energy efficiency technologies to Native American tribal lands and to the international deployment of renewable energy technologies. NREL is also the lead laboratory for the International Renewable Energy interagency program seeking to mobilize private investment in clean energy technologies identified as climate change and development priorities by key developing and transition countries. NREL participates in providing technical assistance in identifying and developing energy policies that will reduce greenhouse gas emissions and contribute to development goals through accelerated deployment of renewable energy and energy efficiency technologies. In addition, NREL works cooperatively with the private sector.

Sandia National Laboratories

Sandia National Laboratories provide technical assistance to the transfer of renewable energy and energy efficiency technologies to Native American tribal lands and to the international deployment of renewable energy technologies. Sandia also is a major laboratory for the International Renewable Energy interagency program seeking to mobilize private investment in clean energy technologies identified as climate change and development priorities by key developing and transition countries.

Idaho Operations Office

The Idaho Operations Office (ID), located in Idaho Falls, ID, provides procurement services and oversight of funding for the Idaho National Engineering and Environmental Laboratory. ID also administers Renewable Energy Resources programs such as the Tribal Energy.

Oak Ridge National Laboratory

In the International Renewable Energy Program, ORNL has senior responsibility for providing technical assistance to developing countries in the Asia-Pacific region. This assistance includes training in the use of various models for analyzing various options for mitigating and sequestering greenhouse gas emissions as well as establishing joint implementation offices and identifying and developing joint implementation projects.

Lawrence Berkeley National Laboratory

For International Renewable Energy, LBNL has provided technical assistance to developing countries in assessing the impacts of climate change, the effects of various mitigation strategies, and in the establishment of joint implementation offices and developing an institutional capacity to assess the impacts of these project

Pacific Northwest National Laboratory

Pacific Northwest National Laboratory (PNNL), located in Richland, WA, performs on-going research and technical assistance for the International Renewable Energy Program, including technical assistance for the International Renewable Energy Program to transition countries for emission trading and developing joint implementation projects. In addition, PNNL participates in the evaluation of joint implementation proposals and in preparing reports on the U.S. Joint Implementation program.

Funding Schedule

(dollars in thousands)

	FY 2002	FY 2003	FY 2004	$ Change	% Change
Intergovernmental Activities					
International Renewable Energy Program	2,840	6,500	6,500	0	0.0%
Tribal Energy	2,840	8,307	6,000	-2,307	-27.8%
Total, Intergovernmental Activities	5,680	14,807	12,500	-2,307	-15.6%

Detailed Program Justification

(dollars in thousands)

	FY 2002	FY 2003	FY 2004
International Renewable Energy Program, Total	**2,840**	**6,500**	**6,500**
▪ **International Renewable Energy Program**	**412**	**6,500**	**6,500**

The International Renewable Energy Program (IREP) activities are focused in three broad areas: market and trade development; U.S. energy security; and global environmental and energy issues. To address these needs, IREP provides technical assistance, disseminates information, conducts trade missions and reverse trade missions. The IREP promotes the use of U.S. renewable energy technologies; assists sector project development; and helps reduce non-technical barriers (e.g., financing, resources, tariffs, and local prohibitions).

FY 2002: IREP facilitated development of the Clean Energy Technology Export (CETE) initiative; closed out U.S. Joint Implementation activities; and provided technical assistance to U.S. and host country public and private sectors, information dissemination, and policy reformation assistance in targeted developing and developed regions.

FY 2003: IREP will implement strategic activities in accordance with the CETE initiative; continue to support bilateral and multilateral agreements; and provide technical assistance, information dissemination, and policy reformation assistance in targeted developing and developed regions, including supporting the Climate Technology Initiative headquartered at the International Energy Agency.

FY 2004: IREP will implement strategic activities in accordance with the CETE initiative; continue to support bilateral and multilateral agreements. Provide technical assistance for sustainable development with emphasis on economic development in an environmentally friendly manner though the use of clean and renewable energy technologies. Provide technical assistance, information dissemination, and policy reformation assistance in targeted developing and developed regions, including supporting the Climate Technology Initiative headquartered at the International Energy Agency.

▪ **Congressionally Directed Intergovernmental Activities**	**2,428**	**0**	**0**

The following project was directed by Congress to be included in this program in FY 2002: International Utility Efficiency Partnership, Incorporated (FY 2001 $1,000,000, FY 2002 $969,000, FY 2003 $0), and National Alliance for Clean Energy Incubators (FY 2002 $1,459,000, FY 2003 $0, FY 2004 $0)

(dollars in thousands)

	FY 2002	FY 2003	FY 2004
Tribal Energy	**2,840**	**8,307**	**6,000**

The Tribal Energy activity supports the development of capacity within the 553 Federally recognized Native American Tribes to assess and meet their energy needs both for residential and productive uses; provides, where appropriate, new power supplies for export to areas facing energy challenges; and advances the Department's technology performance and integration efforts. Through resource assessments, workshops, training and energy plan development assistance, Tribal leaders develop the capacity to make knowledgeable decisions regarding their Tribes' energy future. Through competitively selected cost-shared projects, Tribes will begin implementing comprehensive energy plans to assist Tribal members in using renewable energy technologies and resources.

FY 2002: Issued a solicitation for feasibility studies on renewable energy projects.

FY 2003: The Tribal Energy activity will initiate a comprehensive strategy to build Tribal capacity, develop Tribe-specific energy plans, and competitively select cost-shared deployment projects to enhance use of renewable technologies on Tribal lands.

FY 2004: The Tribal Energy activity will continue efforts to build Tribal capacity, develop Tribe specific energy plans, and competitively select cost-shared deployment projects to enhance use of renewable technologies on Tribal lands.

Total, Intergovernmental Activities	**5,680**	**14,807**	**12,500**

Explanation of Funding Changes

	FY 2003 vs. FY 2004 Request ($000)
Intergovernmental Activities	
■ Tribal Energy was decreased to gain additional experience at a slower level of deployment before a public-private effort to expand these projects.	-2,307
Total Funding Change, Intergovernmental Activities.....	**-2,307**

Electricity Reliability

Program Mission

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

Eliminating transmission constraints and distribution vulnerabilities as well as increasing flexibility (with distributed generation) is essential to ensuring secure, reliable, and affordable electricity now and in the future. Electricity reliability research focuses on developing key technologies as well as addressing economic, regulatory, and environmental issues to facilitate the transition of the Nation's aging electric power infrastructure into a delivery system that will support the Nation's energy needs in the 21st century.

Accomplishing this mission contributes to several national energy and environmental policies. For example, expanding the use of distributed energy and electricity reliability technologies will upgrade America's aging electric 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.

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

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

(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 electricity reliability and distributed energy technologies and programs, including energy storage and high temperature superconducting materials for cables and transformers. The National Transmission Grid Study contains 51 recommendations for improving the reliability of the Nation's electric transmission system. The National Transmission Grid Study States "... that our Nation's transmission system over the next decade will fall short of the reliability standards our economy requires and will result in additional bottlenecks and higher cost to consumers. It is essential that we begin immediately to implement the improvements that are needed to ensure continued growth and prosperity."

In fact, electricity reliability and distributed energy 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. They 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 more opportunities for managing energy costs, achieving desired levels of reliability and power quality, and reducing environmental emissions, including greenhouse gases

Regulatory and institutional barriers currently interfere with the expanded use of these technologies, tools, and techniques. These 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 market price of production and delivery, and the lack of comprehensive national regulations for achieving competitive utility markets. The program is providing the technical standards and technology framework in these areas to create more competition and choice as states develop policies and regulations.

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 R&D partnerships with industry

[a] For example, Distributed Energy Resources - The Power to Choose, Peer Review, November 28-30, 2001; Superconductivity Peer Review, July 17-19, 2002; Energy Storage Peer Review, November 19-20, 2002; Cryogenic Roadmap Assessment Report, April 2002; Transmission Reliability Peer Review, May 20-21, 2002

and others to make electricity reliability and distributed energy systems more energy efficient, reliable, and affordable to utilities and 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 efficiency 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 with 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 unnecessary 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 Energy and Water Development and the Interior and Related Agencies subcommittees. Energy and Water Development activities focus on developing advanced electricity reliability technologies, including high temperature superconducting systems. Interior activities focus on the development of cleaner and more energy efficient distributed energy generation equipment.

The program is organized into the following areas of activity:

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
- Renewable Energy Production Initiative

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

High Temperature Superconductivity (HTS) research and development activities are carried out in partnership with industry to bring the advantages of superconductivity - the ability of certain materials to carry large currents without energy losses due to electrical resistance - to use in a new generation of grid equipment that has higher capacity, lower losses, and significant environmental advantages. An important activity is developing a new

type of electrical wire that has 100 times the current-carrying capacity of equivalent size copper wires without resistive energy losses. In parallel, equipment using this improved wire is being designed and tested that is generally half the size and with only half the losses of conventional alternatives. HTS equipment can reduce transmission and distribution system losses (about 9 percent of energy usually lost between the generator and end user), and also reduce energy losses that occur in the generator and end-use motors. HTS equipment will become available in time for use in rebuilding the grid to meet growing electricity needs in a competitive marketplace.

Transmission Reliability R&D efforts focus on developing technology that, for the first time, will give grid operators information on potential problems before they degrade reliability and on technology that will improve grid operation. This includes developing real-time monitoring and control software tools and developing system operating models that allow grid operators to predict and accommodate increased competition without lower reliability.

Energy Storage activities are developing advanced energy storage systems for applications ranging from power quality for digital facilities to voltage support for transmission lines.

Distribution and Interconnection efforts focus on: 1) developing interconnection standards for deployment of distributed energy resources; 2) developing communication and control systems to integrate distributed energy devices and enhance customer electric service; and 3) modeling and testing advanced grids (powerparks, microgrids) with aggregated distributed resources.

In conducting these activities, the program operates a comprehensive set of R&D partnerships. 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 program coordinates with the Hydrogen and Fuel Cells Technology Programs, and 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 Institute of Electrical and Electronic Engineers for the development of uniform interconnection standards. Partnerships with State agencies include the California Energy Commission, the New York State Energy Research and Development Authority, and the Texas Natural Resources and Public Utilities Commissions. The program works with national laboratories including ORNL, NREL, SNL, PNNL, LBNL, ANL and 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.

The Renewable Energy Production Incentive (REPI) continues to encourage increasing non-profit utility participation and growth in renewable energy output. Electricity Restructuring promotes technical analysis and information dissemination partnerships with national, State, and regional organizations that have roles in utility restructuring legislation and regulation. Additionally, the program continues to implement National Transmission

Grid Study recommendations in: 1) customer load reduction and targeted energy efficiency and distributed generation; 2) regional transmission siting and planning; and 3) regulatory and market approaches to stimulate transmission investment.

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 losses 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 Development Appropriation and the Interior Appropriation:

[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.

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 and control of the transmission and distribution system to identify over 90 percent of incipient system disturbance conditions, mitigate disturbance propagation, reduce peak loads, and alleviate transmission congestion.

