Energy Efficiency and Renewable Energy

Energy Efficiency and Renewable Energy

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Energy Supply
Office of Energy Efficiency and Renewable Energy

Overview
Appropriation Summary by Program

(dollars in thousands)

	FY 2003 Comparable Appropriation	FY 2004 Original Appropriation	FY 2004 Adjustments[a]	FY 2004 Comparable Appropriation	FY 2005 Request
Energy Supply (EERE)					
Hydrogen Technology	38,113	78,000	+3,991[b,c]	81,991	95,325
Solar Energy	82,330	85,000	-1,607[b]	83,393	80,333
Zero Energy Buildings	7,572	0	0	0	0
Wind Energy	41,640	41,600	-290[b,c]	41,310	41,600
Hydropower.....	5,016	5,000	-95[b]	4,905	6,000
Geothermal Technology	28,390	26,000	-492[b]	25,508	25,800
Biomass and Biorefinery Systems R&D.....	85,283	75,000	+11,471[b,c]	86,471	72,596
Intergovernmental Activities...	14,449	15,000	-280[b]	14,720	16,000
Departmental Energy Management Program	1,445	2,000	-37[b]	1,963	1,967
Renewable Program Support	0	4,000	+919[b,c]	4,919	0
National Climate Change Technology Initiative Competitive Solicitation	0	0	0	0	3,000
Facilities and Infrastructure....	5,297	13,200	-250[b]	12,950	11,480

[a] Programs in both the Energy Supply and the Energy Conservation appropriations were reduced by .59 percent as required by the Omnibus Appropriation Bill.

[b] Programs in the Energy Supply appropriation were proportionally reduced based upon the allocated General Reduction of $4,684,000.

[c] Selected programs in Energy Supply appropriation were provided increases by the Omnibus Appropriation Bill initially totaling $19,900,000. These were Hydrogen Technology at $5,500,000, Wind Energy at $500,000, Biomass and Biorefinery Systems R&D at $12,900,000, and the Renewable Program Support at $1,000,000. Each of these amounts was subject to the .59 percent reduction required by the Omnibus Appropriation Bill.

(dollars in thousands)

	FY 2003 Comparable Appropriation	FY 2004 Original Appropriation	FY 2004 Adjustments[a]	FY 2004 Comparable Appropriation	FY 2005 Request
Program Direction	12,615	12,600	-236 [b]	12,364	20,711
Subtotal, Energy Supply (EERE)	322,150	357,400	+13,094	370,494	374,812
Use of prior year balances	0	-13,000	0	-13,000	0
General Reduction	0	-4,684	+4,684	0	0
Total, Energy Supply (EERE)	322,150	339,716	+17,778	357,494	374,812
Energy Conservation					
Vehicle Technologies	174,171	179,059	-1,057	178,002	156,656
Fuel Cell Technologies	53,906	65,574	-387	65,187	77,500
Weatherization and Intergovernmental Activities	314,155	310,444	-1,832	308,612	364,067
Distributed Energy Resources	60,054	61,385	-362	61,023	53,080
Building Technologies	58,327	60,221	-355	59,866	58,284
Industrial Technologies	96,824	93,620	-552	93,068	58,102
Biomass and Biorefinery Systems R&D	24,050	7,551	-45	7,506	8,680
Federal Energy Management Program	19,299	19,833	-117	19,716	17,900
Program Management	76,950	85,508	-504	85,004	81,664
Energy Efficiency Science Initiative	2,440	0	0	0	0
Total, Energy Conservation	880,176	883,195	-5,211	877,984	875,933
Total, Energy Supply and Energy Conservation	1,202,326	1,222,911	+12,567	1,235,478	1,250,745

Preface

It is in the nation's long term national and economic security interest to use our energy resources wisely. Energy Efficiency and Renewable Energy (EERE) pursues a balanced portfolio of research, development, demonstration, and deployment, investing in: 1) the technologies that allow us to harvest domestic solar, wind, hydropower, geothermal, and biomass energy; 2) the technologies to use those resources efficiently in our homes, schools, businesses, factories, and vehicles; and 3) the tools, processes and methods to help consumers fully and productively use these new energy opportunities.

EERE comprises 12 main programs:

Hydrogen Technology, Solar Energy Technology, Wind Energy Technology, Hydropower Technologies, Geothermal Technologies, Biomass and Biorefinery Systems R&D Technology, Intergovernmental Activities Technology, and Departmental Energy Management Program Technology, Vehicle Technologies, Distributed Energy Resources, Building Technologies, and Industrial Technologies. In addition, EERE supports Renewable Program Support, National Climate Change Technology Initiative Competitive Solicitation, Facilities and Infrastructure, Program Direction, and Energy Efficiency Science Initiative. Two appropriation accounts, Energy Supply (EERE) and Energy Conservation, fund these activities. Four programs have complementary funding in Energy Supply (renewables) and Energy Conservation. They are: Biomass; Federal Energy Management; Hydrogen, Fuel Cells, and Infrastructure Technologies; and the Weatherization and Intergovernmental Program.

Within the Energy Supply (EERE) appropriation, EERE currently supports eight programs: Hydrogen Technology (five subprograms) Solar Energy Technology (three subprograms), Wind Energy Technology (two subprograms), Hydropower Technologies Technology (two subprograms), Geothermal Technologies (two subprograms), Biomass and Biorefinery Systems R&D Technology (three subprograms), Intergovernmental Activities Technology (three subprograms), and Departmental Energy Management Program Technology (two subprograms). (The Zero–energy Building component of the Building Technology Program was supported by this appropriation in FY2003.)

This Overview will describe Strategic Context, Mission, Benefits, Strategic Goals, and Funding by General Goal. These items together put the appropriation in perspective. This Overview also addresses the R&D Investment Criteria, the Program Assessment Rating Tool (PART), and Significant Program Shifts.

Strategic Context

Following publication of the Administration's National Energy Policy, the Department developed a Strategic Plan that defines its mission, four strategic goals for accomplishing that mission, and seven general goals to support the strategic goals. Each appropriation has developed quantifiable goals to support the general goals. Thus, the "goal cascade" is the following:

Department Mission → Strategic Goal (25 yrs) → General Goal (10-15 yrs) → Program Goal (GPRA Unit) (10-15 yrs)

To provide a concrete link between budget, performance, and reporting, the Department developed a "GPRA[a] unit" concept. Within DOE, a GPRA Unit defines a major activity or group of activities that support the core mission and aligns resources with specific goals. Each GPRA Unit has completed or will complete a Program Assessment Rating Tool (PART). A unique program goal was developed for each GPRA unit. A numbering scheme has been established for tracking performance and reporting. [b]

The goal cascade accomplishes two things. First, it ties major activities for each program to successive goals and, ultimately, to DOE's mission. This helps ensure the Department focuses its resources on fulfilling its mission. Second, the cascade allows DOE to track progress against quantifiable goals and to

[a] Government Performance and Results Act of 1993

[b] The numbering scheme uses the following numbering convention: First 2 digits identify the General Goal that (01 through 07); second two digits identify the GPRA Unit; last four digits are reserved for future use.

tie resources to each goal at any level in the cascade. Thus, the cascade facilitates the integration of budget and performance information in support of the GPRA and the President's Management Agenda (PMA).

The FY 2005 Congressional Request integrates FY 2004 and FY2005 budget and performance into one document. The Annual Performance Results and Targets sections in the individual Program budgets encompass the FY 2004 targets which were included in the FY 2004 Annual Performance Plan (APP) as amended to reflect final appropriations. These targets are representative of all Energy Supply (EERE) and accommodate the PMA to submit a performance budget.

Mission

EERE strengthens 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.

Benefits

EERE pursues this mission through a mix of research, development, demonstration and deployment efforts which improve the energy efficiency of our economy and increase the use of domestic renewable energy resources. Making greater use of our abundant, clean domestic renewable energy resources and using all of our energy resources more productively provides a number of economic, environmental, and security benefits to the United States. Energy bills are lower and consumers are less susceptible to energy price fluctuations. Emissions of Clean Air Act criteria pollutants (sulfur dioxide, nitrogen oxide, carbon monoxide, and particulates), mercury, and carbon dioxide are lower. Energy security is enhanced as dependence on imported petroleum (and, increasingly in the future, natural gas) is reduced and the mix of domestic energy resources increases. Security is also enhanced as the loads on our energy infrastructure are reduced, reducing the potential for wide-spread energy outages, and the development of distributed energy resources increases the reliability of energy supplies, even during emergencies.

Based on its modeling efforts, EERE estimates that U.S. consumption of non-renewable energy resources would, given current policies and a business-as-usual energy future, be about 10 quads lower in 2025 and over 30 quads lower in 2050 as a result of being able to realize these efficiency and renewable improvements, off-setting more than 50 percent of the expected growth in energy consumption through 2050. More detailed, integrated and comprehensive economic, and energy security benefits estimates and their sensitivities are provided in the Expected Program Integrated Outcomes section at the end of this overview.

Strategic Goals

The Department's Strategic Plan identifies four strategic goals (one each for defense, energy, science, and environmental aspects of the mission plus seven general goals that tie to the strategic goals. The Energy Supply appropriation supports the following goals:

Energy Strategic Goal: To protect our national and economic security by promoting a diverse supply of reliable, affordable, and environmentally sound energy.

General Goal 4, Energy Security: Improve energy security by developing technologies that foster a diverse supply of reliable, affordable and environmentally sound energy by providing for reliable delivery of energy, guarding against energy emergencies, exploring advanced technologies that make a fundamental improvement in our mix of energy options, and improving energy efficiency.

The programs funded by the Energy Supply appropriation have the following eight Program Goals which contribute to the General Goal in the "goal cascade":

Program Goal 04.01.01.00: Hydrogen. The Hydrogen, Fuel Cells and Infrastructure Technologies Program goal is to develop hydrogen production, storage, and delivery technologies to the point that they are cost and performance competitive and are being used by the Nation's transportation, energy, and power industries. As such, the Program will expand and make our clean domestic energy supplies more flexible dramatically reducing or even ending dependence on foreign oil.

Program Goal 04.03.00.00: Solar Energy. The Solar Program goal is to improve performance of solar energy systems and reduce development, production, and installation costs to competitive levels, thereby accelerating both large-scale usage across the Nation and to make a significant contribution to a clean, reliable and flexible U.S. energy supply.

Program Goal 04.05.00.00: Wind Energy. By 2012, complete program technology research and development, collaborative efforts, and provide the technical support and outreach needed to overcome barriers – energy cost, energy market rules and infrastructure, and energy sector acceptance –to enable wind energy to compete with conventional fuels throughout the nation in serving and meeting the Nation's energy needs.

Program Goal 04.06.00.00: Hydropower. The Hydropower Program's goal is to conduct the R&D necessary to improve hydropower's operational and environmental performance so that hydropower generation is increased because of its affordability, abundance, reliability and environmental benefits. In accomplishing this goal, the Program will increase the viability of hydropower, the Nation's most widely used renewable energy source, without construction of new dams.

Program Goal 04.07.00.00: Geothermal. The Geothermal Program goal is to improve performance and reduce market entry costs of geothermal energy to competitive levels. In quantitative terms, the goal is to reduce the levelized cost of power generated from conventional geothermal sources from 5-8 cents per kWh (kilowatt hour) in 2000 to 3-5 cents per kWh by 2010.

Program Goal 04.08.01.00: Biomass. Develop biorefinery-related technologies to the point that they are cost- and performance-competitive and are used by the Nation's transportation, energy, chemical and power industries to meet their market objectives. This helps the Nation by expanding clean, sustainable energy supplies while also improving the Nation's energy infrastructure and reducing our dependence on foreign oil.

Program Goal 04.11.01.00: Intergovernmental Activities. Accelerate the adoption of clean, efficient and domestic energy technologies through efficient intergovernmental demonstration and delivery of cost-effective energy technologies which will benefit the public through improved energy productivity and reduced demand and particularly reduce the burden of energy cost on the disadvantaged.

Program Goal 04.13.01.00: DEMP. The Federal Energy Management Program's goal is to provide the efficiency and renewable energy-related technical assistance Federal agencies need to lead the Nation by example through government's own actions, expressly increasing Federal renewable energy use by 2.5 percent by 2005 and reducing energy intensity in Federal buildings by 35 percent by 2010 (using 1985 as a baseline).

Contributions to General Goal

Hydrogen Technology, Solar Energy Technology, Wind Energy, Hydropower Technologies, Geothermal Technologies, Biomass and Biorefinery Systems R&D, Intergovernmental Activities, and Departmental Energy Management Program contribute to General Goal 4 by working together and with efficiency and load management programs to reduce the probability and potential magnitude of energy based disruptions and to improve the nation's mix of affordable energy options.

These integrated contributions include (1) reducing demand-side pressure on our energy markets, (2) reducing energy imports; (3) diversifying the mix of domestic energy production; (4) providing smaller, non-fuel based sources of electricity generation that are inherently less susceptible to interdiction, attack or large losses; and (5) increasing our ability to adjust demand loads as needed, particularly during emergencies.

Clean distributed generation can reduce transmission and distribution bottle-necks, and can help maintain critical electricity functions during an outage without adding to the unhealthy air quality that often accompanies peak electricity days. Solar photovoltaic systems provide distributed, fuel-free, and portable electricity demand. These technologies cannot replace the need to maintain well-functioning energy infrastructure. They can, however, improve the inherent security of our energy systems, as well as reduce the need for costly expansions of our transmission lines, pipelines, and other infrastructure.

Given current expectations about future energy technologies and markets, and assuming no changes in energy policies, EERE's integrated portfolio, including activities funded by the Energy Conservation Appropriation, can be expected to: (1) reduce future demand for traditional energy sources by approximately 10 quads in 2025 and over 30 quads in 2050 (beyond the efficiency and renewable improvements expected in the absence of these programs); and (2) reduce the need for new electricity capacity by nearly 150 gigawatts (GW) in 2025. Oil savings would be roughly 2 million barrels per day (MBD) in 2025 and over 10 MBD in 2050. Individual program activities planned for and funded by this appropriation would contribute to these improvements in the following ways under these business-as-usual conditions:[a]

Hydrogen Technology contributes to this goal by developing lower cost means of producing hydrogen in large quantities from natural gas and biomass-based renewable sources which will, in conjunction with the development of fuel cells, enable the production of hydrogen displacing 0.4 mbd of oil in 2025 and 6 mbd in 2050 under business-as-usual conditions, while providing the country with the option for substantially faster growth in hydrogen use if circumstances warrant.

[a] Individual program contributions are not strictly additive because of overlap in the markets addressed.

Solar Energy Technology contributes to this goal by developing advanced, lower-cost solar photovoltaic modules and grid application technologies; application of lightweight polymer materials to solar heating; and development of solar light distribution systems which will enable the development of 17 GW of solar energy capacity by 2025 and 23 GW in 2050 while affording the country a source of clean, fuel-free, and portable electricity.

Wind Energy contributes to this goal by developing wind technologies that will provide large scale wind production in Class-4 conditions of 3 cents/kWh onshore and 5 cents/kWh offshore by 2012; distributed wind production at 10-15 cents/kWh by 2007; and the market systems and services that will extend wind production to most of the United States, which will result in additional wind capacity of nearly 60 GW by 2025 and 120 GW by 2050 beyond what is expected to be developed without these program efforts.

Hydropower Technologies contributes to this goal by developing by 2010 advanced turbine designs and other water management and environmental mitigation techniques necessary to increase production by 10 percent at existing plants will increase hydropower electricity generation capacity by 5 GW by 2025.

Geothermal Technologies contributes to this goal by reducing the cost of geothermal energy production to 3-5 cents/kWh by 2010 and the developing commercial Enhanced Geothermal Systems by 2015 which will significantly expand the amount of geothermal resources that can be competitively developed in the United States, allowing for an increase in geothermal electricity capacity of 6 GW by 2025 and more than 35 GW by 2050.

Biomass and Biorefinery Systems R&D contributes to this goal by developing by 2010 advanced technologies for producing fuels, chemicals, materials, and power from biomass via biochemical and thermochemical processes which will increase direct biomass energy production by 1.2 quads by 2050 and potentially more with integrated approaches.

Intergovernmental Activities contributes to this goal by supporting domestic and international access to U.S. renewable technologies, through Tribal and international technical assistance to support sustainable development, providing early market aggregation and economies of production for renewable energy technologies for U.S. companies, while reducing the stress on global energy markets by reducing the world's overall demand for oil and other traditional energy sources.

Departmental Energy Management Program contributes to this goal by providing project financing, technical assistance, and evaluation which will demonstrate in the Department methods to reduce energy intensity in Federal buildings by 35 percent in 2010 from 1985 levels.

These technology and market improvements also help prepare the nation for potential future energy, environmental and security needs by providing options for additional fuel savings, air emission reductions and electricity reliability improvements beyond those expected under business-as-usual energy markets.

Funding by General Goal

(dollars in thousands)

	FY 2003	FY 2004	FY 2005	$ Change	% Change
General Goal 4, Energy Security					
Program Goal 04.01.01.00, Hydrogen	27,517	40,024	95,325	+55,301	+138.2%

(dollars in thousands)

	FY 2003	FY 2004	FY 2005	$ Change	% Change
Technology					
Program Goal 04.03.00.00, Solar Energy	76,921	82,265	80,333	-1,932	-2.3%
Program Goal 04.04.01.00, Zero-Energy Buildings	7,572	0	0	0	0.0%
Program Goal 04.05.00.00, Wind Energy	41,640	41,310	41,600	+290	+0.7%
Program Goal 04.06.00.00, Hydropower	5,016	4,905	6,000	+1,095	+22.3%
Program Goal 04.07.00.00, Geothermal Technology	27,427	24,527	25,800	+1,273	+5.2%
Program Goal 04.08.01.00, Biomass and Biorefinery Systems R&D	58,683	45,775	72,596	+26,821	+58.6%
Program Goal 04.11.01.00, Intergovernmental Activities	13,486	13,003	16,000	+2,997	+23.0%
Program Goal 04.13.01.00, Departmental Energy Management Program	1,445	1,963	1,967	+4	+0.2%
Total General Goal 4, Energy Security	259,707	253,772	339,621	+85,849	+33.8%
All Other					
Hydrogen Technology/Congressionally Directed Activities	10,596	41,985	0	-41,985	-100.0%
Solar Energy/Congressionally Directed Activities	5,409	1,128	0	-1,128	-100.0%
Geothermal Technology/ Congressionally Directed Activities	963	981	0	-981	-100.0%
Biomass and Biorefinery Systems R&D/Congressionally Directed Activities	26,600	40,696	0	-40,696	-100.0%
Intergovernmental Activities/ Congressionally Directed Activities	963	1,717	0	-1,717	-100.0%
Renewable Program Support	0	4,919	0	-4,919	-100.0%
National Climate Change Technology Initiative Competitive Solicitation	0	0	3,000	+3,000	
Facilities and Infrastructure	5,297	12,950	11,480	-1,470	-11.4%

(dollars in thousands)

	FY 2003	FY 2004	FY 2005	$ Change	% Change
Program Direction	12,615	12,364	20,711	+8,347	+67.5%
Total, All Other	62,443	116,722	35,191	-81,549	-69.9%
Subtotal, General Goal 4 (Energy Supply (EERE)	322,150	370,494	374,812	+4,318	+1.2%
Use of Prior Year Balances	0	-13,000	0	+13,000	-100.0%
Total, General Goal 4 (Energy Supply (EERE)	322,150	357,494	374,812	+17,318	+4.8%

R&D Investment Criteria

The President's Management Agenda identified the need to tie R&D investment to performance and well-defined practical outcomes. One criterion by which the Department's performance is assessed involves using a framework in the R&D funding decision process and then referencing the use and outcome of the framework in budget justification material.

The goal is to develop analytical justifications for applied research portfolios in future budgets. This will require the development and application of a uniform cost and benefit evaluation methodology across programs to allow meaningful program comparisons.

This process is underway in several key areas; 1) common, consistent, and integrated analysis (modeling grounded in the EIA basecase); 2) development of a more complete and robust framework for describing program benefits -- provided in the Expected Integrated Program Outcomes section of the overviews and in the individual program Expected Program Outcomes section; and 3) development of sound analytic tools to better estimate and link potential impacts, support budget justification and describe how the R&D Investment Criteria (RDIC) influenced budget decisions.

EERE used the RDIC to support determination of relative areas of strength and weakness in the program and in selected areas of technology development. Programs have made improvements using the individual criteria as a guide to opportunities to improve program strategic management and planning, incorporating key RDIC criteria into their multi-year planning and PART (Program Assessment Rating Tool) documentation. Pilot application of the RDIC to DOE Energy Applied R & D programs was somewhat different than that used for other government programs that underwent PART; there were evidence requirements, a two-tier scoring system, and unique portfolio questions and support requirements that made scoring well on the PART more challenging. That EERE's program generally scored well reflects the quality of EERE's programs. DOE and OMB are working to resolve the requirements and process so they productively meet the intent of the President's Management Agenda.

Program Assessment Rating Tool (PART)

In addition to the use of RDIC, the Department implemented a tool to evaluate selected programs. PART was developed by the Office of Management and Budget (OMB) to provide a standardized way to assess the effectiveness of the Federal Government's portfolio of programs. The structured framework

of the PART provides a means through which programs can assess their activities differently than through traditional reviews.

The current focus is to establish outcome- and output-oriented goals, the successful completion of which will lead to benefits to the public, such as increased national security and energy security, and improved environmental conditions. DOE has incorporated feedback from OMB into the FY 2005 Budget , and the Department will take the necessary steps to continue to improve performance.

Program responsiveness to the President's Management Agenda/PART criteria is reflected in the improved scoring between FY 2004 and FY 2005. For example, three of the four weighted overall scores for the renewable energy program portfolio improved from last year and all were rated Moderately Effective, the second highest rating category. This was achieved while the programs managed the changes in questions and evidence requirements, a two-tier scoring system and unique portfolio questions and support requirements being applied to DOE Energy R&D programs, as distinct from what was required from other government programs that underwent PART.

In the FY 2005 PART review, OMB assessed the Hydrogen Technologies, Solar Energy Technology, Wind Energy, and Geothermal Technologies Programs within the Energy Supply account. Additionally, all EERE programs have completed an internal RDIC review. EERE program and corporate management have incorporated PART items into program planning, performance and management. In FY 2005 all the Energy Supply account R&D programs reviewed received the second highest rating possible, Moderately Effective. Improvements in scores were largely due to development of acceptable annual performance measures, a weakness identified in most of last year's PARTs. The Hydrogen Technologies Program received a score of 73 compared to last year's 64. The Solar Energy Technology Program received a score of 71 compared to last year's score of 78 (the reduction was an artifact of changes in the scoring system). The Wind Energy Program received a score of 72 compared to last year's score of 70. The Geothermal Energy Technologies Program received a score of 71 compared to last year's score of 65. All EERE Programs reviewed have directly addressed or have begun to address FY 2004 PART findings and recommendations within their control. FY 2005 performance hierarchy, goals, targets and program indicators are consistent in PART and program budgets. EERE has corporately addressed common items. One common item that remains a challenge is improving consistency of benefits estimates. EERE has begun to address this challenge through the consolidation of these analyses in its new organization and the addition of a corporate wide program efficiency measure, contributed to by all programs. EERE also addressed those findings outside of EERE's direct program control such as Departmental allocation of costs by providing full internal accounting allocation of program direction by program, and is working with Departmental and OMB staff to improve PART processes, systems and scoring consistency to enable our performance to be more accurately portrayed by PART. The individual program responses are provided in their respective budgets.

Significant Program Shifts

Hydrogen Technology: Additional and realigned resources provided in the FY 2005 budget will allow the program to successfully reach key milestones that enable the goals of the FreedomCAR and Hydrogen Fuel Initiative to be achieved. To this end, research and production of hydrogen from renewables will be expanded; the infrastructure validation activities under the Hydrogen Fleet, and Infrastructure Technology Demonstration and Validation Project will be continued; and power park projects will be reduced. Additionally, an increase in safety, codes and standards research will allow for

systematic analysis of safety that could lead to new standards, and life cycle and systems analysis to identify key cost and technology gaps will be performed.

Solar Energy: As the Concentrating Solar Power (CSP) effort develops a comprehensive program plan for coming fiscal years, in FY 2005 CSP will be maintained at a lower $2 million level that supports essential facilities and work underway with States to establish 1,000 MW of CSP in the Southwest.

Hydropower: Building on the fish-friendly turbine development started in FY 1995, the program is expanding its focus to developing technologies that will enable hydropower plant operators to increase generation levels by as much as 10 percent with enhanced environmental performance.

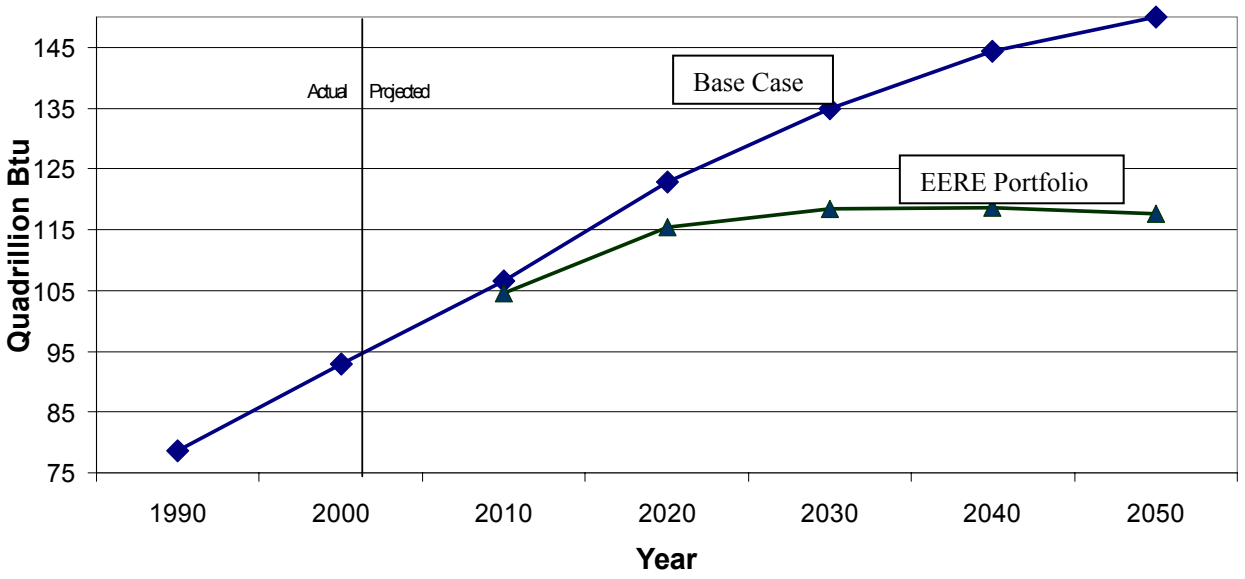
Biomass and Biorefinery Systems R&D: The Program proposes a State/Regional Partnerships activity ($4.0 million) involving collaboration with States on technology transfer, research, development, field testing, and other needed efforts to overcome market barriers in order to achieve common goals of increasing domestic, clean energy supplies and reducing oil imports.

Intergovernmental Activities: Within Intergovernmental Activities, the International Renewable Energy Program is increased by $3.8 million to promote energy innovations that meet growing energy requirements and climate change mitigation objectives in a sustainable manner. This will include support for World Summit on Sustainable Development (WSSD) projects as well as activities with the Asian Pacific Economic Cooperation (APEC).

Expected Integrated Program Outcomes

The program pursues its mission through an integrated portfolio of Research, Development, Demonstration and Deployment activities which improves the energy efficiency and productivity of our economy. Figure 1 below depicts the related potential shift in nonrenewable energy consumption. We expect the energy efficiency and renewable energy components of these energy savings to result in lower energy bills and reduced susceptibility to energy price fluctuations; reduced EPA criteria and other pollutants; enhanced energy security as petroleum and natural gas dependence is reduced and domestic fuel supplies increase; and greater energy security and reliability from improvements in energy infrastructure. Indicators of some of these programs benefits are provided in the tables below. The results shown in the long term benefits tables are preliminary estimates based on initial modeling of some of the possible program production technologies. The assumptions and methods underlying the modeling efforts have significant impact on the expected benefits, the resulting point estimates could also vary significantly based upon market interactions and commodity prices. A summary of the methods, assumptions, sensitivities, and models used in developing these benefit estimates that are important for understanding these results are provided at www.eere.energy.gov/office_eere/budget-gpra.html.

Figure 1. U.S. Nonrenewable Energy Consumption, 1990-2000, and Projections to 2050



EERE's portfolio includes a mix of efforts intended to produce short, mid, and long term benefits. The size of these benefits depend not only on the success of the EERE program efforts funded in this budget request, but on how future energy markets and policies evolve. EERE estimates a sub-set of these benefits assuming a continuation of current policies and business-as-usual development of energy markets. These estimates do not include the underlying, basecase improvements in energy efficiency and renewable energy use that would be expected in the absence of continued funding of EERE's programs.

Mid-term Benefits

		(calendar year)			
		2010	2015	2020	2025
Economic	Energy bill savings (billion 2001$)	27	51	90	134
Environment	CO2 emissions reductions (mmtce)	35	74	139	213
Security	Oil savings (mmbpd)	0.2	0.5	1.1	2.1
	Natural gas savings (quads)	0.7	1.0	1.9	1.9
	Reduced need for additions to central conventional power (GW)	24	65	102	153

Under these assumptions, EERE's programs could provide mid-term benefits in 2025 of over $100 million in annual energy bill savings; a reduction of about 200 million metric tons of annual carbon emissions; a savings of about 2 million barrels of oil per day; and a reduction of over 1.5 quads of natural gas consumption. A combination of reduced peak demand for electricity and additional renewable and DG capacity reduces the need for some 150 GW of additional conventional central power generation, increasing the flexibility and diversity of our electricity system while reducing the potential for a shortage of new generating capacity.

EERE's portfolio includes a number of efforts to develop fundamental breakthroughs in technologies that promise major changes in how we will produce, and the ways we use energy in the decades to come. If these breakthroughs succeed, benefits could continue to grow in the long term. By 2050 benefits may include reductions in the overall annual cost of our energy systems of over $200 billion; reductions in annual carbon dioxide emissions of nearly 600 mmtce; reductions in oil demand of over 10 million barrels per day; and annual savings in natural gas demand of over 4 quads.

Long-Term Benefits

		(calendar year)		
		2030	2040	2050
Economic	Overall Energy cost savings (billion 2001$)	88	171	236
Environment	CO2 emissions reductions (mmtce)	334	471	593
Security	Oil savings (mbpd)	4.7	9.0	11.6
	Natural gas savings (quads)	2.8	5.2	4.5

These mid and long term estimates are derived utilizing a similar baseline case, but different modeling techniques and, as a result, are not directly comparable. While point estimates are presented, both mid-term and long-term modeling are dependent upon the methodology and assumptions used. Many of the key variables affecting the benefits estimates are listed as the external factors that could affect expected results in the means and strategy sections of the individual programs and include variables such as: market and policy interactions, and the future price of oil, natural gas and electricity generation. Uncertainties also increase for the longer-term estimates. Long term estimates should be considered preliminary as EERE refines its analytical approaches for the 2030-2050 timeframe. Nonetheless, they provide a useful picture of growing national benefits over time. A summary of the methodologies, sensitivities and assumptions which are important to the development and understanding of these estimates can be found at http: www.eere.energy.gov/office_eere/budget-gpra.html.

These benefits result from the mix of interrelated investments supported by EERE's budget request. More efficient buildings and factories, for instance, provide the basis for distributed energy resources, such as building solar photovoltaic systems and combined heat and power cogeneration. In addition to these "business-as-usual" benefits, EERE's portfolio would provide the technical potential to reduce conventional energy use even further if warranted by future energy needs. The development of wide-spread sources of wind, solar, geothermal, biomass, and hydropower energy sources; new ways of using energy through hydrogen and distributed power; and technologies that would fundamentally improve the basic efficiency of our homes, businesses, factories, and vehicles could allow us, if desired, to make substantially larger reductions in our oil use and convert a larger portion of our electricity system to decentralized capacity and renewable energy source.