Performance Indicators

The Energy and Water section focuses on electricity reliability, and addresses sub-program goals (3) and (4) in the stated performance goal. The respective performance indicators and technology baselines are stated below:

Performance Indicator

High Temperature Superconductivity and Composite-Core Conductors - By 2008, demonstrate the capability to double the power carrying capacity of transmission and distribution wires compared to that available in 2000.

Performance indicators for HTS wire development include both performance and cost (the estimated manufacturing cost in high volume). The performance goal (developing HTS wires that carry 100 times as much electricity as conventional copper wire) is within 80 percent of being achieved by the "first generation" wires used in equipment prototypes being built and tested. The cost goal is $10 per kiloamp-meter and the baseline is $200 in FY 2002. Additionally, a portfolio of equipment is being developed using available HTS wire (first generation in FY 2003 and FY 2004, second generation in following years). A comprehensive applications portfolio is needed to capture the energy saving benefits of HTS. Both the breadth of applications and the progress of each application toward meeting specific application requirements are performance indicators. *2000 Technology Baseline*: Comparable copper wire/conductors (comparable by cross-sectional area)

Performance Indicator

Distributed Energy and Electricity Reliability - By 2012, develop a portfolio of technologies and software tools that allow real-time monitoring and control of the transmission and distribution system to identify over 90 percent of incipient system disturbance conditions, mitigate disturbance propagation, reduce peak loads, and alleviate transmission congestion.

Performance Indicators

This sub-goal will be tracked based on the following indicators (categorized by nature of disturbance):

Power Quality Events (e.g., voltage excursions and frequency fluctuations): Power quality events are categorized as less than 15 seconds (i.e. the time that it would take for the fastest distributed generation back-up units to come on-line), but typically are much shorter in duration (sometimes only a few cycles). The rapid nature of these events requires careful monitoring of the system by transmission reliability tools, and system resilience through implementation of power electronics and storage devices (for power applications) to prevent disturbance propagation.

By 2007, implement real-time monitoring tools for the transmission system within 5 North American Electric Reliability Council (NERC) regions.

Reduce cost per kW of advanced energy storage systems for power quality applications to $500/kW by 2007. [2000 baseline, $1200/kW for prototype systems]

Local Outages: Large-scale storage systems and distributed generation (e.g. back-up generators such as reciprocating engines, microturbines, fuel cells) offer solutions to long-term interruptions in service.

Reduce cost per kWh of energy storage systems by 30 percent in 2007 compared to 2000. [2000 baseline, $1400/kWh for lead acid systems][a]

Compared with costs in 2000, reduce initial interconnection costs by 30 percent by 2008, and double the lifetime of inverter-based interconnection equipment from 3-5 years in 2000 to 10 years by 2008.

Peak Load Reduction: Distributed generation, demand response, energy storage, and communication and control architecture provide opportunities for reducing peak loads for both customer side and utility systems.

By 2008, demonstrate a demand response program activity that establishes and achieves a 3 percent demand response capability through successful coordination and integration of regional ISO and State programs and implementation of dynamic pricing, advanced metering, and enterprise energy management systems.

Demonstrate advanced communication and control technologies for optimized operation of aggregated DER systems at the smart utility level at multiple end-user sites (with aggregated capacity of 5-10 MW) by 2008.

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[a] Although storage is a solution for both power quality events and local outages (shown with the same goal above), the specific technology needs will be different for each category. For power quality events, the storage device will target power applications (significant power demand, but short duration). Devices include lead-acid and lithium ion batteries, fly wheels, super capacitors, and superconducting magnetic energy storage (SMES). Local outages are energy applications; devices here include NaS and flow battery systems.

Reduce cost per kWh of energy storage systems by 30 percent in 2007 compared to 2000. [2000 baseline, $1400/kWh for lead acid systems]

Annual Performance Results and Targets

FY 2002 Results	FY 2003 Targets	FY 2004 Targets
Completed initial testing of Detroit superconducting transmission cable and document operational costs and reliability. Expanded application research to include (100 MW) generators and coils for low cost MRI systems. In Partnership with DOE, IEEE published draft P1547 Standard for Distributed Resources Interconnected with Electric Power Systems. Completed 300 hrs testing of the ZBB advanced bromine battery system in partnership with Detroit Edison. Published microgrid white paper and presented results in a public forum. Prototype electricity reliability monitoring tool was installed in California to track reactive power from real time data.	Increase the capability to reproducibly fabricate 10-meter lengths of Second Generation HTS wire to carry 50 amps of electricity, and 1-meter lengths that carry 100 amps from a 40 amp base. Complete draft UL1741 safety performance standard to cover interconnection equipment for all distributed resources. Field Test 100kW lithium battery system for 700 hrs at a utility site. Install three prototype monitors and/or tools to benefit transmission reliability. Build and test for 150 hrs a 10kW composite flywheel using superconducting bearings with Boeing. Install prototype real time grid system monitor and/or visualization reliability tools at 2 additional transmission systems. Complete draft of application guide for interconnection standards.	Complete testing of 10 MVA superconducting transformer in operation on the Wisconsin Electric Power Company grid. Second generation wire that carries 100 amps in 10-meter lengths. Field test 12 MW energy storage system in collaboration with TVA. Complete assessment of requirements for development of initial wide area measurement system for transmission providers in the Eastern Interconnection. Complete first national-interest transmission line assessment Complete laboratory test of microgrid concepts.

[a] Testing in Detroit failed to meet its FY 2002 target due to operational problems.

Significant Program Shifts

A new initiative in FY 2004 is the National Transmission Infrastructure (NTI) Initiative with requested funding of $3.0 million. This initiative responds to the National Transmission Grid Study. The NTI Initiative addresses the technical and markets-related recommendations in the NTGS that call specifically for DOE actions. The Initiative focuses primarily on the development and integration of advanced technology (advanced conductors, sensors, instrumentation, and equipment), transmission monitoring (voltage, current, frequency, and line temperature/sag), and events analysis (blackouts, brownouts, instability, frequency excursions/voltage collapse, demand curtailment/reduction, electricity market monitoring, operation, and correction) related to the transmission system.

Reflecting the increasing importance of transmission reliability, the program is increasing its focus on implementation of technical recommendations in the National Transmission Grid Study. This will include national-interest transmission lines assessment, and advanced technology congestion relief options, including sensors, monitoring and control for real time operation, advanced conductors, analysis of new system configurations and dynamics, and demand response. In addition, increased emphasis will be placed on field validation testing technical assistance to states and regions on topics such as regional resource and transmission planning for implementation of the national standard for distributed resources interconnected with electric power systems. The Department plans to create in FY 2003 the Office of Electric Transmission and Distribution that will report directly to the Under Secretary of Energy for Energy, Science, and Environment.

Funding Profile[a]

(dollars in thousands)

	FY 2002 Comparable Appropriation	FY 2003 Amended Request	FY 2004 Request	$ Change	% Change
Electricity Reliability					
Total, Electricity Reliability	76,764	76,506	76,866	+360	+0.5%

Public Law Authorizations:

P.L. 95-91 “Department of Energy Organization Act” (1977)
P.L. 95-618 “Energy Tax Act of 1978"
P.L. 96-294 “Energy Security Act” (1980)
P.L. 100-697 “Superconductivity and Competitiveness Act of 1988"

[a] SBIR/STTR funding in the amount of $541,000 was transferred to the Science Appropriation in FY 2002. Estimates for SBIR/STTR budgeted in FY 2003 and FY 2004 are $597,000 and $597,000 respectively. The FY 2002 Supplemental appropriation increased this program by $8,205,000 for transfer to the Electricity Reliability program. The FY 2002 recession reduced this program by $18,000. This program was reduced by a General Reduction of $884,000.

Funding by Site[a]

(dollars in thousands)

	FY 2002	FY 2003	FY 2004	$ Change	% Change
Albuquerque Operations Office					
Los Alamos National Laboratory	5,000	8,000	10,142	+2,142	+26.8%
National Renewable Energy Laboratory	8,253	5,779	7,326	+1,547	+26.8%
Golden Field Office	10,150	13,000	17,171	+4,171	+32.1%
Sandia National Laboratories	7,380	9,500	10,443	+943	+9.9%
Total, Albuquerque Operations Office	30,783	36,279	45,082	+8,803	+24.3%
Chicago Operations Office					
Argonne National Laboratory	4,020	4,000	5,071	+1,071	+26.8%
Brookhaven National Laboratory	500	0	0	0	0.0%
Chicago Operations Office	3,878	0	0	0	0.0%
Total, Chicago Operations Office	8,398	4,000	5,071	+1,071	+26.8%
Idaho Operations Office					
Idaho National Engineering and Environmental Laboratory	75	150	190	+40	+26.7%
Idaho Operations Office	11,473	545	0	-545	-100.0%
Total, Idaho Operations Office	11548	695	190	-505	-72.7%
Nevada Operations Office					
Nevada Test Site	300	400	507	+107	+26.8%
Total, Nevada Operations Office	300	400	507	+107	+26.8%

[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."

	FY 2002	FY 2003	FY 2004	$ Change	% Change
Oakland Operations Office					
Lawrence Berkeley National Laboratory	1,735	3,150	3,693	+543	+17.2%
Total, Oakland Operations Office	1,735	3,150	3,693	+543	+17.2%
Oak Ridge Operations Office					
Oak Ridge National Laboratory	11,425	19,690	16,462	-3,228	-16.4%
Office of Scientific and Technical Information	27	26	33	+7	+26.9%
Total, Oak Ridge Operations Office	11,452	19,716	16,495	-3,221	-16.3%
Richland Operations Office					
Pacific Northwest National Laboratory	690	1,190	909	-281	-23.6%
Total, Richland Operations Office	690	1,190	909	-281	-23.6%
Washington Headquarters	11,858	11,076	4,919	-6,157	-55.6%
Total, Electricity Reliability	76,764	76,506	76,866	+360	+0.5%

Site Description

Los Alamos National Laboratory

LANL works with industry to develop second generation HTS wires based on the ion beam assisted deposition (IBAD) process pioneered by LANL. LANL's expertise in film deposition processes and materials science is used to improve the performance of IBAD wires. Commercial versions are expected to be able to carry 1000 amperes of current through a centimeter wide metal strip coated with a film the thickness of only a few human hairs - a revolutionary change. LANL is also developing superconducting transmission cables and superconducting fault current limiters (a device that protects the electrical system against lightning strikes and other accidents).

National Renewable Energy Laboratory

NREL works with industry to develop a uniform national standard for interconnection of distributed power resources with the electric grid and performs research to develop related test and certification procedures. NREL also performs analysis addressing regulatory and institutional barriers to distributed power and provides technical assistance to State agencies and others on these issues. NREL maintains the Electricity Restructuring web site and provides analyses on an as-needed basis on restructuring impacts on renewable technology development and deployment.