Energy Supply
Office of Energy Efficiency and Renewable Energy

Funding by Site by Program

(dollars in thousands)

	FY 2003	FY 2004	FY 2005	$ Change	% Change
Atlanta Regional Office					
Solar Energy	50	50	50	0	0.0%
Wind Energy	140	75	75	0	0.0%
Total, Atlanta Regional Office	190	125	125	0	0.0%
Bonneville Power Administration					
Wind Energy	95	300	300	0	0.0%
Hydropower Technologies	50	0	50	+50	
Total, Bonneville Power Administration	145	300	350	+50	+16.7%
Boston Regional Office					
Solar Energy	50	50	50	0	0.0%
Wind Energy	70	75	75	0	0.0%
Total, Boston Regional Office	120	125	125	0	0.0%
Chicago Operations Office					
Argonne National Lab					
Hydrogen Technology	640	985	1,000	+15	+1.5%
Biomass & Biorefinery Systems R&D	188	115	90	-25	-21.7%
Intergovernmental Activities	0	150	150	0	0.0%
Total, Argonne National Lab	828	1,250	1,240	-10	-0.8%
Brookhaven National Laboratory					
Solar Energy	400	400	400	0	0.0%
Geothermal Technology	845	420	400	-20	-4.8%
Biomass and Biorefinery Systems R&D	40	40	40	0	0.0%
Total, Brookhaven National Laboratory	1,285	860	840	-20	-2.3%

(dollars in thousands)

	FY 2003	FY 2004	FY 2005	$ Change	% Change
National Renewable Energy Laboratory					
Hydrogen Technology	8,491	7,962	16,890	+8,928	+112.1%
Solar Energy	58,000	58,000	57,000	-1,000	-1.7%
Zero Energy Buildings	7,572	0	0	0	0.0%
Wind Energy	30,883	30,500	31,300	+800	+2.6%
Hydropower Technologies	210	149	149	0	0.0%
Geothermal Technology	3,102	2,320	2,300	-20	-0.9%
Biomass and Biorefinery Systems R&D	32,949	26,100	26,100	0	0.0%
Intergovernmental Activities	1,800	2,300	2,400	+100	+4.3%
Facilities and Infrastructure	5,297	12,950	11,480	-1,470	-11.4%
Total, National Renewable Energy Laboratory	148,304	140,281	147,619	+7,338	+5.2%
Total, Chicago Operations Office	150,417	142,391	149,699	+7,308	+5.1%
Chicago Regional Office					
Solar Energy	50	50	50	0	0.0%
Wind Energy	100	75	75	0	0.0%
Total, Chicago Regional Office	150	125	125	0	0.0%
Denver Regional Office					
Solar Energy	50	50	50	0	0.0%
Wind Energy	389	250	250	0	0.0%
Total, Denver Regional Office	439	300	300	0	0.0%
Golden Field Office					
Solar Energy	2,450	3,885	2,850	-1,035	-26.6%
Hydropower Technologies	0	200	200	0	0.0%
Geothermal Technology	8,004	11,469	10,000	-1,469	-12.8%
Intergovernmental Activities	9,724	8,895	9,775	+880	+9.9%
Program Direction	1,990	2,602	4,587	+1,985	+76.3%
Total, Golden Field Office	22,168	27,051	27,412	+361	+1.3%

(dollars in thousands)

	FY 2003	FY 2004	FY 2005	$ Change	% Change
Idaho Operations Office					
Idaho National Engineering & Environment Lab					
Hydrogen Technology	600	199	1,500	+1,301	+653.8%
Wind Energy	125	100	100	0	0.0%
Hydropower Technologies	965	791	850	+59	+7.5%
Geothermal Technology	3,139	2,177	2,100	-77	-3.5%
Biomass & Biorefinery Systems R&D	680	580	280	-300	-51.7%
Total, Idaho National Engineering & Environment Lab	5,509	3,847	4,830	+983	+25.6%
Idaho Operations Office					
Hydropower Technologies	1,600	0	0	0	0.0%
Total, Idaho Operations Office	1,600	0	0	0	0.0%
Total, Idaho Operations Office	7,109	3,847	4,830	+983	+25.6%
Livermore Site Office					
Lawrence Livermore National Laboratory					
Hydrogen Technology	1,750	630	2,000	+1,370	+217.5%
Geothermal Technology	1,200	671	650	-21	-3.1%
Total, Lawrence Livermore National Laboratory	2,950	1,301	2,650	+1,349	+103.7%
Total, Livermore Site Office	2,950	1,301	2,650	+1,349	+103.7%
Los Alamos Site Office					
Los Alamos National Laboratory					
Hydrogen Technology	415	1,490	1,000	-490	-32.9%
National Energy Technology Lab					
Hydrogen Technology	200	400	2,200	+1,800	+450.0%
Biomass and Biorefinery Systems R&D	15	0	0	0	0.0%
Total, National Energy Technology Lab	215	400	2200	+1,800	+450.0%

(dollars in thousands)

	FY 2003	FY 2004	FY 2005	$ Change	% Change
National Nuclear Security Administration's (NNSA) Service Center					
Lawrence Berkeley National Laboratory					
Wind Energy	250	250	250	0	0.0%
Geothermal Technology	900	880	800	-80	-9.1%
Intergovernmental Activities	400	300	400	+100	+33.3%
Total, Lawrence Berkeley National Lab	1,550	1,430	1,450	+20	+1.4%
NNSA Service Center					
Solar Energy	2,000	2,000	2,000	0	0.0%
Wind Energy	581	350	350	0	0.0%
Hydrogen Technology	5,195	0	0	0	0.0%
Geothermal Technology	4,500	0	0	0	0.0%
Total, NNSA Service Center	12,276	2,350	2,350	0	0.0%
Total, NNSA Service Center	13,826	3,780	3,800	+20	+0.5%
Oak Ridge Operations Office					
Oak Ridge National Laboratory					
Hydrogen Technology	410	1,896	1,000	-896	-47.3%
Solar Energy	400	280	250	-30	-10.7%
Wind Energy	152	150	150	0	0.0%
Hydropower Technologies	1,053	960	1,150	+190	+19.8%
Biomass and Biorefinery Systems R&D	2,486	1,700	1,400	-300	-17.6%
Intergovernmental Activities	600	1,100	1,100	0	0.0%
Total, Oak Ridge National Laboratory	5,101	6,086	5,050	-1,036	-17.0%
Oak Ridge Operations Office					
Solar Energy	500	500	500	0	0.0%
Total, Oak Ridge Operations	500	500	500	0	0.0%
Total, Oak Ridge Operations Office	5,601	6,586	5,550	-1,036	-15.7%

(dollars in thousands)

	FY 2003	FY 2004	FY 2005	$ Change	% Change
Philadelphia Regional Office					
Solar Energy	50	50	50	0	0.0%
Wind Energy	100	100	100	0	0.0%
Total, Philadelphia Regional Office	150	150	150	0	0.0%
Richland Operations Office					
Pacific Northwest National Laboratory					
Hydrogen Technology	100	1,148	220	-928	-80.8%
Hydropower Technologies	1,078	875	950	+75	+8.6%
Biomass and Biorefinery Systems R&D	3,679	2,800	2,500	-300	-10.7%
Intergovernmental Activities	550	650	650	0	0.0%
Total, Pacific Northwest National Laboratory	5,407	5,473	4,320	-1,153	-21.1%
Total, Richland Operations Office	5,407	5,473	4,320	-1,153	-21.1%
Sandia Site Office					
Sandia National Laboratories					
Hydrogen Technology	2,613	3,867	3,900	+33	+0.9%
Solar Energy	10,000	10,100	9,000	-1,100	-10.9%
Wind Energy	3,760	3,700	3,900	+200	+5.4%
Geothermal Technology	6,425	4,690	4,540	-150	-3.2%
Intergovernmental Activities	375	525	525	0	0.0%
Biomass and Biorefinery Systems R&D	30	30	0	-30	-100.0%
Total, Sandia National Laboratories	23,203	22,912	21,865	-1,047	-4.6%
Total, Sandia Site Office	23,203	22,912	21,865	-1,047	-4.6%
Seattle Regional Office					
Solar Energy	50	50	50	0	0.0%
Wind Energy	352	150	150	0	0.0%
Total, Seattle Regional Office	402	200	200	0	0.0%

(dollars in thousands)

	FY 2003	FY 2004	FY 2005	$ Change	% Change
Washington Headquarters					
Office of Scientific & Technical Information					
Solar Energy	20	0	0	0	0.0%
Wind Energy	10	10	10	0	0.0%
Hydropower Technologies	11	11	11	0	0.0%
Geothermal Technology	10	10	10	0	0.0%
Biomass and Biorefinery Systems R&D	22	0	0	0	0.0%
Total, Office of Scientific & Technical Information	73	31	31	0	0.0%
Washington Headquarters					
Hydrogen Technology	17,699	63,414	65,615	+2,201	+3.5%
Solar Energy	8,260	7,928	8,033	+105	+1.3%
Wind Energy	4,553	4,825	4,115	-710	-14.7%
Hydropower Technologies	49	1,919	2,590	+671	+35.0%
Geothermal Technology	265	2,871	5,000	+2,129	+74.2%
Biomass and Biorefinery Systems R&D	45,194	55,106	42,186	-12,920	-23.4%
Intergovernmental Activities	1,000	800	1,000	+200	+25.0%
Departmental Energy Management Program	1,445	1,963	1,967	+4	+0.2%
Program Direction	10,625	9,762	16,124	+6,362	+65.2%
National Climate Change Technology Initiative	0	0	3,000	+3,000	
Renewable Program Support	0	4,919	0	-4,919	-100.0%
Total, Washington Headquarters	89,090	153,507	149,630	-3,877	-2.5%
Total, Washington Headquarters	89,163	153,538	149,661	-3,877	-2.5%
Western Area Power Administration					
Wind Energy	80	400	400	0	0.0%
Hydropower Technologies	0	0	50	+50	
Total, Western Area Power Administration	80	400	450	+50	+12.5%

(dollars in thousands)

	FY 2003	FY 2004	FY 2005	$ Change	% Change
Subtotal, Energy Supply (EERE)	322,150	370,494	374,812	+4,318	+1.2%
Use of prior year balances	0	-13,000	0	+13,000	-100.0%
Total, Energy Supply (EERE)	322,150	357,494	374,812	+17,318	+4.8%

Site Description

Atlanta Regional Office

Introduction

The Atlanta Regional Office provides (1) global analytical support to EERE programs; (2) support to the R&D programs by administering grants and cooperative agreements to regional, State, and local organizations, both public and private; and (3) provides direction, guidance, and support deployment and outreach programs on a local and regional level. It is located in Atlanta, Georgia. It supports Solar Energy, Wind energy and Biomass and Biorefinery R&D.

Solar Energy

Atlanta Regional Office helps to administer the Million Solar Roofs Initiative.

Wind Energy

Atlanta Regional Office provides support deployment and outreach programs on a local and regional level.

Bonneville Power Administration

Introduction

The Bonneville Power Administration is located in Portland, Oregon. It supports the Wind and Hydropower programs.

Wind Energy

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

Hydropower Technologies

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

Boston Regional Office

Introduction

The Boston Regional Office provides (1) global analytical support to EERE programs; (2) support to the R&D programs by administering grants and cooperative agreements to regional, State, and local organizations, both public and private; and (3) provides direction, guidance, and support deployment and outreach programs on a local and regional level. It is located in Boston, Massachusetts and supports Solar Energy, Wind Energy and Biomass and Biorefinery Systems R&D.

Solar Energy

Boston Regional Office helps to administer the Million Solar Roofs Initiative.

Wind Energy

Boston Regional Office provides support deployment and outreach programs on a local and regional level.

Chicago Operations Office

Argonne National Laboratory

Introduction

Argonne National Laboratory is located in Argonne, Illinois. It is a multi-discipline laboratory providing support to Hydrogen Technology and Biomass and Biorefinery Systems R&D.

Hydrogen Technology

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

Biomass and Biorefinery Systems R&D

Argonne National Laboratory (ANL) conducts environmental benefits analysis for several EERE programs, including energy balance and emissions for biofuels in conventional and advanced vehicles with and without fuel cells.

Intergovernmental Activities

Funding to ANL supports international activities, primarily in the Asia-Pacific Economic Cooperation (APEC) area by providing technical assistance and support to the program's APEC related projects. Brookhaven National Laboratory.

Brookhaven National Laboratory

Introduction

Brookhaven National Laboratory is located in Upton, New York. It is a multi-discipline laboratory providing support to the Solar Energy, Geothermal Technology, and Biomass and Biorefinery Systems.

Solar Energy

Brookhaven National Laboratory (BNL) performs research and development for the Photovoltaic Energy Systems efforts. 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.

Geothermal Technology

Brookhaven National Laboratory supports System Development research activities in advanced drilling and energy conversion research, including drilling materials, high temperature elastomers, and silica recovery from geothermal brines.

Biomass and Biorefinery Systems R&D

Brookhaven National Laboratory conducts analysis of market penetration for EERE technologies, including biomass technologies, in support of all the programs, using the internationally acclaimed energy technology model MARKAL.

National Renewable Energy Laboratory

Introduction

National Renewable Energy Laboratory is located in Golden, Colorado. It is a multi-discipline laboratory providing support to Hydrogen Technology, Solar Energy, Zero Energy, Wind Energy, Hydropower, Geothermal, Biomass and Biorefinery Systems R&D, Intergovernmental Activities, and Facilities and Infrastructure.

Hydrogen Technology

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.

Solar Energy Technology

National Renewable Energy Laboratory (NREL) is the lead laboratory for the Solar Energy Technology 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 serves as the lead laboratory for the Solar Heating and Lighting activity and has a major role in the Concentrating Solar Power activity. NREL supports this by conducting technical analyses and design, experimentation, and managing technical tasks and subcontracts to universities and industry. NREL's technical responsibilities include the development of low-cost solar collectors for water or space heating, trough R&D, parabolic dish reliability, concentrating photovoltaic system R&D, and materials

research. In addition, NREL coordinates related technical activities with the Sandia National Laboratories.

Zero Energy Buildings

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

Wind Energy

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.

Hydropower Technologies

The National Renewable Energy Laboratory conducts hydropower/renewable energy integration studies and hydropower outreach activities.

Geothermal Technology

The National Renewable Energy Laboratory (NREL) serves as the lead laboratory for heat transfer research under Systems Development. The laboratory also supports the Geothermal Technology Program in the Deployment areas of education, outreach and systems analysis.

Biomass and Biorefinery Systems R&D

The National Renewable Energy Laboratory (NREL) is the lead laboratory for biomass R&D. NREL also develops analytical methodologies (chemical and life-cycle) that are used to facilitate industry's commercialization efforts, including economic assessment of technologies. NREL operates two user facilities, the Thermochemical Users Facility (TCUF) for syngas technologies, and the Alternative Fuels Users Facility (AFUF) for bioconversion technologies. Private sector participants may use the facilities after appropriate arrangements are made.

Intergovernmental Activities

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.

Facilities and Infrastructure

The Facilities and Infrastructure program provides funding for General Plant Projects (GPP) and General-Purpose Equipment (GPE), which provides for maintenance and routine upgrades of the

laboratory's office, research and user facilities. The program also supports major construction projects, such as the Science Technology Facility that is beginning construction in FY 2004.

Chicago Regional Office

Introduction

The Chicago Operations Office provides (1) global analytical support to EERE programs; (2) support to the R&D programs by administering grants and cooperative agreements to regional, State, and local organizations, both public and private; and (3) provides direction, guidance, and support deployment and outreach programs on a local and regional level. Chicago Regional Office is located in Chicago, Illinois. It supports Solar Energy, Wind Energy and Biomass and Biorefinery Systems R&D.

Solar Energy

Chicago Regional Office helps to administer the Million Solar Roofs Initiative.

Wind Energy

Chicago Regional Office provides support deployment and outreach programs on a local and regional level.

Denver Regional Office

Introduction

The Denver Regional Office provides (1) global analytical support to EERE programs; (2) support to the R&D programs by administering grants and cooperative agreements to regional, State, and local organizations, both public and private; (3) provides direction, guidance, and support deployment and outreach programs on a local and regional level; and Denver Regional Office is located in Denver, Colorado. It provides support to Solar Energy, Wind Energy and Biomass and Biorefinery Systems R&D.

Solar Energy

Denver Regional Office helps to administer the Million Solar Roofs Initiative.

Wind Energy

Denver Regional Office provides support deployment and outreach programs on a local and regional level.

Golden Field Office

Introduction

The Golden Field Office(GO) is located in Golden, Colorado. It provides project management and procurement support for Hydrogen Technology, Wind Energy, Hydropower Technologies, Geothermal Technologies, Biomass and Biorefinery Systems R&D, Intergovernmental Activities, and Program Direction.

Solar Energy

Golden Field Office develops competitive procurements for the Solar Program and manages the resulting contracts and grants. These procurements include solar conferences, standards and certifications for solar systems, and solar education and outreach. Golden also manages the Georgia Institute of Technology photovoltaic Center of Excellence.

Hydropower Technologies

The Golden Field Office administers contracts, grants, and interagency agreements under the Hydropower subprogram.

Geothermal

Golden Field Office provides management of research at National Renewable Energy Laboratory, administers financial assistance awards to universities, and oversees projects in Enhanced Geothermal Systems under Resource Development. Activities previously conducted at the Idaho Operations Office were transferred to the Golden office in 2004.

Intergovernmental Activities

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. GO also 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.

Program Direction

Provides program direction, guidance, and support. Serves as a central Project Management Office (PMO) to EERE. Activities previously performed at other Operations Offices are being consolidated at GO.

Idaho Operations Office

Idaho National Engineering & Environmental Laboratory

Introduction

Idaho National Engineering Laboratory is located in Idaho Falls, Idaho. It is a multi-discipline laboratory providing support to Hydrogen Technology, Wind Energy, Hydropower, Geothermal Technology, and Biomass and Biorefinery Systems R&D.

Hydrogen Technology

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.

Wind Energy

INEEL provides technical support to the program on government and military applications of wind energy.

Hydropower Technologies

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, and conducts resource and economic assessments.

Geothermal Technology

INEEL serves as the lead laboratory for research in Resource Development. INEEL studies fluid flow and solute transport modeling in hydrothermal reservoirs and conducts site investigations of geothermal resource potential. INEEL also conducts research on instrumentation and other ancillary technologies for energy conversion systems.

Biomass and Biorefinery Systems R&D

INEEL provides biomass-related R&D services and support for the feedstock infrastructure development effort. This work is performed in close collaboration with ORNL and NREL.

Idaho Operations Office

Introduction

Idaho Operations office solicits, awards, and administers research and development contracts, cooperative agreements, and grants with industry, academia, and other Government organizations and provides contract administration for grants and cooperative agreements for university research for Hydropower.

Hydropower Technologies

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.

Livermore Site Office

Lawrence Livermore National Laboratory

Introduction

Lawrence Livermore National Laboratory is located in Livermore, California. It is a multi-discipline laboratory providing support to the Hydrogen Technology and Geothermal Technology.

Hydrogen Technology

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 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.

Geothermal Technology

Lawrence Livermore National Laboratory performs Resource Development research on problems related to Enhanced Geothermal Systems and exploration technology, including isotope and geochemical studies. The laboratory also conducts research on brine chemistry.

Los Alamos Site Office

Introduction

Los Alamos National Laboratory is located in Los Alamos, New Mexico. It is a multi-discipline laboratory providing support to the Hydrogen Technology Program.

Hydrogen Technologies

The Los Alamos National Laboratory (LANL) is conducting research and development of advanced hydrogen storage concepts such as polymer micro-spheres. It is a multi-discipline laboratory providing support to Hydrogen Technology.

National Energy Technology Laboratory

Introduction

National Energy Technology Laboratory (NETL) is located in Morgantown, West Virginia. It provides procurement support to the Hydrogen Technology Programs.

Hydrogen Technology

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.

Biomass and Biorefinery Systems R&D

National Energy Technology Laboratory coordinates with biomass projects funded under Energy Supply appropriation in view of NETL's extensive involvement with biomass/black liquor gasification work funded by Energy Conservation Appropriations.

National Nuclear Security Administration's (NNSA) Service Center

Lawrence Berkeley National Laboratory

Introduction

Lawrence Berkeley National Laboratory is located in Berkeley, California. It is a multi-discipline laboratory providing support to the Wind Energy, Geothermal Technology, and Intergovernmental Activates.

Wind Energy

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.

Geothermal Technology

Lawrence Berkeley National Laboratory performs research on geoscience problems related to Enhanced Geothermal Systems and exploration technology including studies of reservoir dynamics and seismic, isotopic, and electromagnetic exploration techniques. These activities are under Resource Development.

NNSA Service Center

Solar Energy

NNSA administers the cooperative agreements for the Southeast and Southwest Regional Experiment Stations (RESs) for Solar Energy. NNSA Service Center is responsible for funding solar research and analysis activities performed at the Southwest and Southeast Regional Energy Stations (RES).

Wind Energy

NNSA Service Center (USDA Agricultural Research Center) is located Bushland, Texas. It performs research on agricultural applications of Wind Energy including irrigation and small hybrid power systems.

Hydrogen

The National Nuclear Security Administration's Service Center administered cooperative agreements for the Hydrogen program.

Geothermal Technology

NNSA Service Center administers financial assistance awards to cost-sharing industry partners for geothermal resources exploration and definition activities under Technology Verification for Geothermal Technology.

Oak Ridge Operations Office

Oak Ridge National Laboratory

Introduction

Oak Ridge National Laboratory is located in Oak Ridge, Tennessee. It is a multi-disciplinary laboratory providing support to Hydrogen Technology, Wind Energy, Hydropower Technologies, Biomass and Biorefinery Systems R&D and Intergovernmental Activities.

Hydrogen Technology

The Oak Ridge National Laboratory performs research and development activities in photobiology and storage in support of the lead labs, NREL and Sandia National Laboratories, respectively. ORNL has collaborated 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.

Solar

Oak Ridge National Laboratory is the primary laboratory responsible for conducting hybrid solar lighting R&D for the Solar Program. This includes conducting research into sunlight transmission through fiber optics; designing and testing systems that collect the sunlight, transfer it into fiber optics, and then distribute the sunlight into rooms; and coordinating industrial partners interested in commercializing the technology.

Wind Energy

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

Hydropower Technologies

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.

Biomass and Biorefinery Systems R&D

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

Intergovernmental Activities

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.

Oak Ridge Operations Office

Oak Ridge Operations Office is located in Oak Ridge, Tennessee. It provides technical support for the Solar Energy program. It provides procurement support and provides support to the R&D programs by administering grants and cooperative agreements to regional, State and local organizations, both public and private.

Solar

Oak Ridge Operations Office helps to administer the Million Solar Roofs Initiative.

Philadelphia Regional Office

Introduction

The Philadelphia Regional Office provides (1) global analytical support to EERE programs; (2) support to the R&D programs by administering grants and cooperative agreements to regional, State, and local organizations, both public and private; and (3) provides direction, guidance, and support deployment and outreach programs on a local and regional level. They are located in Philadelphia, Pennsylvania. It provides support to Solar Energy and Wind Energy.

Solar Energy

Philadelphia Regional Office helps to administer the Million Solar Roofs Initiative.

Wind Energy

Philadelphia Regional Office provides support deployment and outreach programs on a local and regional level.

Richland Operations Office

Pacific Northwest National Laboratory

Introduction

Pacific Northwest National Laboratory is located in Richland, Washington. It is a multi-discipline laboratory providing support to Hydrogen Technology, Hydropower, Biomass and Biorefinery Systems R&D, and Intergovernmental Activities.

Hydrogen Technology

For the Hydrogen Technology, 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.

Hydropower Technologies

PNNL is providing biological testing support for the Advanced Hydropower 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.

Biomass and Biorefinery Systems R&D

PNNL provides thermochemical research and development in support of the syngas platform and related products. Major components include thermocatalysts for fuels and chemicals and wet biomass for syngas production.

Intergovernmental Activities

PNNL 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.

Sandia Site Office

Sandia National Laboratories

Introduction

Sandia National Laboratories is located in Albuquerque, New Mexico. It is a multi-discipline laboratory providing support to Hydrogen Technology, Solar Energy, Wind Energy, Geothermal Technology, Biomass and Biorefinery Systems R&D, and Intergovernmental Activities.

Hydrogen Technology

The Sandia National Laboratories 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.

Solar Energy Technology

Sandia National Laboratories supports the Photovoltaic Energy Systems efforts with the principal responsibility for systems and balance-of-systems technology development and reliability. Indoor and outdoor measurement and evaluation facilities provide support to industry for cell, module, and systems measurement, evaluation, and analysis. Systems-level work concentrates on application engineering reliability, database development, and technology transfer. SNL is the lead laboratory for the Concentrating Solar Power activity. SNL's technical responsibilities include power tower R&D, dish R&D, and the management of technical tasks and subcontracts to industry and universities. SNL also has responsibilities within the Solar Heating and Lighting activity, providing technical support to the solar industry and homebuilders that are part of the Zero Energy Building efforts.

Wind Energy

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

Geothermal Technology

Sandia National Laboratories (SNL) serves as the lead laboratory for coordination of geothermal drilling research under Systems Development. 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 also manages cost-shared exploration with industry partners under Technology Verification.

Intergovernmental Activities

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.

Biomass and Biorefinery Systems R&D

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

Seattle Regional Office

Introduction

The Seattle Regional Office provides (1) global analytical support to EERE programs; (2) support to the R&D programs by administering grants and cooperative agreements to regional, State, and local organizations, both public and private; and (3) provides direction, guidance, and support deployment and outreach programs on a local and regional level. Seattle Regional Office is located in Seattle, Washington and provides support to Solar Energy, Wind Energy, and Biomass and Biorefinery Systems R&D.

Solar Energy

Seattle Regional Office helps to administer the Million Solar Roofs Initiative.

Wind Energy

Seattle Regional Office provides support deployment and outreach programs on a local and regional level.

Washington Headquarters

Office of Scientific and Technology Information

Introduction

Office of Scientific and Technical Information is located in Oak Ridge, Tennessee. It provides technical support for Hydrogen Technology, Solar Energy, Wind Energy, Hydropower Technologies, and Geothermal Technology.

Solar Energy Technology

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

Wind Energy

OSTI distributes technical information for the program, including publishing and maintaining on-line full text of eight electronic current awareness publications.

Hydropower Technologies

OSTI distributes information for the Hydropower subprogram, including publishing and maintaining on-line full text of eight electronic current awareness publications.

Geothermal Technology

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.

Biomass and Biorefinery Systems R&D

In FY 2003, OSTI performed distribution of information for Biomass and Biorefinery Systems R&D. The Office of Scientific and Technology Information (OSTI) distributes technical information for the program, including publishing and maintaining on-line full text of several technical publications sponsored by the Program.

Washington Headquarters

Washington, D.C. is the headquarters for the Office of Energy Efficiency and Renewable Energy operations. The Headquarters operations provides specialized, technical expertise in planning, formulation, execution, and evaluation, in order to support the responsible guidance and management of the budget. In addition, competitive solicitations are planned and implemented through Headquarters. It provides support to Hydrogen Technology, Solar Energy, Wind Energy, Hydropower, Geothermal Technology, Biomass and Biorefinery Systems R&D, Intergovernmental Activities, Departmental Energy Management Program, Program Direction, National Climate Change Technology Initiative Competitive Solicitation, and Renewable Program Support.

Western Area Power Administration

Introduction

Western Area Power Administration is located in Lakewood, Colorado. It is a multi-region power making agency that is providing support to Wind Energy and Hydropower Technologies.

Wind Energy

The Western Area Power Administration is conducting analysis of integrating wind into its power system, including assessment of opportunities for coordinating operation with its hydropower assets.

Hydropower Technologies

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

Hydrogen Technology

Funding Profile by Subprogram[a]

(dollars in thousands)

	FY 2003 Comparable Appropriation	FY 2004 Original Appropriation	FY 2004 Adjustments[b,c]	FY 2004 Comparable Appropriation	FY 2005 Request
Hydrogen Technology					
Production and Delivery R&D	11,215	23,000	- 436	22,564	25,325
Storage	10,790	30,000	- 568	29,432	30,000
Infrastructure Validation	9,680	13,160	+5,219[d]	18,379	15,000
Safety, Codes & Standards, and Utilization	4,531	6,018	- 114	5,904	18,000
Education and Cross-Cutting Analysis	1,897	5,822	- 110	5,712	7,000
Total, Hydrogen Technology	38,113	78,000	+3,991	81,991	95,325

Public Law Authorizations:

P.L. 95-91, "Department of Energy Organization Act" (1977)
P.L. 96-294, "Energy Security Act" (1980)
P.L. 101-566, "Spark M. Matsunaga, Hydrogen Research, Development, and Demonstration Act of 1990" (1990)
P.L. 102-486, "Energy Policy Act of 1992, Section 2026" (1992)
P.L. 104-271, "Hydrogen Future Act of 1996" (1996)

[a] SBIR/STTR funding in the amount of $421,976 was transferred to the Science appropriation in FY 2003. Estimates for SBIR/STTR budgeted in FY 2004 and FY 2005 are $2,181,014 and $1,549,100 respectively.

[b] Programs in Energy Supply appropriations were reduced by .59 percent as required by the Omnibus Appropriation Bill.

[c] Programs in the Energy Supply appropriation were proportionally reduced based upon the allocated General Reduction of $4,684,000.

[d] Hydrogen Technology Program increases by the Omnibus Appropriation Bill of $5,500,000. This amount was subject to the .59 percent reduction required by the Omnibus Appropriations Bill.

Mission

The Hydrogen Technology Program is part of the overall integrated Hydrogen, Fuel Cells and Infrastructure Technologies Program (HFCIT) in DOE's Office of Energy Efficiency and Renewable Energy.[a] The mission of the integrated HFCIT program is to research, develop, and validate fuel cell and hydrogen production, delivery, and storage technologies for transportation and stationary applications. The program aims to have Hydrogen from diverse domestic resources used in a clean, safe, reliable, and affordable manner in fuel cell vehicles, central station electric power production and distributed thermal electric and combined heat and power applications.

Benefits

The Hydrogen Technology Program is a key component of both the President's Hydrogen Fuel Initiative, which allows the Nation to aggressively move forward to achieve the vision of a diverse, secure, and emissions-free energy future. To the extent that hydrogen is produced from domestic resources in an environmentally sound manner, the Hydrogen Technologies Program will provide a significant environmental benefit for the Nation. Research undertaken by the Hydrogen Technology Program is targeted to reduce the cost of distributed production of hydrogen from natural gas by a factor of 3-4, enable cost competitive production from renewables, and provide storage technology that enables greater than 300 mile driving range for vehicles. Together, the FreedomCAR Partnership and the Hydrogen Fuel Initiative will facilitate a decision by industry to commercialize hydrogen-powered fuel cell vehicles in the year 2015. Widespread commercialization of hydrogen-powered vehicles will support our national security interests by significantly reducing to our reliance on oil.

More detailed, integrated and comprehensive economic, energy and energy security benefits estimates are provided in the Expected Program Outcomes section at the end of the program level budget narrative.

Strategic and Program Goals

The Department's Strategic Plan identifies four strategic goals (one each for defense, energy, science, and environmental aspects of the mission) plus seven general goals that tie to the strategic goals. The Hydrogen program supports the following goal:

Energy Strategic Goal

General Goal 4, Energy Security: Improve energy security by developing technologies that foster a diverse supply of reliable, affordable, and environmentally sound energy by providing for reliable delivery of energy, guarding against energy emergencies, exploring advanced technologies that make a fundamental improvement in our mix of energy options, and improving energy efficiency.

The Hydrogen program has one program goal which contributes to General Goal 4 in the "goal cascade":

[a] The integrated HFCIT program receives funding from the Energy Supply (for the Hydrogen Technology Program) and Energy Conservation (for the Fuel Cell Technologies Program) appropriations. This budget description is for the Hydrogen Technology portion of the integrated HFCIT Program.

Program Goal 04.01.01.00: Hydrogen Technology. The Hydrogen, Fuel Cells and Infrastructure Technologies Program goal is to develop hydrogen production, storage, and delivery technologies to the point that they are cost and performance competitive and are being used by the Nation's transportation, energy, and power industries. As such, the program will expand clean domestic energy supplies to dramatically reduce or even end dependence on oil.

Contribution to Program Goal 04.01.01.00 (Hydrogen Technology)

By 2010, the Hydrogen Technology Program will contribute to General Goal 4, Energy Security, through its Production and Delivery activities by developing market based technologies that will reduce the cost of producing hydrogen from natural gas and renewables. Specific goals are to:

- Complete research for distributed hydrogen generation technology that will reduce the cost of producing hydrogen from natural gas from $5.00 per gallon of gasoline equivalent (gge) untaxed in 2003 to $1.50/gge (at 5000 pounds per square inch [psi]) untaxed at the station with mature production volumes (e.g. 100 units/year).
- Complete research for hydrogen production from renewables to achieve $3.90/gge untaxed at the station (5000 psi).

The program also contributes to General Goal 4, Energy Security, through its storage activities by developing and validating a market based hydrogen storage technology that enables greater than 300-mile vehicle driving range. Specifically, a hydrogen storage technology with capacity of 2.0 kWh/kg (6 weight percent) and 1.5 kWh/L (kilowatt-hours per liter) will be developed and validated by 2010.

The Hydrogen Technology Program will contribute to General Goal 4, Energy Security, through Education activities which will significantly increase the number of students, teachers, and local and State government representatives, and large scale end-users who understand the concept of a hydrogen economy. The program expects to achieve a four-fold increase in the number of students, teachers, and local and State government representatives, and a two-fold increase in the number of large scale end users, who understand the concept of a hydrogen economy and how it may affect them by 2010 (relative to the 2004 baseline) thus accelerating the market adoption of hydrogen-based technology. [a]

The program also contributes to General Goal 4, Energy Security, through its Systems Analysis activities which define and implement a fully functional systems integration capability to establish and validate the DOE Hydrogen integrated baseline requirements and schedule by 2005, enabling improved planning and management of this complex initiative.

The Hydrogen Technology Program will contribute to General Goal 4, Energy Security, through Infrastructure Validation activities which will validate the technology at full scale to achieve the cost of hydrogen production and delivery at the station. The indicator of performance expected is to validate infrastructure and vehicle interface technologies in 2009 at full scale with a cost of $3.00 per gallon gasoline equivalent (excludes co-production of electricity).

The program also will contribute to General Goal 4, Energy Security, through its Safety, Codes and Standards, and Utilization activities by drafting technical specifications that will enable preparation of a global technical regulation for hydrogen fuel cell vehicles and infrastructure beginning in 2008.

[a] This modification to the education contribution was made to better differentiate between the goals for certain target audiences, based on their educational needs and roles in a hydrogen economy (end-users vs. teachers, students, and governments).

Standardization is critical for infrastructure development necessary for market growth of this new energy carrier.

Annual Performance Results and Targets

FY 2000 Results	FY 2001 Results	FY 2002 Results	FY 2003 Results	FY 2004 Targets	FY 2005 Targets
Program Goal 04.01.01.00 (Hydrogen Technology)					
Production & Delivery R&D					
No targets established.	No targets established.	Non-renewables: Completed construction of a prototype hydrogen generator with ceramic membrane for production and purification of hydrogen from natural gas.	Non-renewables: Completed the design of a distributed natural gas-to- hydrogen production and dispensing system.	Non-renewables: Complete research for natural gas-to-hydrogen production and dispensing component development and fabrication towards achieving 5,000 psi hydrogen for $3.00/gge (untaxed and without co-production of electricity) at the station in 2006.	Non-renewables: Complete the research for a distributed natural gas- to- hydrogen production and dispensing system that can produce 5,000 psi hydrogen for $3.00/gge (untaxed and without coproducing electricity) at the station in 2006.
No targets established.	No targets established.	No targets established.	No targets established.	Renewables: Complete research for biomass syngas reforming catalysts to improve durability and reduce cost towards achieving 5,000 psi hydrogen produced for $5.70/gallon of gasoline equivalent (untaxed, modeled cost) at the station by 2005.	Renewables: Model cost of hydrogen produced from renewables for $5.70 /gge (untaxed) at the station at 5000 psi.
Storage/Tanks					
No targets established.	No targets established	Completed certification of a 5000 pounds per square inch (psi) hydrogen storage tank achieving 1.7 kilo watt-hour per kilogram (kWh/kg) and 0.8 kilo watt-hour per liter (kWh/L) (tank-only).	Completed design of the 5,000 psi cryogenic-gas tank and 10,000 psi compressed gas tank achieving 1.3 kWh/kg and 1.0 kWh/L.	Complete development of 5,000 psi cyro-gas tank and 10,000 psi compressed gas tank achieving 1.3 kWh/kg and 1.0 kWh/L.	Tanks: Complete testing and validation of 10,000 psi hydrogen storage tank achieving the 2005 hydrogen storage system targets of 1.5 kWh/kg (4.5 weight percent), 1.2 kWh/L, and $6/KWh.

FY 2000 Results	FY 2001 Results	FY 2002 Results	FY 2003 Results	FY 2004 Targets	FY 2005 Targets
Storage/Solid State					
No targets established.	No targets established.	Developed materials enabling system targets of 0.8 kWh/kg and 0.5 kWh/L.	Designed sub-scale solid state system meeting targets of 0.8 kWh/kg and 0.5 kWh/L.	Solid State: Complete draft of standard test protocol and construction of test facility for solid-state hydrogen storage materials in support of the 2005 targets of 1.2 kWh/L and 4.5 wt% and the 2010 targets of 2.0kWh/kg (6 wt. %), 1.5 kWh/L at $4/kWh.	Identify materials with the potential to meet 2010 targets of 2.0 kWh/kg (6 weight percent), 1.5 kWh/L, at $4/kWh.
Education and Cross-Cutting Analysis					
No targets established.	No targets established.	No targets established.	No targets established.	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)	
No targets established.	No targets established.	No targets established.	No targets established.	Define requirements for system analysis integration to link the program's technical objectives to cost and schedule.	
Infrastructure and Validation					
No targets established.	No targets established.	Completed hydrogen refueling station from renewable sources.	Completed development of an integrated refueling station that can produce 5,000 psi hydrogen from natural gas for $3.60 per gallon of gasoline equivalent (gge) (including co-production of electricity), untaxed at the station.	Identify and complete feasibility and system design of an isothermal compressor to be incorporated in hydrogen refueling stations to produce hydrogen at $3.00/gge by 2009.	Complete validation 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 with mature production volumes (e.g., 100 units/year).

FY 2000 Results	FY 2001 Results	FY 2002 Results	FY 2003 Results	FY 2004 Targets	FY 2005 Targets
Safety, Codes and Standards, and Utilization					
No targets established.	No targets established.	No targets established.	No targets established.	Complete the harmonized technical standard for high pressure vehicle storage that can be incorporated into a regulation (i.e. incorporating the various standards of different countries into a single regulation) for hydrogen storage. Complete the draft technical standard for vehicular safety.	
Management of Funds					
				Contribute proportionately to EERE's corporate goal of reducing corporate and program uncosteds to a range of 20-25 percent by reducing program annual uncosteds by 10 percent in 2004 relative to the program uncosted baseline (in 2003) until the target range is met.	Contribute proportionately to EERE's corporate goal of reducing corporate and program uncosteds to a range of 20-25 percent by reducing program annual uncosteds by 10 percent in 2005 relative to the program uncosted baseline (2003) until the target range is met.

Means and Strategies

The Hydrogen Technology Program will use various means and strategies to achieve its program goals as described below. "Means" include operational processes, resources, information, and the development of technologies, and "strategies" include program, policy, management and legislative initiatives and approaches. Various external factors, as listed below, may impact the ability to achieve the program's goals. Collaborations are integral to the planned investments, means and strategies, and to addressing external factors.

The Hydrogen Technology Program will implement the following means:

- Conduct 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.
- Develop hydrogen production, delivery and storage technologies to achieve cost, efficiency, and other required targets to meet program goals.
- Conduct infrastructure validation activities in partnership with industry to develop and validate the feasibility of hydrogen generation stations that derive hydrogen from both renewable and fossil fuels for stationary and transportation fuel cell systems.
- Conduct safety, codes and standards, and utilization activities, focused on ensuring the safety aspects of hydrogen technologies and developing widely accepted codes and standards. Code developers will be assisted by experimental data from hydrogen refueling demonstration sites.
- Invest in technical program and market analyses and performance assessments, in order to direct effective strategic planning.
- Develop and distribute educational materials and training to facilitate the transition to a hydrogen economy.

The Hydrogen Technology Program will implement the following strategies:

- Utilize the Multi-year Research, Development and Demonstration Plan, developed by the HFCIT program. The Plan identifies barriers, technical targets, and schedule for carrying out the program mission. Focus on addressing the high risk, critical technology barriers as described in the Plan.
- Utilize the National Hydrogen Energy Roadmap, released in November 2002 by Energy Secretary Abraham. This document developed by over 200 technical experts from public and private organizations, lays out research and development pathways, and serves as a guide to public and private investment in hydrogen and fuel cell technologies.
- Coordinate with the FreedomCAR Partnership, which was announced by the Secretary of Energy and senior executives of DaimlerChrysler, Ford, and General Motors in January 2002.
- Coordinate with other DOE programs and with other Federal agencies involved in hydrogen-related research and development. (See list of collaborative activities below)
- Align the program to the goals of the Hydrogen Fuel Initiative. The Hydrogen Fuel Initiative, along with the FreedomCAR Partnership, aims to facilitate an industry decision to commercialize hydrogen-powered fuel cell vehicles by the year 2015. Program strategies are also aligned with the FreedomCAR Partnership goals (see below).
- Perform formal merit reviews, closely coordinated with those supported within the Fuel Cell Technologies Program (funded under the Energy Conservation Appropriation), to develop and

demonstrate highly efficient, integrated hydrogen technologies for stationary and transportation applications. The merit review evaluation incorporates the principles of the Administration's R&D investment criteria.

- Participate in the development of uniform codes and standards at the international level to ensure that the U.S. industry can compete globally.
- Centers of Excellence for R&D on chemical hydrides, metal hydrides and carbon-based materials will be used to support the solid state storage goal and enable independent, standardized testing and evaluation of storage materials under development.
- Conduct cross-cutting analyses and 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).

These means and strategies will result in improving energy security by increasing the generation of reliable, affordable, and environmentally sound hydrogen, adding to the diversity and security of the Nation's energy supply−thus putting the taxpayer's dollars to more productive use.

The following external factors could affect the Hydrogen Technology Program's ability to achieve its strategic goal:

- Congressionally-directed projects that do not contribute to the program's goals.
- Once a commercialization decision is made by industry in 2015, the price and availability of alternative technologies (such as gasoline hybrid vehicles) and conventional fuels that will compete with hydrogen fueled vehicles will affect the market outcomes.
- Decisions on the nature and timing of supporting policy instruments to help stimulate end-use markets.
- Public acceptance and concerns regarding the safe use of hydrogen.

In carrying out the program's mission, the Hydrogen Technology Program performs the following collaborative activities:

- Collaborating with other DOE offices and Federal agencies, including closely coordinating vehicle related activities with the DOE's FreedomCAR and Vehicles Technologies Program.
- For activities that support transportation applications, cooperating with the U.S. Council for Automotive Research (USCAR) and energy companies. This collaboration, implemented through technical teams, provides a mechanism for developing requirements, industry consensus, and recommendations for program direction. These technical teams are composed of government and industry experts that meet on a periodic basis to review and provide guidance on projects.
- Working with the Department of Transportation (DOT), the Environmental Protection Agency (EPA) and the National Institute for Standards and Technology (NIST) on safety, codes and standards activities.

- Developing and publishing a comprehensive planning document in collaboration with the Department's Offices of Science, Fossil Energy, and Nuclear Energy, Science and Technology (and with input by DOT).

Hydrogen Fuel Initiative (HFI)

(dollars in thousands)

Hydrogen Fuel Initiative	FY 2005 Budget Request
EERE	172,825
FE	16,000
NE	9,000
SC	29,183
Total, DOE	227,008
DOT	832
Total, Hydrogen Fuel Initiative	227,840

- Participating in the Hydrogen R&D Interagency Task Force involving all Federal agencies that have hydrogen-related activities.
- Conducting R&D and demonstration activities through competitive, cost-shared contracts with industry, as well as collaborating with national laboratories and universities.
- Initiating and implementing an International Partnership for a Hydrogen Economy to leverage R&D capabilities in other countries.
- Through the Department's newly formed partnership with the energy industry, expand upon FreedomCAR's 2010 technology specific goals initially formed with the U.S. automotive industry partners. These additional technology goals will more specifically address hydrogen technology barriers.

FreedomCAR Partnership 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 responsibility with HFCIT)*

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

- 60 percent peak energy-efficient, durable direct hydrogen Fuel Cell Power Systems (including hydrogen storage) that achieves a 325 W/kg power density and 220 W/L operating on hydrogen. Cost targets are $45/kW by 2010 and $30/kW by 2015.
- Fuel Cell Systems (including an on-board fuel processor) having a peak brake engine efficiency of 45 percent, and that meet or exceed emissions standards with a cost target of $45/kW by 2010 and $30/kW by 2015.
- Hydrogen Refueling Systems demonstrated with developed commercial codes and standards and diverse renewable and non-renewable energy sources. Targets: 70 percent energy efficiency well-to-pump; cost of energy from hydrogen equivalent to gasoline at market price, assumed to be $1.50 per gallon (2001 dollars).
- Hydrogen Storage Systems demonstrating an available capacity of 6 weight percent hydrogen, specific energy of 2.0 kWh/kg and energy density of 1.5 kWh/L at a cost of $4/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 responsibility with FCVT)

Validation and Verification

To validate and verify program performance, the Hydrogen Technology Program will conduct internal and external reviews and audits. These programmatic activities are subject to continuing review by, for example, the Congress, the General Accounting Office, the Department's Inspector General, the U.S. Environmental Protection Agency, and state environmental agencies. Specific milestones, go/no go decision points, and technical progress are systematically reviewed through the HFCIT program's merit review process. The table below summarizes validation and verification activities.

Data Sources: Merit Review and Peer Evaluation of R&D, and program peer reviews are conducted. Engineering models are used to validate technical targets.

Baselines: The following are the key baselines used in the Hydrogen Technology program:

- non-renewable production (delivered) (2003): $5.00/gge
- renewable production (delivered) (2003): $6.20/gge
- compressed hydrogen storage (2003): 1.3 kWh/kg and 1.0 kWh/L
- solid state materials for storage systems (2002): 0.8 kWh/kg and 0.5 kWh/L

- education (2004): Survey[a]

Frequency: GPRA Benefits are estimated annually, Merit Review and Peer Evaluation of R&D projects are evaluated annually, and Program Peer Review is conducted biennially

Data Storage: EE Strategic Management System

Verification: Evaluation -- Merit reviews and peer evaluations by energy, hydrogen, and fuel cell experts from outside of the U.S. Department of Energy are used to ensure that the directions and priorities of the program are focused on long term research. The program conducts peer review meetings and supports the development of industry-driven technology roadmaps.[b] The National Academy of Sciences also conducts Program peer review. These efforts are used to focus the program's investments on activities that are within the Federal Government's role and that address top priority needs.

The National Laboratories receive direct funds for hydrogen and fuel cell technology research and development of a very high risk and basic nature, based on their capabilities and performance. Hydrogen and fuel cell industry experts review each laboratory and industry project at the annual Merit Review and Peer Evaluation of R&D. Projects are evaluated based on the following criteria: 1) Relevance to overall DOE objectives; 2) Approach to performing the research and development; 3) Technical Accomplishments and Progress toward project and DOE goals; 4) Technology Transfer/Collaborations with Industry/Universities/Laboratories; and 5) Approach and relevance of proposed future research. Principles of the Administration R&D investment criteria for research have been incorporated into this evaluation. The panel also evaluates the strengths and weaknesses of each project, and recommends additions to or deletions from the scope of work. The program organization facilitates supplier-customer relationships to ensure that R&D results from federally sponsored laboratories are transferred to industry suppliers and that industry supplier developments are made available to automakers, energy industry and stationary power producers.

Program Assessment Rating Tool (PART)

The Department implemented a tool to evaluate selected programs. PART was developed by OMB to provide a standardized way to assess the effectiveness of the Federal Government's portfolio of programs. The structured framework of the PART provides a means through which programs can assess their activities differently than through traditional reviews. Based on the FY 2004 PART review, the Hydrogen Technology Program has incorporated feedback from OMB into the FY 2005 Budget Request and has taken or will take the necessary steps to continue to improve performance.

The FY 2004 PART review of the Hydrogen Technologies Program contained a recommendation to establish a new partnership with the energy industry to complement the Administration's FreedomCAR Partnership, which will accelerate the Nation's transition to a hydrogen-based economy. A partnership that was launched to develop initial plans for coordinating hydrogen research activities with automotive

[a] A survey is currently underway to determine the 2004 baseline.

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

and energy industry partners.

The FY 2004 PART recommendation to expand high-risk R&D on hydrogen production from renewable resources and on hydrogen storage technologies was addressed with two solicitations for proposals that will lead to cooperative agreements with universities and industry, and field work proposals with national laboratories to develop high-risk hydrogen production from renewables and hydrogen storage technologies. Another FY 2004 PART recommendation suggested the development of adequate annual performance measures, and annual performance measures have been included in annual budget requests that correlate with multi-year program plan technical targets. These improvements in planning and accountability were reflected in the Hydrogen program's improved FY 2005 score in those areas, resulting in an overall score improvement of nine points to seventy three, and a moderately effective rating, the second highest rating possible.

The FY 2005 PART also found that the program has coordinated well with other DOE programs and with industry in establishing a plan to achieve the goals of President's Hydrogen Fuel Initiative. The PART noted that significant earmarks in FY 2004, of nearly half of the program's budget, jeopardize progress on the President's initiative by reducing program funding available for competitive solicitations and core national laboratory research designed to contribute toward program goals.

Funding by General and Program Goal

(dollars in thousands)

	FY 2003	FY 2004	FY 2005	$ Change	% Change
General Goal 4, Energy Security					
Program Goal 04.01.01, Hydrogen					
Production and Delivery R&D	6,398	10,344	25,325	+14,981	+144.8%
Storage R&D	10,790	13,981	30,000	+16,019	+114.6%
Infrastructure Validation	5,864	5,849	15,000	+9,151	+156.5%
Safety, Codes & Standards, and Utilization	2,568	5,904	18,000	+12,096	+204.9%
Education and Cross-Cutting Analysis	1,897	3,946	7,000	+3,054	+77.4%
Total, Program Goal 04.01.01.00, Hydrogen	27,517	40,024	95,325	+55,301	+138.2%
All Other					
Congressionally Directed Activities, Production and Delivery R&D [a]					
Fuel Cell Development for DG & CO2 sequestration – Northwest Indiana	0	1,962	0	-1,962	-100.0%
EVermont Hydrogen Electrolyzer Project	0	937	0	-937	-100.0%

[a] The Hydrogen Technology Program is working with the recipients of the congressionally directed funding to attempt to develop statements of work that address technology barriers and support program goal.

(dollars in thousands)

	FY 2003	FY 2004	FY 2005	$ Change	% Change
Startech Hydrogen Production Project ..	0	491	0	-491	-100.0%
Solar-powered Thermo-chemical Production of Hydrogen from Water Project.....	1,927	2,943	0	-2,943	-100.0%
Hawaii Hydrogen Ctr. for Dev. and Deploy. of Distrib. Energy System.....	0	491	0	-491	-100.0%
Shared Technology Transfer Program by Nicholls State Univ.....	0	981	0	-981	-100.0%
Production & Delivery/HI-Way Initiative in New York State.....	0	1,962	0	-1,962	-100.0%
Production & Delivery/SOFC Solicitation	0	2,453	0	-2,453	-100.0%
PEM Fuel Cell and Purification.....	2,890	0	0	0	0.0%
Total, Production and Delivery R&D	4,817	12,220	0	-12,220	-100.0%
Congressionally Directed Activities, Storage R&D[a].....					
Florida Hydrogen Partnership.....	0	1,962	0	-1,962	-100.0%
Fuel Cell Research by Univ. of South Florida.....	0	1,962	0	-1,962	-100.0%
Hydrogen Futures Park at University of Montana.....	0	736	0	-736	-100.0%
Fuel Cell Mine Loader and Prototype Locomotive	0	1,962	0	-1,962	-100.0%
Univ. of Nevada-Las Vegas for Renewable H2 Fueling Station System.....	0	2,943	0	-2,943	-100.0%
Edison Materials Technology Center.....	0	2,943	0	-2,943	-100.0%
National Center for Manufacturing Sciences	0	2,943	0	-2,943	-100.0%
Total, Storage R&D.....	0	15,451	0	-15,451	-100.0%
Congressionally Directed Activities, Infrastructure Validation [a]					
Hydrogen Regional Infrastructure Program in Pennsylvania.....	0	2,943	0	-2,943	-100.0%
Expanding Clean Energy Research and Education Univ. South Carolina.....	0	2,158	0	-2,158	-100.0%
Hydrogen Regional Fuel Cell Project - Washoe County, Nevada.....	0	1,962	0	-1,962	-100.0%

[a] The Hydrogen Technology Program is working with the recipients of the congressionally directed funding to attempt to develop statements of work that address technology barriers and support the program goal.

(dollars in thousands)

	FY 2003	FY 2004	FY 2005	$ Change	% Change
Enterprise Center for Chattanooga Fuel Cell Demo	0	2,485	0	-2,485	-100.0%
Hawaii Hydrogen Ctr. for Dev. and Deploy. of Distrib. Energy System	0	2,982	0	-2,982	-100.0%
Ohio University Fuel Pilot Project	2,853	0	0	0	0.0%
Fuel Cell Project – Gallatin County, Montana	963	0	0	0	0.0%
Total, Infrastructure Validation	3,816	12,530	0	-12,530	-100.0%
Congressionally Directed Activities, Safety, Codes & Standards and Utilization[a]					
Ohio University Fuel Pilot Project	1,000	0	0	0	0.0%
Fuel Cell R&D at South AL Energy	963	0	0	0	0.0%
Total, Safety Codes & Standards and Utilization	1,963	0	0	0	0.0%
Congressionally Directed Activities, Education and Cross-Cutting Analysis[a]					
Residential Fuel Cell Demo by the Delaware County Electric Coop	0	294	0	-294	-100.0%
Smart Energy Management Control Systems	0	491	0	-491	-100.0%
Lansing Community College Alternative Energy Center	0	981	0	-981	-100.0%
Total, Education and Cross-Cutting Analysis	0	1,766	0	-1,766	-100.0%
Total, All Other	10,596	41,967	0	-41,967	-100.0%
Total, General Goal 4 (Hydrogen Technology)	38,113	81,991	95,325	+13,334	+16.3%

Expected Program Outcomes

The Hydrogen Program pursues its mission through integrated activities designed to improve the energy efficiency, flexibility, and productivity of our energy economy. We expect these improvements to reduce susceptibility to energy price fluctuations and potentially lower energy bills; reduce EPA criteria and other pollutants; enhance energy security by increasing the production and diversity of domestic fuel supplies; and provide greater energy security and reliability by improving our energy infrastructure. In addition to these "EERE business-as-usual" benefits, realizing the Hydrogen Program goals would provide the technical potential to reduce conventional energy use even further if warranted by future energy needs.

[a] The Hydrogen Technology Program is working with the recipients of the congressionally directed funding to attempt to develop statements of work that address technology barriers and support program goal.

Estimates for energy savings, energy expenditure savings carbon emission reductions, oil savings, and natural gas savings that result from the realization of the integrated Hydrogen, Fuel Cells and Infrastructure Technologies Program goals are shown in the tables below through 2050, reflecting the increasing availability of commercial fuel cells and hydrogen sources. When hydrogen-powered fuel cell vehicles are introduced in substantial numbers and fuel cells reach the mass consumer market for electronics and other stationary applications, the oil savings and other benefits to the Nation are expected to be significant. Achievement of the program goals could result in mid-term oil savings of 0.4 million barrels per day (MBPD) in 2025 (based on the GPRA05-NEMS model) and in the long term ramp up to savings of 6 MBPD in 2050 (based on preliminary estimates using the GPRA05–MARKAL model).

The full long-term potential for renewable-based hydrogen is not reflected in this FY05 benefits analysis. Further improvements in the analysis for renewable-based hydrogen technology are underway. In addition, these estimates do not include an assessment of the role of policy measures in facilitating the development of the infrastructure necessary to provide hydrogen at refueling stations nationwide, or in stimulating consumer demand for hydrogen fuel cell vehicles.

FY 2005 GPRA Benefits Estimates for Hydrogen, Fuel Cells and Infrastructure Technologies Program[a]

Mid-term benefits[b]

	2010	2015	2020	2025
Primary Non-Renewable Energy Savings (Quads)	ns	0.1	0.1	0.5
Energy Expenditure Savings (Billion 2000$)	ns	0.3	1	5
Carbon Emission Réductions (MMT)	ns	1	4	12
Oil Savings (MBPD)	ns	ns	0.1	0.4
Natural Gas Savings (Quads)[c]	ns	ns	-0.13	-0.42

[a] Benefits reported are annual, not cumulative, for the year given. Estimates reflect the benefits associated with program activities from FY 2005 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] Mid-term program benefits were estimated utilizing the GPRA05-NEMS model, based on the Energy Information Administration's (EIA) National Energy Modeling System (NEMS) and utilizing the EIA's Annual Energy Outlook (AEO) 2003 Reference Case.

[c] Although these results show a small negative impact on natural gas demand in the short and mid-term, an analysis by the Office of Energy Efficiency and Renewable Energy (EERE) of its entire research and deployment portfolio indicates that by 2020 the industrial, buildings, and other portions of this EERE portfolio will be freeing up significant natural gas demand to more than offset the estimated small impacts on natural gas of the HFCIT program during the early phases of the transition to a hydrogen economy. In the long term, the program is targeting more renewable-based hydrogen.

Long-term benefits[a]

	2030	2040	2050
Primary Non-Renewable Energy Savings (Quads)	2.8	6.4	9.2
Energy System Cost Savings (Billion 2000$)	16	51	79
Carbon Emission Reductions (MMT)	54	105	138
Oil Savings (MBPD)	2.0	4.3	6.2
Natural Gas Savings (Quads)	-0.56	-0.09	0.40

[a] Long-term benefits were estimated utilizing the GPRA05 - MARKAL developed by Brookhaven National Laboratory (BNL). Results can differ among models due to differences in their structure. In particular, the two models estimate economic benefits in different ways, with the MARKAL model reflecting the cost of additional investments required to achieve reductions in energy bills.

Production and Delivery R&D

Funding Schedule by Activity

(dollars in thousands)

	FY 2003	FY 2004	FY 2005	$ Change	% Change
Production and Delivery R&D					
Production and Delivery R&D	6,398	10,344	25,325	+14,981	+144.8%
Congressionally Directed Activities	4,817	12,220	0	-12,220	-100.0%
Total, Production and Delivery R&D	11,215	22,564	25,325	+2,761	+12.2%

Description

The activity 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, wind, 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.

Benefits

The Production and Delivery R&D activity supports the mission of the HFCIT Program by developing new and advanced technologies to produce hydrogen from diverse domestic resources. The benefits of the R&D activity support the achievement of fuel costs on a cents/mile basis less than for existing gasoline vehicles. The research will enable the projected cost of hydrogen produced in large quantities by renewable and non-renewable fuel sources to be reduced as indicated.

Hydrogen Production Costs (modeled)[a]: Non-renewable and Renewable delivered at 5000 psi

	2003	2004	2005	2006	2007	2008	2009	2010
Non-renewables ($/gge).....	5.00			3.00			2.50	1.50
Renewables ($/gge) [b]	6.20		5.70	5.30			4.60	3.90

Detailed Justification

(dollars in thousands)

FY 2003	FY 2004	FY 2005
Production and Delivery R&D..... **6,398**	**10,344**	**25,325**

Increase emphasis on renewable feedstocks and energy sources. Continue developing advanced electrolyzer concepts that address cost, energy efficiency, and durability issues that will achieve a hydrogen cost of $3.90 per gasoline gallon equivalent (untaxed) at 5000 psi by 2010 using renewable electricity sources. Conduct research using biomass feedstocks to integrate steam methane reforming with gasification processes toward achieving a cost of $4.60/gge at the station by 2009. In photoelectrochemical water splitting production, complete development of semiconductor material that achieves 7.5 percent photon-to-hydrogen efficiency with 1000 hour durability by 2006. Continue conducting research in photobiological micro-organism systems to improve photon absorption of sunlight for water splitting production. Conduct research in high and ultra-high temperature water splitting chemical cycles using solar concentrators.

Complete the research of natural gas-to-hydrogen production systems that can verify the production and delivery of 5000 psi gaseous hydrogen for $3.00 per gasoline gallon equivalent (untaxed) at the station, with mature production volumes (e.g. 100 units/year) in 2006. Continue developing separation membrane technologies toward improving flux rates from 60 to 200 standard cubic feet per hour per square foot and reducing material costs from $200 to less than $100 per square foot by 2010.

Complete the initial analysis on various hydrogen delivery technology and infrastructure options relative to advantages and trade-offs for the transition to, and long term use of hydrogen for transportation and stationary power. Continue research to reduce capital costs and increase energy efficiency of delivery systems from central production facilities including lower pipeline material costs, higher compression and liquefaction energy efficiencies, and liquid and solid carrier technologies.

Conduct economic and environmental analyses and technical assessments for technologies being

[a] Hydrogen production costs are based on estimates that use laboratory data to project the cost of hydrogen produced at mature production volumes.

[b] Central biomass-based hydrogen costs at the plant gate are $4/gge in 2003, $3.60/gge in 2005, $3.30/gge in 2006, and $2.60/gge in 2009. Hydrogen delivery costs are based on estimates for a central plant within 30 miles of a large city using liquid hydrogen delivered via truck at hydrogen quantities need to fuel 20% of the total light duty fleet.

(dollars in thousands)

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.

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. In FY 2003 this activity was reduced by $113,932 for SBIR/STTR and transferred to the Science Appropriation.

Participants include: NETL, NREL, ANL, PNNL, TIAX, Iowa State University, Praxair, Air Products and Chemicals, Inc., InnovaTek, G.E., INEEL, Technology Management, Inc., LLNL, Giner Electrochemical, Proton Energy, Teledyne Energy, SRI International, University of California - SB, ORNL, University of California - Berkeley, University of Hawaii, and SNL.

Congressionally Directed Activities, Production and Delivery R&D	**4,817**	**12,220**	**0**

Funding for the following projects was directed by Congress to be included in this activity:

PEM Fuel Cell and Purification (FY 2003 $2,890,117); Competitive Solicitation for Solid Oxide Fuel Cells (FY 2004 $2,453,000); HI-Way Initiative in New York State (FY 2004 $1,962,140); Shared Technology Transfer Program by Nicholls State University (FY 2004 $981,070); Fuel Cell Development for Distributed Generation and Carbon Sequestration in Northwest Indiana (FY 2004 $1,962,140); EVermont Hydrogen Electrolyzer Project (FY 2004 $936,920); Evaluation of Solar-Powered Thermo-Chemical Production of Hydrogen from Water (FY 2003 1,926,744; FY 2004 $2,943,210); Startech Hydrogen Production Project (FY 2004 $490,540); and Hawaii Hydrogen Center for Development and Deployment of Distributed Energy Systems (FY 2004 $490,540).

Total, Production and Delivery R&D	**11,215**	**22,564**	**25,325**

Explanation of Funding Changes

	FY 2005 vs. FY 2004 ($000)
Production and Delivery R&D	
Accelerate and expand research on renewable-based hydrogen. Increases development of electrolysis technologies using renewable energy sources.	+14,981
Congressionally Directed Activities, Production and Delivery R&D	
No funds are requested because funds are being allocated to other activities more closely aligned with the Program's goal.	-12,220
Total Funding Change, Production and Delivery R&D	**+2,761**

Storage

Funding Schedule by Activity

(dollars in thousands)

	FY 2003	FY 2004	FY 2005	$ Change	% Change
Storage					
Storage	10,790	13,981	30,000	+16,019	+114.6%
Congressionally Directed Activities, Storage	0	15,451	0	-15,451	-100.0%
Total, Storage	10,790	29,432	30,000	+568	+1.9%

Description

The Hydrogen Storage activity will focus primarily on the research and development of on-board vehicular hydrogen storage systems that allow for a driving range of greater than 300 miles. The activity will develop and demonstrate compressed gas and cryogenic hydrogen tanks for near-term storage of hydrogen capable of meeting 2005 on-board hydrogen storage targets. The activity will also develop and demonstrate solid-state materials and conformable tank technologies for hydrogen storage systems capable of meeting 2010 and 2015 on-board hydrogen storage targets. In addition, the activity will develop hydrogen storage systems for off-board applications such as the hydrogen delivery and refueling infrastructure.

Benefits

Hydrogen storage is a key enabling technology for the advancement of hydrogen and fuel cell technologies for transportation, stationary power, and portable power applications. Current hydrogen storage systems for vehicles are inadequate to meet customer driving range expectations without intrusion into vehicle cargo or passenger space. The Hydrogen Storage activity supports the mission of the HFCIT program by focusing on the development of compact, light-weight, low-cost, and efficient storage systems to achieve a driving range of greater than 300 miles.

The research will enable the volumetric (kWh/L) and gravimetric (kWh/kg or weight percent)[a] hydrogen storage capacities (while meeting cost targets) to be improved as indicated below.

[a] 1 kg of hydrogen contains 33.3kWh, so, 6 kg contains approximately 200kWh. A 6 wt.% hydrogen storage system contains 6 kg of hydrogen in a system weighing 100 kg. A 200 kWh Hydrogen/100 kg system = 2kWh/kg.

Compressed Gas

	2003	2004	2005	2006	2007	2008	2009	2010
Volumetric (kWh/L)	1.0	1.0	1.2			1.4		1.5
Gravimetric (kWh/kg)	1.3	1.3	1.5			1.8		2.0
Gravimetric (weight percent)	4.0	4.0	4.5			5.5		6.0

Solid State

	2003	2004	2005	2006	2007	2008	2009	2010
Volumetric (kWh/L)	0.5	0.6	1.2			1.3		1.5
Gravimetric (kWh/kg)	0.7	1.0	1.5			1.8		2.0
Gravimetric (weight percent)	2.3	3.0	4.5			5.5		6.0

Detailed Justification

(dollars in thousands)

FY 2003	FY 2004	FY 2005
Storage	**10,790**	**13,981**	**30,000**

Complete testing and validation of 10,000 psi hydrogen storage tank achieving the 2005 hydrogen storage system targets of 1.5 kWh/kg (4.5 weight percent) and 1.2 kWh/L. Investigate materials that allow novel tank geometries for conformable tank design.

Initiate research and development at Hydrogen Storage Centers of Excellence directed at meeting the 2010 hydrogen storage system targets of 2.0 kWh/kg (6 weight percent), 1.5 kWh/L, and $4/kWh, and identifying scientific/technological paths to meet the 2015 hydrogen storage system targets of 3.0 kWh/kg (9 weight percent), 2.7 kWh/L, and $2/kWh.

Enhance existing R&D in reversible storage materials, such as carbon nanotubes and metal hydrides, and address regeneration issues related to chemical hydrogen storage, such as sodium borohydride. 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. Advanced concepts include novel carbon nanostructures (other than nanotubes), metal-organic materials and polymers.

Explore options for hybrid approaches that combine compressed gas storage with reversible materials to reduce pressure requirements and increase vehicle range.

Complete verification of a standard test protocol and independent test facility to compare the capacities of hydrogen storage materials under development.