Golden Field Office

GO administers the Renewable Energy Production Incentive (REPI) program. REPI encourages the acquisition of renewable generation systems that use solar, wind, geothermal or biomass technologies, by State and local governments and non-profit electric cooperatives by providing financial incentive payments for their electric production from appropriations.

GO also administers the Superconductivity Partnership with Industry (SPI) for the Electricity Reliability High Temperature Superconducting R&D program. The SPI is 50 percent cost-shared with industry and consists of six projects to develop first-of-a-kind designs for more efficient power cables, transformers, industrial motors and flywheel energy systems.

Sandia National Laboratories

SNL are part of a national laboratory/industry/university consortium that was formed to support research on Transmission Reliability R&D. SNL is participating in planning and design of simulations and field testing on a distributed technologies test bed, developing and demonstrating computer simulation for distributed controls in the management of the operation of regional power systems, and developing risk-based analytical methods for assessing reliability in power systems. SNL also develops advanced conductors based on chemical deposition process.

SNL develops improved energy storage systems components including power conversion electronics and modular multi-functional energy storage systems. SNL characterizes the performance of integrated systems with customer-site data collection and identifies and evaluates the benefits of storage technologies in specific applications. SNL cooperates with industry partners in implementing the program to increase awareness of the benefits of energy storage and options of providing storage alternatives.

Argonne National Laboratory

Argonne National Laboratory performs research and development for the Electricity Reliability High Temperature Superconducting R&D (HTS) program. Argonne utilizes unique expertise in ceramics, and materials science to improve conductor performance and to investigate deposition processes, such as metal-organic chemical vapor deposition (MOCVD), which are potentially scalable by industry for a second generation of HTS conductors. Unique facilities such as the Intense Pulsed Neutron Source (IPNS) and the Advanced Photon Source are used for measurement and characterization in ANL's research. Argonne also performs research on superconducting electric motors, transmission cables, and flywheel electricity systems.

Brookhaven National Laboratory

BNL supports the High Temperature Superconductivity R&D program by working with national laboratory/industry teams and universities to undertake research on fundamental wire processing and application issues.

Chicago Operations Office

The Chicago Operations Office handles all contracts for the composite conductor work.

Idaho National Engineering and Environmental Laboratory (INEEL)

The INEEL is a multi-program laboratory conducing a broad range of environmental, research and technology programs for a number of customer organizations within DOE and other Federal agencies. The INEEL partners with the DEER program to conduct research and development in support of distribution and interconnection R&D.

Idaho Operations Office

The Idaho Operations Office is charged with overseeing the operations and work of the Idaho National engineering and Environmental Laboratory (INEEL). The Idaho Operations Office also supports the DEER program by administering a university solicitation for high temperature superconducting R&D.

Nevada Test Site

The Nevada Operations Office oversees and takes responsibility for the operations and programs of the Nevada Test Site. The Nevada Test Site serves the Nation as proving ground for alternative energy research. In particular, Bechtel Nevada has supported distribution and interconnection R&D activities.

Lawrence Berkeley National Laboratory

In support of Electricity Reliability, Transmission Reliability R&D, LBNL has the lead for a national laboratory/industry/university consortium that was formed to support research in Transmission Reliability R&D. This consortium is assisting in implementing the DOE Transmission Reliability R&D program. LBNL also conducts development work related to modeling studies to assess system benefits of distributed resources on the electric power system, analysis of alternative scenarios for the future operation of electric transmission systems, including the value of load as a resource, and the evaluation on market and power system performance of changing markets rules and structures.

Oak Ridge National Laboratory

ORNL is part of a national laboratory/industry/university consortium that was formed to support research in Transmission Reliability R&D. ORNL is performing: electric power system studies related to the impact of distributed resources on electric power systems reliability, design assistance for a test bed for field or simulation testing of distributed resource concepts, analyses of alternative market designs for ancillary services in competitive markets, and analysis and planning to evaluate load as a reliability resource. ORNL also develops second generation HTS wires based on the rolling-assisted biaxially textured substrate process (RABiTS) patented by ORNL. Five private companies have licenced this technology and are working with ORNL to scale up these discoveries. ORNL's expertise in metals and ceramics is used to address materials science issues in doing this scale up. ORNL is also applying its expertise in cryogenic systems and power system technology in projects to develop superconducting transformers and transmission cables.

Office of Scientific and Technology Information

The OSTI publishes and maintains on-line, full-text electronic current awareness publications and produces CD-ROM disks containing the Electricity Reliability High Temperature Superconductivity R&D program annual Peer Reviews.

Pacific Northwest National Laboratory

PNNL is part of a national laboratory/industry/university consortium that was formed to support research on Transmission and Reliability R&D. PNNL conducts evaluations of the technological and institutional aspects of recent reliability events on the Nation's electric power system, and is the lead for research activities in real-time monitoring and control for the power grid.

Funding Schedule

(dollars in thousands)

	FY 2002	FY 2003	FY 2004	$ Change	% Change
Electricity Reliability					
High Temperature Superconducting R&D	31,991	47,838	47,838	0	0.0%
Transmission Reliability R&D	18,257	7,720	10,720	+3,000	+38.9%
Distribution and Interconnection R&D	10,791	7,249	7,249	0	0.0%
Energy Storage R&D	9,098	7,640	5,000	-2,640	-34.5%
Renewable Energy Production Incentive	3,787	4,000	4,000	0	0.0%
Electricity Restructuring	2,840	2,059	2,059	0	0.0%
Total, Electricity Reliability	76,764	76,506	76,866	+360	+0.5%

Detailed Program Justification

(dollars in thousands)

	FY 2002	FY 2003	FY 2004
High Temperature Superconducting R&D	**31,991**	**47,838**	**47,838**

The High Temperature Superconductivity (HTS) R&D program utilizes the property of certain crystalline materials that become free of electrical resistance at liquid nitrogen temperature. The absence of electrical resistance makes possible super-efficient electrical power components that have only half the energy losses and are half the size of conventional technology of the same power rating. The program believes that HTS electrical wires will someday be able to carry 100 times the amount of electricity compared to the same size conventional copper wires. In the near-term, the superconductive transmission cables that carry 3 to 5 times more power than present technology will enable direct replacement of existing underground power cables by urban utilities to meet demand growth without costly, disruptive construction.

FY 2002: Completed design and construction of the prototype reciprocating magnetic materials separator with DuPont, and began testing. Completed the design and component construction of the HTS-bearing, energy-storage flywheel with Boeing. Began new 3 to 4 year competitively-selected, cost-shared projects with industrial consortia to develop and test prototype HTS grid technologies. Began operation of Los Alamos and Oak Ridge National Laboratories "industrial research parks" for joint laboratory/industry research using state-of-the-art equipment to scale up processes for second generation HTS wire manufacture.

FY 2003: Complete additional and final testing and evaluation for the prototype 100-MW, 3-phase, HTS cable installed in downtown Detroit. Complete final testing and evaluation for the prototype reciprocating magnetic separator and the HTS-bearing, energy-storage flywheel. Began construction of new prototypes of generators, power cables, and other HTS systems under cost-shared projects with industrial consortia. The national laboratories and industry demonstrated the capability to reproducibly fabricate 10-meter lengths of Second Generation Wire that carry 50 amps of electricity and 1-meter lengths that carry 100 amps of electricity. (a performance measure)

FY 2004: Encourage successful industrial equipment scale-up to commercial volumes by competitively procuring 100 meters of continuously processed HTS coated conductor that can be wound into coils and tested at operating conditions suitable for power transformers and generators. Field test a 5 MW HTS transformer in the Wisconsin electricity grid. The national laboratories and industry will demonstrate the capability to reproducibly fabricate 10-meter lengths of Second Generation Wire that carry 100 amps of electricity.

P	**Superconductivity Partnerships . . . . . .**	**12,000**	**17,838**	**17,838**

(dollars in thousands)

FY 2002	FY 2003	FY 2004

FY 2002: Completed previously selected multi-year projects with industry to develop first-of-a-kind high temperature superconducting electrical transmission cables, HTS generators, and HTS transformers which demonstrated great improvements in efficiency and capacity for application to the U.S. electric grid. The solicitation for the next stage of developing these innovative electrical systems was cancelled.

FY 2003: Public-private partnerships, selected competitively, provide DOE 50 percent cost-share to multi-year projects with industry to develop first-of-a-kind high temperature superconducting electrical systems using the latest high temperature superconducting wire. The design of these new systems includes Second Generation Wire so that new prototypes can be tested when the wire becomes commercially available. Work will also include development of prototype superconducting magnetic mineral separators, superconducting flywheel electricity storage systems, and open-structure MRI medical equipment.

FY 2004: Vertically integrated company teams (including manufacturer, suppliers, and user) will be selected competitively to develop first-of-a-kind HTS electrical equipment using the best available HTS wire in this 50 percent cost-shared public-private partnership. Projects active in FY 2004 will develop pre-commercial prototypes for 100 MW generators, longer distance power cables, fault current limiters, larger-scale flywheel electricity systems, and advanced MRI units for medical use. Begin testing of a 100 MVA superconducting generator using groundbreaking design that is applicable to upgrading rebuilt generators in the 100 MW to 1200 MW sizes, as well as in new equipment. Complete testing of 10 MVA superconducting transformer.

P	**Second Generation Wire Development . . . . . .**	**11,000**	**20,000**	**20,000**

FY 2002: Industrial consortia worked with national laboratories to develop high performance, low-cost, second-generation, high temperature superconducting wire, and produced the first 100-meter lengths of second generation high temperature superconducting wire. Installed and monitored the world's first utility application of a high temperature superconducting power cables and industrial high temperature superconducting transformer in the United States.

FY 2003: Industrial consortia to continue working with national laboratories to develop high-performance, low-cost, second-generation, high temperature superconducting wire. Specific national laboratories provided with cutting-edge facilities and instrumentation where industry researchers can be stationed for extended periods to work with national laboratory scientists in accelerating the development, commercialization, and application of second-generation, high temperature superconductor wires. These partnerships enable scale-up of discoveries in materials laboratory processes that give unprecedented ability to carry large electric currents.

(dollars in thousands)

FY 2002	FY 2003	FY 2004

FY 2004: The HTS industry will work with national laboratories to develop high-performance, low-cost, second-generation, high temperature superconducting wire. Specific national laboratories have developed cutting edge research facilities where industry researchers can work collaboratively with national laboratory scientists. This partnering arrangement is designed to accelerate development and private sector application of second-generation, high temperature superconductor wires. These partnerships will also enable faster scale-up of discoveries in materials laboratory processes that give unprecedented ability to carry large electric currents. A performance measure is achieving industry production of kilometer lengths of second-generation, high temperature superconducting wire by 2005. Beyond this, work will focus on cooperative national laboratory/private company research intended to reproducibly fabricate 10-meter lengths of wire that carry over 100 amps in single strands.