Focus analysis activities on advanced storage options for hydrogen with special attention to the energy efficiency of the storage system. Assess regenerative chemical storage for efficiency, emissions, and

(dollars in thousands)

FY 2003	FY 2004	FY 2005

the cost of chemical regeneration, and carbon nanotube storage for economic and technological potential to provide the needed breakthrough in hydrogen storage technology. 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. In FY 2003 this activity was reduced by $130,804 for SBIR/STTR and transferred to the Science Appropriation. *Participants include: NREL, Air Products, SNL, University of Hawaii, UTRC, SRTC, UOP, Safe Hydrogen, Millennium Cell, Cleveland State University, SwRI, LLNL, Quantum, LANL, INEEL, and ANL.*

Congressionally Directed Activities, Storage..... **0** **15,451** **0**

The following projects were directed by Congress to be included in this activity: Edison Materials Technology Center to Develop Improved Materials to Support the Hydrogen Economy (FY 2004 $2,943,210); National Center for Manufacturing Science to Develop Advanced Manufacturing Technologies for Renewable Energy Applications (FY 2004 $2,943,210); Florida Hydrogen Partnership (FY 2004 $1,962,140); Fuel Cell Research by the University of South Florida (FY 2004 $1,962,140); Hydrogen Future Park at the University of Montana (FY 2004 $735,800); Fuel Cell Mine Loader and Prototype Locomotive (FY 2004 $1,962,140); and Renewable Hydrogen Fueling Station System (FY 2004 $2,943,210).

Total, Storage **10,790** **29,432** **30,000**

Explanation of Funding Changes

	FY 2005 vs. FY 2004 ($000)
Storage	
Research and development of on-board vehicular hydrogen storage systems that allow for a driving range of greater than 300 miles……	+16,019
Congressionally Directed Activities, Storage	
No funds are requested because funds are being allocated to other activities more closely aligned with the Program's goal……	-15,451
Total Funding Change, Storage ……	**+568**

Infrastructure Validation

Funding Schedule by Activity

(dollars in thousands)

	FY 2003	FY 2004	FY 2005	$ Change	% Change
Infrastructure Validation					
Infrastructure Validation.....	2,974	5,849	15,000	+9,151	+156.5%
Congressionally Directed Activities, Infrastructure Validation	6,706	12,530	0	-12,530	-100.0%
Total, Infrastructure Validation...	9,680	18,379	15,000	-3,379	-18.4%

Description

This activity includes the validation of advanced hydrogen technologies using full-scale demonstrations. Validation of hydrogen technology targets under real world conditions occurs three years after the research demonstrates potential to achieve the targets. Hydrogen technology R&D are then verified at commercial scale for performance against established R&D goals which include high pressure storage tanks, production and delivery processes, and hydrogen refueling station technologies.

Benefits

In order for the automotive, utility, and fuel industries to make commercialization decisions by 2015, integrated vehicle and infrastructure systems need to be validated and individual component targets need to be met under real-world operating conditions. This activity supports the HFCIT program's mission by providing critical statistical data that fuel cell vehicles can meet efficiency and durability targets, storage systems can efficiently meet 300+ mile range requirements, and fuel costs are less than for existing gasoline vehicles. Technology Validation also provides information so that standards can be written and vehicle and infrastructure safety can be demonstrated.

The research will enable commercial scale validation of the projected cost of hydrogen produced in larger quantities by non-renewables (in $/gge), untaxed, as indicated below.

	2003	2004	2005	2006	2007	2008	2009
Validate cost of hydrogen production ($/gge)[a]			$3.60 per gge[b]				$3.00 per gge[c]

Detailed Justification

(dollars in thousands)

FY 2003	FY 2004	FY 2005

Infrastructure Validation **2,974** **5,849** **15,000**

Continue the Controlled Hydrogen Fleet and Infrastructure Technology Demonstration and Validation Project. Continue to design and construct hydrogen refueling stations to support demonstrations of hydrogen fuel cell fleet vehicles. Three of the refueling stations and several maintenance facilities will be commissioned to service hydrogen vehicles provided by major automobile companies. These first generation stations will validate the ability to produce hydrogen for $3.60 per gallon gasoline equivalent (untaxed) at 5000 psi hydrogen (with mature production volumes e.g. 100 units/year) and at least two stations will incorporate renewable systems. By 2009, this activity will validate the ability to produce the hydrogen for $3.00 per gallon gasoline equivalent (untaxed) at 5000 psi hydrogen when produced in quantity with 68% well to pump efficiency. Data will be collected on scheduled and unscheduled maintenance, and on the operation of the refueling stations.

Power park projects will be operated and maintained. Data on reliability, safety and operating costs will be collected. In FY 2003 this activity was reduced by $67,515 for SBIR/STTR and transferred to the Science Appropriation. *Participants include: Clark University, UOP/SunLine, Air Products and Chemicals, Inc., Praxair/LAX, Sunline, Collier Technologies, DTE, APS/Pinnacle West, DBEDT (formerly NEHLA), State of Texas, Apollo, Proton, NEXT Energy, Zoot Enterprises, SNL, Fuel Cell Propulsion Institute, GTI, LLNL, TIAX, and, NREL.*

Congressionally Directed Activities, Infrastructure Validation **6,706** **12,530** **0**

The following projects were directed by Congress to be included in this activity: Ohio University Fuel Cell Pilot Project (FY 2003 $2,853,489); NEXT ENERGY Fuel Cell Demonstration project

[a] The validation activity validates the 2006 laboratory data for estimated hydrogen production costs for non-renewables in real world conditions. Hydrogen production costs are based on estimates that use the real world data to project the cost of hydrogen produced at mature production volumes.

[b] Including the co-production of electricity.

[c] Cost without co-producing electricity.

(FY 2003 $1,926,744); Gallatin County (FY 2003 $963,372); University of Nevada Las Vegas Hydrogen Filling Station (FY 2003 $963,372); Hydrogen Regional Infrastructure Program in Pennsylvania (FY 2004 $2,943,210); Expanding Clean Energy Research and Education Program at the University of South Carolina (FY 2004 $2,158,360); Hydrogen Fuel Cell Project Washoe County, Nevada (FY 2004 $1,962,140); Hawaii Hydrogen Center for Development and Deployment of Distributed Energy Systems (FY 2004 $2,982,300) (Included in the Omnibus Appropriation Bill.); and the Chattanooga Fuel Cell Demonstration Project (FY 2004 $2,485,250) (Included in the Omnibus Appropriation Bill.)

Total, Infrastructure Validation	**9,680**	**18,379**	**15,000**

Explanation of Funding Changes

	FY 2005 vs. FY 2004 ($000)
Infrastructure Validation	
In FY 2005, the Hydrogen Fleet and Infrastructure Demonstration and Validation Project will be increased and the power park and infrastructure activities will be reduced	+9,151
Congressionally Directed Activities, Infrastructure Validation	
No funds are requested because funds are being allocated to other activities more closely aligned with the Program's goal.	-12,530
Total Funding Change, Infrastructure Validation	**-3,379**

Safety, Codes & Standards, and Utilization

Funding Schedule by Activity

(dollars in thousands)

	FY 2003	FY 2004	FY 2005	$ Change	% Change
Safety, Codes & Standards, and Utilization					
Safety, Codes & Standards, and Utilization..	2,568	5,904	18,000	+12,096	+204.9%
Congressionally Directed Activities, Safety, Codes & Standards, and Utilization..	1,963	0	0	0	0.0%
Total, Safety, Codes & Standards, and Utilization.....	4,531	5,904	18,000	+12,096	+204.9%

Description

This activity includes identifying critical failure modes and safety issues for hydrogen and fuel cell technologies, development of the technical data required for applicable codes and standards for hydrogen production and delivery processes as well as for hydrogen storage and fuel cell systems for both transportation and stationary applications. Activities also include the development of passive and active safety systems based on new sensor technologies, comprehensive safety analysis and compilation of a defensible database on safety.

Benefits

In order for industry to make commercialization decisions the technologies must meet safety standards. This requires a comprehensive and defensible database on component reliability and safety, published performance-based domestic standards and international standards or regulations that will allow the technologies to compete in a global market. This activity supports HFCIT's mission by providing the critical data needed to write and adopt standards, the safety criteria and systems that meet or exceed current technologies and will lead to new Federal Motor Vehicle Safety Standards for fuel cell vehicles by the Department of Transportation.

Activities under Safety, Codes & Standards, and Utilization will facilitate the establishment of a global technical regulation for hydrogen and fuel cell vehicles and infrastructure.

	2006	2007	2008	2009	2010
Global technical regulation	ISO Standards for hydrogen refueling and storage		Draft U.S. Technical standards for preparation of draft regulation.		Finalize U.S. technical standards for preparation of a Global Technical Regulation (GTR).

Detailed Justification

(dollars in thousands)

	FY 2003	FY 2004	FY 2005
Safety, Codes & Standards, and Utilization	**2,568**	**5,904**	**18,000**

Continue the development of standards for fuel cell power plant systems that include performance verification of efficiency and emissions. Collaborate with DOT, EPA, NIST and other agencies to implement a comprehensive safety research 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. Work with these agencies will be conducted utilizing inter-agency agreements. Define 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.

Design a test system to simulate bulk storage, fuel dispensing and distribution piping systems based on the work conducted in FY 2004 and initiate the construction of the system in FY 2005. Revise plan for safety tests and analysis to validate the performance of the systems for new standards and review with the technical team. Produce training modules on hydrogen safety and design for Fire Marshals. Provide system safety requirements which have to be demonstrated for production, storage and utilization program elements. Initiate the development of a new intrinsically safe, hand held optical sensor to detect and measure hydrogen leaks. Prepare draft materials compatibility guide for hydrogen systems, identify material needs, and establish research program to develop them. In FY 2003 this activity was reduced by $80,174 for SBIR/STTR and transferred to the Science Appropriation. *Participants include: NREL, , SNL, PNNL, LANL, SAE, and LLNL, Gas Technology Institute, International Code Council, National Fire Protection Association, Underwriters Laboratory, Compressed Gas Association, Canadian Standards Association of America, American Society of Mechanical Engineers, American National Standards Institute, DOT Centers, Environmental Protection Agency Laboratories, National Institute of Standards and Testing.*

(dollars in thousands)

	FY 2003	FY 2004	FY 2005
Congressionally Directed Activities, Safety, Codes & Standards, and Utilization	**1,963**	**0**	**0**
The following projects were directed by Congress to be included in this activity: Ohio University Fuel Cell Pilot Project (FY 2003 $1,000,000); and Fuel Cell R&D So. Alabama (FY 2003 $963,372).			
Total, Safety, Codes & Standards, and Utilization	**4,531**	**5,904**	**18,000**

Explanation of Funding Changes

	FY 2005 vs. FY 2004 ($000)
Safety, Codes and Standards, and Utilization	
Increase systematic safety studies including evaluation of hydrogen release scenarios from piping, storage systems, equipment failures and sabotage; determine fire and explosion potential; develop engineering practices leading to new standards; and support focused research testing and certification for hydrogen components	+12,096
Total Funding Change, Safety, Codes and Standards, and Utilization	**+12,096**

Education and Crosscutting Analysis

Funding Schedule by Activity

(dollars in thousands)

	FY 2003	FY 2004	FY 2005	$ Change	% Change
Education and Crosscutting Analysis					
Education and Crosscutting Analysis.....	1,897	3,946	7,000	+3,054	+77.4%
Congressionally Directed Activities, Education and Crosscutting Analysis.....	0	1,766	0	-1,766	-100.0%
Total, Education and Crosscutting Analysis	1,897	5,712	7,000	+1,288	+22.5%

Description

The activity includes development and distribution of educational materials and training to serve the specific needs of target audiences that can facilitate the transition to a hydrogen economy, such as teachers and students; state and local governments, including safety and code officials; potential end-users; and the public. Materials include films, manuals, lesson plans and modules, and instruction books/booklets about hydrogen production, delivery, storage, and safety processes, as well as technology applications. This activity also includes development of an independent systems analysis and integration function consistent with recommendations by the National Academy of Sciences.

Benefits

The Education and Cross Cutting Analysis activities support the HFCIT program's mission and the National Energy Policy recommendation to communicate hydrogen benefits, safety, and utilization information to key stakeholders. The activities supporting education and cross cutting analysis aid in overcoming the institutional barriers to a hydrogen economy. Cross-cutting analysis will be used to assess the potential impact and benefits of hydrogen technology in society.

Activities in Education and Crosscutting Analysis will increase the number of people in each target audience who understand the concept of a hydrogen economy and how it may affect them, and also help establish within the HFCIT program a fully functional systems integration capability. Independent systems analysis on the energy, economic and environmental implications of the technology development will drive key program decisions.

Education

	2004	2005	2006	2007	2008	2009	2010
Students, teachers, etc	Survey[a]				two fold increase		four-fold increase
End users	Survey[a]				one fold increase		two fold increase

	2004	2005
Systems Analyses	Define system analysis requirements	Publish requirements and assumptions

Detailed Justification

(dollars in thousands)

	FY 2003	FY 2004	FY 2005
Education and Cross-Cutting Analysis	**1,897**	**3,946**	**7,000**

The program will develop and pilot test materials for use in middle and high schools; develop a teacher training program; develop a hydrogen education program for state and local government representatives; and publish and distribute safety codes and standards training materials.

Education activities will include collaboration with other DOE education initiatives, national laboratories, and industry partners to implement a training program for teachers. The effort will pair teachers with technology experts and feature lesson plans and materials that have been pilot tested in the classroom. Critical components of this effort will be a training and professional development program for teachers to build their knowledge of and experience with hydrogen technology and its applications, as well as an assessment and evaluation mechanism with which to measure the effectiveness of the program. 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 and ensure an understanding of the hydrogen economy among the community. In addition, the library of educational materials will be expanded to provide interested stakeholders, including the public, with greater access to current and objective information about hydrogen technology.

[a] A survey is currently underway to determine the 2004 baseline.

(dollars in thousands)

FY 2003	FY 2004	FY 2005

Cross-cutting analysis activity to establish systems integration capability will include publishing a Technical Requirements document and Systems Analysis Planning Assumptions document.

Perform cross-cutting analysis on the impact of hydrogen technologies to the economy and energy markets and evaluate transition strategies for low-cost hydrogen infrastructure development. On a well-to-wheels basis, determine the impacts on energy efficiency, costs, and the environment from potential pathways and technologies to be pursued. Analyze synergies between automotive and stationary applications and the related infrastructure requirements.

In collaboration with industry stakeholders, continue development of robust modeling tools capable of analyzing options and trade-offs of multiple scenarios for the transition from liquid hydrocarbons to a hydrogen-based transportation system. This will include modeling of 1) infrastructure – all energy sources, conversion technologies, distribution and retailing options; 2) demand – representing vehicle manufacturing decisions, consumer demand, and potential stationary power uses; and 3) time-space economics – a methodology for integrating the infrastructure build-up strategy and market demands in specific regions and times. This modeling effort will be used, in collaboration with industry, to provide direction for research and development efforts, and to provide insight into issues regarding timing of infrastructure investment, large-scale vs. small-scale hydrogen production facilities, and hydrogen delivery infrastructure needs for the transition to a hydrogen economy. As part of systems engineering and analysis activities, implement a fully functional system integration capability that establishes and validates integrated baseline requirements. Conduct analysis to identify the impacts of various technology pathways, to assess associated cost elements and drivers, to identify key cost and technological gaps, to respond to any specific recommendation(s) of the National Academy of Sciences, and to assist in prioritizing R&D. In FY 2003 this activity was reduced by $29,551 for SBIR/STTR and transferred to the Science Appropriation. *Participants include: ANL, NREL, ORNL, LLNL, TIAX, Central WA University, University of ND, NC State University, RSIS, Inc., and University of California – Davis.*

Congressionally Directed Activities, Education and Cross-Cutting Analysis	**0**	**1,766**	**0**

The following projects were directed by Congress to be included in this activity: Lansing Community College Alternative Energy Center (FY 2004 $981,070); Residential Fuel Cell Demonstration by the Delaware County Electric Cooperative (FY 2004 $294,320); and Smart Energy Management Control System (FY 2004 $490,540).

Education and Cross-Cutting Analysis	**1,897**	**5,712**	**7,000**

Explanation of Funding Changes

	FY 2005 vs. FY 2004 ($000)
Education and Cross-Cutting Analysis	
Increase funding for cross-cutting life cycle analysis and systems integration analysis to identify key cost and technological gaps	+3,053
Congressionally Directed Activities, Education and Cross-Cutting Analysis	
No funds are requested because funds are being allocated to other activities more closely aligned with the Program's goal	-1,765
Total Funding Change, Education and Cross-Cutting Analysis	**+1,288**

Solar Energy

Funding Profile by Subprogram[a]

(dollars in thousands)

	FY 2003 Comparable Appropriation	FY 2004 Original Appropriation	FY 2004 Adjustments[b,c]	FY 2004 Comparable Appropriation	FY 2005 Request
Solar Energy					
Photovoltaic Energy Systems	73,249	76,500	-1,447	75,053	75,433
Solar Heating and Lighting	3,783	3,000	-56	2,944	2,900
Concentrating Solar Power	5,298	5,500	-104	5,396	2,000
Total, Solar Energy	82,330	85,000	-1,607	83,393	80,333

Public Law Authorizations:

P.L. 93-409, "Solar Heating and Cooling Demonstration Act" (1974)
P.L. 94-163, "Energy Policy and Conservation Act" (EPCA) (1975)
P.L. 94-385, "Energy Conservation and Production Act" (ECPA) (1976)
P.L. 95-91, "Department of Energy Organization Act" (1977)
P.L. 95-619, "National Energy Conservation Policy Act" (NECPA) (1978)
P.L. 96-294, "Energy Security Act" (1980)
P.L. 95-590, "Solar Photovoltaic Energy Research, Development and Demonstration Act" (1984)
P.L. 101-218, "Renewable Energy and Energy Efficiency Technology Competitiveness Act of 1989" (1989)
P.L. 101-575, "Solar, Wind, Waste, and Geothermal Power Production Incentives Act of 1990" (1990)
P.L. 102-46, "Solar, Wind, Waste, and Geothermal Power Production Incentives Technical Amendments Act" (1991)
P.L. 104-271, "Hydrogen Future Act" (1996)

Mission

The mission of the Solar Energy Program ("Solar Program") is to improve America's security, environmental quality, and economic prosperity through public-private partnerships that bring reliable and affordable solar energy technologies to the marketplace.

[a] SBIR/STTR funding in the amount of $1,480,717 was transferred to the Science appropriation in FY 2003. Estimates for SBIR/STTR budgeted in FY 2004 and FY 2005 are $2,210,912 and $2,136,884 respectively.

[b] Programs in the Energy Supply appropriation were reduced by .59 percent as required by the Omnibus Appropriation Bill.

[c] Programs in the Energy Supply appropriation were proportionally reduced based upon the allocated General Reduction of $4,684,000.

Benefits

Through its research and development activities, the Solar Program develops solar energy technologies -- such as photovoltaic systems, concentrating solar power, and solar water heating systems -- that are reliable, affordable, and environmentally sound. Transforming our Nation's vast supply of free and available solar energy into a widely available energy resource will increase energy security by diversifying its domestically available energy supply options for use in both normal and emergency situations.

The Solar Program provides additional types of public benefits in the areas of reliability, security, and environment not reflected in the quantified benefits reported below. Photovoltaic (PV) systems can either be integrated with the electricity grid or work independently as distributed systems, which increases our national energy security by providing a widely available and flexible source of power not dependant on our aging and vulnerable electricity grid system. 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 during emergencies in the form of local power and hot water availability that is not dependent on fuel deliveries or overhead wires (subject to disruption) and which will not contribute to local air pollution during a protracted emergency. Finally, solar energy displaces electricity demand most during the hottest, sunniest days of the year when demand for space cooling is high, helping to avoid blackouts while reducing Clean Air Act criteria pollutant emissions from generation plants when air pollution levels are at their highest and non-attainment status is most at risk.

More detailed, integrated and comprehensive economic, energy and energy security benefits estimates are provided in the Expected Program Outcomes section at the end of the program level budget narrative.

Strategic and Program Goals

The Department of Energy's Strategic Plan identifies four Strategic Goals (one each for defense, energy, science, and environmental aspects of the Department's mission) in addition to seven General Goals that tie to the Strategic Goals. The Solar Program supports the following goals:

Energy Strategic Goal: To protect our National and economic security by promoting a diverse supply and delivery of reliable, affordable, and environmentally sound energy.

General Goal 4, Energy Security: Improve energy security by developing technologies that foster a diverse supply of reliable, affordable, and environmentally sound energy by providing for reliable delivery of energy, guarding against energy emergencies, exploring advanced technologies that make a fundamental improvement in our mix of energy options, and improving energy efficiency.

The Solar Program has one Program Goal which contributes to General Goal 4 in the "goal cascade":

Program Goal 04.03.00.00: Solar Energy. The Solar Program goal is to improve performance of solar energy systems and reduce development, production, and installation costs to competitive levels, thereby accelerating both large-scale usage across the Nation and to make a significant contribution to a clean, reliable and flexible U.S. energy supply.

Contribution to Program Goal 04.03.00.00 (Solar Energy)

The Solar Program contributes to the Department's General Goal 4 through Program Goal 04.03.00.00 by developing next generation technologies with improved performance and by reducing system, manufacturing, and installation costs of solar energy technologies to levels competitive with fossil and nuclear energy sources. When Federal solar energy research began in the 1970s in response to oil price shocks, the cost of electricity from solar resources was about $2.00 per kilowatt-hour (kWh). Technological advances over the last two decades have significantly reduced solar electricity costs. Today, the cost of solar electricity ranges from $0.12/kWh for CSP to $0.24/kWh for certain PV applications. The long-term user cost goal for electricity from PV systems is $0.06/kWh.

Key technology pathways to the goal include (detailed annual performance progress indicators are presented in their respective benefits sections):

- by 2006, reduce the 30-year user cost for PV electric energy to $0.16 - $0.21/kWh from $0.19 - $0.24/kWh in 2003.
- by 2006, reduce the cost of solar water heating in non-freezing climates to $0.04/kWh from $0.08/kWh in 2003.

In response to the lessons learned from the DOE FY 2003 performance audit and consistent with production cost measures developed for the FY 2005 PART, the solar PV subprogram is transitioning its performance target from actual manufacturer production costs (external outcomes) to engineering estimates of production costs (program outputs), based on the impacts of annual R&D progress. This new engineering-based cost estimation model will incorporate the portfolio of program R&D factors described in the Solar Program's Multi-Year Technical Plan that impact the price of electricity from PV. While transitioning to this new model, in FY 2004 one key component in production cost, conversion efficiency, will be used as a measure of progress as the program develops and vettes the model.

Note that FY 2004 PV targets refer to conversion efficiencies of PV modules, while FY 2000 and FY 2001 targets refer to conversion efficiencies of PV cells.

Annual Performance Results and Targets

FY 2000 Results	FY 2001 Results	FY 2002 Results	FY 2003 Results	FY 2004 Targets	FY 2005 Targets
Program Goal 04.03.00.00 (Solar Energy)					
Photovoltaic Energy Systems, Solar Heating and Lighting, and Concentrating Solar Power.					
Developed a 13-percent-efficient stable prototype thin-film photovoltaic cell.	Developed a 14-percent-efficient stable prototype thin-film photovoltaic cell.	Reduced the manufacturing cost of 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 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).	Verify, with standard laboratory measurements, U.S.-made commercial production crystalline silicon PV modules with a 12.5-percent conversion efficiency. Verify with standard laboratory measurements, U.S.-made commercial production thin-film PV modules with a 10-percent conversion efficiency. Develop conceptual designs of a low-cost polymer solar water heater capable of operation in freezing climates.	Based upon the FY 2004 development of an engineering-based cost estimation model, provide a production cost target for PV modules that reflects planned FY 2005 R&D activities. The cost target is expected to be in the range of $1.85-1.95 per Watt. This engineering-based cost estimate will be validated through market surveys and reported not later than FY 2007. Complete evaluation of conceptual designs of a low-cost polymer solar water heater capable of operation in freezing climates.
Management of Funds					
				Contribute proportionately to EERE's corporate goal of reducing corporate and program uncosteds to a range of 20-25 percent by reducing program annual uncosteds by 10 percent in 2004 relative to the program uncosted baseline (in 2003) until the target range is met.	Contribute proportionately to EERE's corporate goal of reducing corporate and program uncosteds to a range of 20-25 percent by reducing program annual uncosteds by 10 percent in 2005 relative to the program uncosted baseline (2004) until the target range is met.

Means and Strategies

The Solar Program will use various means and strategies to achieve its program goals as described below. "Means" include operational processes, resources, information, and the development of technologies, and "strategies" include program, policy, management and legislative initiatives and approaches. Various external factors, as listed below, may impact the ability to achieve the program's goals. Collaborations are integral to the planned investments, means and strategies, and to addressing external factors.

The Solar Program enhances our Nation's energy security through solar energy technology advances that increase PV cell efficiency, system reliability, and manufacturing capability and efficiency, and by reducing the production cost of PV, CSP, and solar water heating systems. These technical advances are intended to lower the cost of solar technologies in the marketplace and therefore increase their usage across the Nation.

These means and strategies will result in improving energy security by increasing the generation of reliable, affordable and environmentally sound solar energy, adding to the diversity of the Nation's energy supply --- thus putting the taxpayers' dollars to more productive use.

The following external factors could affect the Solar Program's ability to achieve its goals:

- economic growth
- labor costs
- the price and availability of alternative technologies and conventional fuels
- State and international R&D and deployment efforts
- financial incentives and other policies.

In carrying out its mission, the Solar Program collaborates with several groups on its key activities including:

- industrial manufacturers, National Laboratories, and universities.
- solar energy experts outside of the Department, who:
    - help ensure that the Solar Program's research directions and priorities address the needs of manufacturers, utilities, State agencies, consumers, and other stakeholders and that these activities are within the realm of technical feasibility and properly aligned with market forces.
    - collaborate on technology roadmaps and peer reviews, which have been completed within the last three years for each of the primary subprogram and activity.

Validation and Verification

To validate and verify program performance, the Solar Program will conduct internal and external reviews and audits. These programmatic activities are subject to continuing review by, for example, the Congress, the General Accounting Office, the Department's Inspector General, the U.S. Environmental Protection Agency, and state environmental agencies. The table below summarizes validation and verification activities.

Data Sources:	Annual Energy Review (EIA); Renewable Energy Annual (EIA); Annual Energy Outlook (EIA); Solar Electric Power: The U.S. Photovoltaic Industry Roadmap, (2001); Photovoltaics, Energy for the New Millennium: The National Photovoltaics Program Plan 2000-2004 (2000); Zero Energy Homes Roadmap (2002); Peer Review of the U.S. Department of Energy's Solar Buildings Technology Research Program (2001); Peer Review of the DOE Photovoltaic Program (2003).
Baselines:	The Solar Program's 2003 baselines for system production cost reduction goals are as follows: $0.19 – $0.24/kWh for PV electric energy; $0.08/kWh for solar water heating in non-freezing climates (see the Solar Program Multi-Year Technical Plan (2003)).
Frequency:	Annual.
Data Storage:	EIA and other data sources, such as National Laboratories (National Renewable Energy Laboratory (NREL) and Sandia National Laboratories (Sandia)), store the data on computer servers.
Verification:	Trade association reviews; National Laboratory survey of PV manufacturing cost/capacity data from U.S. industry; EIA survey of solar manufacturers; peer reviews.

Program Assessment Rating Tool (PART)

The Department implemented a tool to evaluate selected programs. The Program Assessment Rating Tool (PART) was developed by OMB to provide a standardized way to assess the effectiveness of the Federal Government's portfolio of programs. The structured framework of the PART provides a means through which programs can assess their activities differently than through traditional reviews. Based on the FY 2004 PART Review, the Solar Program has incorporated feedback into the FY 2005 Budget Request and has taken or will take the necessary steps to continue to improve performance.

In response to the FY 2004 PART review, the Solar Program is attempting to adhere to the specific direction of congressional appropriation language while increasing the contribution to program goals to the maximum extent possible.

One specific FY 2004 PART recommendation was to terminate the Concentrating Solar Power (CSP) subprogram, in alignment with a recommendation from a peer review by the National Research Council (NRC), a branch of the National Academy of Sciences (NAS).[a] At the Department's request, an independent engineering company, Sargent and Lundy, evaluated CSP technology and found that the potential exists to lower the cost of power from CSP plants to between $0.035/kWh and $0.062/kWh by 2020.[b] To verify its credibility, the Department asked the NRC to review the draft version of the evaluation. The NRC agreed with the Sargent and Lundy review that there was potential for cost reduction and determined that "since 1999, significant progress has been made in understanding the

[a] National Research Council, "Renewable Power Pathways: A Review of the U.S. Department of Energy's Renewable Energy Programs" (2000).

[b] Sargent and Lundy, "Assessment of Parabolic Trough and Power Tower Solar Technology Cost and Performance Forecasts" (draft version, 2002); final version: SL-5641 (May 2003).

potential impacts of thermal storage technologies, thin film glass mirrors, improved heat collection units, improved trough support structures, and other technical opportunities to improve CSP technology."[a]

In light of these studies, the Department is funding CSP activities in FY 2005. The Solar Program believes that the technical potential exists for great benefits through CSP. A more thorough investigation, however, of the proper R&D course necessary to realize those benefits needs to be conducted in light of these studies. The program is requesting $2 million to maintain essential facilities, support work with several States on the establishment of 1,000 MW of CSP solar power in the Southwest, and develop a comprehensive program plan for the coming fiscal years.

Last year's PART review and score provided suggestions that resulted in refined long-term and annual measures incorporated in this FY 2005 budget request. The FY 2005 PART showed Solar Program improvement in accountability scoring (+7 points) and the PART findings reflect recognition of that improvement. While the findings recognize the program's clear purpose and strength in planning, overall changes in the scoring system and unique scoring standards for EERE resulted in reduced scores in those areas. Although the net result was a lower overall weighted score in the FY 2005 PART, the Solar Program maintained its rating of "Moderately Effective," the second highest rating category. The PART review also found the program has implemented a new "systems driven" approach to help prioritize activities in its portfolio by analyzing present and potential markets, technology trade-off studies, and research and development reviews, and recognized that the program had developed a multi-year technical plan to guide its research efforts. The PART also found that congressionally-directed activities reduce the program funding available for competitive solicitations and core National Laboratory research designed to support program goals.

Funding by General and Program Goal

(dollars in thousands)

	FY 2003	FY 2004	FY 2005	$ Change	% Change
General Goal 4, Energy Security					
Program Goal 04.03.00.00, Solar Energy					
Photovoltaic Energy Systems	67,840	73,925	75,433	+1,508	+2.0%
Solar Heating and Lighting	3,783	2,944	2,900	-44	-1.5%
Concentrating Solar Power	5,298	5,396	2,000	-3,396	-62.9%
Total, Program Goal 04.03.00.00, Solar Energy	76,921	82,265	80,333	-1,932	-2.3%
All Other					
Congressionally Directed Activity, Photovoltaic Energy Systems					
Navajo Electrification Project	2,408	0	0	0	0.0%
Power Modules	1,445	0	0	0	0.0%

[a] National Academy of Sciences, "Letter Report: Critique of the Sargent and Lundy Assessment of Concentrating Solar Power Cost and Performance Forecasts" (2002).

	(dollars in thousands)				
	FY 2003	FY 2004	FY 2005	$ Change	% Change
Palo Alto Photovoltaic Demonstration Project	1,445	0	0	0	0.0%
Hard Bargain Farm	111	0	0	0	0.0%
Yucca Valley Project	0	245	0	-245	-100.0%
Center for Ecological Technology	0	392	0	-392	-100.0%
Hackensack Univ. Green Building Medical Center	0	491	0	-491	-100.0%
Total, All Other	5,409	1,128	0	-1,128	-100.0%
Total, General Goal 4 (Solar Technology)	82,330	83,393	80,333	-3,060	-3.7%

Expected Program Outcomes

The Solar Program pursues its mission through integrated activities designed to increase the use of domestic renewable resources. We expect these improvements to reduce susceptibility to energy price fluctuations and potentially lower energy bills; reduce EPA criteria and other pollutants; enhance energy security by increasing the production and diversity of domestic fuel supplies; and provide greater energy security and reliability by improving our energy infrastructure. In addition to these "EERE business-as-usual" benefits, realizing the Solar Program goals would provide the technical potential to reduce conventional energy use even further if warranted by future energy needs. 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.

Estimates of annual non-renewable energy savings, energy expenditure savings, carbon emission reductions, natural gas savings, and solar electricity capacity additions that result from the realization of Solar Program goals are shown in the table below through 2050. Benefits are expected to grow beyond 2050 as research advances, market penetration grows, and capital stock turns over.

The estimates reported here reflect market experience with consumer demand for "green" power. They do not, however, 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 likely understate the demand for solar energy.

The assumptions and methods underlying the modeling efforts have significant impact on the estimated benefits, and results could vary significantly if external factors, such as future energy prices, differ from the baseline case assumed for this analysis. A summary of the methods, assumptions, and models used in developing these benefit estimates that are important for understanding these results are provided at www.eere.energy.gov/office_eere/budget_gpra.html Final documentation estimated to be completed and posted by March 15, 2004. Uncertainties are larger for longer term estimates. The results shown in the long term benefits tables are preliminary estimates based on initial modeling of some of the possible program production technologies; nonetheless, they provide a useful picture of growing national benefits over time.

FY 2005 GPRA Benefits Estimates for Solar Energy Program[a]

Mid-Term Benefits[b]

	2010	2015	2020	2025
Primary Non-Renewable Energy Savings (Quads)	0.04	0.12	0.23	0.42
Energy Expenditure Savings (Billion 2001$)	0.2	1.2	6.6	4.9
Carbon Emission Reductions (MMTCE)	1	2	5	9
Natural Gas Savings (Quads)	0.00	0.10	0.10	0.15
Program Specific Electric Capacity Additions (GW)	1	4	11	17

Long-Term Benefits[c]

	2030	2040	2050
Primary Non-Renewable Energy Savings (Quads)	0.4	1.5	1.6
Energy System Cost Savings (Billion 2001$)	0.1	0.3	0.3
Carbon Emission Reductions (MMTCE)	5	22	29
Natural Gas Savings (Quads)	0.3	1.4	1.2
Program Specific Electric Capacity Additions (GW)	11	22	23

[a] Benefits reported are annual, not cumulative, for the year given. Estimates reflect the benefits associated with program activities from FY 2005 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] Mid-term program benefits were estimated utilizing the GPRA05-NEMS model, based on the Energy Information Administration's (EIA) National Energy Modeling System (NEMS) and utilizing the EIA's Annual Energy Outlook (AEO) 2003 Reference Case.

[c] Long-term benefits were estimated utilizing the GPRA05 - MARKAL developed by Brookhaven National Laboratory (BNL). Results can differ among models due to differences in their structure. In particular, the two models estimate economic benefits in different ways, with the MARKAL model reflecting the cost of additional investments required to achieve reductions in energy bills.

Photovoltaic Energy Systems

Funding Schedule by Activity

(dollars in thousands)

	FY 2003	FY 2004	FY 2005	$ Change	% Change
Photovoltaic Energy Systems					
Fundamental Research	27,186	29,341	30,000	+659	+2.2%
Advanced Materials and Devices	26,874	29,230	29,000	-230	-0.8%
Technology Development	8,883	10,350	12,433	+2,083	+20.1%
Congressionally Directed Activity, Photovoltaic Energy Systems/Navajo Electrification Project	2,408	0	0	0	0.0%
Congressionally Directed Activity, Photovoltaic Energy Systems/Power Modules	1,445	0	0	0	0.0%
Congressionally Directed Activity, Photovoltaic Energy Systems/Palo Alto Photovoltaic Demonstration Project	1,445	0	0	0	0.0%
Congressionally Directed Activity, Photovoltaic Energy Systems/Hard Bargain Farm	111	0	0	0	0.0%
Congressionally Directed Activity, Photovoltaic Energy Systems/Yucca Valley Project	0	245	0	-245	-100.0%
Congressionally Directed Activity, Photovoltaic Energy Systems/Million Solar Roofs	2,489	2,551	2,000	-551	-21.6%
Congressionally Directed Activity, Photovoltaic Energy Systems/Southeast and Southwest Experimentation Stations	2,408	2,453	2,000	-453	-18.5%
Congressionally Directed Activity, Photovoltaic Energy Systems/Center for Ecological Technology	0	392	0	-392	-100.0%
Congressionally Directed Activity, Photovoltaic Energy Systems/Hackensack University Green Building Medical Center	0	491	0	-491	-100.0%
Total, Photovoltaic Energy Systems	73,249	75,053	75,433	+380	+0.5%

Description

Photovoltaic (PV) technologies are semi-conducting materials that directly convert sunlight into electricity. Modular by nature with no moving parts, they can be sized to every need and placed almost anywhere sunlight is available.

Benefits

The Solar Program focuses on achieving the Department's long-term goal of making solar energy an important part of the national energy supply portfolio through the development of highly-reliable PV systems with user lifetime energy costs of approximately $0.06/kWh. The PV subprogram attempts to achieve this goal by 1) increasing their sunlight-to-electricity conversion efficiency (performance), 2) increasing system operating lifetime and reliability, and 3) reducing the manufacturing cost of cells, modules, and systems.

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

For FY 2005, the PV subprogram's priorities are:

- Cell and module development efforts, i.e., advanced crystalline silicon modules, thin-film modules, and super high-efficiency concentrator solar cells.
- Advanced module manufacturing technologies for high throughput and low-cost products.
- Systems reliability technologies, which increase the lifetime of thin-film modules and the mean time to failure of DC-to-AC current for low-cost, grid-tied distributed PV systems.

The Photovoltaic Energy Systems subprogram contributes to the overall program goal by developing PV technologies that are reliable, affordable, and environmentally sound. PV technologies transform our Nation's vast supply of free and available solar energy into a significant usable supply of electricity for use in homes, commercial buildings, industry, government facilities, and many other applications. Diversifying our national electricity generation fuel portfolio will increase national security by providing domestically available energy supply options for use both in normal and emergency situations. In addition, photovoltaic systems can either be integrated with the electricity grid or work independently, further increasing our national energy security by decreasing reliance on our vulnerable, aging electricity grid.

Key indicators of progress toward achieving these benefits include:

Historical and Expected Contributions

Cost	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
PV[a] ($/Watt)	2.50	2.35	2.25	2.10	1.95	1.85	1.75	1.65	1.60	1.55	1.50
CSP ($/kWh).....	0.13	0.13	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12

In response to the lessons learned from the DOE FY 2003 performance audit by KPMG and consistent with production cost measures developed for the FY 2005 PART, the solar PV subprogram is transitioning its performance target from actual manufacturer production costs (external outcomes) to engineering estimates of production costs (program outputs), based on the impacts of annual R&D progress. This new engineering-based cost estimation model will incorporate the portfolio of program R&D factors described in the Solar Program's Multi-Year Technical Plan that impact the price of electricity from PV.

While transitioning to this new model, in FY 2004 one key component in production cost, conversion efficiency, will be used as a measure of progress as the program develops and vettes the model. PV technology cost reductions are achieved in part through increases in PV module conversion efficiencies. These efficiencies are fairly simple to measure in the laboratory; such measurements also provide valuable feedback on progress toward R&D goals. Note that FY 2004 PV targets refer to conversion efficiencies of PV modules, while FY 2000 and FY 2001 targets refer to conversion efficiencies of PV cells (see Annual Performance Results and Targets table).

Efficiency levels differ for the two main types of PV modules. Crystalline silicon (c-Si) is the dominant PV technology, while thin films are a family of promising PV technologies that have recently entered commercial production. Accordingly, the projected efficiencies in the table below address both technologies.

PV Module Efficiency Projections

Conversion Efficiency (percentage)	2004	2005	2006	2007	2010	2020
Crystalline Silicon	12.5	13.5	14	14.5	16	20
Thin Films	10	11	12	12.5	14	18

To implement the budget and performance integration portion of the President's Management Agenda, the Solar Program participated in the Administration's R&D Investment Criteria (R&DIC) evaluation process, the OMB Program Assessment Rating Tool (PART) process, and a multi-year program planning process. These exercises guided program budget planning, management decisions, and performance goals and targets. As a result, this budget request for this subprogram redirects requested funding from congressionally-directed activities in FY 2003 and FY 2004 to R&D that better supports the program's performance goals.

[a] PV module manufacturing cost.

Detailed Justification

(dollars in thousands)

FY 2003	FY 2004	FY 2005

Fundamental Research **27,186** **29,341** **30,000**

Fundamental research is critical to continued advancement of photovoltaic technology to meet the Solar Program's long-term goal of $0.06/kWh electricity by 2020. There are three focus areas within Fundamental Research: Measurements and Characterization, Basic Research and University Program, and the High Performance Initiative.

The Measurements and Characterization capabilities at the National Laboratories provide an important contribution to industry and universities. In partnership with the laboratories, industry and university researchers are focused on improving 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. In FY 2005, the Measurements and Characterization activity will expand its effort to identify degradation mechanisms and intrinsic instabilities in thin-film materials and devices that affect reliability.

The Basic Research and University Program investigates innovative ideas and leap-frog technologies through laboratory and university research. This high-risk research opens the door to non-conventional concepts that could dramatically improve cost effectiveness in the long term. In support of thin films, research in FY 2005 will focus on processing methods to improve large-area deposition techniques and growth mechanisms such as non-vacuum deposition processes that can achieve better uniformity, fewer defects, and faster throughput. In support of this research, $2,100,000 from this subactivity will be used in FY 2005 to purchase laboratory instrumentation to equip the new Science and Technology Facility (S&TF) at the National Renewable Energy Laboratory (NREL). [The remainder of the $6,480,000 anticipated for equipment expenditures at the S&TF will be funded by the Solar Program in this and other subactivities in future years.]

The High Performance Initiative supports research to substantially increase the efficiency of two key technologies: 1) large-area, monolithically interconnected multi-junction thin films and 2) super high-efficiency multi-junction concentrating cells. Both approaches have the potential to substantially reduce the costs of photovoltaic cells. Fundamental research continued in FY 2005 is aimed at increasing, by 2010, the conversion efficiency of thin films from 8-10 percent to 14 percent and multi-junction concentrating cell efficiency from 30 percent to 40 percent.

In FY 2003 this activity was reduced by $1,157,129 for SBIR/STTR and transferred to the Science Appropriation.

Advanced Materials and Devices **26,874** **29,230** **29,000**

The Advanced Materials and Devices activity has three focus areas: the Thin Film Partnership, 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. Many PV technologists agree that thin-film technologies have the best chance for attaining the Solar

(dollars in thousands)

FY 2003	FY 2004	FY 2005

Program'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, cadmium telluride 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. In FY 2005, the program will begin the first full year of three-year cost-shared contracts under the Thin Film Partnership solicitation issued in FY 2004. Efforts will be continued by the new thin-film module reliability team to address degradation mechanisms and intrinsic instabilities of pre-commercial modules. In support of this research, $1,000,000 from this subactivity will be used in FY 2005 to purchase laboratory instrumentation to equip the S&TF at NREL. [The remainder of the $6,480,000 anticipated for equipment expenditures at the S&TF will be funded by the Solar Program in this and other subactivities in future years.]

Crystalline silicon (c-Si) is the workhorse of the U.S. industry, comprising 90 percent of the modules sold in the market today. The Crystalline Silicon R&D strategy is to use a small amount of Federal funding to leverage continued industry research to improve module efficiencies to 14 percent by 2006. In FY 2005, the university contracts that support the crystalline silicon R&D effort will be re-competed. Efforts will focus on the most innovative silicon crystal growth methods with improved throughput, conversion efficiency, and lower energy and materials costs.

In Advanced Manufacturing R&D, strong partnerships with the domestic PV industry have been formed with the goal of reducing costs, increasing efficiency, and increasing capacity to help enhance the industry's leadership in the development and manufacture of PV modules. 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 deficiencies 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. In FY 2005, the program will begin the first full year of new manufacturing cost-shared contracts to improve reliability of products in addition to reducing costs.

In FY 2003 this activity was reduced by $253,588 for SBIR/STTR and transferred to the Science Appropriation.

Technology Development **8,883** **10,350** **12,433**

The Technology Development activity has three focus areas: 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 codes and standards, as well as procedures for certifying performance of commercial systems. In FY 2005, funding will decrease slightly for systems engineering and reliability research, while the program maintains an emphasis on inverter reliability and completes Phase 2 of the inverter initiative. The program will work through Regional Experiment Stations to improve the reliability of distributed grid-tied systems, especially in the buildings sector.

Building Integrated Photovoltaics (BIPV) is a promising 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. In FY 2005, the program will continue BIPV research to more fully integrate PV into buildings.

Outreach and Analysis activities are necessary for a national R&D program to remain viable in a rapidly changing energy sector. Such activities include testing, verification, and deployment activities for grid-connected applications and analyzing private sector commercialization options to better target R&D pathways. In FY 2005, core technology analysis and outreach activities will continue, as well as the systems-driven approach activity to help identify research priorities.

Congressionally Directed Activity, Photovoltaic Energy Systems/Navajo Electrification Project	**2,408**	**0**	**0**

In FY 2003, the U.S. Congress set aside funds for activities to assist the Navajo Nation in providing power to homes that lack electric power, primarily for power line extension.

Congressionally Directed Activity, Photovoltaic Energy Systems/Power Modules	**1,445**	**0**	**0**

In FY 2003, the U.S. Congress set aside funds to develop high-reliability photovoltaic inverters.

Congressionally Directed Activity, Photovoltaic Energy Systems/Palo Alto Photovoltaic Demonstration Project	**1,445**	**0**	**0**

In FY 2003, the U.S. Congress set aside funds to install PV systems on city-owned buildings to reduce utility costs and educate utility customers.

(dollars in thousands)

	FY 2003	FY 2004	FY 2005
Congressionally Directed Activity, Photovoltaic Energy Systems/Hard Bargain Farm	**111**	**0**	**0**

In FY 2003, the U.S. Congress set aside funds to install PV systems on a 350-acre farm for student and teacher education on renewable energy.

Congressionally Directed Activity, Photovoltaic Energy Systems/Yucca Valley Project	**0**	**245**	**0**

In FY 2004, the U.S. Congress set aside funds to assist solar energy activities in Yucca Valley, California.

Congressionally Directed Activity, Photovoltaic Energy Systems/Million Solar Roofs	**2,489**	**2,551**	**2,000**

In FY 2003 and FY 2004, the U.S. Congress set aside funds for the Million Solar Roofs project.

Congressionally Directed Activity, Photovoltaic Energy Systems/Southeast and Southwest Experimentation Stations	**2,408**	**2,453**	**2,000**

In FY 2003 and 2004, the U.S. Congress set aside funds for activities to support the Southeast and Southwest PV experimentation stations.

Congressionally Directed Activity, Photovoltaic Energy Systems/Center for Ecological Technology	**0**	**392**	**0**

In FY 2004, the U.S. Congress set aside funds to assist the Center for Ecological Technology (Pittsfield, Massachusetts) with solar energy activities.

Congressionally Directed Activity, Photovoltaic Energy Systems/Hackensack University Green Building Medical Center	**0**	**491**	**0**

In FY 2004, the U.S. Congress set aside funds to assist the Hackensack University Green Building Medical Center (Hackensack, New Jersey) with solar energy activities.

Total, Photovoltaic Energy Systems	**73,249**	**75,053**	**75,433**

Explanation of Funding Changes

	FY 2005 vs. FY 2004 ($000)
Fundamental Research	
Increase long-term research on leap-frog technologies that show potential for meeting Program goals	+659
Advanced Materials and Devices	
Focus on those activities and contracts that show substantial progress under the Thin Film Partnership Program	-230
Technology Development	
Increase systems engineering evaluations on fielded systems through improved coordination of activities at National Laboratories	+2,083
Congressionally Directed Activity, Photovoltaic Energy Systems/Yucca Valley Project	
No funds are requested because funds are being allocated to other activities more closely aligned with the Program's goal.	-245
Congressionally Directed Activity, Photovoltaic Energy Systems/Million Solar Roofs	
Funding is being requested at an appropriate level based on anticipated activities in FY 2005 and after consultation with the program's multi-year plan	-551
Congressionally Directed Activity, Photovoltaic Energy Systems/Southeast and Southwest Experimentation Stations	
Funding is being requested at an appropriate level based on anticipated activities in FY 2005 and after consultation with the program's multi-year plan	-453
Congressionally Directed Activity, Photovoltaic Energy Systems/Center for Ecological Technology	
No funds are requested because funds are being allocated to other activities more closely aligned with the Program's goal.	-392
Congressionally Directed Activity, Photovoltaic Energy Systems/Hackensack University Green Building Medical Center	
No funds are requested because funds are being allocated to other activities more closely aligned with the Program's goal.	-491
Total Funding Change, Photovoltaic Energy Systems	+380

Solar Heating and Lighting

Funding Schedule by Activity

(dollars in thousands)

	FY 2003	FY 2004	FY 2005	$ Change	% Change
Solar Heating and Lighting					
Solar Heating and Lighting	3,783	2,944	2,900	-44	-1.5%
Total, Solar Heating and Lighting	3,783	2,944	2,900	-44	-1.5%

Description

The Solar Heating and Lighting (SHL) subprogram develops solar technologies that provide hot water and space heating for residential and commercial buildings in collaboration with industry partners.

Benefits

The glass-and-copper configuration of current solar water heaters makes them costly to manufacture, difficult to install and maintain, and inflexible in their applications. The SHL subprogram uses new formulations of lightweight polymer materials to modernize solar water heaters, making them easier to install, while lowering the cost of solar water heating in non-freezing climates by 50 percent from an equivalent of $0.08/kWh in 2003 to $0.04/kWh in 2006, which is expected to expand the market. The initial emphasis on systems designed for mild climates is expected to determine which polymeric materials will be able to withstand ultraviolet radiation for twenty years or more. SHL also provides technical support to the building industry and manufacturers in designing solar water heaters. In addition, SHL develops lighting systems that could increase the productivity of workers by bringing sunlight into interior rooms of office buildings, industrial and government facilities, hospitals, and schools.

The SHL subprogram contributes to the overall program goal by developing energy supply technologies that are reliable, affordable, and environmentally sound. SHL technologies use free and available solar energy to provide hot water and space heating in homes, commercial buildings, industry, government facilities, and many other applications. Using solar energy to provide this heat increases our national security by reducing our reliance on imported fossil fuel, diversifying our energy portfolio for both normal and emergency situations, and alleviating pressure on both the natural gas supply and the aging electricity grid. In addition, the use of natural light in buildings has been shown to improve student performance and worker productivity, as well as increase the proclivity of shoppers to purchase goods.

Key indicators of progress toward achieving these benefits include:

Historical and Expected Contributions

Cost	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Water Heating (Non-Freezing Climates) ($/kWh)	0.08	0.08	0.08	0.08	0.07	0.05	0.04[a]	--	--	--	--
Water Heating (Freezing Climates) ($/kWh)	--	--	--	--	0.10[b]	0.10	0.10	0.10	0.10	0.05	0.05

Detailed Justification

(dollars in thousands)

	FY 2003	FY 2004	FY 2005
Solar Heating and Lighting	**3,783**	**2,944**	**2,900**

Starting in FY 2004, the emphasis on solar water heater research shifted to development of systems that can withstand hard-freeze climates, which includes all of the U.S. north of the sunbelt states. In FY 2005, SHL will evaluate the conceptual designs developed in FY 2004 of low-cost solar water heating systems suitable for cold climates. SHL will continue to evaluate systems appropriate for non-freeze climates being field tested at numerous locations around the country.

In the area of solar lighting systems, the subprogram continues to support work at Oak Ridge National Laboratory (ORNL) in developing the second generation of hybrid solar lighting systems. ORNL is preparing the prototype systems for a lighting manufacturer to develop. Research concentrates on a solar concentrating dish and tracking system that focuses sunlight onto large-core optical fibers, which transfer the sunlight into interior rooms. This reduces energy requirements for artificial light and improves the quality of indoor lighting. In FY 2005, data from the hybrid solar lighting system installed at a commercial site in FY 2004 will be evaluated and modifications made to the design as needed.

In FY 2003 this subprogram was reduced by $70,000 for SBIR/STTR and transferred to the Science Appropriation.

Total, Solar Heating and Lighting	**3,783**	**2,944**	**2,900**

[a] Conclude development of the solar water heater suitable for non-freezing climates.
[b] Begin development of the solar water heater suitable for freezing climates.

Explanation of Funding Changes

	FY 2005 vs. FY 2004 ($000)
Solar Heating and Lighting	-44
Total Funding Change, Solar Heating and Lighting	**-44**

Concentrating Solar Power

Funding Schedule by Activity

(dollars in thousands)

	FY 2003	FY 2004	FY 2005	$ Change	% Change
Concentrating Solar Power					
Concentrating Solar Power	5,298	5,396	2,000	-3,396	-62.9%
Total, Concentrating Solar Power	5,298	5,396	2,000	-3,396	-62.9%

Description

Concentrating solar power (CSP) systems utilize the heat generated by concentrating and absorbing the sun's energy to drive a heat engine/generator to produce electric power. The concentrated sunlight produces temperatures ranging from 600°F to over 1500°F which are used to run heat engines or steam turbines for generating power or producing fuels such as hydrogen.

In light of a May 2003 report by Sargent and Lundy, Inc., a draft of which was reviewed by the National Research Council (NRC), the Department believes that cost and technical barriers associated with CSP can be overcome, and that deployment and associated public benefits can be achieved. A more thorough investigation, however, of the proper R&D course necessary to realize those benefits needs to be conducted in light of this study.

Benefits

The CSP subprogram contributes to the overall program goal by developing energy supply technologies that are reliable, affordable, and environmentally sound. Expanding our national electricity generation fuel portfolio will increase energy security by diversifying our domestically available energy supply options for use both in normal and emergency situations.

Detailed Justification

(dollars in thousands)

	FY 2003	FY 2004	FY 2005
Concentrating Solar Power	**5,298**	**5,396**	**2,000**

Essential CSP facilities at Sandia National Laboratories will be funded. Analytical support will be provided to several States (e.g., Nevada, California, Arizona, and New Mexico) that have expressed an interest in establishment of a CSP solar plant in their State. The program will develop a new comprehensive program plan for CSP. This plan is scheduled to be completed in calendar year 2004 and will help to inform the FY 2006 budget development process.

Total, Concentrating Solar Power	**5,298**	**5,396**	**2,000**

Explanation of Funding Changes

	FY 2005 vs. FY 2004 ($000)
Concentrating Solar Power	
Focus resources on analytical support to the States. R&D activities will be suspended during an assessment of evolving technological opportunities and development of a program plan	-3,396
Total Funding Change, Concentrating Solar Power	**-3,396**

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Zero Energy Buildings

Funding Profile by Subprogram[a]

(dollars in thousands)

	FY 2003 Comparable Appropriation	FY 2004 Original Appropriation	FY 2004 Adjustments	FY 2004 Comparable Appropriation	FY 2005 Request
Zero Energy Buildings					
Zero Energy Buildings Design	7,572	0	0	0	0
Total, Zero Energy Buildings	7,572	0	0	0	0

Public Law Authorizations:

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" (1978)
P.L. 95-619, "National Energy Conservation Policy Act" (NECPA) (1978)
P.L. 96-294, "Energy Security Act" (1980)
P.L. 100-357, "National Appliance Energy Conservation Amendments" (1988)
P.L. 101-218, "Renewable Energy and Energy Efficiency Technology Competitiveness Act" (1989)
P.L. 101-575, "Solar, Wind, Waste, and Geothermal Power Production Incentives Act" (1990)

Mission

The Zero Energy Buildings activities (ZEB) develop strategies to effectively integrate renewable energy technologies into high energy-efficient buildings. This involves research, development, demonstration, and technology transfer activities in partnership with industry, government agencies, universities, and national laboratories. The goal is to develop design strategies for buildings that are marketable and produce as much energy as they consume on an annual basis.

Benefits

In 2002, residential and commercial buildings accounted for 39 percent of the Nation's total energy consumption,[b] which cost the Nation $240 billion annually. 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. Introduction of new energy efficient technologies and designs, including those supported by the ZEB activity, can have significant economic and environmental benefits.

[a] SBIR/STTR funding in the amount of $136,171 was transferred to the Science appropriation in FY 2003. Estimates for SBIR/STTR budgeted in FY 2004 and FY 2005 are $0 and $0 respectively.

[b] Energy Information Agency, Monthly Energy Review, Aug. 2003, Table 2.1.

Funding Schedule by Activity

(dollars in thousands)

	FY 2003	FY 2004	FY 2005	$ Change	% Change
Zero Energy Buildings					
Zero Energy Buildings Design	3,719	0	0	0	0.0%
Congressionally Directed Activity, National Center for Energy Management & Buildings Technology	3,853	0	0	0	0.0%
Total, Zero Energy Buildings	7,572	0	0	0	0.0%

Description

In the next decade, it will be possible to build affordable homes and cost-effective commercial buildings that are 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.

As a result of program management and the PART review the Building Technologies Program FY 20005 budget proposal specifically is requesting funds to combine the necessary renewable energy R&D with ongoing activities in the energy conservation portion of the program funding to reduce redundancies.

Detailed Justifications

(dollars in thousands)

FY 2003	FY 2004	FY 2005
Zero Energy Buildings Design **3,719**	**0**	**0**

In FY 2003, ZEB teams developed prototype designs for broader geographic and economic market diversity and develop designs to integrate solar electric and solar thermal systems. Beginning in FY 2004, integration of energy supply technologies, developed under the Energy Supply appropriation, into buildings will be accomplished using funds from Energy Conservation Appropriations. In FY 2003 this activity was reduced by $136,171 for SBIR/STTR and transferred to the Science Appropriation.

(dollars in thousands)

	FY 2003	FY 2004	FY 2005
Congressionally Directed Activity, National Center for Energy Management & Buildings Technology	**3,853**	**0**	**0**

In FY03 the National Center for Energy Management and Building Technologies (NCEMBT) conducted four projects at the University of Nevada at Las Vegas: an IAQ survey and short term monitoring of 30 buildings; a survey of buildings with underfloor air distribution systems and laboratory studies of these systems; laboratory studies of variable air volume terminal air distribution systems to compare them to conventional air distribution systems; and the development of design data and a study of waste heat recovery in commercial buildings. In FY2004, funds for these activities were provided in the EERE Facilities and Infrastructure Budget.

Total, Zero Energy Buildings Design	**7,572**	**0**	**0**

Wind Energy

Funding Profile by Subprogram[a]

(dollars in thousands)

	FY 2003 Comparable Appropriation	FY 2004 Original Appropriation	FY 2004 Adjustments[b,c]	FY 2004 Comparable Appropriation	FY 2005 Request
Wind Energy					
Technology Viability.....	28,209	29,800	-565[d]	29,235	31,000
Technology Application	13,431	11,800	+275	12,075	10,600
Total, Wind Energy	41,640	41,600	-290	41,310	41,600

Public Law Authorizations:

P.L. 94-163 "Energy Policy and Conservation Act (EPCA)" (1975)
P.L. 101-218 "Renewable Energy and Energy Efficiency Technology Competitiveness Act" (1989)
P.L. 101-575 "Solar, Wind, Waste, and Geothermal Power Production Incentives Act" (1990)
P.L. 102-1018 "Energy Policy Act (EPACT)" (1992)

Mission

The mission of the Wind Energy Program is to lead the Nation's research and development efforts to improve wind energy technology through public/private partnerships that enhance domestic economic benefit from wind power development, and to address barriers to the use of wind energy in coordination with stakeholders, resulting in more diverse, clean, reliable, affordable and secure domestic supply.

Benefits

The Wind Program's mission and activities contribute directly to EERE's and DOE's mission of improving national, energy and economic security by addressing the President's National Energy Policy call for increasing the diversity of our Nation's energy resources. Achieving the Wind Program's mission will enhance the competitiveness of wind energy in conventional electricity markets, growing the domestic energy supply resource, yielding environmental benefits by avoiding pollutant emissions

[a] SBIR/STTR funding in the amount of $748,889 was transferred to the Science appropriation in FY 2003. Estimates for SBIR/STTR budgeted in FY 2004 and FY 2005 are $1,003,618 and $1,000,160 respectively.

[b] Programs in the Energy Supply Appropriation were reduced by .59 percent as required by the Omnibus Appropriations Bill.

[c] Programs in the Energy Supply appropriation were proportionally reduced based upon the allocated General Reduction of $4,684,000.

[d] Wind was provided increases by the Omnibus Appropriation Bill of $500,000. This amount was subject to the .59 percent reduction required by the Omnibus Appropriation Bill.

and benefiting the Nation's infrastructure posture by diminishing economic and system reliability effects of fuel price or supply disruptions.

More detailed, integrated and comprehensive economic, energy and energy security benefits estimates are provided in the Expected Program Outcomes section at the end of the program level budget narrative.

Strategic and Program Goals

The Department's Strategic Plan identifies four strategic goals (one each for defense, energy, science, and environmental aspects of the mission) plus seven general goals that tie to the strategic goals. The Wind program supports the following goal:

Energy Strategic Goal

General Goal 4, Energy Security: Improve energy security by developing technologies that foster a diverse supply of reliable, affordable and environmentally sound energy by providing for reliable delivery of energy, guarding against energy emergencies, exploring advanced technologies that make a fundamental improvement in our mix of energy options, and improving energy efficiency.

The Wind program has one program goal which contributes to General Goal 4 in the "goal cascade":

Program Goal 04.05.00.00: Wind Energy. By 2012, complete program technology research and development, collaborative efforts, and provide the technical support and outreach needed to overcome barriers – energy cost, energy market rules and infrastructure, and energy sector acceptance –to enable wind energy to compete with conventional fuels throughout the nation in serving and meeting the Nation's energy needs.

Contribution to Program Goal 04.05.00.00 (Wind Energy)

The Wind Program contributes to General Goal 4, Energy Security, by focusing on developing new, cost-effective technologies through research and development with competitively selected public-private partnerships and by facilitating the installation of wind systems by providing supporting research in power systems integration, technology acceptance and other analytical and engineering support. Key technology pathways that contribute to achievement of these benefits include (annual performance indicators are provided in the individual technology benefits narrative):

- Low Wind Speed Technology: By 2012, reduce the cost of electricity from large wind systems in Class 4 winds to 3 cents/kWh for onshore systems (from a baseline of 5.5 cents/kWh in 2002) or 5 cents/kWh for offshore systems (from a baseline of 7.5 cents in FY2005).
- Distributed Wind Technology: By 2007, reduce the cost of electricity from distributed wind systems to 10-15 cents/kWh in Class 3 wind resources, from a baseline of 17-22 cents/kWh in 2002. [Note: a range of cost performance targets are most appropriate for distributed wind systems, which require an approach based on relative improvement within scale, application, and market segments. The 10 cent/kWh target corresponds to a 50-100 kw turbine that is typical for large farms, small to mid-size commercial and/or remote village applications. The 15 cent/kWh target corresponds to a 3-10 kw turbine for residential applications.]
- Technology Acceptance: By 2005, provide the technical assistance needed to increase the number of States with at least 20 MS of wind power installed from 13 states in FY 2003 to 32 states; and by 2010, facilitate the installation of at least 100 MW in at least 30 States.

Annual Performance Results and Targets

FY 2000 Results	FY 2001 Results	FY 2002 Results	FY 2003 Results	FY 2004 Targets	FY 2005 Targets
Program Goal 04.05.00.00 (Wind Energy)					
Technology Viability					
4.0 cents per kilowatt-hour in Class 6 wind.	Advanced wind hybrid control system technology developed jointly with USDA Agricultural Research Center became commercially available.	Initiated development of an improved resolution national wind resource atlas, focusing first on new maps for high priority regions for commercial projects.	Completed low wind speed turbine conceptual design studies, and fabricated and began testing advanced wind turbine components optimized for low wind speed application initiated under industry partnership projects.	Complete testing of prototypes of first advanced low wind speed technology components, and complete detailed design under first public-private partnership project for full system low wind speed turbine development.	1) LWST: Complete fabrication and begin testing advanced variable speed power converter. Test first advanced blade, incorporating improved materials and manufacturing techniques. Field test an advanced 100-meter self-erecting tower and the first full-scale Low Wind Speed Technology prototype turbine. Contributing to the Annual LWST COE Target: 4.3 cents per kWh in Class 4 winds 2) DWT: Complete prototype testing of 1.8 KW Small Wind Turbine, finishing the International Electrotechnical Commission suite of tests for acoustics, power, durability, and safety. Contributing to the Annual DWT COE Target: 12-18 cents per kWh in Class 3 winds. 3) Technology Acceptance: 32 states with over 20 MW installed; 16 states with over 100 MW installed.
Management of Funds					
				Contribute proportionately to EERE's corporate goal of reducing corporate and program uncosteds to a range of 20-25 percent by reducing program annual uncosteds by 10 percent in 2004 relative to the program uncosted baseline (in 2003) until the target range is met.	Contribute proportionately to EERE's corporate goal of reducing corporate and program uncosteds to a range of 20-25 percent by reducing program annual uncosteds by 10 percent in 2005 relative to the program uncosted baseline (2004) until the target range is met.

Means and Strategies

The Wind Program will use various means and strategies to achieve its program goals as described below. "Means" include operational processes, resources, information, and the development of technologies, and "strategies" include program, policy, management and legislative initiatives and approaches. Various external factors, as listed below, may impact the ability to achieve the program's goals. Collaborations are integral to the planned investments, means and strategies, and to addressing external factors.

The program's current R&D focus is on the development of wind turbines that can operate economically in lower wind resource areas, which would significantly expand opportunities for wind energy use in the United States. Cost effective turbine technology for areas of the country with Class 4[a] wind resources would increase the total amount of economically viable wind energy resource in the Nation by a factor of twenty, and reduce the average distance to load centers by a factor of five. In FY 2005, the Program is including offshore systems in its Low Wind Speed Technology (LWST) activities. Offshore wind technology could enable harnessing abundant wind resources near major hard-to-serve load centers, such as in the Northeastern and Mid-Atlantic U.S.

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] Under the Distributed Wind Technology (DWT) activity, the program supports cost-shared public/private R&D partnerships for developing cost effective small wind turbine systems for Class 3[a] wind speed areas.

These means and strategies will result in improving energy security by increasing the generation of reliable, affordable and environmentally sound wind energy, adding to the diversity of the Nation's energy supply --- thus putting the taxpayers' dollars to more productive use.

The following external factors could affect Wind Technologies' ability to achieve its strategic goal:

- the availability of conventional supplies;
- the cost of competing technologies;

[a] The following table defines wind classes and their relative significance to energy production potential.

Wind Class	6	5	4	3
Wind speed (annual average wind speed in miles per hour at 33 feet above the ground)	15	14	13	12
Relative Energy Content at Different Wind Classes (%)	100	81	66	49

[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.