P **Strategic Research 9,388 10,000 10,000**

FY 2002: Maintained cost-shared core research to support new discoveries and innovations for the Second Generation Wire Development. These efforts leveraged research of complementary work funded by the DOE Office of Basic Energy Science. This included work on planning and analysis as well as communication and outreach to gather information on future requirements for the HTS technologies and maintain contact with stakeholders. SBIR/STTR funding in the amount of $379,000 was transferred from this subprogram to the Science Appropriation.

FY 2003: Advanced, cost-shared, fundamental research activities will be conducted to better understand relationships between the microstructure of HTS materials and their ability to carry large electric currents over long lengths. New projects will be added to investigate the varied technical aspects of this key problem. Also, work on enabling technologies such as joining HTS conductors to normal conductors will be supported as well as additional research on electrical losses due to alternating currents. These losses can be reduced through better understanding of technical parameters. This research will support new discoveries and innovations for the Second Generation Wire Development.

FY 2004: Fundamental research activities provide better understanding of relationships between the microstructure of HTS materials and their ability to carry large electric currents over long lengths. The benefit will be higher performance wires and inherently lower manufacturing costs. Competitive proposals will be solicited for development of specifically designed cryogenic systems to cool HTS wire that have twice the efficiency of existing commercial systems. These efforts leverage research funded by the DOE Office of Science.

Transmission Reliability R&D 18,257 7,720 10,720

(dollars in thousands)

FY 2002	FY 2003	FY 2004

Transmission Reliability (TR) core research is developing information management, wide area measurement, disturbance recognition, and reliability compliance monitoring systems to enable reliable system operation, efficient electricity markets, and compliance with electric reliability and security standards. The subprogram collaborates closely with independent transmission system operators and other electricity industry stakeholders to identify electric transmission and distribution technology research needs. This activity will support the integration of advanced transmission monitoring and control systems. TR also provides technical support to allow all customers to control their own loads and participate in competitive electricity markets, and performs electricity markets simulation and design analysis to identify market participant behaviors and impacts, and develops unbiased, third party options for more efficient, fair competitive markets. Performance is measured by the acceptance and effective utilization of reliability adequacy tools by independent system operators and utility control centers, and by partnerships initiated to evaluate load as a reliability resource.

Working with the Consortium for Electric Reliability Technology Solutions (CERTS), the DOE Transmission Reliability R&D program has created a grid reliability management platform to support the evolving needs of transmission system operators in competitive regional electricity markets. DOE is currently working with a variety of industry stakeholders, including NERC security coordinators, California ISO, American Electric Power, and others to pilot demonstration of reliability management tools. These efforts are also refining future research pathways.

P	**Transmission Reliability R&D . . . . . .**	**4,685**	**7,720**	**10,720**

FY 2002: Installed a prototype area control error/frequency monitor for test in seven NERC reliability regions that displays the difference in actual versus scheduled power flow between control areas. Installed real time post disturbance workstations for engineers at the California independent system operator. Extended the experimental energy auction to include load as a reliability resource in the auction, and initiated work on including ancillary services markets. Completed a distribution system three phase model to be used for distributed generation integration into microgrids. Accelerated planning for an expanded Federal transmission system reliability research and development activity in response to recommendations in the NEP National Transmission Grid Study final report. SBIR/STTR funding in the amount of $50,500 was transferred from this subprogram to the Science Appropriation.

FY 2003: Support installation of a suite of performance monitoring tools at major transmission operating organizations to allow operators to monitor compliance with reliability standards. Expand the real time workstation for engineers to a workstation for transmission operators, and support linking operator work stations for more than one region to share system conditions on a regional basis. Complete integration of load as a resource in the experimental market auctions, and expand development of the characterization and aggregation of customer loads to respond to the energy and ancillary services markets. Initiate work on verifying transmission system model changes required to conform to real time system data analysis, and on identifying signature oscillations that are precursors to

(dollars in thousands)

FY 2002	FY 2003	FY 2004

voltage collapse. Begin development of real time measurement sensors hardware and software enhancements.

FY 2004: Complete assessment of data communication requirements between real time operator workstations for major transmission providers. Support demonstration of demand response for the energy and ancillary services markets including spinning reserve. Complete recommendations for reliability metrics for transmission system reliability. Simulate the operation of combined energy, ancillary services and demand response markets in partnership with the New York Independent System Operator (ISO). Complete report on status and availability of a suite of integrated system security and analysis tools to assess grid security in real-time. Initiate development of visualization tools to display transmission provider compliance with the North American Electric Reliability Council control performance standards. National Transmission Infrastructure Initiative (FY 2002 $0; FY 2003 $0; FY 2004 $3,000,000).

P	**Congressionally Directed Activities . . . . . .**	**13,572**	**0**	**0**

The following projects were directed by Congress in FY 2002 to be included in this program: field testing of aluminum ceramic fiber composite conductors (FY 2001 $0, FY 2002 $3,878,000, FY 2003 $0); Glenallen power generation upgrades, including extension of electricity to residents of Lake Louise (FY 2001 $0, FY 2002 $1,939,000, FY 2003 $0); Kachemak Bay Power System to extend and upgrade marine power cabling to provide power to the villages of Seldovia, Nanwalek, and Port Graham (FY 2001 $0, FY 2002 $1,939,000, FY 2003 $0); Swan Lake-Lake Tyee electrical intertie pursuant to the Southeast Alaska intertie authorization enacted into law last year (FY 2001 $0, FY 2002 $2,908,000, FY 2003 $0); complete Prince of Wales Island electrical intertie (FY 2001 $0, FY 2002 $2,908,000, FY 2003 $0)

Distribution and Interconnection R&D (formerly DER Electric System Integration)	**10,791**	**7,249**	**7,249**

Distribution and Interconnection develops concepts, technologies, standards for the integration of DER with electric systems. Efforts to support implementation of a national interconnection standard for DER will continue. This includes supporting the development of an Applications Guide for the IEEE interconnection standard; addressing the issues related to the interconnection of DER on network type distribution systems; and modeling, field testing and utility case studies of the interaction of DER with the utility power system not only to validate the interconnection standard but also to develop recommendations for amendments to the standard, facilitate utility acceptance, and support the design of advanced interconnection technology.

(dollars in thousands)

FY 2002	FY 2003	FY 2004

Equipment for interconnecting DER with the utility power system account for a third or more of the installed cost of DER systems and have a lifetime of only 3-5 years. R&D is focused on developing, in the near term, a modular technology that is "plug-and-play" with all distributed generation and storage technologies, minimizes custom hardware design, reduces the cost of interconnection equipment by 30 percent, and increases the mean time to first failure of inverter-based technology to 10 years.

Modeling and testing in the development of the interconnection standard has highlighted the need for changes in utility distribution system operation and technology in order to achieve the benefits of significant DER penetration. Today, the protection schemes and safety procedures employed on most utility distribution systems do not readily accommodate energizing of the grid by DER during outages. Advanced approaches to addressing system protection and personnel safety and other aspects of distribution system operation will be explored to more fully integrate DER into the operation of the distribution system and exploit the benefits of DER to the grid. The existing grid system is deficient in shedding peak loads, providing the level of power quality and reliability required by the digital economy, and offering customer choice in power generation and use. Self-contained microgrids, a cluster of distributed generation and storage serving multiple local loads with a single point of common coupling with the utility power system, may be a key mechanism for penetration of DER into the market place and integration with the utility distribution system. The microgrid concept will be developed and issues such as system architectures, power system issues, interactions with other elements on the microgrid, and system protection and safety will be addressed.

P	**Distribution and Interconnection R&D . . . . . .**	**4,493**	**7,249**	**7,249**

FY 2002: Published a draft IEEE interconnection standard. Completed pilot interconnection field test and distributed generation demonstration at the Nevada Test Site and began Phase I interconnection standard validation tests. Completed case study modeling of distributed generation penetration impacts on grid power stability and system protection. Completed draft UL1741 safety performance standard to cover interconnection equipment for all distributed resources. SBIR/STTR funding in the amount of $50,500 was transferred from this subprogram to the Science Appropriation.

FY 2003: Conduct interconnection field validation testing. Complete draft of application guide for interconnection standard. Establish process for certifying compliance of interconnection systems with national standards. Develop prototype improved interconnection technology reducing installed interconnection costs by 15 percent from 2001 costs. Initiate distributed energy resources integration field tests with multiple distributed generation and storage technologies and high feeder penetration.

FY 2004: Complete Phase II interconnection field validation tests. Complete amendments to the national interconnection standard. Field test prototype improved interconnection technology.

(dollars in thousands)

FY 2002	FY 2003	FY 2004

Test microgrid concept in California Energy Commission (CEC) test bed using commercial products incorporating advanced control and protection systems.

P **Congressionally Directed Activities 6,298 0 0**

The following projects were directed by Congress in FY 2002 to be included in this program: fuel cell powered home using Smart Energy Management Control System in Alabama (FY 2001 $0, FY 2002 $969,000, FY 2003 $0); UA Dispatch Outage Management System in Alabama (FY 2001 $0, FY 2002 $1,938,000, FY 2003 $0); distributed generation projects in Indiana (FY 2001 $0, FY 2002 $2,907,000, FY 2003 $0); joint effort between New Mexico Tech and the National Energy Laboratory in Hawaii to integrate, demonstrate, and deploy distributed energy systems (FY2001 $0, FY 2002 $484,000, FY 2003 $0); distributed energy systems (FY 2001 $0, FY 2002 $484,000, FY 2003 $0).

Energy Storage R&D 9,098 7,640 5,000

Energy storage technologies, together with distributed energy resources technologies, provides the high "nines" of reliability required by the digital economy, telecommunication, and high tech manufacturing. While today's grid can at best give three nines of reliability (i.e., 99.9 percent reliability), energy storage provides seamless power during micro outages, voltage sags, and frequency disturbances yielding the equivalent of seven to nine "nines" of reliability. Industry estimates that disturbances cost U.S. industry up to $150 billion per year. Energy storage systems, backed up by distributed generation, are the cost effective way to provide required reliability for the consumer.

Large scale (MW) energy storage systems can significantly reduce transmission system congestion, help manage peak loads and increase the reliability of the overall electric grid. Energy storage also benefits transmission system stability by injecting power to damp out system disturbances. Such disturbances have led to grid collapse and widespread blackouts. Storage will help relieve transmission bottlenecks through better operations, one goal identified in the National Transmission Grid Study. These activities also support Chapter 7 National Energy Policy recommendations to develop a comprehensive energy delivery system.

The sub-program funds the design of systems with integrated power electronics and controls, contributes to research on advanced storage components, and performs strategic research analysis by developing economic and performance models to effectively guide future research. Technologies involved in the Energy Storage subprogram include battery systems, flywheels, and supercapacitors.