- state and international efforts to support wind energy;
- continuation of Federal tax incentives; and
- implementation of other policies at the national level, including Federal efforts to reduce carbon and criteria emissions.

In carrying out the program's mission, the Wind Technologies program collaborates in several important activities including:

- peer review of the Wind Program's overall strategies and its activities by academia, manufacturers and National Laboratories and with independent experts
- technological validation, systems integration and design with users.

Validation and Verification

To validate and verify program performance, the Wind Program will conduct internal and external reviews and audits. These programmatic activities are subject to continuing review by, for example, the Congress, the General Accounting Office, and the Department's Inspector General. The table below summarizes validation and verification activities.

Data Sources:	Low Wind Speed Turbine Technology Characterization, Migliore and Cohen, presented at Windpower 2003; Wind Energy Technology Characterization, 1997, published by EPRI. Low Wind Speed Turbine Technology Benefits, internal analysis for the FY 2002 request, peer reviewed by A.D. Little. FY 2001, FY 2002 and FY 2003 Wind Program Peer Reviews. American Wind Energy Association (AWEA)/Global Energy Concepts Wind Plant Database, reviewed by EIA, contains proprietary data. Various published and confidential data on wind projects economics. AWEA Small Wind Turbine Industry Roadmap.
Baselines:	WindPACT Final Report, National Renewable Energy Laboratory, documenting baseline cost of typical 1.5 MW wind turbine. AWEA's Small Wind Turbine Roadmap. Low Wind Speed Technology: 5.5 cents/KWh in FY 2002, Distributed Wind Technology : 17-22 cents/KWh in FY 2002, and Technology Application: 8 states with at least 20 MW installed wind in FY 2000, and 8 states with at least 100 MW installed wind in FY 2002.
Frequency:	Annual. As needed.
Data Storage:	Web, paper publications and on-line storage
Verification:	Wind Program Peer Reviews, industry experience, EIA Renewables Data group, meetings with State stakeholders, energy officials and technical groups.

Program Assessment Rating Tool (PART)

The Department implemented a tool to evaluate selected programs. The PART was developed by OMB to provide a standardized way to assess the effectiveness of the Federal Government's portfolio of programs. The structured framework of the PART provides a means through which programs can assess

their activities differently than through traditional reviews. The Wind Program has incorporated feedback from OMB into the FY 2005 Budget Request and has taken or will take the necessary steps to continue to improve performance.

The FY 2004 PART review of the Wind Energy Technology Program contained a recommendation to continue emphasis on wind technology development for low wind-speed areas, and Low Wind Speed Technologies are the FY 2005 Wind Program's budget focus. Another PART recommendation suggested the development of practical but meaningful annual performance measures, and the Wind Energy Program has developed annual performance targets for its 3 goals, covering over 90% of its budget request. The Wind program is also attempting to adhere to the specific direction of Congressional appropriation language while increasing the contribution to program goals to the extent possible. These improvements in accountability were reflected in the Wind program's significantly improved FY 2005 score in the results/accountability area, resulting in a modest overall score improvement of two points to seventy two, and a moderately effective rating, the second highest rating possible.

The FY2005 PART found that the program has a clear purpose and strong planning and management, the apparently contradictory lower scores in those areas were an artifact of a changed scoring system. The PART acknowledged the role of the program in commercial success of high wind-speed and transition to greater focus on low wind-speed area, reflected in the budget priorities. The PART also found that Congressional earmarks reduced program funding available for competitive solicitations and core national laboratory research designed to contribute toward program goals.

Funding by General and Program Goal

(dollars in thousands)

	FY 2003	FY 2004	FY 2005	$ Change	% Change
General Goal 4, Energy Security					
Program Goal 04.05.00.00, Wind Energy					
Technology Viability	28,209	29,235	31,000	+1,765	+6.0%
Technology Application	13,431	12,075	10,600	-1,475	-12.2%
Total, Program Goal 04.05.00.00, Wind Energy	41,640	41,310	41,600	+290	+0.7%
Total, General Goal 4 (Wind Energy)	41,640	41,310	41,600	+290	+0.7%

Expected Program Outcomes

The Wind Program pursues its mission through integrated activities designed to increase the use of domestic renewable resources. We expect these improvements to reduce susceptibility to energy price fluctuations and potentially lower energy bills; reduce EPA criteria and other pollutants; enhance energy security by increasing the production and diversity of domestic fuel supplies; and provide greater energy security and reliability by improving our energy infrastructure, In addition to these "EERE business-as-usual" benefits, realizing the Wind Program goals would provide the technical potential to reduce conventional energy use even further if warranted by future energy needs.

Estimates of non-renewable annual energy savings, energy expenditure savings, carbon emission reductions, natural gas savings, and wind electricity capacity additions that result from the realization of Wind Program goals are shown in the table below through 2050.

The assumptions and methods underlying the modeling efforts have significant impact on the estimated benefits, and results could vary significantly if external factors, such as future energy prices, differ from the baseline case assumed for this analysis. A summary of the methods, assumptions, and models used in developing these benefit estimates that are important for understanding these results are provided at www.eere.energy.gov/office_eere/budget_gpra.html Final documentation estimated to be completed and posted by March 15, 2004. Uncertainties are larger for longer term estimates. The results shown in the long term benefits tables are preliminary estimates based on initial modeling of some of the possible program production technologies; nonetheless, they provide a useful picture of growing national benefits over time.

FY 2005 GPRA Benefits Estimates for Wind Program[a]

Mid-Term Benefits[b]

	2010	2015	2020	2025
Primary Non-Renewable Energy Savings (Quads)	0.18	0.64	1.47	1.61
Energy Expenditure Savings (Billion 2001$)	0.6	3.8	10.1	3.7
Carbon Emission Reductions (MMTCE)	3.6	12.7	28.5	35.7
Natural Gas Savings (Quads)	0.08	0.32	0.80	0.48
Program Specific Electric Capacity (GW) Additions	7	24	55	59

[a] Benefits reported are annual, not cumulative, for the year given. Estimates reflect the benefits associated with program activities from FY 2005 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] Mid-term program benefits were estimated utilizing the GPRA05-NEMS model, based on the Energy Information Administration's (EIA) National Energy Modeling System (NEMS) and utilizing the EIA's Annual Energy Outlook (AEO) 2003 Reference Case.

Long-Term Benefits[a]

	2030	2040	2050
Primary Non-Renewable Energy Savings (Quads)	1.81	2.35	4.01
Energy System Cost Savings (Billion 2001$)	4.3	5.8	5.7
Carbon Emission Reductions (MMTCE)	35	46	85.0
Oil Savings (MBPD)	0.03	0.05	0.02
Natural Gas Savings (Quads)	0.84	1.31	1.56
Program Specific Electric Capacity (GW) Additions	50	61	121

[a] Long-term benefits were estimated utilizing the GPRA05 - MARKAL developed by Brookhaven National Laboratory (BNL). Results can differ among models due to differences in their structure. In particular, the two models estimate economic benefits in different ways, with the MARKAL model reflecting the cost of additional investments required to achieve reductions in energy bills.

Technology Viability

Funding Schedule by Activity

(dollars in thousands)

	FY 2003	FY 2004	FY 2005	$ Change	% Change
Technology Viability					
Low Wind Speed Technology (Large Systems)	11,560	11,772	12,000	+228	+1.9%
Distributed Wind Technology (DWT – Small Systems)	1,927	1,962	2,000	+38	+1.9%
Supporting Research and Testing (SR&T)	14,722	15,501	17,000	+1,499	+9.7%
Total, Technology Viability	28,209	29,235	31,000	+1,765	+6.0%

Description

Technology Viability focuses on developing new, cost-effective technologies through research and development using competitively selected public/private partnerships (Low Wind Speed Technology and Distributed Wind Technology projects) closely coordinated with Supporting Research and Testing conducted by National laboratories.

Benefits

The Technology Viability key activity focuses on the research and development for improving the cost effectiveness of large and small wind energy systems, which is a primary barrier to wind energy competing without disadvantage to serve the Nation's energy needs.

The following table provides expected annual indicators of progress for the LWST and DWT activities:

Fiscal Year	02	03	04	05	06	07	08	09	10	11	12
Low Wind Speed Technology[a]											
Target	5.5	5.0	4.6	4.3	4.0	3.7	3.5	3.3	3.2	3.1	3.0
Actual	5.5	4.5									
Distributed Wind Technology[b]											
Target	17-22	14-20	13-19	12-18	11-16	10-15					
Actual		14-20									

The Wind Program also has developed a methodology for demonstrating performance. Levelized cost of energy (COE), in constant dollars, is the primary performance indicator for the LWST and DWT efforts. Achieving the planned COE target will be possible through the incremental improvement opportunities presented by the various LWST, DWT, and Supporting Research and Testing (SR&T) efforts. Estimating cost of energy for full-scale prototypes will be based on industry experience in maturation of technologies and manufacturing processes. Determining the COE impact of improvements in individual components and subsystems will be based on comparisons against a baseline turbine composite with a well-understood cost of energy. On a yearly basis throughout the course of the LWST and DWT projects, the impact of technology improvements will be assessed and the results will be peer-reviewed. Forecasts of COE impact will be based on progress of existing subcontracts and results of research efforts at the time of the assessment, thereby allowing a clear picture of the impact of improvements against the overall goals and objectives.

Detailed Justification

(dollars in thousands)

FY 2003	FY 2004	FY 2005
Low Wind Speed Technology (Large Systems)	**11,560**	**11,772**	**12,000**

The Low Wind Speed Technology (LWST) project supports public-private partnerships for multiple large wind system technology pathways (turbines over 100 kilowatts) to achieve the goal of 3¢/kWh for onshore systems or 5 cents/kWh for offshore systems in Class 4 winds by 2012. New partnerships to catalyze industry adoption of component technology developments and emerging innovation are supported through a series of three LWST competitive solicitations - Phase I was initiated in FY 2002, Phase II is planned to begin in FY 2004, and Phase III is planned to commence in FY 2007. These

[a] cents/kilowatt hour in Class 4
[b] cents/kilowatt hour in Class 3

concentrate on three technical areas: 1) conceptual design studies, 2) component development and testing; and 3) full turbine prototype development and testing. The Phase II LWST solicitation has offered the opportunity for supporting offshore wind energy system technology development. The LWST portfolio and related Supporting Research and Testing activities are 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.

In 2005, three major milestones are expected under this effort: 1) Complete fabrication and begin testing of an advanced variable speed power converter; 2) Testing of the first advanced blade incorporating improved materials and manufacturing techniques; and 3) Field testing of the first full-scale LWST proof-of-concept turbine.

Distributed Wind Technology (DWT - Small Systems)..... **1,927** **1,962** **2,000**

The Distributed Wind Technology (DWT) project supports public-private partnerships for multiple small wind system (less than 100 kilowatts) pathways for achieving the program goal of 10-15 cents per kilowatt-hour in Class 3 resources by 2007. The DWT strategy is patterned after the LWST project in its low wind speed focus and project structures. Public-private partnerships selected through DWT project competitive solicitations in FY 2003 for concept studies, component development, and full turbine prototype development will be coordinated with Supporting Research and Testing activities, and periodically reviewed against established project milestones to assure performance.

In FY 2005, the program will complete final designs and commence fabrication of distributed wind technology components and subsystems under public-private partnerships for projects that were competitively selected in 2003; complete design and commence fabrication of components for prototype turbine systems; complete prototype testing of 1.8 kW and 50 kW Small Wind Turbine (SWT) projects; finish the International Electrotechnical Commission suite of tests for acoustics, power, durability, and safety to enable industry to begin commercialization activity; and issue a new solicitation in FY 2005 for further development of conceptual designs and components resulting from the Distributed Wind Solicitation of FY 2003.

Supporting Research and Testing (SR&T) **14,722** **15,501** **17,000**

Supporting Research and Testing (SR&T) is composed of three key program elements that directly support development of Low Wind Speed Technology (LWST) and Distributed Wind Technology (DWT): Design Review and Analysis, Enabling Research, and Testing Support. SR&T provides technical support essential to the LWST and DWT public/private partnerships by engaging the capabilities of the National Labs, universities and other technical support available in private industry.

The Design Review and Analysis task ensures that improved products resulting from advances in R&D

(dollars in thousands)

FY 2003	FY 2004	FY 2005

are developed in a logical and safe manner and in compliance with the applicable international certification standards - a vital step in mitigating the risk of market acceptance for LWST and DWT output technology.

Enabling Research activities in advanced rotor development, drive train and power systems, inflow and site characterization, and systems and controls provide the technical improvements in components and integrated systems needed to support LWST and DWT projects. Characterization of the design environment, improved computer simulation codes, advanced components, and integrated systems and controls are the main product outputs.

The third program element, Testing Support, includes both facility and field tests of all newly developed LWST and DWT components and systems to ensure design and performance compliance. Structural testing of blades up to 45 meters in length and fully integrated power drive train tests, up to 2.5 MW, are accomplished in the controlled environments of the Industrial User Facility (IUF) and Dynamometer Test Facility (DTF). Field testing of fully integrated prototypes in actual wind farms and distributed power applications provides the final validation of the LWST and DWT designs.

SR&T also includes Small Business Innovation Research (SBIR) support, and funding required for operation of the National Wind Technology Center (NWTC) at the National Renewable Energy Laboratory (NREL) for specialized engineering test facilities and equipment that directly support LWST and DWT public-private technology development partnerships. (Of the $2.0 million for NWTC in FY05, $350,000 falls under SR&T.) Capital equipment expenditures of approximately $450,000 are expected by the National Renewable Energy Laboratory in FY 2005. Performance is measured for R&D activities using analytically-established targets linking contributions from each activity to meeting LWST and DWT program goals. Outputs of this activity include periodic design reviews and conduct of tests at industry and laboratory locations.

In FY 2005, begin testing of one component under DWT cooperative agreement. Initiate Great Plains long-term inflow and structural dynamics test of a 1.5 MW machine in a joint public/private partnership with industries. Release several control paradigms for load reduction strategies for very large machines; begin new R&D efforts to support offshore and Great Plains deployment with advanced atmospheric inflow monitoring sensor development and analysis and simulation enhancements to support turbine/ocean platform integration; and complete the Small Wind Research Turbine Field Test. In FY 2003 this activity was reduced by $500,000 for SBIR/STTR and transferred to the Science Appropriation.

Total, Technology Viability	**28,209**	**29,235**	**31,000**

Explanation of Funding Changes

	FY 2005 vs. FY 2004 ($000)
Low Wind Speed Technology	
Increase restores activity to a level of effort consistent with FY 2004 appropriation levels prior to general reductions, and will allow accelerating support for competitively selected public-private partnerships	+228
Distributed Wind Technology	
No significant change	+38
Supporting Research and Testing	
Increase supports additional laboratory and field testing requirements for component and system prototypes developed under LWST and DWT public/private partnership projects	+1,499
Total Funding Change, Technology Viability	**+1,765**

Technology Application

Funding Schedule by Activity

(dollars in thousands)

	FY 2003	FY 2004	FY 2005	$ Change	% Change
Technology Application					
Systems Integration	3,083	3,637	3,200	-437	-12.0%
Resource Assessment	964	981	0	-981	-100.0%
Technology Acceptance	3,467	3,532	4,000	+468	+13.3%
Supporting Engineering and Analysis					
Supporting Engineering and Analysis	4,472	2,996	3,400	+404	+13.5%
Congressionally Directed Activities, Supporting Engineering and Analysis	1,445	929	0	-929	-100.0%
Total, Supporting Engineering and Analysis	5,917	3,925	3,400	-525	-13.4%
Total, Technology Application	13,431	12,075	10,600	-1,475	-12.2%

Description

The Technology Application subprogram addresses opportunities and barriers other than turbine cost of energy concerning use of wind energy systems. Activities include Systems Integration that requires applied technical efforts, and Technology Acceptance, which focuses on resolving institutional issues and providing energy sector outreach. Technology Application also includes cross-cutting Supporting Engineering and Analysis 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. Technology Application also includes resource assessment as required to support Systems Integration and Technology Acceptance activities as core natural resource assessment and mapping are being completed in FY 2004.

Benefits

Technology Application helps the program achieve its mission by focusing on the non-energy cost barriers that are impeding wind energy's use in the United States.

The following table provides expected annual indicators of progress for Technology Application:

Technology Acceptance

	(fiscal year)										
	00	01	02	03	04	05	06	07	08	09	10
# of states with 20 MW Target	8	10	13	19	25	32					
# of state with 20 MW Actual	8	12	13	17							
# of states with 100 MW Target			8	10	12	16	19	22	25	27	30
# of states with 100 MW Actual.....	4	7	8	10							

The Technology Application performance targets above are used as a way to measure the success of the Wind Energy Program's outreach activities. Since each State is a unique regulatory, policy and economic entity, reaching 20 MW installed capacity is a critical introductory threshold whereby initial barriers to development are overcome, and further wind development on a greater scale can proceed and thus contribute to the goal of increasing domestic energy supplies. Reaching 100 MW installed capacity threshold is an important indicator that wind is being accepted as a large-scale generating option by the State's utilities, regulators, and investors.

Detailed Justification

(dollars in thousands)

FY 2003	FY 2004	FY 2005

Systems Integration **3,083** **3,637** **3,200**

Systems Integration is comprised of efforts to enhance the compatibility of wind energy technologies with the electric power system, and to develop information to assure fair treatment of wind energy by power system operators, transmission owners and regulators. 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 stand-alone applications such as hybrid diesel systems, and wind turbines in distributed applications, often close to customers. Technical assistance is provided to electric utilities, regulators, and other stakeholders to address issues such as system impacts from wind plant power variations, and appropriate treatment for an intermittent source such as wind power to allow such plants to participate in the competitive marketplace. Systems Integration also includes coordinated assessment and analysis of integration of wind with hydropower, other renewable energy systems, and emerging energy-related needs, such as production of hydrogen, and desalination, purification and delivery of water. This activity includes $497,050 in FY04 for the Wind Energy Transmission Study, as provided for in the Omnibus Appropriations Bill.

In FY 2005, real time performance data will be collected from wind plants operating in different regions of the country to provide expanded data for assessment of power system impacts, control measures and mitigation options. Staff in at least two regional transmission organizations will be engaged to identify problems with the treatment of wind energy and opportunities for mitigation through wind plant forecasting, wind plant control, coordination with hydropower and energy storage. Through stakeholder groups, the program will facilitate consideration of regional transmission upgrades to support wind and other resources. Also, a wind/hydropower pilot test to validate models for improved coordination of wind and hydropower will be completed. Cooperative research will be conducted with National Oceanic and Atmospheric Administration (NOAA) Laboratories in adapting numerical weather prediction models for use in wind energy forecasting.

Resource Assessment **964** **981** **0**

The program has employed the best scientific knowledge and regional and local experience to collect wind resource data and prepare detailed maps as an essential tool in identifying promising areas for development. In the last 10 years, efforts have focused on refinement of initial resource maps by adding measurements, finer scale surface and terrain data through geographic information systems, and large-scale weather modeling. The program has largely transferred this level of mapping technology to the private sector where a small number of companies can provide mapping services.

In FY 2005, no funds are requested for this activity since core resource assessment and mapping efforts

will be completed in FY 2004. The program intends to transfer State and local mapping capability completed in previous years to industry, and remaining needs for resource assessment-related activities to other parts of the program.

Technology Acceptance	**3,467**	**3,532**	**4,000**

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 ($3.1 million) 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, supporting 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 access to wind resource information and to provide data on technical and institutional barriers to wind power development and other topical issues. Performance for this activity is measured by tracking the number of states that have installations of 20 MW and 100 MW, respectively, indicating the level of acceptance of wind power in these states.

In FY 2005, activities will focus on continuing support for existing and emerging state wind working groups, expanding tribal wind outreach on wind resource assessment and technical assistance, strengthening partnership activities with agriculture-sector national organizations, and expanding small wind system support activities. FY 2005 performance targets for this activity: 32 states with over 20 MW installed; and 16 states with at least 100 MW installed.

Supporting Engineering and Analysis	**5,917**	**3,925**	**3,400**
▪ **Supporting Engineering and Analysis**	**4,472**	**2,996**	**3,400**

The Supporting Engineering and Analysis (SE&A) activity provides a number of cross-cutting functions for supporting the achievement of the program's goals. These include systems analysis to track improvements in wind technology in diverse applications; assessment of future improvements in cost performance of wind technology (i.e., technology characterization); market analyses leading to benefits assessments to support the Government Performance and Results Act (GPRA); investigation of technical, environmental, and institutional issues to address near-term barriers for industry; participation in development of domestic and international design standards for wind turbine design and testing, design review and testing support for the Underwriters Laboratories wind turbine certification program; and operation and management of the National Wind Technology Center (NWTC) to support staff, facilities and Technology Application activities. [Of the $2.0 million for the NWTC, $1.45 million falls under SE&A.]

In FY 2005, the Program will complete certification testing of two industry turbines at the NWTC;

complete programmatic analyses and data collection required to update wind technology characterization and projections, wind project database, and to support program benefits assessment required by GPRA; and support program annual outreach publications and website maintenance. In FY 2003 this activity was reduced by a transfer to the Science Appropriation of $248,889 for SBIR/STTR.

- **Congressionally Directed Activities, Supporting Engineering and Analysis** **1,445** **929** **0**

Vermont-Department of Public Service - for a public education and outreach project to reduce barriers to wind energy use in the State. FY 2003 ($482,000), FY 2004 ($490,536); Wind Generation Facility for St. Paul Island and Unalaska, Alaska. FY 2003 ($963,000); St. Francis, Pennsylvania Wind Farm Feasibility Study. FY 2004 ($144,218); Saginaw, Michigan Chippewa Wind Project. FY 2004 ($294,321)

Total, Technology Application	**13,431**	**12,075**	**10,600**

Explanation of Funding Changes

	FY 2005 vs. FY 2004 ($000)
Systems Integration	
No funds requested for the Wind Energy Transmission study as directed in the FY 2004 Omnibus Appropriation bill	-437
Resource Assessment	
No funds requested since core resource mapping activities completed in FY 2004	-981
Technology Acceptance	
Increase due to expanded scope of State collaborative activities, particularly those focused on tribes and small wind installations	+468
Supporting Engineering and Analysis	

- **Supporting Engineering and Analysis**

	FY 2005 vs. FY 2004 ($000)
Decrease due to reduced funding requirements for Regional Field Verification projects and related support as project installations are completed and operational periods of prior projects are completed	+404
▪ **Congressionally Directed Activities, Supporting Engineering and Analysis**	
No funds are requested because funds are being allocated to other activities more closely aligned with the Program's goal	-929
Total, Supporting Engineering and Analysis	-525
Total Funding Change, Technology Application	**-1,475**

Hydropower Technologies

Funding Profile by Subprogram[a]

(dollars in thousands)

	FY 2003 Comparable Appropriation	FY 2004 Original Appropriation	FY 2004 Adjustments[b,c]	FY 2004 Comparable Appropriation	FY 2005 Request
Hydropower Technologies					
Technology Viability.....	3,811	3,555	-68	3,487	4,400
Technology Application	1,205	1,445	-27	1,418	1,600
Total, Hydropower Technologies	5,016	5,000	-95	4,905	6,000

Public Law Authorizations:

P.L. 93-577, "Federal Non-Nuclear Energy Research and Development Act" (1974)
P.L. 94-163, "Energy Policy and Conservation Act (EPCA)" (1975)
P.L. 94-385, "Energy Conservation and Production Act (ECPA)" (1976)
P.L. 95-91, "Department of Energy Organization Act" (1977)
P.L. 95-238, "Department of Energy Act – Civilian Applications" (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" (1989)
P.L. 104-303, "Water Resources Development Act" (1996)

Mission

The mission of the Hydropower Technologies Program ("Hydropower Program") is to lead the Nation's efforts to improve the technical, societal, and environmental benefits of hydropower, and develop cost-competitive technologies that enable the development of new and incremental hydropower capacity, adding to the diversity of the Nation's energy supply.

Benefits

The Hydropower Program's mission and activities contribute directly to EERE's and DOE's mission of improving National, Energy, and Economic security in responding to the President's National Energy Policy Supply Goal, which stated:

[a] SBIR/STTR funding in the amount of $90,201 was transferred to the Science appropriation in FY 2003. Estimates for SBIR/STTR budgeted in FY 2004 and FY 2005 are $130,446 and $159,600 respectively.

[b] Programs in the Energy Supply appropriation were reduced by .59 percent as required by the Omnibus Appropriation Bill.

[c] Programs in the Energy Supply appropriation were proportionally reduced based upon the allocated General Reduction of $4,684,000.

*A primary goal of the National Energy Policy is to add supply from diverse sources. This means domestic oil, gas, and coal. It also means **hydropower** and nuclear power.*[a]

Achieving the Program's mission to develop and test new technologies will enable an additional increment of power to be safely developed in the United States without the need for new dams, and allow hydropower to continue its role as an important part of the Nation's renewable energy portfolio.

More detailed, integrated and comprehensive economic, energy and energy security benefits estimates are provided in the Expected Program Outcomes section at the end of the program level budget narrative.

Strategic and Program Goals

The Department's Strategic Plan identifies four strategic goals (one each for defense, energy, science, and environmental aspects of the mission) plus seven general goals that tie to the strategic goals. The Hydropower program supports the following goal.

Energy Strategic Goal

General Goal 4, Energy Security: Improve energy security by developing technologies that foster a diverse supply of reliable, affordable and environmentally sound energy by providing for reliable delivery of energy, guarding against energy emergencies, exploring advanced technologies that make a fundamental improvement in our mix of energy options, and improving energy efficiency.

The Hydropower program has one program goal which contributes to General Goal 4 in the "goal cascade":

Program Goal 04.06.00.00: Hydropower. The Hydropower Program's goal is to conduct the R&D necessary to improve hydropower's operational and environmental performance so that hydropower generation is increased because of its affordability, abundance, reliability and environmental benefits. In accomplishing this goal, the Program will increase the viability of hydropower, the Nation's most widely used renewable energy source, without construction of new dams.

[a] National Energy Policy, Report of the National Energy Policy Development Group, p. xiii, 2001 (emphasis added).

Contribution to Program Goal 04.06.00.00 (Hydropower)

The Hydropower Program will contribute to the General Goal 4, Energy Security, through development of Advanced Hydropower Technology. The key technology pathway that contributes to achievement of these benefits is developing new technology that will enable 10 percent growth from FY 2005 in hydropower generation at existing plants with enhanced environmental performance, compared to an expected average loss of 6 percent[a] at all non-Federal plants up for relicensing before 2015 as well as 6 percent loss from all Federal plants. The performance progress indicators for this mid-term goal are plant adoptions of the technologies which are presented in greater detail in the technology viability section.

[a] The EIA 2003 Annual Energy Outlook currently projects that hydropower capacity will remain level through 2025. Because a significant number of non-Federal facilities are up for relicensing during that period, and because Federal facility operations will face continuing scrutiny, the AEO projection to presumed to already reflect the success of the hydropower program's efforts. The 2005 baseline, above which program benefits are measured, was therefore set by reducing the AEO 2003 projection for hydropower generation by 6% of the sum of the generation from the non-Federal facilities to be relicensed and the generation from all Federal facilities. In the program benefits case, this amount of generation is restored as a program benefit. In addition, the program anticipates that increased reservoir operational efficiency can result in additional generation from existing reservoir systems. The program's long-term goal of enabling a 10% increase in efficiency is represented in the benefits estimate for GPRA2005 as 1% of total generation, a small portion of the total targeted benefit. The two sources of benefits) relicensing and operation efficiency) are summed to give the total program benefit.

Annual Performance Results and Targets

FY 2000 Results	FY 2001 Results	FY 2002 Results	FY 2003 Results	FY 2004 Targets	FY 2005 Targets
Program Goal 04.06.00.00 (Hydropower)					
Technology Validation, Technology Application					
N/A	Test facility completed for pilot-scale testing of the innovative turbine design developed by the Alden Research Laboratory team.	Pilot-scale biological and hydraulic testing initiated.	Completed pilot-scale testing, providing the basis for future full-scale testing at an operational site. Successful testing would provide industry with a proven design, helping attain the 2 percent mortality goal. Completed study of regulatory approaches for addressing dissolved oxygen concerns at hydropower facilities. Completed low-head/ low-power resource assessment for the lower 48 States.	Complete report comparing field tests and model results for the effects of blade strike on turbine-passed fish.	Complete prototype testing at the Osage project that demonstrates 2 percent improvement in oxygen content of water downstream of the hydropower plant.
Management of Funds					
				Contribute proportionately to EERE's corporate goal of reducing corporate and program uncosteds to a range of 20-25 percent by reducing program annual uncosteds by 10 percent in 2004 relative to the program uncosted baseline (in 2003) until the target range is met.	Contribute proportionately to EERE's corporate goal of reducing corporate and program uncosteds to a range of 20-25 percent by reducing program annual uncosteds by 10 percent in 2005 relative to the program uncosted baseline (2004) until the target range is met.

Means and Strategies

The Hydropower Program will use various means and strategies to achieve its program goals as described below. "Means" include operational processes, resources, information, and the development of technologies, and "strategies" include program, policy, management and legislative initiatives and approaches. Various external factors, as listed below, may impact the ability to achieve the program's goals. Collaborations are integral to the planned investments, means and strategies, and to addressing external factors.

The Program conducts research, development, testing, and field verification of hydropower systems through laboratory and public-private partnerships. In pursuing these activities, the Program regularly obtains inputs from hydropower experts from outside of the Department. The perspectives of hydropower practitioners help 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).

These strategies will result in these means and strategies improving energy security by increasing the generation of reliable, affordable, and environmentally sound hydropower energy, adding to the diversity of the Nation's energy supply.

The following external factors could affect Hydropower Technologies ability to achieve its strategic goal:

- Regulatory licensing and water use constraints associated with dam operations. Also, increasing hydropower generation at existing sites is dependent on incremental technology improvements that build on each other over several years.
- For undeveloped hydropower resources at new sites to be added to the energy mix, cost-effective and environmentally safe technologies need to be available for hydropower developers.

In carrying out the program's mission, Hydropower Technologies performs the following collaborative activities:

- peer reviewing the Program and its activities with academia, manufacturers and National laboratories, and with independent experts; and
- collaborates with users for technological validation systems integration and design.

Validation and Verification

To validate and verify program performance, the Hydropower Program will conduct internal and external reviews and audits. These programmatic activities are subject to continuing review by, for example, the Congress, the General Accounting Office, and the Department's Inspector General. The table below summarizes validation and verification activities.

Data Sources:	DOE Final Report, US Hydropower Resource Assessment (1998); DOE Low Head/Low Power Hydropower Resource Assessment (2003); Energy Information Administration Annual Energy Outlook, Annual Energy Review.

Baselines:	The baseline for total electricity net generation of conventional hydroelectric power is 260 billion kWh (2002), according to the EIA Annual Energy Review 2004. Dissolved Oxygen: 1.8 mg/l in 2002, Fish survivability: 5% for the best existing turbines, Generation Improvements from Advanced Turbine: 2005 is base year, Generation Improvements from Optimization: 2005 is base year.
Frequency:	Annual.
Data Storage:	Computer storage and available on DOE/EERE and EIA websites.
Verification:	DOE Hydropower Resource Assessment based on Federal Energy Regulatory Commission data and developed in coordination with state energy offices. DOE Low Head/Low Power Resource Assessment based on U.S. Geological Survey stream data and models.

Funding by General and Program Goal

(dollars in thousands)

	FY 2003	FY 2004	FY 2005	$ Change	% Change
General Goal 4, Energy Security					
Program Goal 04.06.00.00, Hydropower					
Technology Viability	3,811	3,487	4,400	+913	+26.2%
Technology Application	1,205	1,418	1,600	+182	+12.8%
Total, Program Goal 04.06.00.00, Hydropower	5,016	4,905	6,000	+1,095	+22.3%
Total, General Goal 4 (Hydropower Technology)	5,016	4,905	6,000	+1,095	+22.3%

Expected Program Outcomes

The Hydropower Program pursues its mission through integrated activities designed to increase the use of domestic renewable resources. We expect these improvements to help reduce susceptibility to energy price fluctuations and potentially lower energy bills; reduce EPA criteria and other pollutants; enhance energy security by increasing the production and diversity of domestic fuel supplies; and provide greater energy security and reliability by improving our energy infrastructure In addition to these "EERE business-as-usual" benefits, realizing the Hydropower Program goals would provide the technical potential to reduce conventional energy use even further if warranted by future energy needs.

Estimates of annual energy savings, energy expenditure savings, carbon emission reductions, natural gas savings, and electricity capacity that result from the realization of Hydropower Program goals are shown in the table below through 2025.

The assumptions and methods underlying the modeling efforts have significant impact on the estimated benefits, and results could vary significantly if external factors, such as future energy prices, differ from the baseline case assumed for this analysis. A summary of the methods, assumptions, and models used in developing these benefit estimates that are important for understanding these results are provided at www.eere.energy.gov/office_eere/budget_gpra.html Final documentation estimated to be completed and posted by March 15, 2004.