(dollars in thousands)

	FY 2002	FY 2003	FY 2004
P **Energy Storage R&D**	**5,218**	**7,640**	**5,000**

FY 2002: Completed peak shaving testing of the ZBB-Waukesha advanced zinc-bromine battery system. Tested the advanced hybrid controller at Sandia National Laboratories demonstrating operation with hybrid energy storage, diesel and PV operation. Assembled and performed initial testing on 67 kW lithium ion battery energy storage system, including the power conditioning system and system controls. Completed system design of a 10 kWh advanced composite flywheel with Boeing in collaboration with the DOE Superconducting Partnership with Industry (SPI). Acquired and tested a novel supercapacitor energy storage system in collaboration with EPRI Power Electronics Applications Center. SBIR/STTR funding in the amount of $61,000 was transferred from this subprogram to the Science Appropriation.

FY 2003: Test the 67 kW lithium battery energy storage system at a utility site with a partnering utility. Build and bench test a 10 kWh superconducting flywheel system with Boeing. Break ground on construction of multi-megawatt utility battery energy storage system in collaboration with industry. Begin construction of a multi-megawatt power conditioning system in a cost-shared project with industry.

FY 2004: Begin collaborative field testing of the Boeing superconducting advanced composite flywheel together with the Superconductivity Partnership with Industry (SPI) and Southern California Edison. With a utility partner, develop a 16 MW transmission stability device incorporating supercapacitor storage with fast, inexpensive switches developed by DOE. Monitor and test 12 MW flow battery system in collaboration with TVA. In collaboration with the CEC, manage the design and construction of several major energy storage demonstration projects in the State of California.

P **Congressionally Directed Activities**	**3,880**	**0**	**0**

The following projects were directed by Congress to be included in the FY 2002 program: Nickel metal hydride battery development (FY 2001 $0, FY 2002 $970,000, FY 2003 $0); Thermal energy storage (FY 2001 $0, FY 2002 $2,910,000, FY 2003 $0).

Renewable Energy Production Incentive (REPI)	**3,787**	**4,000**	**4,000**

For over a decade, in recognition of renewable energy's 100 percent reliance on domestic sources and favorable environmental attributes, the U.S. has had Federal tax credits to encourage adoption of renewable energy systems. While tax credits exist to encourage private utilities to own and operate renewable energy

(dollars in thousands)

systems, they offer no benefit to non-profit organizations. The Renewable Energy Production Incentive was created by Congress to provide a corresponding stimulus for the Nation's non-tax paying electricity producers (mostly the 3,000 publicly owned and electric cooperative electric utilities) to own and operate renewable energy systems. Within the limits of the enabling legislation, the Department's program fairly and equitably seeks to provide an incentive payment of 1.74 cents/kWh (FY 2002) for adoption of the renewable technologies most needing Federal assistance. Importantly, all qualifying projects are planned, bid, purchased, built, and operated following normal commercial practices. Payments are energy output-based and occur only after electricity from renewable sources actually enters U.S. electricity markets. Payments occur over a ten year eligibility period.

FY 2002: Received applications for 701 million kWh total of qualified renewable energy produced, eligible for $37.5 million of incentive payments, during the prior fiscal year. Paid $3.787 million worth of qualified energy.

FY 2003: Receive applications for more than 900 million kWh total of qualified renewable energy produced during the prior fiscal year.

FY 2004: Review applications for renewable energy incentive payments and pay qualified energy

Electricity Restructuring (formerly Renewable Program Support)		**2,840**	**2,059**	**2,059**

Technical Analysis and Assistance – Perform technical analyses in demand response, market-based, and other types of energy efficiency programs; public benefits funds; electric utility green marketing programs; distributed generation; renewable portfolio standards; and other policy and market mechanisms for energy efficiency and renewable energy technologies in electricity markets. A substantial effort is placed on quickly and cost effectively disseminating findings of sponsored technical analyses, which is accomplished in collaboration with State, regional, and national organizations that have roles in utility restructuring legislation and regulation. Expert technical assistance on an as-requested basis is also given to State public utility commissions, State legislatures, Federal officials and Governors' offices. The subprogram does not advocate, but serves as a clearinghouse to state-based policymakers on policies and programs that work/don't work if a State wants to use, maintain or expand energy efficiency and/or renewable energy in electric markets. Performance will be measured by establishing technical analysis and information dissemination partnerships with 10 to 15 national, State, and regional organizations that have roles in utility restructuring legislation and regulation.

P	**Electricity Restructuring . . . . . .**	**1,381**	**2,059**	**2,059**

(dollars in thousands)

FY 2002	FY 2003	FY 2004

FY 2002: Established and maintained technical analysis and information dissemination partnerships with 10 to 15 national, State, and regional organizations that have roles in utility restructuring legislation and regulation. For example, assisted the New England region's State and electric market officials negotiate a common set of rules to allow an energy efficiency "demand response" to be used in wholesale and electric markets (New England Demand Response Initiative). Performed an assessment of the private sector retail energy efficiency services industry under electric restructuring. Continued emphasis on technical assistance to States on market-based mechanisms, such as demand response programs that reduce peak loads, that provide near-term assistance to electricity-short regions of the United States.

FY 2003: Establish and maintain technical analysis and information dissemination partnerships with 10 to 15 new national, State, and regional organizations that have roles in utility restructuring legislation and regulation. Complete assistance to New England Demand Response Initiative. Identify and distribute results of 15 successful demand response programs offered by utilities or Independent System Operators (ISOs). Begin to implement, within available funds, regional transmission and resource planning recommendations in the National Transmission Grid Study.

FY 2004: Establish and maintain technical analysis and information dissemination partnerships with 10 to 15 new national, State, and regional organizations that have roles in utility restructuring legislation and regulation. Complete three to five assessments/evaluations of State public benefit programs for renewable energy. Develop technical education program for the Clean Energy States Alliance, a consortium of approximately 15 state energy renewable funds. Additionally, the subprogram will continue to implement National Transmission Grid Study recommendations in 1) customer load reduction and targeted energy efficiency and distributed generation; 2) regional transmission siting and planning; and 3) regulatory and market approaches to stimulate transmission investment.

P	**Congressionally Directed Activities . . . . . .**	**1,459**	**0**	**0**

The following project was directed by Congress in FY 2002 to be included in this program: National Alliance for Clean Energy Incubators (FY 2001 $0, FY 2002 $1,459,000 FY 2003 $0)

Total, Electricity Reliability	**76,764**	**76,506**	**76,866**

Explanation of Funding Changes

		FY 2004 vs FY 2003 ($000)
Transmission Reliability R&D		
P	Increase to expand R&D on grid monitoring tools for generator performance monitoring under the National Transmission Infrastructure Initiative.	+3,000
Energy Storage R&D		
P	Reduction reflects need to support higher priority transmission reliability research and development, in addition this research will be supplemented by the synergies with the vehicle technology battery program which significantly increased its request.	-2,640
Total Funding Change, Electricity Reliability		+360

Departmental Energy Management Program

Program Mission

The 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 Departmental Energy Management Program (DEMP) implements the FEMP mission for U.S. Department of Energy facilities.

Specifically, DEMP provides funding and technical assistance to DOE sites for accomplishing energy management projects and expanding the use of private sector financing for energy management. These actions help the Department to meet the requirements of Executive Order 13123, "Greening the Government Through Efficient Energy Management."

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 U.S. Department of Energy is second to the Postal Service among civilian Federal agencies in annual energy consumption. The Department owns or leases about 11,000 buildings at more than fifty sites across the United States. These facilities include office space, laboratories, and manufacturing plants, including those supporting the Nation's nuclear weapons complex.

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, and "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.

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

FEMP is organized into the following areas of activity:

Departmental Energy Management (Energy and Water)

- Energy management project support
- Energy management model program development

Federal Energy Management (Interior)

- Project financing
- Technical guidance and assistance
- Planning, reporting, and evaluation

The Departmental Energy Management Program uses direct funding for retrofit projects and support for comprehensive adoption of model programs or "best practices" as the two major mechanisms for reducing energy consumption in DOE facilities. Energy management project support involves direct funding for energy retrofit projects and new energy technologies at DOE facilities. Project proposals are evaluated based on cost-effectiveness, energy savings, and return-on-investment. It is expected that these activities will have returns on investment of greater than 25 percent based on performance of DEMP projects previously funded. Energy management model program development involves a comprehensive approach to making energy improvements at DOE facilities by providing direct funding for the implementation of "best practices." Model programs have included such initiatives as sustainable building design, the acquisition of Energy Star Labels for buildings, building re-commissioning, and energy consumption reductions in excess buildings. Federal energy management activities cover interagency coordination for achieving national energy and environmental policy goals.

These efforts have led to a number of successes in lowering DOE energy consumption. The Department of Energy's (DOE) total energy costs for fiscal year 2001 were over $288 million. In the standard buildings category, DOE used approximately 266,000 British thermal units (Btu) per gross square foot energy, compared to approximately 473,000 Btu per gross square foot energy in 1985, a 43 percent reduction. Energy management activities and changes in mission activities, notably from weapons production to environmental restoration, contributed to the reduction.

This reduction in energy consumption also resulted in reduced emissions of greenhouse gases by over 19 percent from FY 1990 levels, or 1.3 million tons - equivalent to removing over 900,000 cars from the road. In addition to reductions in energy consumption, DOE accomplished emissions reductions by switching from fuel oil and coal to less greenhouse gas intensive fuels. DOE reduced its use of coal and fuel oil from FY 1990 levels by greater than 70 percent and 58 percent, respectively.

Several recent energy retrofit projects are particularly noteworthy. For example, the Princeton Plasma Physics Laboratory will save $18,000 annually in electricity and natural gas costs from the installation of direct variable frequency drives with direct digital controls. This project has a simple payback of less than three years. The Thomas Jefferson National Accelerator Facility is retrofitting power supplies with variable voltage cathode devices. When complete, this project will save $270,000 in electricity costs annually and will pay for itself in less than two years.

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.[a] FEMP activities over the course of the next 15 years are expected to reduce our annual Federal energy bill by about

[a] 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.

$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.

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 Goal

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 government wide 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 DOE only baseline levels of 473,126 Btus per square foot thus saving $100 million annually in avoided costs.

The Energy and Water section addresses sub-program goal (2) in the stated performance goal. The respective performance indicators and technology baselines are stated below:

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

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.

Performance Indicators

Level of site energy intensity (Btus per square foot)

Return on investment (ROI) for energy projects.

Annual Performance Results and Targets:

FY 2002 Results	FY 2003 Target	FY 2004 Proposed Target
Decreased energy consumption intensity in DOE facilities by 37 percent from the 1985 baseline.	Decrease energy consumption intensity in DOE facilities by 38 percent from the 1985 baseline.	Decrease energy consumption intensity in DOE facilities by 39 percent from the 1985 baseline.
25 percent ROI for energy projects	25 percent ROI for energy projects	25 percent ROI for energy projects

Significant Program Shifts

Funding reductions have been taken to ensure funding for higher priorities within the EERE portfolio. As a result, DEMP funding will be concentrated on the following areas: DEMP will audit facilities to identify energy conservation opportunities; provide funding for best practices identification and dissemination; and accomplish energy conservation retrofits through direct funding and alternative financing.

Funding Profile[a]

(dollars in thousands)

	FY 2002 Comparable Appropriation	FY 2003 Amended Request	FY 2004 Request	$ Change	% Change
Departmental Energy Management Program					
Total, Departmental Energy Management Program	1,421	3,000	2,300	-700	-23.3%

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[b]

(dollars in thousands)

	FY 2002	FY 2003	FY 2004	$ Change	% Change
Washington Headquarters	1,421	3,000	2,300	-700	-23.3%
Total, Departmental Energy Management Program	1,421	3,000	2,300	-700	-23.3%

[a] The FY 2002 Supplemental appropriation reduced this program by $37,000 for transfer to the Electricity Reliability program. This program was reduced by a General Reduction of $42,000 in FY 2002.

[b] "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

Washington Headquarters

DEMP funding will be provided to multiple DOE sites for projects and model programs which are identified through a DOE wide competition and selected to both maximize return on investment and demonstrate leadership in implementing emerging energy savings technologies. The competition will take place in early FY 2004, and the DOE sites receiving the DEMP funding will be then be selected.

Funding Schedule

(dollars in thousands)

	FY 2002	FY 2003	FY 2004	$ Change	% Change
Departmental Energy Management Program					
Energy Management Project Support	1,068	2,250	1,800	-450	-20.0%
Energy Management Model Program	353	750	500	-250	-33.3%
Total, Departmental Energy Management Program	1,421	3,000	2,300	-700	-23.3%

Detailed Program Justification

	(dollars in thousands)		
	FY 2002	FY 2003	FY 2004
Departmental Energy Management	**1,421**	**3,000**	**2,300**

The Departmental Energy Management Program funds leadership activities to improve energy and water efficiency, promote the use of renewable energy and manage utility costs in DOE's facilities and operations.

P Energy Management Project Support	**1,068**	**2,250**	**1,800**

Provide support through direct funding and leveraged cost sharing at various DOE facilities for energy projects to increase the energy efficiency of our facilities and reduce future utility and maintenance costs. Funding will be provided to multiple projects which are identified through a DOE wide competition and selected to both maximize return on investment and demonstrate leadership in implementing emerging energy savings technologies. Performance will be measured by the following: providing a rate of return of at least 25 percent per dollar invested; and achieving annual savings of 20 billion Btus. Overall energy saved from projects and mission changes will be equal to 1 percent of FY 2002 DOE energy consumption.

FY 2002: Funded eight energy management retrofit projects for energy efficiency improvements in lighting, motors and HVAC equipment that FEMP estimates will provide a rate of return of 29 percent on the dollars invested. It is expected that these initiatives when completed will achieve an annual savings of greater than 10 billion Btus. Overall energy saved from projects and mission changes was equal to 1 percent of FY 2002 DOE energy consumption.

FY 2003: Fund approximately 10-12 energy projects including two to three renewable energy projects or other emerging technologies; provide a rate of return of at least 25 percent on the dollars invested; and achieve an annual savings of 30 billion Btus by 2005. Overall energy saved from projects and mission changes will be equal to 1 percent of FY 2002 DOE energy consumption.

FY 2004: Will fund approximately 8-10 energy projects including two to three renewable energy or other emerging technologies; projects provide a rate of return of at least 25 percent per dollar invested; and achieve annual savings of 20 billion Btus by 2006. Overall energy saved from projects and mission changes will be equal to 1 percent of FY 2002 DOE energy consumption.

P Energy Management Model Program Development . . .	**353**	**750**	**500**

At selected DOE facilities analyze opportunities for energy management and conservation. Expand the use of private sector financing by identifying candidate sites to replace chillers using ozone depleting substances and reduce energy consumption in surplus facilities. Evaluate DOE office buildings for ENERGY STAR

labels, and assist in the design of energy-efficient buildings. Performance will be measured by the following: acquiring ENERGY STAR labels for two office buildings; and acquiring Leadership in Energy and Environmental Design Building (LEED) Certification for one new sustainable building design. Overall energy saved from projects and mission changes will be equal to 1 percent of FY 2002 DOE energy consumption.

FY 2002: Funded seven projects at DOE facilities to develop model programs that included comprehensive facility audits, evaluating buildings for Energy Star Labels, metering of buildings, and Energy Savings Performance Contract development.

FY 2003: Provide support at various DOE facilities to develop model programs for energy management in areas that have not previously been emphasized.

FY 2004: Provide support at selected DOE facilities to develop model programs for energy management in areas that have not previously been emphasized.

Explanation of Funding Changes

	FY 2004 vs. FY 2003 ($000)
Energy Management Project Support	
P Decrease in number of energy retrofit and new technology projects at DOE facilities	-450
Energy Management Model Program Development	
P Decrease in number of best practices projects at DOE facilities	-250
Total Funding Change, Departmental Energy Management Program	**-700**

National Climate Change Technology Initiative (NCCTI)
Energy Supply

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 GHGs 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. Projects supported by this Program will be those that optimize climate change benefit per dollar spent.

Strategic Context

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 of 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 (EWD)	0	15,000
EERE (Interior)	15,000	9,500
Subtotal, EERE	15,000	24,500
Fossil Energy (Interior)	0	13,200
Nuclear Energy (EWD)	0	2,300
Total, NCCTI, Department of Energy	15,000	40,000

Program 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 projects with the greatest potential for reducing, avoiding, or sequestering greenhouse gas emissions in the near-, mid-, and long-term.

Program Strategic Performance Goals

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
	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.

Funding 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	0	15,000	+15,000	+100.0%

Public Law Authorizations:

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"

Funding by Site[b]

(dollars in thousands)

	FY 2002	FY 2003	FY 2004	$ Change	% Change
Washington Headquarters	0	0	15,000	+15,000	NA
Total, NCCTI	0	0	15,000	+15,000	NA

[a] SBIR/STTR are estimated to be $420,000 in FY 2004.

[b] "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."

Detailed Program Justification

(dollars in thousands)

	FY 2002	FY 2003	FY 2004
National Climate Change Technology Initiative	**0**	**0**	**15,000**

FY 2002: No activities.

FY 2003: 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. 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 projects and award 100 percent of funds available. Announce a second round solicitation for NCCTI, contingent on future funding.

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. 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.

Total NCCTI	**0**	**0**	**15,000**

Explanation of Funding Changes

	FY 2004 vs. FY 2003 ($000)
NCCTI Solicitations	
P 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.	+15,000
Total Funding Change, NCCTI	**+15,000**

Facilities and Infrastructure

Program Mission

This Facilities and Infrastructure budget addresses capital investments that are essential to support a vibrant world class research and development program at major participant DOE laboratory sites. Included are funding requirements for projects and equipment that are of general benefit to all research activities at the National Renewable Energy National Laboratory (NREL), as well as other program specific facilities.

For FY 2004, funding is requested for NREL general plant projects and general purpose equipment. General plant projects (GPP) serve to address rising maintenance expenses, and general purpose equipment (GPE) acquisitions promote better operational efficiencies. Efforts supporting the design and construction of a 64,600 square foot Science and Technology Facility (S&TF) are deferred until FY 2005.

Funding Profile

(dollars in thousands)

	FY2002	FY2003	FY2004	$ Change	% Change
National Renewable Energy Laboratory					
Operations and Maintenance	4070	4200	4200	0	0
Construction	800	800	0	-800	-100%
Oak Ridge National Laboratory	0	0	750	750	NA
Total, Facilities and Infrastructure[a]	4,870	5,000	4,950	-50	6.2%

Public Law Authorization:

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

[a] The FY 2002 Supplemental appropriation reduced this program by $ 130,000 for transfer to the Electricity Reliability program.

Subprogram National Renewable Energy Laboratory

Mission Supporting Goals and Measures

Approximately $0.6 billion of the Department' FY 2001 Energy Efficiency and Renewable Energy budget was directed to Department-owned laboratories. Within this context, the National Renewable Energy Laboratory (NREL) in Golden, CO received $0.2 billion in funding, Renewable Energy $0.15 billion and Energy Efficiency $0.05 billion. This total represented nearly 92 percent of the Laboratory's operating funds. With these resources, NREL conducts in-house research and manages subcontracted projects. Where research has near term potential and a reasonable level of risk, cost-sharing with industry and universities is used for both financial partnering and promoting technology transfer into the marketplace.

NREL is leading the Nation toward a sustainable energy future by developing renewable energy technologies, improving energy efficiency, advancing related science, and engineering, and facilitating technology commercialization. NREL's research efforts cover nearly 50 areas of scientific investigation including biomass-derived fuels and chemicals, hydrogen fuel cells, energy efficient buildings, wind energy, photovoltaics, advanced vehicles, solar manufacturing, industrial processes, superconductivity and geothermal technologies.

Proposed funds supporting NREL's infrastructure needs include necessary repairs, maintenance, calibration, equipment replacement, new construction, and facility modifications. These expenditures protect the Federal government's cumulative investment, support the domestic renewable energy industry, and ensure that NREL remains the Nation's preeminent center for research, development, and demonstration of renewable energy and energy efficiency technologies.

This FY 2004 budget submission includes NREL facility and infrastructure funding for continued maintenance.

Subprogram Goals

Designs will be negotiated by architect-engineer contracts or laboratory personnel. To the extent feasible, construction and procurement are accomplished by fixed-price contracts awarded on the basis of competitive bids.

Significant Program Shifts

No significant changes from FY 2003 in either scope or funding.

Detailed Program Justification

Infrastructure

This infrastructure budget funds two general ongoing National Renewable Energy Laboratory (NREL) requirements: (1) replaces and upgrades NREL general purpose capital equipment; and (2) updates and expands capabilities of facilities and infrastructure already in use at NREL.

(dollars in thousands)

Design and Construction	FY 2001	FY 2002	FY 2003	FY 2004
Appropriations	3,991	4,070	4,200	4,200
Obligations	3,991	4,070	4,200	4,200
Costs	3,300	3,900	4,200	4,200

(dollars in thousands)

Design and Construction	FY 2005	FY 2006	FY 2007	FY 2008
Appropriations	5,000	5,000	5,000	5,000
Obligations	5,000	5,000	5,000	5,000
Costs	5,000	5,000	5,000	5,000

P General Capital Needs

The following section addresses general infrastructure that constitute's NREL's general capital needs (general purpose projects, general purpose equipment). This does not include technology-specific capital equipment funded by individual program budgets.

Projects to correct environmental, safety and health deficiencies including fire safety and roadway improvements.

Projects that renovate or replace inefficient and unreliable facilities including utility systems, roads, general purpose research and support facilities, general purpose research, and support equipment.

Projects that improve or enhance general purpose facilities or capabilities including utility systems, energy efficiency, renewable energy use, roads, site improvements, general purpose research and support facilities, general purpose research and support equipment.