FY 2005 GPRA Benefits Estimates for Hydropower Program[a]

Mid-Term Benefits[b]

	2010	2015	2020	2025
Primary Non-Renewable Energy Savings (Quads)	0.10	0.15	0.18	0.16
Energy Expenditure Savings (Billion 2001$)	0.5	0.4	1.9	0.2
Carbon Emission Reductions (MMTCE)	2	3	4	3
Natural Gas Savings (Quads)	0.04	0.05	0.03	0.09
Program Specific Electric Capacity (GW)*	4	4	5	5

[a] Benefits reported are annual, not cumulative, for the year given. Estimates reflect the benefits associated with program activities from FY 2005 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] Mid-term program benefits were estimated utilizing the GPRA05-NEMS model, based on the Energy Information Administration's (EIA) National Energy Modeling System (NEMS) and utilizing the EIA's Annual Energy Outlook (AEO) 2003 Reference Case.

Technology Viability

Funding Schedule by Activity

(dollars in thousands)

	FY 2003	FY 2004	FY 2005	$ Change	% Change
Technology Viability					
Advanced Hydropower Technology (formerly Advanced Hydro Turbine Technology	2,761	1,987	3,000	+1,013	+51.0%
Supporting Research and Testing (formerly Biologically-Based Criteria Development).....	1,050	1,500	1,400	-100	-6.7%
Total, Technology Viability.....	3,811	3,487	4,400	+913	+26.2%

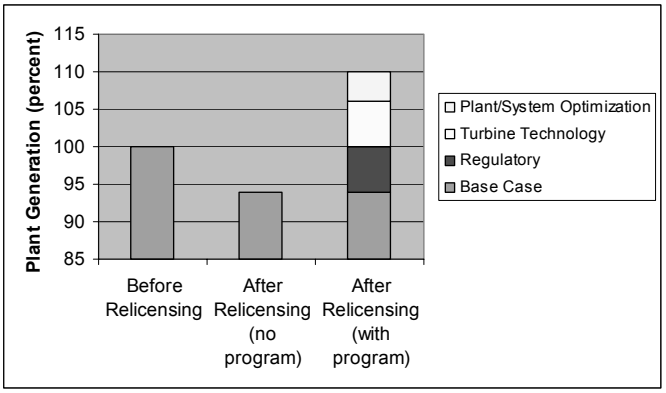
Description

The Technology Viability key activity focuses on development of advanced technologies that will have enhanced environmental performance and greater energy efficiencies.

The program is being reoriented to add to the prior emphasis on fish survivability and improved oxygen levels. The reoriented program's effect on generation is made up of three components:

- Regulatory
- Turbine Technology
- Plant/System Optimization

The chart to the side summarizes the components. The regulatory component is based on historical licensing trends. Typically, there has been a 6 percent plant generation reduction after relicensing due to new regulatory constraints aimed at environmental protection, like increased spill levels to protect fish. Fish-friendly turbines that have survival rates similar to spill provide a technology option to the hydropower operator that may allow them to avoid the regulatory generation loss. The second component is due to the performance characteristics of advanced turbines and being able to achieve 5 to 6 percent more generation from the given water supply. The third component is due to better water management and optimization of plants and systems. When implemented, these technologies will enable a 10 percent growth in hydropower generation at existing plants that implement these technologies, compared to an expected loss of 6 percent at all non-Federal plants up for relicensing before 2015 as well as 6 percent loss from all Federal plants.



The EIA 2003 Annual Energy Outlook currently projects that hydropower capacity will remain level through 2025. Because a significant number of non-Federal facilities are up for relicensing during that period, and because Federal facility operations will face continuing scrutiny, the AEO projection to presumed to already reflect the success of the hydropower program's efforts. The 2005 baseline, above which program benefits are measured, was therefore set by reducing the AEO 2003 projection for hydropower generation by 6% of the sum of the generation from the non-Federal facilities to be relicensed and the generation from all Federal facilities. In the program benefits case, this amount of generation is restored as a program benefit. In addition, the program anticipates that increased reservoir operational efficiency can result in additional generation from existing reservoir systems. The program's long-term goal of enabling a 10% increase in efficiency is represented in the benefits estimate for GPRA2005 as 1% of total generation, a small portion of the total targeted benefit. The two sources of benefits) relicensing and operation efficiency) are summed to give the total program benefit.

Research and Development conducted under Advanced Hydropower Technology directly contributes to increased hydropower generation. The turbine technology component is supported by the development and testing of improved hydropower turbines. The plant/system optimization component is supported by the development of operations tools that improve water management practices. Supporting Research and Testing provides the necessary basic research that is needed by industry and regulators to evaluate hydropower licensing options, which directly supports the regulatory component of increased generation.

Benefits

Technology Viability focuses on that part of the Hydropower Program's mission having to do with research and development into new advanced technologies, which is important both to achieving environmental improvements and to increasing overall electricity generation.

At selected sites where technology is implemented, the Program will measure the operational and environmental improvements. The program currently has large turbine testing planned at four sites to be completed in FY 2005-2008. As the technology improves, the results of plant testing are expected to improve so that by the end of the turbine testing projects in FY 2008, the program will have shown that at least a 6 percent generation increase is achievable. In FY 2009 and 2010, the program plans to evaluate the performance of water-use optimization technologies. The specific technologies to be implemented and sites to be studies will be determined at a later date. The following table shows annual indicators of progress toward achieving those benefits:

Year	Project	Dissolved Oxygen	Measured Fish Survivability	Generation Improvement from Advanced Turbines	Generation Improvement from Optimization
FY 2002	Baseline	1.8 mg/l	93%		
	Actual	1.8 mg/l	93%		
FY 2003	Target	4 mg/l	95%		
	Actual	4.2 mg/l	95%		
FY 2004		4 mg/l	95%[a]		
FY 2005	Osage Dam	2 mg/l improvement	95%[a]		
FY 2006	Wanapum Dam		96%	3%	
FY 2007	Box Canyon Dam		97%	4.5%	
FY 2008	Ice Harbor Dam		98%	6%	
FY 2009	Plant Optimization #1				1.5%
FY 2010	Plant Optimization #2				4%

As noted in the table above, by 2010, the program expects a 10% improvement in generation, a 3% improvement in fish survival and a 2 mg/l improvement in dissolved oxygen.

Detailed Justification

(dollars in thousands)

FY 2003	FY 2004	FY 2005
Advanced Hydropower Technology	**2,761**	**1,987**	**3,000**

The Advanced Hydropower Technology project supports the development of technologies that will enable hydropower operators at existing plants to generate more electricity with less environmental impact. This will be done through environmentally enhanced, improved efficiency turbines, as well as with new methods for optimizing unit, plant, and reservoir systems to increase energy production per unit water (i.e., water-use efficiency).

In FY 2005, the program will continue with competitively selected fish-friendly turbine testing projects of large turbines (greater than 1 MW) at the Wanapum, Box Canyon, and Osage hydropower

[a] No measurements planned for FY 2004 or FY 2005 because turbine installation not completed until FY 2006.

(dollars in thousands)

FY 2003	FY 2004	FY 2005

plants. The program will also work with the U.S. Army Corps of Engineers on laboratory scale modeling tests of the Ice Harbor hydropower plant. The program will continue research on methods to optimize water use efficiencies at the turbine unit and plant levels, and develop new public-private partnerships to test and demonstrate these new methods. The program will also begin developing integrated systems models for optimizing the operation of a series of plants in a river basin for enhanced energy and environmental quality. The program will initiate studies to evaluate the effectiveness of environmental mitigation practices, with emphasis on instream flow requirements at hydropower projects.

In FY 2003 this activity was reduced by $90,201 for SBIR/STTR and transferred to the Science Appropriation.

Supporting Research and Testing (formerly called Biologically-Based Criteria Development)	**1,050**	**1,500**	**1,400**

This activity addresses the need to fill significant gaps in the scientific understanding of fish response to the physical stresses experienced in passage through turbine systems. The research directly supports advanced technology development by producing biological design criteria. Research under this activity includes studies of fish passage through the hydropower system as a whole, including the cumulative effects of several injury mechanisms. The Department's research approach involves a unique combination of computer modeling, instrumentation, lab testing, and field-testing that is improving the design and operation of the next generation of hydropower technology.

In FY 2005, the program will continue studies on the cumulative effects of stresses on fish and the modeling and quantification of hydraulic forces within a turbine system. The program will complete physical modeling of turbulence, and computer models will be validated against new physical data sets from field and physical model systems. Development and testing of advanced instrumentation and measurement technology, such as the sensor fish device and imaging/monitoring methods, will also continue.

Total, Technology Viability	**3,811**	**3,487**	**4,400**

Explanation of Funding Changes

	FY 2004 vs. FY 2005 ($000)
Advanced Hydropower Technology	
Increased funding is due to the ramping up of the large turbine testing projects at Wanapum Dam and Box Canyon Dam, and cost-shared large turbines testing at Ice Harbor Dam with the Corps of Engineers. Will also be increasing research in water-use optimization technologies, an effort that was started in FY 2004	**+1,013**
Supporting Research and Testing	
Decreased funding is due to the completion of some hydropower turbulence measuring and modeling work	**-100**
Total Funding Change, Technology Viability	**+913**

Technology Application

Funding Schedule by Activity

(dollars in thousands)

	FY 2003	FY 2004	FY 2005	$ Change	% Change
Technology Application					
Systems Integration and Technology Acceptance (formerly part of Advanced Hydro Turbine Technology)	800	1,025	1,300	+275	+26.8%
Supporting Engineering and Analysis (formerly Low Head/Low Power Resource Assessment).....	405	393	300	-93	-23.7%
Total, Technology Application ...	1,205	1,418	1,600	+182	+12.8%

Description

The focus of Technology Application is Systems Integration and Technology Acceptance, a set of projects that are designed to assess technology requirements for and address barriers to undeveloped hydropower, and Supporting Engineering and Analysis, which focuses on technology characterization and analysis.

Benefits

By focusing on that part of the Hydropower Program that has to do with assessing technology requirements for and addressing barriers to undeveloped hydropower, the Technology Application subprogram can help to develop new sources of hydropower without building new dams.

Detailed Justification

(dollars in thousands)

	FY 2003	FY 2004	FY 2005
Systems Integration and Technology Acceptance (formerly part of Advanced Hydro Turbine Technology)	**800**	**1,025**	**1,300**

This activity addresses reducing the barriers to hydropower development, and includes the integration of hydropower with other renewables, an activity that was started in FY 2004. With many renewable energies being intermittent in nature, hydropower represents an important stored energy asset that can enable the larger scale deployment of renewable power plants such as wind. Systems Integration and Technology Acceptance also addresses Program outreach, working with hydropower stakeholders to address their issues and concerns.

In FY 2005, the program will conduct case studies of wind-hydropower integration opportunities in the United States and from these, develop lessons learned for distribution to industry. The program will also continue to work with international hydropower integration experts and apply international experience to the U.S. market. Additionally, the program will continue outreach activities with hydropower stakeholders, such as providing technical analysis, preparing reports, coordinating peer reviews and program reviews, maintaining a web site, and participating in technology advisory panels.

Supporting Engineering and Analysis (formerly called Low Head/Low Power Resource Assessment)	**405**	**393**	**300**

This activity addresses the characterization of hydropower technologies for developing currently undeveloped hydropower resources, including those resources identified in the Department's Low Head/Low Power Resource Assessment. It also includes the development of new analysis methods to quantify hydropower benefits and values that will provide better understanding of hydropower's role within renewable energy portfolios.

In FY 2005, as a follow-on to the Low Head/Low Power Resource Assessment, which was completed in FY 2004, the program will characterize the low head hydropower technologies available in the market and identify technology gaps. The program will initiate efforts to identify and develop low head technologies that are cost-effective, environmentally friendly, and could be used for development of low head hydropower resources. The program will also initiate new research to develop and test methods for measuring the economic and environmental value of hydropower, including net greenhouse gas emissions.

Total, Technology Application	**1,205**	**1,418**	**1,600**

Explanation of Funding Changes

	FY 2004 v FY 2005 ($000)
Systems Integration and Technology Acceptance	
Increased funding supports more detailed follow-on studies of hydropower and wind power integration, based on the scoping study recommendations completed in FY04, under the Systems Integration and Technology Acceptance effort	+275
Supporting Engineering and Analysis	
Decreased funding reflects the completion of the Low Head/Low Power Resource Assessment in FY 2004.....	-93
Total Funding Change, Technology Application	**+182**

Geothermal Technology

Funding Profile by Subprogram[a]

(dollars in thousands)

	FY 2003 Comparable Appropriation	FY 2004 Original Appropriation	FY 2004 Adjustments[b,c]	FY 2004 Comparable Appropriation	FY 2005 Request
Geothermal Technology					
Technology Development	18,656	19,600	-1,695	17,905	19,750
Technology Application	9,734	6,400	+1,203	7,603	6,050
Total, Geothermal Technology	28,390	26,000	-492	25,508	25,800

Public Law Authorizations:

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

Mission

The mission of the Geothermal Technology Program ("Geothermal 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.

Benefits

The Geothermal Program's mission and activities directly support DOE's mission to promote scientific and technological innovation in support of advancing the national, economic and energy security of the

[a] SBIR/STTR funding in the amount of $510,598 was transferred to the Science appropriation in FY 2003. Estimates for SBIR/STTR budgeted in FY 2004 and FY 2005 are $590,334 and $605,815 respectively.

[b] Programs in the Energy Supply appropriation were reduced by .59 percent as required by the Omnibus Appropriation Bill.

[c] Programs in the Energy Supply appropriation were proportionally reduced based upon the allocated General Reduction of $4,684,000.

United States. The technologies developed by this program will provide the Nation with new sources of electricity that are highly reliable and cost competitive and do not add to America's air pollution or the emission of greenhouse gases. Geothermal electricity generation is not subject to price volatility and supply disruptions from changes in global energy markets. Geothermal energy systems use a domestic and renewable source of energy.

More detailed, integrated and comprehensive economic, energy and energy security benefits estimates are provided in the Expected Program Outcomes section at the end of the program level budget narrative.

Strategic and Program Goals

The Department's Strategic Plan identifies four strategic goals (one each for defense, energy, science, and environmental aspects of the mission) plus seven general goals that tie to the strategic goals. The Geothermal program supports the following goals:

Energy Strategic Goal

General Goal 4, Energy Security: Improve energy security by developing technologies that foster a diverse supply of reliable, affordable, and environmentally sound energy by providing for reliable delivery of energy, guarding against energy emergencies, exploring advanced technologies that make a fundamental improvement in our mix of energy options, and improving energy efficiency.

The Geothermal program has one program goal which contributes to General Goal 4 in the "goal cascade":

Program Goal 04.07.00.00: Geothermal. The Geothermal Program goal is to improve performance and reduce market entry costs of geothermal energy to competitive levels. In quantitative terms, the goal is to reduce the levelized cost of power generated from conventional geothermal sources from 5-8 cents per kWh (kilowatt hour) in 2000 to 3-5 cents per kWh by 2010.

Contribution to Program Goal 04.07.00.00 (Geothermal Technology)

The Geothermal Program contributes to General Goal 4, Energy Security, by developing technology to enhance geothermal systems, thereby improving their productivity and increasing their economic lifetime.

Annual Performance Results and Targets

FY 2000	FY 2001	FY 2002	FY 2003	FY 2004	FY 2005
Program Goal 04.07.00.00: (Geothermal Technology)					
Technology Development/Systems Development					
Completed two designs of advanced air-cooled condensers for geothermal applications.	Selected industrial partners to increase reservoir productivity at three sites using Enhanced Geothermal System (EGS) technology.	Completed design and environmental assessment of a small-scale (300 kW to 1MW) geothermal power plant for field verification.	Begin construction 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 conversions system. Terminated as a result of partner failure to secure cost share financing.	Create an Enhanced Geothermal System (EGS) with an industry partner and test associated technology needed to operate and monitor the system.	Field test a fully integrated Diagnostics-While-Drilling (DWD) advanced drilling system in a high-temperature geothermal well, verifying control of drilling operations in real time, thereby reducing costs. If successful, DWD will reduce drilling costs by one half of the total cost reduction for drilling.
Management of Funds					
				Contribute proportionately to EERE's corporate goal of reducing corporate and program uncosteds to a range of 20-25 percent by reducing program annual uncosteds by 10 percent in 2004 relative to the program uncosted baseline (in 2003) until the target range is met.	Contribute proportionately to EERE's corporate goal of reducing corporate and program uncosteds to a range of 20-25 percent by reducing program annual uncosteds by 10 percent in 2005 relative to the program uncosted baseline (2004) until the target range is met.

Means and Strategies

The Geothermal Program will use various means and strategies to achieve its program goals as described below. "Means" include operational processes, resources, information, and the development of technologies, and "strategies" include program, policy, management and legislative initiatives and approaches. Various external factors, as listed below, may impact the ability to achieve the program's goals. Collaborations are integral to the planned investments, means and strategies, and to addressing external factors.

The Geothermal Program will use various means and strategies to achieve its program goal to improve performance and reduce market entry costs of geothermal energy technologies to competitive levels. Consequently, the Program has adopted a two-fold strategy: (1) provide selected, but aggressive, technology improvements that have the greatest impacts on performance and cost, and (2) mitigate non-technical barriers that can influence or affect performance and cost.

Four areas in which technology advances are vital to the success of a geothermal project include: resource discovery; resource access; resource production; and resource utilization. In resource discovery the program works to improve exploration tools while collaborating with stakeholders to expand the useful amounts of geothermal resources. In resource access the program seeks to reduce drilling costs and expand drilling capabilities through the adoption of an innovative drilling system. The program's approach in production focuses on making marginal resources (low-temperature, low-permeability, unsaturated) economic. And in resource utilization the program improves conversion technologies to increase efficiencies and decrease costs. Beyond the unique expertise resident at the National Laboratories, virtually all research projects are awarded via cost-shared competitive solicitations.

Besides advances in technology, the strategy is to reduce or eliminate institutional, regulatory, and other non-technical barriers that hamper the expanded use of geothermal energy in the United States. To do so the Program provides comprehensive and timely information about geothermal resources and how they are developed to interested stakeholders from the public and private sectors.

These means and strategies will result in improving energy security by increasing the generation of reliable, affordable, and environmentally sound geothermal energy, adding to the diversity and economic security of the Nation's energy supply.

The following external factors could influence the extent to which the Geothermal Program can achieve its strategic goal:

- Partner cost share (ability of research partners from other Federal and state agencies, such as U.S. Geological Survey, Department of Defense, and the California Energy Commission, to secure funding).
- demand for electricity
- availability of conventional energy supplies
- regulatory requirements
- market incentives
- cost of competing technologies
- continuation of Federal tax incentives and implementation of other policies at the national level

In carrying out its mission, the program performs the following collaborative activities:

- New geothermal resources are sought through teaming efforts involving a variety of public and private organizations such as universities and government agencies.
- Collaborating with stakeholders to expand the useful amounts of geothermal resources.
- Technical and programmatic input is provided from academia, National Laboratories, Federal and State government agencies, industry, and other stakeholder organizations through forums, working groups, and oversight committees.
- A broad cross section of stakeholders participates in planning future work and reviewing current activities.
- Emphasis has shifted in the research program from laboratory-based studies to field applications projects with cost-sharing collaborators.

Validation and Verification

To validate and verify program performance, the Geothermal Program conducts internal and external reviews and audits with the assistance of experts from a variety of stakeholder organizations. Research is coordinated closely with the geothermal community to ensure that the program's research directions and priorities address the needs of power producers, consumers, and other interested parties and to ensure that these activities are within the realm of technical feasibility and properly aligned with market forces. Peer reviews are performed using expert independent reviewers from geothermal and related fields. As the major stakeholder organizations, the Geothermal Resources Council and the Geothermal Energy Association, provide independent comments and recommendations on the current and future direction of the Geothermal Program (Geothermal Resources Council Bulletin, Vol. 32/Number 2, March/April 2003, p. 63, www.geothermal.org/articles).

Data Sources:	Geothermal Resources Council Bulletin; Geothermal Energy Association Update; Energy Information Administration's Annual Energy Review, Renewable Energy Annual, and Annual Energy Outlook; Geothermal Resources Council Transactions; Stanford Geothermal Program Workshop Proceedings; various system analyses by NREL and other contractors; International Energy Agency's Geothermal Implementing Agreement Annual Report; International Geothermal Association Newsletter; Peer Reviews of the U. S. Department of Energy's Geothermal Technology Program August 23-24, 2001, March 25-27, 2002, and July 29-August 1, 2003; Program Briefing March 20, 2003.
Baselines:	The Geothermal Program's baselines for cost reduction goals are contained in the draft Geothermal Technology Program's Multi-Year Technical Program Plan, April 2003. At higher grade geothermal resource areas, the cost of geothermal power in 2000 was 3.8 cents/kWh for flash power and 5.6 cents/kWh for binary power.
Frequency:	Annual
Data Storage:	Corporate Planning System

Verification: Trade association and educational association reviews; Geothermal Resources Council Annual Conference; personal contacts with the U.S. geothermal industry; Energy Information Administration's survey of geothermal heat pumps.

Program Assessment Rating Tool (PART)

In response to one of the FY 2004 PART recommendations, the Geothermal Program developed a set of performance measures dealing with the cost of drilling wells and the cost of building geothermal surface systems. In addition, the program developed performance measures for the number of new geothermal fields expected to be discovered in the United States, the amount of developable geothermal resources confirmed by resource assessment. A Multi-Year Program Plan is being generated that describes the technical pathways the program will follow to achieve the performance measures and the programmatic goal.

In response to one of the FY 2005 PART recommendations, the program continues to emphasize the Enhanced Geothermal Systems R&D that focuses on high-grade engineered geothermal systems. These improvements in planning, management and accountability were reflected in the program's significantly improved FY 2005 PART score in those three areas, resulting in an overall score improvement of six points to 71 and a rating improvement from "adequate" to "moderately effective", the second highest rating possible.

The FY 2005 PART found that the program has a very clear purpose and strong planning and management. The PART acknowledged the role of the Program in cost reduction and subsequent growth of competitive power production from expanded geothermal resources and implementation of the recommendation to shift resources to Enhanced Geothermal Systems. The PART also found that Congressional earmarks reduced program funding available for competitive solicitations and core national laboratory research designed to contribute toward program goals.

Funding by General and Program Goal

(dollars in thousands)

	FY 2003	FY 2004	FY 2005	$ Change	% Change
General Goal 4, Energy Security					
Program Goal 04.07.00.00, Geothermal Technology					
Technology Development	18,656	17,905	19,750	+1,845	+10.3%
Technology Application	8,771	6,622	6,050	-572	-8.6%
Total, Program Goal 04.07.00.00, Geothermal Technology	27,427	24,527	25,800	+1,273	+5.2%
All Other					
Congressionally Directed Activity, Technology Application/Lake County Basin Geothermal Project	963	981	0	-981	-100.0%
Total, All Other	963	981	0	-981	-100.0%
Total, General Goal 4 (Geothermal Technology)	28,390	25,508	25,800	+292	+1.1%

Expected Program Outcomes

The Geothermal Program pursues its mission through integrated activities designed to increase the use of domestic renewable resources and contribute towards improved energy productivity of our economy. We expect these improvements to reduce susceptibility to energy price fluctuations and potentially lower energy bills; reduce EPA criteria and other pollutants; enhance energy security by increasing the production and diversity of domestic fuel supplies; and provide greater energy security and reliability by improving our energy infrastructure. In addition to these "EERE business-as-usual" benefits, realizing the Geothermal Program goals would provide the technical potential to reduce conventional energy use even further if warranted by future energy needs.

Estimates of annual non-renewable energy savings, geothermal energy expenditure savings, carbon emission reductions, natural gas savings, and electricity capacity additions that result from the realization of Geothermal Program goals are shown in the table below through 2050.

The assumptions and methods underlying the modeling efforts have significant impact on the estimated benefits, and results could vary significantly if external factors, such as future energy prices, differ from the baseline case assumed for this analysis. A summary of the methods, assumptions, and models used in developing these benefit estimates that are important for understanding these results are provided at www.eere.energy.gov/office_eere/budget_gpra.html Final documentation estimated to be completed and posted by March 15, 2004. Uncertainties are larger for longer term estimates. The results shown in the long term benefits tables are preliminary estimates based on initial modeling of some of the possible

program production technologies; nonetheless, they provide a useful picture of growing national benefits over time.

FY 2005 GPRA Benefits Estimates for Geothermal Technology Program[a]

Mid-Term Benefits[b]

	2010	2015	2020	2025
Primary Non-Renewable Energy Savings (Quads)	0.2	0.2	0.2	0.3
Energy Expenditure Savings (Billion 2001$)	1	2	2	2
Carbon Emission Reductions (MMTCE)	3	2	4	7
Natural Gas Savings (Quads)	0.08	0.18	0.16	0.20
Program Specific Electric Capacity Additions (GW)	3	4	4	6

Long-Term Benefits[c]

	2030	2040	2050
Primary Non-Renewable Energy Savings (Quads)	0.4	1.5	2.1
Energy System Cost Savings (Billion 2001$)	4	5	9
Carbon Emission Reductions (MMTCE)	9	27	50
Program Specific Electric Capacity Additions (GW)	7	22	36

[a] Benefits reported are annual, not cumulative, for the year given. Estimates reflect the benefits associated with program activities from FY 2005 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] Mid-term program benefits were estimated utilizing the GPRA05-NEMS model, based on the Energy Information Administration's (EIA) National Energy Modeling System (NEMS) and utilizing the EIA's Annual Energy Outlook (AEO) 2003 Reference Case.

[c] Long-term benefits were estimated utilizing the GPRA05 - MARKAL developed by Brookhaven National Laboratory (BNL). Results can differ among models due to differences in their structure. In particular, the two models estimate economic benefits in different ways, with the MARKAL model reflecting the cost of additional investments required to achieve reductions in energy bills.

Technology Development

Funding Schedule by Activity

(dollars in thousands)

	FY 2003	FY 2004	FY 2005	$ Change	% Change
Technology Development					
Resource Development					
Resource Development	3,200	2,019	3,200	+1,181	+58.5%
Congressionally Directed Activity, Resource Development	963	981	0	-981	-100.0%
Total, Resource Development	4,163	3,000	3,200	+200	+6.7%
Enhanced Geothermal Systems	5,915	6,680	8,000	+1,320	+19.8%
Systems Development	8,578	8,225	8,550	+325	+4.0%
Total, Technology Development	18,656	17,905	19,750	+1,845	+10.3%

Description

This subprogram examines processes affecting the economical production capacity of geothermal systems with the intent of providing technology to increase that capacity substantially. The three components of this activity involve: (1) finding resources; (2) creating new techniques for improving geothermal reservoirs; and (3) developing advanced technology in drilling and energy conversion, the two major cost elements of a geothermal facility.

Benefits

Technology Development serves the program's mission through the design, construction, and testing of innovative technologies that reduce the cost of geothermal energy to competitive levels or make more geothermal resources available for production. This work is accomplished in close collaboration with industry as cost-sharing partners.

Historical and expected contributions within Technology Development include:

	2000	2001	2002	2003	2004	2005	2010	2015
Drilling ($/ft)								
Goal	300	291	282	273	264	255	215	200
Actual	300	291	282	273	--	--	--	--
Surface Systems ($/kW)								
Goal	2000	1960	1920	1880	1840	1800	1600	1500
Actual	2000	1960	1920	1880	--	--	--	--

Detailed Justification

(dollars in thousands)

	FY 2003	FY 2004	FY 2005
Resource Development	**4,163**	**3,000**	**3,200**
▪ **Resource Development**	**3,200**	**2,019**	**3,200**

Resource Development deals with finding, characterizing, and assessing the geothermal resource through understanding the formation and evolution of geothermal systems.

This activity subsumes portions of the former subactivities of Core Research, University Research, and Detection and Mapping. The work builds on continuing research that investigates seismicity, isotope geochemistry, 3-D magnetotellurics, and remote sensing as exploration tools. Available exploration technology from related industries (e.g., petroleum, mining, waste management) is evaluated for adaptation to geothermal environments. The objective is to double the exploration success rate, as determined by wildcat wells, from 20 percent in 2000 to 40 percent by 2015.

In FY 2005, the program will develop a suite of improved remote sensing, geophysical, and geochemical techniques and test them in collaboration with industry as reliable means to locate hidden geothermal resources. Cost-shared investigations of promising new sites will be conducted to verify the presence of resources. The program will continue to collaborate with the U.S. Geological Survey (USGS) on a national geothermal resource assessment by providing data, equipment, and personnel. An interagency report will be issued on geothermal resources in the Great Basin, based in part on FY 2004 assessment work with the USGS.

▪ **Congressionally Directed Activity, Resource Development**	**963**	**981**	**0**

Congressionally directed funds for geothermal research at the University of Nevada-Reno (FY 2003 $963,000; FY 2004 981,072).

(dollars in thousands)

FY 2003	FY 2004	FY 2005

Enhanced Geothermal Systems..... **5,915** **6,680** **8,000**

This activity includes portions of the former subactivities of Core Research and University Research as well as Enhanced Geothermal Systems.

Natural geothermal systems depend on three factors to produce energy: heat, water, and permeability. Heat is present virtually everywhere at depth; water and permeability are more problematic. Enhanced Geothermal Systems (EGS) are engineered reservoirs created to produce energy from geothermal resources deficient in economical amounts of water and/or permeability. EGS technology will increase the productivity and lifetime of those reservoirs. The Department estimates that the application of EGS technology can more than double the amount of viable geothermal resources in the West. The objective is to increase the amount of economic geothermal resources to 40,000 MW from about 19,000 MW as estimated by the Geothermal Energy Association in 1999.

The program will broaden our understanding of natural geothermal processes, such as fluid flow, fracture dynamics, and rock-water interaction, while continuing EGS research with industry partners at three project sites. In FY 2005, the program will conduct the following major activities: long-term flow testing of the enhanced reservoir at the Coso Hot Springs geothermal field on the U.S. Naval Weapons Air Station (China Lake, California); preliminary flow testing of the reservoir enhanced in FY 2004 at Desert Peak, Nevada; and evaluation of wellbore stimulation experiments conducted in FY 2004. The program will conduct analyses of flow tests at The Geysers and perform chemical stimulation of a well at Glass Mountain.

Systems Development **8,578** **8,225** **8,550**

Systems Development subsumes the former subactivities of Innovative Drilling Subsystems and Advanced Heat and Power Systems. Drilling and completion of wells account for 30 - 50 percent of the cost of a geothermal power project. High up-front costs and the chance of unsuccessful drilling can drive financial risk to unacceptable levels relative to anticipated project return on investment. Drilling research aims to produce new technologies for reducing the cost of geothermal wells through an integrated systems approach that focuses on improvements to key subsystems. The research effort draws on advancements from the petroleum, mining, and related industries, wherever new technology can be adapted for geothermal applications. The objective is to reduce the cost of drilling by 25 percent by 2008 compared to year 2000 costs. Systems Development also focuses on improved energy conversion technologies. These include better heat exchangers and condensers, which enable exploitation of lower temperature resources. Use of advanced materials and innovative energy conversion technologies can substantially improve the economics of geothermal energy generation. The objective is to reduce the capital costs of geothermal surface systems by 20 percent by 2010 compared to year 2000 costs.

In FY 2005, the program will demonstrate a robust Diagnostics-While-Drilling subsystem in geothermal wells, including a high-speed data link, a downhole instrumented sub-assembly for controlling a drag cutter drill bit, and a software package to assist the driller in controlling the drilling

(dollars in thousands)

FY 2003	FY 2004	FY 2005

operation. This demonstration builds on previous research on the Diagnostics-While-Drilling subsystem, advanced drill bits, a bit vibration suppression subsystem, and an improved lost circulation subsystem. The program will complete a computational model to predict the limits of stability for drag bits as a function of bit/drillstring design, operating conditions, and control methodologies; complete laboratory development of various technologies for augmenting drag bits such as hydraulic or particle-assisted drilling; and reduce polyurethane well grouting technology to common practice within the geothermal industry.

For energy conversion technologies, in FY 2005 the program will field test coatings suitable for 300^{o}C applications such as wellheads; complete a database on silica scale properties; demonstrate condenser enhancements yielding a 25% improvement in overall heat transfer for the same capital cost as in 2002; and establish a commercially viable design for a high-resolution, steam purity monitor. Condenser enhancements are based on prior year testing at an operating geothermal power plant. Improvements to these systems will have the highest likelihood of increasing efficiency while reducing costs for energy conversion facilities.

In FY 2003 Technology Development was reduced by $510,598 for SBIR/STTR which was transferred to the Science Appropriation.

Total, Technology Development	**18,656**	**17,905**	**19,750**

Explanation of Funding Changes

	FY 2005 vs. FY 2004 ($000)
Resource Development	
▪ **Resource Development**	
The increase provides for expanded efforts in resource assessment with the U.S. Geological Survey	+1,181
▪ **Congressionally Directed, Resource Development**	
No funds are requested because funds are being allocated to other activities more closely aligned with the Program's goal	-981
Total, Resource Development	+200

	FY 2005 vs. FY 2004 ($000)
Enhanced Geothermal Systems	
The increase provides support for the continued testing of EGS-related technologies in cost-shared projects at Coso, Desert Peak, Glass Mountain and The Geysers	+1,320
Systems Development	
The increase reflects the high priority placed on accelerating the integration of the Diagnostics-While-Drilling (DWD) subsystem. The funding allows a field test of the fully integrated DWD advanced drilling system in a high temperature geothermal well .	+325
Total Funding Change, Technology Development.....	**+1,845**

Technology Application

Funding Schedule by Activity

(dollars in thousands)

	FY 2003	FY 2004	FY 2005	$ Change	% Change
Technology Application					
Technology Verification.....	5,250	3,500	4,000	+500	+14.3%
Technology Deployment					
Technology Deployment.....	3,521	3,122	2,050	-1,072	-34.3%
Congressionally Directed Activity, Technology Deployment.....	963	981	0	-981	-100.0%
Total, Technology Deployment.....	4,484	4,103	2,050	-2,053	-50.0%
Total, Technology Application ...	9,734	7,603	6,050	-1,553	-20.4%

Description

This subprogram concerns the practical application of advancements made under the Technology Development subprogram. The focus involves the field verification of new technology, deployment of that technology, and its transfer to commercial applications. In addition, the activity examines barriers to the transfer and use of geothermal technology within the U.S. The success of this transfer effort depends upon involvement by industry partners and other interested parties. A large element of cost sharing by the private sector is an important measure of that success.