< **General Purpose Equipment Subproject 01**

TEC	Prev.	FY 2002	FY 2003	FY 2004	Outyear 2005-2008	Construction Start / Completion Dates
2,400/yr	2,210[a]	2,100	2,100	2,100	10,000	Not Applicable

This investment replaces and upgrades NREL's general capital equipment at a regular annual rate of approximately 4 percent. Currently 20 percent of NREL's capital equipment, both general purpose and program-specific, is in operation beyond its useful life. Specific equipment needs are initially identified for annual spring DOE budget submission, then reevaluated as funding becomes available in the requested execution year. This equipment includes:

- Upgrades to NREL's information technology systems necessary to keep them near state-of-the-art.
- Upgrades and additions to NREL's scientific instrumentation shared by several programs or projects, to replace equipment that is no longer reliable or serviceable, to meet changing research needs, and to keep these instruments near the state-of-the-art in capability.

< **General Plant Projects - Subproject 02**

TEC	Prev.	FY 2002	FY 2003	FY 2004	Outyear 2005-2008	Construction Start / Completion Dates
2,400/yr	1,781[a]	1,970	2,100	2,100	10,000	1Q 2001 - 4Q 2008

This investment serves to renovate and extend the capabilities of the buildings and infrastructure already in place at NREL sites. These projects apply to both the South Table Mountain (STM) and National Wind Technology Center (20 miles away) locations in Golden, CO. Specific projects are initially identified at the time of budget submission, then reevaluated as funding becomes available in the requested execution year. These projects include:

- Safety and security improvements within buildings.
- Upgrades to utilities, Heating Ventilation and Air Conditioning systems, and related systems within buildings.
- Energy efficiency improvements within buildings
- Small expansions of existing buildings or small additional buildings to accommodate changes or growth in R&D programs or research support needs.

[a] Previous year (FY 2001) funding level.

- Expansions and upgrades of site-wide utility systems, such as electrical, water, sewer/septic, natural gas, telecommunications and computer networks.
- Addition of onsite electricity generating capacity.
- Road, parking, and traffic infrastructure improvements.
- Walkway, landscaping, water management, water treatment, and other site improvements to enhance the sustainability, cohesiveness, and pedestrian nature of the site.

Capital Operating Expenses & Construction Summary

Capital Operating Expenses

(dollars in thousands)

	FY 2002	FY 2003	FY 2004	$ Change	% Change
General Plant Projects	1,970	2,100	2,100	0	0.0%
General Purpose Equipment	2,100	2,100	2,100	0	0.0%
Total, Capital Operating Expenses	4,070	4,200	4,200	0	0.0%

Construction Projects

(dollars in thousands)

	Total Estimated Cost (TEC)	Prior-Year Appropriations	FY 2002	FY 2003	FY 2004	Unappro-priated Balance
02-E-001, NREL Science and Technology Facility	16,370[a]	0	800	800	0	14,770
Total, Construction	16,370	0	800	800	0	14,770

[a]The current preliminary total project cost (TPC) estimate is currently $16,790,000 without adjustment due to project deferral. Preliminary design was completed on December 27, 2002.

04-E-TBD, Energy Reliability and Efficiency Laboratory
Oak Ridge National Laboratory, Oak Ridge, Tennessee

1. Construction Schedule History

	Fiscal Quarter					
	A-E Work Initiated	A-E Work Completed	Physical Construction Start	Physical Construction Complete	Total Estimated Cost ($000)	Total Project Cost ($000)
FY 2004 Budget Request (Preliminary Estimate)	1Q '04	4Q '04	2Q '05	4Q '06	16,500*	16,240*

* 16,500 denotes Total Estimated Cost of the project including fifty percent industry cost share.

2. Financial Schedule

(dollars in thousands)

Fiscal Year	Appropriations	Obligations	Costs
Project Engineering & Design (PED)			
2004	750*	750	550
2005	0	0	200
Construction			
2005	7,320*	7,320	3,500
2006	0	0	3,820

* Denotes federal share 50 percent of project cost only.

3. Project Description, Justification and Scope

This project will construct a new multistory building of approximately 52,000 square feet. It will be located at the north entrance of ORNL and will provide facilities for research and development activities in support of DOE's Office of Energy Efficiency and Renewable Energy (EERE).

This budget provides half of the requested amount for Project Engineering and Design. No funds can be obligated for this project until the Department obtains a commitment in writing from an industry partner to provide 50 percent cost share for facility design, construction, and operation, as directed by the National Transmission Grid Study.

EERE leads the nation in research, development and deployment of affordable, advanced energy-efficient and clean energy technologies and practices providing Americans with a stronger economy, healthier environment, and more secure future. EERE's strategies include: (1) improving energy technologies and practices through R&D; (2) facilitating the deployment of advanced energy technologies and practices into their target markets, and (3) formulating policies and standards. The Energy Reliability and Efficiency Laboratory (EREL) is consistent with these strategies and will support EERE's mission in three strategically important areas: distributed energy resources, electricity transmission and distribution, and net zero energy building systems. Improving the performance of these technologies will accelerate their penetration into the market, stimulating economic and job growth, improving the environment, and lessening the threat of future energy disruptions. The National Energy Policy Development (NEPD) Group highlighted the strategic importance of these R&D areas in its 2001 *National Energy Policy* as did the 2002 *National Transmission Grid Study*.

The project is also consistent with the ORNL Strategic Facilities Plan and complementary to the Facilities Revitalization Project of the DOE-ORNL Office of Science initiative to modernize their national laboratories. This building will be an attractive state-of-the-art facility designed to operate as a demonstration of energy efficiency technology. Energy Star certification will be sought for applicable portions of the building. The facility will include on-site power generation, virtual laboratory capabilities and built-in flexibility to incorporate new research and development and next-generation technologies. Approximately 80 percent of the building's net usable space will be dedicated to research facilities, including high bay space for large equipment and integrated systems demonstration as well as two 2-ton cranes. The remainder of the space will contain offices for approximately 40 occupants, conference/meeting room(s), and break rooms. The building structure will be steel and will be clad with an aesthetic low-maintenance exterior. An advanced heating, ventilating, and air-conditioning (HVAC) system will provide cost-effective, energy-conserving space conditioning utilizing the waste heat from on-site power generation. Land improvements will include service drives, walkways, drainage, and landscaping. Utilities will be extended from the existing distribution systems adjacent to the site and upgraded as required.

The EREL will be a showcase for sustainable energy technologies and design practices. It will be designed and engineered to achieve a silver rating based on the Leadership in Energy & Environmental Design (LEED™) rating system developed by the U.S. Green Building Council.

Obligations for FY 2004 will be used to award the Architectural-Engineering (A-E) contract for the project design and to provide project management.

Obligations for FY 2005 will be used to award the construction (FPSC) contract and to provide project management.

4. Details of Cost Estimate[a]

(dollars in thousands)

	Current Estimate	Previous Estimate
Design Phase		
Preliminary and Final Design Costs (Cost of Design, Drawings, and Specifications $700,000)	930	N/A
Design Management Costs (1.2% of TEC)	210	N/A
Project Management Costs (2.0% of TEC)	360	N/A
Total, Design Costs	1,500	N/A
Construction Phase		
Improvements to Land	410	N/A
New Building and Additions	10,230	N/A
Utilities	560	N/A
Inspection, design and project liaison, testing, checkout and acceptance	690	N/A
Construction Management (2.1% of TEC)	330	N/A
Project Management (0.9% of TEC)	140	N/A
Total, Construction Costs	12,360	N/A
Contingencies		
Design Phase (1.1% of TEC)	170	N/A
Construction Phase (15.5% of TEC)	2,470	N/A
Total, Contingencies (16.6% of TEC)	2,640	N/A
Total, Line Item Costs	16,500	N/A
Less: Non-Agency Contribution	0	N/A
Total, Line Item Costs (TEC)	16,500	N/A

[a] The annual escalation rates are: FY 2002 – 2.6 percent, FY 2003 – 2.8 percent, FY 2004 – 2.8 percent, FY 2005 – 2.9 percent and FY 2006 – 2.9 percent as directed by DOE. A conceptual design report was completed in May 2002 at a cost of $110,000.

5. Method of Performance

Design will be performed by an Architect-Engineer with the subcontract managed by the ORNL operating contractor, UT-Battelle, LLC. Construction and procurement will be performed by fixed-price subcontractors with the subcontracts administered by the ORNL operating contractor. Procurement of research capital equipment will be performed by the ORNL operating contractor. The ORNL operating contractor will perform project and construction management, inspection, coordination, tie-ins, testing and checkout witnessing, and acceptance.

6. Schedule of Project Funding

	Prior Years	FY 2004	FY 2005	Outyears	Total
Project Cost					
Facility Cost					
Design	0	650	100	0	750
Construction	0	0	3,400	3,815	7,315
Total, Line item TEC	0	650	3,500	3,815	8,065
Other Project Costs					
Conceptual Design Costs[a]	110	0	0	0	110
Other project related Costs[b]	100	0	0	0	100
Total, Other Project Costs	210	0	0	0	210
Total Project Cost	210	600	3,500	3,815	8,275
Non-Agency Contribution (memo entry)	0	650	3,500	3,815	7,965
Total, Project Cost (TPC)[c]	210	1,300	7,000	7,630	16,240

[a] A conceptual design report (CDR) was completed in May 2002 at a cost of $110,000.

[b] Design Criteria, Project Execution plan, Readiness Assessment activities, and other supporting project documentation are estimated at $100,000.

[c] Non-Agency contribution accounts for fifty percent of total project costs.

7. Related Annual Funding Requirements

(FY 2007 dollars in thousands)

	Current Estimate	Previous Estimate
Annual facility operating costs[a]	150	N/A
Facility maintenance and repair costs[b]	85	N/A
Utility costs[c]	105	N/A
Total related annual funding	340	N/A
Total operating costs (operating from FY 2007 through FY 2056)	17,000	N/A

8. Design and Construction of Federal Facilities

All DOE facilities are designed and constructed in accordance with applicable Public Laws, Executive Orders, OMB Circulars, Federal Property Management Regulations, and DOE Orders. The total estimated cost of the project includes the cost of measures necessary to assure compliance with Executive Order 12088, "Federal Compliance with Pollution Control Standards"; section 19 of the Occupational Safety and Health Act of 1970, the provisions of Executive Order 12196, and the related Safety and Health provisions for Federal Employees (CFR Title 29, Chapter XVII, Part 1960); and the Architectural Barriers Act, Public Law 90-480, and implementing instructions in 41 CFR 101-19.6.

This project will be located in an area not subject to flooding determined in accordance with the Executive Order 11988. DOE has reviewed the U.S. General Services Administration (GSA) inventory of Federal Scientific laboratories and found insufficient space available, as reported by the GSA inventory.

[a]This includes janitorial and other miscellaneous support services. Approximately two staff years of effort will be required to provide these services.

[b]Based on expected cost to repair and maintain a new facility.

[c]The estimated annual utility cost of $105,000 is based on expected energy usage in an Energy Star facility and the per unit cost of the utility at ORNL.

Program Direction

Program Mission

This Program Direction budget component provides the Federal staffing resources as well as associated properties, equipment, supplies and materials required for supporting the responsive management and oversight of programs. Activities also include necessary funds for support service contractors, equipment, travel, crosscutting activities and Assistant Secretary for Energy Efficiency and Renewable Energy (EERE) initiatives.

Information technology gains have led to productivity increases of the Federal staff. However, this progress comes with the requirement of added support expenses for individual Full-Time Equivalent (FTE) positions. Every fiscal year, the costs for sustaining salary levels, information technology, office space, office supplies, equipment and travel have increased because of nominal inflation. The
FY 2004 budget request makes provision for these normal operating considerations, as well as a level of support services commensurate with a vibrant research and development portfolio that has proven to be successful in achieving significant results.

This budget will focus on continued realization of renewable energy goals and objectives while implementing the President's Management Agenda. To further promote program management, key renewable energy technologies such as biomass, hydrogen, distributed energy resource electric infrastructure/reliability, wind/hydroelectric, solar and geothermal were reconstituted during FY 2002 into individual organizational elements to offer more visibility and accountability. In addition, supporting business management functions are now centralized to eliminate overlap of responsibilities and reinforce program customer focus. This new EERE business operation model is aimed at removing sources of myopic "stovepipes" and fragmentation; eliminating artificial organizational layers; enhancing competitive sourcing, fiscal accountability and information technology services through one central organization for business systems and processes; empowering program managers with accountability; focusing their attention on results rather than bureaucratic processes; assigning EERE executives, especially former Deputy Assistant Secretaries, to roles better aligned with their areas of expertise; integrating performance planning and budgeting; and providing the Assistant Secretary for Energy Efficiency and Renewable Energy with more direct accessibility for improved program and business oversight.

Funding Profile[a]

(dollars in thousands, whole FTE's)

	FY 2002 Comparable Appropriation	FY 2003 Amended Request	FY 2004 Request	$ Change	% Change
Golden Field Office					
Salaries and Benefits	1,951	1,925	2,025	+100	+5.2%
Travel	75	80	90	+10	+12.5%
Support Services	390	314	300	-14	-4.5%
Other Related Expenses	285	105	105	0	0.0%
Total, Golden Field Office	2,701	2,424	2,520	+96	+4.0%
FTE's, Golden Field Office	20	18	19	+1	+5.6%
Idaho Operations Office					
Salaries and Benefits	114	118	0	-118	-100.0%
Travel	14	10	0	-10	-100.0%
Support Services	0	0	0	0	0.0%
Other Related Expenses	0	0	0	0	0.0%
Total, Idaho Operations Office	128	128	0	-128	-100.0%
FTE's, Idaho Operations Office	1	1	0	-1	-100.0%
Headquarters					
Salaries and Benefits	10,806	9,913	9,888	-25	-0.3%
Travel	443	390	350	-40	-10.3%
Support Services	2,815	1,801	2,267	+466	+25.9%
Other Related Expenses	1,780	1,531	1,552	+21	+1.4%
Total, Headquarters	15,844	13,635	14,057	+422	+3.1%

[a]The FY 2002 Supplemental appropriation reduced this program by $497,000 for transfer to the Electricity Reliability program. The FY 2002 rescission reduced this program by $30,000.

(dollars in thousands, whole FTE's)

	FY 2002 Comparable Appropriation	FY 2003 Amended Request	FY 2004 Request	$ Change	% Change
FTE's, Headquarters	95	83	82	-1	-1.2%
Total Renewable Energy Resources					
Salaries and Benefits	12,871	11,956	11,913	-43	-0.4%
Travel	532	480	440	-40	-8.3%
Support Services	3,205	2,115	2,567	+452	+21.4%
Other Related Expenses	2,065	1,636	1,657	+21	1.3%
Total, Program Direction	18,673	16,187	16,577	+390	+2.4%
Additional net budget authority to cover the cost of full accruing retirement (non-add)	(817)	(720)	(720)	(0)	(0.0%)
Total, FTE's	116	102	101	-1	-1.0%

Funding by Site[b]

(dollars in thousands)

	FY 2002	FY 2003	FY 2004	$ Change	% Change
Albuquerque Operations Office					
Golden Field Office	2,701	2,424	2,520	+96	+4.0%
Total, Albuquerque Operations Office	2,701	2,424	2,520	+96	+4.0%
Idaho Operations Office	128	128	0	-128	-100.0%
Washington Headquarters	15,844	13,635	14,057	+422	+3.1%
Total, Program Direction	18,673	16,187	16,577	+390	+2.4%

[ba]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."

Detailed Program Justification

(dollars in thousands)

		FY 2002	FY 2003	FY 2004
P	**Salaries and Benefits**	**12,871**	**11,956**	**11,913**

Funds a total of 101 full time equivalent employees. Staff funded in this decision unit provide the executive management, program oversight, analysis, and information required for the effective implementation of the EERE programs funded in the Energy Supply appropriation.

The DOE Headquarters component, consisting of 82 FTEs in FY 2004, is responsible for the development of policies, strategic plans and related guidance to program offices; the evaluation of program performance; the formulation, defense and execution of renewable energy budgets; as well as communications with the public and stakeholders regarding policies, funding, program performance, and related issues.

EERE Energy Supply Program Direction also supports a Golden Field Office personnel level of 19 FTEs. As of FY 2004, 1 FTE from the Idaho Operations Office will transfer to Golden, CO where the office is accountable for contract acquisition and management, as well as direct R&D project direction and monitoring. The reallocation of one FTE from Idaho Falls, ID to Golden, CO is aimed at concentrating all EERE field support in a single location. This consolidation of expertise dedicated to EERE field management is expected to increase productivity because of focus on a single DOE program and adoption of best business practices.

Current and future staff performance is measured by responsiveness to National Energy Policy goals and objectives; implementation of the President's R&D criteria for priority decision making; continued improvement in the utilization of Federal personnel, travel, and support service activities; increases in competitive and cost-sharing procurement awards; extending the use of more efficient electronic government information systems, improving financial performance; and further integration of program metrics into resource allocation processes.

P	**Travel**	**532**	**480**	**440**

The proposed travel budget is reduced over the period, assuming that a restructured EERE headquarters and field organization will provide efficiencies to offset probable cost escalation. The rising priorities of Renewable Energy's hydrogen, biomass, wind, superconducting and transmission programs must be addressed on a widely dispersed national scale.

P	**Support Services**	**3,205**	**2,115**	**2,567**

Includes funding for support service contractors, equipment, crosscutting activities, and general Assistant Secretary initiatives that support all renewable energy resources programs. This proposed

(dollars in thousands)

budget provides support services needed for energy technology specific advisement on critical science, engineering, environmental, economic and legal issues; as well as business management; safety and health support; facility safeguards and security; computer systems development along with subsequent hardware and software installation, configuration, and maintenance activities. The restructured EERE organization will result in future support service efficiencies. However, a critical level of contracted skills and abilities is necessary to help assess and exploit the potential of renewable energy technologies, as well as implement the President's Management Agenda to the fullest extent possible.

P	**Other Related Expenses . . . . . .**	**2,065**	**1,636**	**1,657**

This activity encompasses the Headquarters Working Capital Fund (WCF) and contractual services associated with landlord support of the Golden Field Office. Funding for the WCF in FY 2002 through FY 2004 is $1,780,000, $1,531,000 and $1,552,000 respectively. Rent is the largest Working Capital Fund component (FY 2002 through FY 2004 is $953,000, $838,000 and $869,000 respectively). The balance of the Other Related Expense budget consists of Golden landlord requirements such as rental payments to the Federal Government's General Services Administration, expendable office supplies and materials, telecommunications and utilities, training, purchase of goods and services from other Government accounts, printing and graphics, postage, maintenance and service agreements, and publications. Total costs for the Golden Field Office are split funded between the Congressional appropriations subcommittees on 1) Energy and Water Development and 2) Interior and Related Agencies' based upon estimated demands for field management services from energy supply and conservation technologies.

Total, Renewable Energy Resources Program Direction	**18,673**	**16,187**	**16,577**

Explanation of Funding Changes

		FY 2004 vs. FY 2003 ($000)
Salaries and Benefits		
#	Reduction of one FTE from the FY 2003 Request of 102 is offset by the full effect of the FY 2003 pay raise and the partial effect of the FY 2004 pay raise	-43
Travel		
#	Consolidation of field management support staff at Golden, CO and greater reliance on electronic technology allows planned travel expenditures to be reduced	-40
Support Services		
#	A 21 percent increase for partial restoration of contract support to historical levels. Contractor assistance is needed to analyze renewable energy technology potential, as well as satisfactorily implement EERE's organizational restructuring and other presidential management agenda actions	+452
Other Related Expenses		
#	Mostly reflects increase for Headquarters occupancy (rent)	+21
Total Funding Change, Renewable Energy Resources Program Direction		**+390**

Support Services

(dollars in thousands)

	FY 2002	FY 2003	FY 2004	$ Change	% Change
Technical Support Services					
Economic and Environmental	1,205	1,000	1,200	+200	+20.0%
Management Support Services					
ADP Support	200	205	210	+5	+2.4%
Administrative Support Services	1,800	910	1,157	+247	+27.1%
Total, Management Support Services	2,000	1,115	1,367	+252	+22.6%
Total, Support Services	3,205[a]	2,115	2,567	+452	+21.4%

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[a] Includes all funding for support services contractors, ADP equipment, crosscutting activities, and Assistant Secretary initiatives

Other Related Expenses

(dollars in thousands)

	FY 2002	FY 2003	FY 2004	$ Change	% Change
Working Capital Fund					
Working Capital Fund (Excluding HQ Rent)	827	693	683	-10	-1.4%
Rental Space (HQ)	953	838	869	+31	+3.7%
Subtotal, Working Capital Fund	1,780	1,531	1,552	+21	+1.4%
Other	285	105	105	0	0.0%
Total, Other Related Expenses	2,065	1,636	1,657	+21	+1.3%

Explanation of Funding Changes

		FY 2004 vs. FY 2003 ($000)
Salaries and Benefits		
#	Reduction of one FTE from the FY 2003 Request of 102 is offset by the full effect of the FY 2003 pay raise and the partial effect of the FY 2004 pay raise	-43
Travel		
#	Consolidation of field management support staff at Golden, CO and greater reliance on electronic technology allows planned travel expenditures to be reduced	-40
Support Services		
#	A 21 percent increase for partial restoration of contract support to historical levels. Contractor assistance is needed to analyze renewable energy technology potential, as well as satisfactorily implement EERE's organizational restructuring and other presidential management agenda actions	+452
Other Related Expenses		
#	Mostly reflects increase for Headquarters occupancy (rent)	+21
Total Funding Change, Renewable Energy Resources Program Direction		**+390**