Benefits

By providing a pathway for transferring geothermal technology into the business arena, Technology Application supports the program mission of working in partnership with U.S. industry to establish geothermal as an economically competitive contributor to the U.S. energy supply. The pathway consists of verifying technology and deploying technology with industry at U.S. geothermal sites. Working with geothermal stakeholders to reduce non-technical barriers that inhibit geothermal expansion also assists in establishing geothermal as an important source of energy supply.

Historical and expected contributions within Technology Application include:

	2000	2001	2002	2003	2004	2005	2010	2015
Resources (GW)								
Goal	5	5	5	5.2	5.3	5.4	10	20
Actual	5	5	5	5.2	--	--	--	--
New Geo Fields (#)								
Goal	0	0	0	2	4	6	20	40
Actual	0	0	0	2	--	--	--	--

Detailed Justification

(dollars in thousands)

	FY 2003	FY 2004	FY 2005
Technology Verification	**5,250**	**3,500**	**4,000**

Technology Verification subsumes a portion of the former key subactivity of Detection and Mapping, and includes cost-shared projects and deployment of near commercial research products. Technology Verification moves technologies from research and development to a level where the technologies are accepted and actively used and applied by the US geothermal industry and other stakeholders. All development components of exploration, EGS, drilling, and energy conversion should eventually be field tested to demonstrate improvements in technology performance at a commercial scale. Such verifications of improved technology are done in collaboration with cost-sharing industry partners, who will adopt the technology.

In FY 2005, the program will collaborate with 10 new industry partners chosen from a FY 2004 competitive solicitation to find and evaluate new geothermal resources using DOE-sponsored technology improvements. This activity builds on prior exploration and will directly contribute to the addition of substantial new resources in the western United States. The program will also test innovative energy conversion technology with an industry partner at a new power plant whose construction began in FY 2004.

Technology Deployment	**4,484**	**4,103**	**2,050**
▪ **Technology Deployment**	**3,521**	**3,122**	**2,050**

The widespread use of new advancements in geothermal technology or the adoption of geothermal applications often encounter problems or barriers of a non-technical nature. These institutional issues, such as complex regulations, can often stymie the smooth transition from a prototype of new technology to a commercial product. This activity addresses the factors affecting the deployment of geothermal systems. The scope is broad and includes education and outreach, technical support, and systems analysis. Interested parties come from the public and private

(dollars in thousands)

sectors working in concert to raise awareness levels and solve problems of common interest. The objective of Technology Deployment is to double the number of States generating geothermal electricity to eight by 2006.

Activities under Technology Deployment are conducted in part through the former key subactivity of GeoPowering the West (GPW) which is subsumed herein. GPW ($1.5 million) contributes to the overall use of domestic geothermal resources by facilitating partnerships with the geothermal industry, power companies, energy consumers, and public officials at all levels, with the goal of removing barriers to geothermal deployment. GPW usually takes a grass roots approach in which stakeholders at the State and local levels use GPW and its resources as a vehicle to come up with acceptable solutions to problems. GPW has sponsored the formation of State working groups throughout the West as the means of implementing this approach.

In FY 2005, the program will conduct outreach activities focused on key state and regional development issues. Those activities include: (1) continue support of the National Geothermal Collaborative that brings together involved stakeholders from all sectors to deal with institutional issues; (2) gather and disseminate information about geothermal resources, including the completion of the geothermal leasing workbook; and (3) add two new State working groups, bringing the total number of groups to nine. In addition, analytical work will continue on the performance and economics of geothermal systems.

▪ **Congressionally Directed Activity, Technology Deployment**	**963**	**981**	**0**

Congressionally directed funds for the Lake County Basin geothermal project in California (FY 2003 $963,000; FY 2004 $981,072).

Total, Technology Application	**9,734**	**7,603**	**6,050**

Explanation of Funding Changes

	FY 2005 vs. FY 2004 ($000)
Technology Verification	
The increase supports a solicitation in 2004 which will result in awarding 10 new exploration projects to find and evaluate new geothermal resources using DOE-sponsored technology improvements	+500
Technology Deployment	
▪ **Technology Deployment**	
The decrease reflects completion of the congressionally-directed project and funding for GeoPowering the West to a level needed to continue GPW as a beneficial component of the Geothermal Technologies Program	-1,072
▪ **Congressionally Directed Activity, Technology Deployment**	
No funds are requested because funds are being allocated to other activities more closely aligned with the Program's goal	-981
Total, Technology Deployment	-2,053
Total Funding Change, Technology Application	**-1,553**

Biomass and Biorefinery Systems R&D

Funding Profile by Subprogram[a]

(dollars in thousands)

	FY 2003 Comparable Appropriation	FY 2004 Original Appropriation	FY 2004 Adjustments[b,c]	FY 2004 Comparable Appropriation	FY 2005 Request
Biomass and Biorefinery Systems R&D					
Feedstock Infrastructure	2,405	2,000	+212	2,212	2,000
Platforms Research and Development.....	44,841	42,000	-509	41,491	43,000
Utilization of Platform Outputs	38,037	31,000	+11,768[d]	42,768	27,596
Total, Biomass and Biorefinery Systems R&D	85,283	75,000	+11,471	86,471	72,596

Public Law Authorization:

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

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[a] SBIR/STTR funding in the amount of $1,421,337 was transferred to the Science appropriation in FY 2003. Estimates for SBIR/STTR budgeted in FY 2004 and FY 2005 are $2,160,452 and $1,815,184 respectively.

[b] Programs in the Energy Supply appropriation were reduced by .59 percent as required by the Omnibus Appropriation Bill.

[c] Programs in the Energy Supply appropriation were proportionally reduced based upon the allocated General Reduction of $4,684,000.

[d] Biomass was provided increases by the Omnibus Appropriation Bill of $12,900,000. This amount was subject to the .59 percent reduction required by the Omnibus Appropriation Bill.

Mission

The mission of the Biomass and Biorefinery Systems R&D Program ("Biomass Program") is to partner with U.S. industry to foster research and development on advanced technologies that will transform our nation's biomass resources into affordable, and domestically-produced biofuels, biopower, and high-value bioproducts.

The program receives funds from both the Energy Supply and the Energy Conservation appropriations. Energy Supply-funded activities focus primarily on developing advanced technologies for producing transportation fuels and power from biomass feedstocks. Energy Conservation-funded activities focus on developing advanced technologies for more energy efficient industrial processes and co-production of high-value industrial products.

Benefits

The program's research focus covers three areas: Feedstock Infrastructure for reducing the cost of collecting and preparing raw biomass[a], Platforms R&D for reducing the cost of outputs and byproducts from biochemical and thermochemical processes; and Utilization of Platform Outputs for developing technologies and processes that co-produce liquid and gaseous fuels, chemicals and materials, and heat and power, and on integrating those technologies and processes in biorefinery configurations.

The next generation of biorefinery[b], being developed by the program and U.S. industry, will produce value-added chemicals and materials together with fuels and/or power from non-conventional, lower cost feedstock such as agricultural and forest residues and other biomass materials. Using our diverse biomass resources in future biorefineries will accelerate economic development and increase energy supply options and energy security.

More detailed, integrated and comprehensive economic, energy and energy security benefits estimates are provided in the Expected Program Outcomes section at the end of the program level budget narrative.

Strategic and Program Goals

The Department's Strategic Plan identifies four strategic goals (one each for defense, energy, science, and environmental aspects of the mission) plus seven general goals that tie to the strategic goals. The Biomass program supports the following goals:

Energy Strategic Goal

General Goal 4, Energy Security: Improve energy security by developing technologies that foster a diverse supply of reliable, affordable and environmentally sound energy by providing for reliable

[a] Biomass includes agricultural crops and trees, wood and wood wastes and residues, plants, grasses, residues, fibers, and animal wastes, municipal solid wastes, and other waste materials.

[b] Biorefineries are processing facilities that extract carbohydrates, oils, lignin, and other materials from biomass, convert them into multiple products such as transportation fuel, chemicals, and materials. Corn wet and dry mills, and pulp and paper mills are examples of existing biorefinery facilities that produce some combination of food, feed, power, and industrial and consumer products.

delivery of energy, guarding against energy emergencies, exploring advanced technologies that make a fundamental improvement in our mix of energy options, and improving energy efficiency.

The Biomass program has one program goal which contributes to General Goal 4 in the "goal cascade":

Program Goal 04.08.01.00: Biomass. Develop biorefinery-related technologies to the point that they are cost- and performance-competitive and are used by the Nation's transportation, energy, chemical and power industries to meet their market objectives. This helps the Nation by expanding clean, sustainable energy supplies while also improving the Nation's energy infrastructure and reducing our dependence on foreign oil.

Contribution to Program Goal 04.08.01.00 (Biomass)

The Program directly supports General Goal 4, Energy Security; the goals and recommendations of the President's National Energy Policy, the Biomass R&D Act of 2000 and the Farm Security and Rural Investment Act of 2002.

Key technology pathways that contribute to the achievement of these benefits include:

Feedstock Infrastructure

- Reduce biomass harvesting and storage costs so that the delivered cost will be reduced from $53 per dry ton in 2003 to $38 per dry ton by 2015. Indicators of progress toward that goal include developing a conceptual, novel harvesting system and testing a dry storage system by 2010.

Platforms Research and Development

- Reducing the cost of cleaned and reformed biomass-derived synthesis gas produced, from a mature gasification plant, from $9.80 per million Btu in 2003 to $7.58 per million Btu by 2010. Indicators of progress toward that goal include successful bench-scale studies by 2007 and pilot-scale studies by 2010.
- Reducing the cost of a mixed, dilute sugar stream suitable for fermentation to ethanol, in a mature biochemical plant, from $0.15 per lb. in 2003 to $0.10 per lb. by 2010. Indicators of progress toward that goal include successful bench-scale studies by 2007 and pilot-scale studies by 2010.

Syngas cost reduction will be achieved as a result of increased process efficiency in syngas production and conversion of syngas to fuels, chemicals and materials through (a) developing and verifying thermochemical technologies in production, clean-up and reforming, and (b) validating their integration into biorefinery configurations. Thermochemical systems integrated within a biorefinery will realize additional cost reductions due to the synergies resulting from co-producing chemicals, materials and fuels.

Sugar cost reduction will be achieved as a result of (a) developing advanced pretreatment, hydrolysis and fermentation technologies, and (b) validating their integration into biorefinery configurations. Biochemical systems integrated within a biorefinery will realize additional reductions in the cost of producing ethanol due to the synergies resulting from co-producing chemicals, materials and fuels.

Utilization of Platform Outputs R&D:

- Accelerating the use of cellulosic feedstock in existing corn ethanol plants. Indicators of progress toward that goal include the completion of a pilot plant project in partnership with a corn ethanol producer by 2008 and another by 2012.
- Increasing partnering activities with states, industry, universities, other Federal agencies, etc. Indicators of progress toward that goal include annual intensities of collaborative activities.

The performance indicators used in the FY 2004 budget were the costs of ethanol and bio-power. In view of the integrated bio-refinery emphasis, the current budget request focuses on sugars and syngas, the bio-refinery intermediate products from which fuels (including ethanol), heat and power, and various chemicals would be produced. The program's progress, as measured using the FY 2004 indicators, is reflected by the estimated reduction in cellulosic ethanol production cost by a factor of at least 2 over the past 6 years, to $2.75 per gallon in 2003. The more near term technology for converting corn kernel fiber to ethanol should be much less expensive, although corn residues would be a much more significant feedstock source than corn fiber. The program is partnering with industry to develop the technologies that reduce costs further. The recent success in reducing the cost of required enzymes by a factor of 10 contributed to the largest drop in estimated production costs to date.

Annual Performance Results and Targets

FY 2000 Results	FY 2001 Results	FY 2002 Results	FY 2003 Results	FY 2004 Targets	FY 2005 Targets
Program Goal 04.08.01.00 (Biomass and Biorefinery Systems R&D)					
Utilization of Platforms Outputs					
Demonstrated conversion of agricultural wastes to ethanol at a small commercial scale using a genetically engineered fermentative microorganism.			Established 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 needed to be integrated with the gasification components to produce power, fuels, and chemicals.	Demonstrate clean syngas production in three thermochemical conversion systems. 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.	Complete a technical and economic evaluation of integrated biomass to fuels systems to validate the sugar cost of $0.15 per pound and syngas cost of $9.80 per million Btu.
Platforms Research and Development					
	Conducted a competitive solicitation and selected at least one partner for demonstrating the conversion of cellulosic feedstock at a corn ethanol plant.	DOE waited for responses associated with the biomass solicitation issued in FY 2002, and delayed to 2004 the development of a prototype yeast capable of fermenting multiple biomass-derived sugars to meet cost goals for the ethanol/gasoline blend markets.	Completed the thermochemical options analysis to assess various process pathways to fuels (e.g., F-T, gasoline, diesel, alcohols). Developed an improved enzyme preparation for reducing the cost of producing ethanol from biomass. Evaluated 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 to achieve $2.75 per gallon of ethanol.
Management of Funds					
				Contribute proportionately to EERE's corporate goal of reducing corporate and program uncosteds to a range of 20-25 percent by reducing program annual uncosteds by 10 percent in 2004 relative to the program uncosted baseline (in 2003) until the target range is met.	Contribute proportionately to EERE's corporate goal of reducing corporate and program uncosteds to a range of 20-25 percent by reducing program annual uncosteds by 10 percent in 2005 relative to the program uncosted baseline (2004) until the target range is met.

Means and Strategies

The Biomass Program will use various means and strategies to achieve its program goals as described below. "Means" include operational processes, resources, information, and the development of technologies, and "strategies" include program, policy, management and legislative initiatives and approaches. Various external factors, as listed below, may impact the ability to achieve the program's goals. Collaborations are integral to the planned investments, means and strategies, and to addressing external factors.

America's diverse biomass resources, and favorable climates offer many opportunities for using domestic, sustainable biomass to meet our needs for fuel, power and products made from plants and plant-derived resources. The program focuses on industrial biorefineries that co-produce fuels and/or power along with high-value chemicals and materials by forming R&D partnerships to advance processing and conversion technologies, improve the efficiency and effectiveness of harvesting, storage and handling of biomass feedstock, and condition markets by increasing consumer awareness of, and acceptance for bio-based products, fuels and power.

The strategy consists of improving the cost-competitiveness of biomass technologies (including feedstock collection and storage subsystems) through research, development, and partnerships with industry, USDA, farmers, states and local communities. The program uses competitive solicitations to attract innovation and ensure investment value for industry's and universities' contracts; manages National Laboratory research to overcome technical barriers, and coordinates biomass activities at a local level through the State and Regional Partnership Activity. Funding for public-private collaborative R&D is made on a cost shared basis; managed by a series of objectives and milestones; and reviewed under the industrially developed "stage gate" process for moving each project through an independent review "gate", from a less costly stage (such as preliminary paper studies) to a more costly stage (such as bench scale experiments). Technical oversight of the R&D portfolio and planning and analysis for the program is based at DOE Headquarters, and individual project management is provided by field office staff. Finally, the program conducts analysis and performance assessments in order to direct effective strategic planning.

These means and strategies will result in improving energy security by increasing the generation of reliable, affordable and environmentally sound biobased energy, adding to the diversity and economic security of the Nation's energy supply --- thus putting the taxpayers' dollars to more productive use.

In carrying out the program's mission, the Biomass Program collaborates with several groups on its key activities including:

- Partnerships with industry, USDA, farmers, states and local communities.
- Program decisions about research directions and priorities are guided by the Biomass Technical Advisory Committee and the Biomass R&D Board established under the Biomass R&D Act of 2000.

- The program also relies on input from peer reviews, several of which have been completed in the last three years.[a]

External factors affecting performance include availability of conventional fossil resources, consumer acceptance, and the cost of competing technologies. The market penetration rate of bio-based technologies is a function of technical breakthrough, price trends of coal, oil and natural gas, and policy factors.

Validation and Verification

To validate and verify program performance, the Biomass Program will conduct internal and external reviews and audits. These programmatic activities are subject to continuing review by, for example, the Congress, the General Accounting Office, the Department's Inspector General, the U.S. Environmental Protection Agency, and state environmental agencies. The table below summarizes validation and verification activities.

Data Sources:	The Renewable Fuels Association's production statistics; the National Renewable Energy Laboratory's Renewable Electric Plant Information System (REPIS); the Energy Information Administration's (EIA) Annual Energy Review, Renewable Energy Annual and Annual Energy Outlook; the Gas Technology Institute Survey of Distributed Resources; EIA Form 860 data analyzed by the Resource Dynamics Corporation. Individual projects develop production cost and quantity estimates for sugar, syngas, ethanol, and other fuels and chemicals.
Baselines:	The following are the key baselines used in the Biomass Program: ▪ Biomass delivered cost: $53 per dry ton ▪ cleaned and reformed syngas (2003): $9.80/million btu ($0.082 per kwh power) ▪ mixed, diluted, unfermented sugars (2003): $0.15/lb ($2.75 per gallon ethanol)
Frequency:	GPRA benefits are estimated annually. Independent evaluation of R&D projects are performed according to schedule per the "stage gate" process for moving each project through an independent review "gate", from a less costly stage (such as preliminary paper studies) to a more costly stage (such as bench scale experiments). Program Peer Reviews are conducted annually.
Data Storage:	EE Strategic Management System, and other computer-based data systems.
Verification:	Various trade associations review the data and the modeling processes (e.g. REPIS renewable and Distributed Energy Resources), and the EIA verifies the

[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.

REPIS database. Stage-gate, peer and program reviews of technology development and economic modeling efforts are independently conducted by personnel from industry, academia and governmental agencies other than the U.S. Department of Energy. These efforts help to focus the program's investments on activities that are within the Federal Government's role and that address top priority needs.

The national laboratories receive direct funds for technology research and development, based on their capabilities and performance. Independent panels consisting non-Federal and industry experts review each laboratory and industry project at scheduled Stage-Gate Reviews and Peer Evaluation of R&D. Projects are evaluated based on the following criteria: 1) Relevance to overall DOE objectives; 2) Approach to performing the research and development; 3) technical accomplishments and progress toward project and DOE goals; 4) Technology transfer/collaborations with industry/universities/laboratories; and 5) Approach and relevance of proposed future research. OMB's R&D investment criteria have been incorporated into this evaluation. The panels also evaluate the strengths and weaknesses of each project, and recommend additions to or deletions from the scope of work. The program organization facilitates relationships to ensure that federal R&D results are transferred to industry.

Funding by General and Program Goal

(dollars in thousands)

	FY 2003	FY 2004	FY 2005	$ Change	% Change
General Goal 4, Energy Security					
Program Goal 04.08.01.00, Biomass					
Feedstock Infrastructure	1,924	982	2,000	+1,018	+103.7%
Platforms Research and Development	27,907	31,275	43,000	+11,725	+37.5%
Utilization of Platform Outputs	28,852	13,518	27,596	+14,078	+104.1%
Total, Program Goal 04.08.01.00, Biomass	58,683	45,775	72,596	+26,821	+58.6%
All Other					
Congressionally Directed Activities, Feedstock Infrastructure					
Hybrid Poplar Tree Research	481	0	0	0	0.0%
University of Tennessee Switchgrass Demonstration Project	0	981	0	-981	-100.0%
Eastern NV Landscape Coalition	0	249	0	-249	-100.0%
Total, Congressionally Directed Activities, Feedstock Infrastructure	481	1,230	0	-1,230	-100.0%

(dollars in thousands)

	FY 2003	FY 2004	FY 2005	$ Change	% Change
Congressionally Directed Activities, Platforms Research and Development					
Thermochemical Platform R&D					
Vermont Biomass Energy Center	481	392	0	-392	-100.0%
Biomass Gasification Research Center AL	1,927	0	0	0	0.0%
Iowa Switchgrass Project - Chariton Valley	2,582	1,962	0	-1,962	-100.0%
Winona, MS Biomass Project	2,889	0	0	0	0.0%
Clean Energy from Gasification of Switchgrass - IA State University	481	736	0	-736	-100.0%
Agricultural Mixed Waste Biorefinery	2,408	0	0	0	0.0%
Combined Heat and Power Green Institution	1,927	0	0	0	0.0%
Center for Biomass Utilization at University of North Dakota	385	491	0	-491	-100.0%
Biomass Cogeneration Project at North Country Hospital	0	245	0	-245	-100.0%
Mount Wachusett Community College	0	942	0	-942	-100.0%
White Pine County Schools Heating	0	249	0	-249	-100.0%
Total, Thermochemical Platform R&D	13,080	5,017	0	-5,017	-100.0%
Bioconversion Platform R&D for Sugars					
Ethanol Production from Biomass – Univ. of Louisville	0	294	0	-294	-100.0%
Michigan Biotechnology Initiative	1,927	1,962	0	-1,962	-100.0%
Consortium for Plant Biotechnology Research	1,927	2,943	0	-2,943	-100.0%
Total, Bioconversion Platform R&D for Sugars	3,854	5,199	0	-5,199	-100.0%
Total, Congressionally Directed Activities, Platforms Research and Development	16,934	10,216	0	-10,216	-100.0%
Congressionally Directed Activities, Utilization of Platform Outputs					
Integration of Biorefinery Technologies					
On-Farm Small Scale Waste Energy Demonstration Project	0	736	0	-736	-100.0%

(dollars in thousands)

	FY 2003	FY 2004	FY 2005	$ Change	% Change
North Central Texas Dairy Waste Control Pilot Project	0	196	0	-196	-100.0%
Corn Bioproducts Research with the National Corn Growers Association	1,000	0	0	0	0.0%
Oxygenated Diesel Emissions Testing in CA and NV, AAE Technologies	963	981	0	-981	-100.0%
New Uses Information and Entrepreneur Development Center	0	981	0	-981	-100.0%
Gridley Rice Straw Project	0	2,943	0	-2,943	-100.0%
Biorefinery at Louisiana State University	0	491	0	-491	-100.0%
Iroquois Bioenergy Cooperative	2,889	0	0	0	0.0%
Total, Integration of Biorefinery Technologies	4,852	6,328	0	-6,328	-100.0%
Products Development					
Regional Biomass Energy Program	2,889	1,962	0	-1,962	-100.0%
Fibrowatt Biomass Project	481	0	0	0	0.0%
Ag-Based Industrial Lubricants Located at the University of Northern Iowa	963	981	0	-981	-100.0%
Missouri Soybean Association	0	294	0	-294	-100.0%
Mississippi State Biodiesel Production Project	0	981	0	-981	-100.0%
Research in Nebraska on Improved Soybean Oil for Biodiesel Fuel	0	491	0	-491	-100.0%
McMinnville Biodiesel Project	0	981	0	-981	-100.0%
Bio-Based Products and Energy with Midwest Consortium	0	1,962	0	-1,962	-100.0%
Maine Forest Bio-Products R&D	0	981	0	-981	-100.0%
Iowa State Univ. Catalysis Research	0	981	0	-981	-100.0%
E-Diesel Research with NCGA	0	981	0	-981	-100.0%
Fuels from Agricultural and Animal Wastes	0	12,327	0	-12,327	-100.0%
Total, Products Development	4,333	22,922	0	-22,922	-100.0%
Total, Congressionally Directed Activities, Utilization of Platform Outputs	9,185	29,250	0	-29,250	-100.0%
Total, All Other	26,600	40,696	0	-40,696	-100.0%

(dollars in thousands)

	FY 2003	FY 2004	FY 2005	$ Change	% Change
Total, Biomass and Biorefinery Systems R&D.....	85,283	86,471	72,596	-13,875	-16.0%

Expected Program Outcomes

The Biomass Program pursues its mission through integrated activities designed to increase the use of domestic renewable resources and contribute towards improved energy productivity of our economy. We expect these improvements to reduce susceptibility to energy price fluctuations and potentially lower energy bills; reduce several EPA-criteria pollutants and other pollutants; enhance energy security by increasing the production and diversity of domestic fuel supplies; and provide greater energy security and reliability by improving our energy infrastructure. In addition to these "EERE business-as-usual" benefits, realizing the Biomass Program goals would provide the technical potential to reduce conventional energy use even further if warranted by future energy needs.

Estimates of annual non-renewable energy savings, energy expenditure savings, carbon emission reductions, oil savings, and natural gas savings that result from the realization of Biomass Program goals are shown in the table below through 2050. The level of cellulosic ethanol production expected as a result of realizing the program goals is also reported through 2025.

These estimates are a conservative initial effort at assessing the benefits of the Biomass Program activities and likely significantly underestimate the benefits from integrated biorefinery production options that are yet to be modeled. In addition, these estimates do not yet address some of the more fundamental technologies being developed in the Integrated Biorefinery and Bioproducts processes.

The assumptions and methods underlying the modeling efforts have significant impact on the estimated benefits, and results could vary significantly if external factors, such as future energy prices, differ from the baseline case assumed for this analysis. A summary of the methods, assumptions, and models used in developing these benefit estimates that are important for understanding these results are provided at www.eere.energy.gov/office_eere/budget_gpra.html Final documentation is estimated to be completed and posted by March 15, 2004. Uncertainties are larger for longer term estimates. The results shown in the long term benefits tables are preliminary estimates based on initial modeling of some of the possible program production technologies; nonetheless, they provide a useful picture of growing national benefits over time.

FY 2005 GPRA Benefits Estimates for Biomass Program[a]

Mid-Term Benefits[b]

	2010	2015	2020	2025
Cellulosic Ethanol Production (Million Gallons per year)	90	300	710	1,410
Primary Non-Renewable Energy Savings (quads)	0.04	0.06	0.09	0.15
Carbon Emission Reductions (mmtce)	1	1	1	3
Energy Expenditure Savings (Billion 2001$)	ns	ns	1	2
Oil Savings (MBPD)	0.012	0.015	0.019	0.027
Natural Gas Savings (quads)	0.01	0.02	0.02	0.04

Long-Term Benefits[c]

	2030	2040	2050
Primary Non-Renewable Energy Savings (Quads)	0.4	0.7	1.2
Energy System Cost Savings (Billion 2001$)	3	2	0
Carbon Emission Reductions (MMTCE)	4	11	23
Oil Savings (MBPD)	0.03	0.18	0.36
Natural Gas Savings (Quads)	0.3	0.3	0.4

[a] Benefits reported are annual, not cumulative, for the year given. Estimates reflect the benefits associated with program activities from FY 2005 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. These estimates are a conservative initial effort at assessing the benefits of the Biomass Program activities and likely significantly underestimate the benefits from integrated biorefinery production options that are yet to be modeled. In addition, these estimates do not yet address some of the more fundamental technologies being developed in the Integrated Biorefinery and Bioproducts processes.

[b] Mid-term program benefits were estimated utilizing the GPRA05-NEMS model, based on the Energy Information Administration's (EIA) National Energy Modeling System (NEMS) and utilizing the EIA's Annual Energy Outlook (AEO) 2003 Reference Case. The cellulosic ethanol production estimates were derived from the Ethanol Long Range Systems Analysis Spreadsheet (ELSAS) model. "ns" stands for "not significant."

[c] Long-term benefits were estimated utilizing the GPRA05 - MARKAL developed by Brookhaven National Laboratory (BNL). Results can differ among models due to differences in their structure. In particular, the two models estimate economic benefits in different ways, with the MARKAL model reflecting the cost of additional investments required to achieve reductions in energy bills.

Feedstock Infrastructure

Funding Schedule by Activity

(dollars in thousands)

	FY 2003	FY 2004	FY 2005	$ Change	% Change
Feedstock Infrastructure					
Feedstock Infrastructure	1,924	982	2,000	+1,018	+103.7%
Congressionally Directed Activities, Feedstock Infrastructure	481	1,230	0	-1,230	-100.0%
Total, Feedstock Infrastructure ..	2,405	2,212	2,000	-212	-9.6%

Description

Biomass is bulkier than fossil resources such as coal and oil, resulting in higher costs for transport and storage when compared to fossil fuels. The goal of this work is to develop novel harvesting equipment designs and storage and logistics systems for agricultural residues. The requested level of support also provides funds to conduct systems level design studies such as analysis of biomass feedstock systems (including sustainability requirements) and regional and national cost/supply relationships.

Benefits

Feedstock costs account for up to 30 percent the production costs of bio-based fuels and products. These activities will reduce biomass harvesting and storage costs in order to facilitate the growth of the biomass industry. Indicators of progress toward that goal include developing a conceptual, novel harvesting system and testing a dry storage system by 2010.

Detailed Justification

(dollars in thousands)

	FY 2003	FY 2004	FY 2005
Feedstock Infrastructure	**1,924**	**982**	**2,000**

In FY 2005, the program will continue work based on the harvesting and logistics roadmap, the sustainability roadmap, policy considerations and other relevant factors. This is expected to include work on one-pass harvesting systems for wheat straw and corn stover, innovative densification and

(dollars in thousands)

FY 2003	FY 2004	FY 2005

storage systems, continued development of models for total infrastructure systems optimization, development of sustainability guidelines, and regional modeling that integrates economic and environmental considerations.

Congressionally Directed Activities, Feedstock Infrastructure	**481**	**1,230**	**0**

The following projects were directed by Congress to be included: Hybrid Poplar Tree Research (FY 2003 $481,000, FY 2004 $0); Switchgrass Demonstration Project (FY 2004 $981,072); Biomass Restoration by Eastern Nevada Landscape Coalition[a] (FY 2004 $248,525).

Total, Feedstock Infrastructure	**2,405**	**2,212**	**2,000**

Explanation of Funding Changes

	FY 2005 vs. FY 2004 ($000)
Feedstock Infrastructure	
Increase efforts related to conceptual design of biomass harvesting and storage subsystems	+1,018
Congressionally Directed Activities, Feedstock Infrastructure	
No funds are requested because funds are being allocated to other activities more closely aligned with the Program's goal	-1,230
Total Funding Change, Feedstock Infrastructure	**-212**

[a] Included in the Omnibus Appropriation Bill.

Platforms Research and Development

Funding Schedule by Activity

(dollars in thousands)

	FY 2003	FY 2004	FY 2005	$ Change	% Change
Platforms Research and Development					
Thermochemical Platform R&D					
Thermochemical Platform R&D	9,921	16,835	24,000	+7,165	+42.6%
Congressionally Directed Activities, Thermochemical Platform R&D	13,080	5,017	0	-5,017	-100.0%
Total, Thermochemical Platform R&D	23,001	21,852	24,000	+2,148	+9.8%
Bioconversion Platform R&D for Sugars					
Bioconversion Platform R&D for Sugars	17,986	14,440	19,000	+4,560	+31.6%
Congressionally Directed Activities, Bioconversion R&D	3,854	5,199	0	-5,199	-100.0%
Total, Bioconversion Platform R&D for Sugars	21,840	19,639	19,000	-639	-3.3%
Total, Platforms Research and Development	44,841	41,491	43,000	+1,509	+3.6%

Description

The program has defined two basic processes for the conversion of biomass into intermediates that can be used for the production of a number of liquid fuels, power, or chemical and materials. The process intermediates are synthesis gas (syngas), pyrolysis oils, and sugars. One of the key thermochemical R&D goals of the Platform R&D subprogram is to complete the development of gas cleanup technologies that allow biomass feedstocks to be converted to clean products that meet the stringent gas quality specifications for advanced systems that can produce liquid fuels or hydrogen. The subprogram will also improve the performance and costs of enzymes, biomass pretreatment, and fermentation of multiple biomass sugars for the production of fuel ethanol and other bio-based products.

Benefits

Integration and optimization of these processes will be necessary in order to:

- Reduce the cost of cleaned and reformed biomass-derived synthesis gas produced, from a mature gasification plant, from $9.80 per million Btu in 2003 to $7.58 per million Btu by 2010. Indicators of progress toward that goal include successful bench-scale studies by 2007 and pilot-scale studies by 2010.
- Reduce the cost of a mixed, dilute sugar stream suitable for fermentation to ethanol, in a mature biochemical plant, from $0.15 per lb. in 2003 to $0.10 per lb. by 2010. Indicators of progress toward that goal include successful bench-scale studies by 2007 and pilot-scale studies by 2010.

Progress toward these goals are:

	FY 2003	FY 2005	FY 2010	FY 2015
Syngas cost ($/MM Btu)	9.80	9.80	7.58	6.02
Sugars cost ($/lb.)	0.15	0.15	0.10	0.082

Detailed Justification

(dollars in thousands)

	FY 2003	FY 2004	FY 2005
Thermochemical Platform R&D	**23,001**	**21,852**	**24,000**
▪ **Thermochemical Platform R&D**	**9,921**	**16,835**	**24,000**

The Thermochemical Platform R&D Activity includes the former Advanced Biomass Technology R&D-Thermochemical Conversion R&D activity and the Systems Integration and Production-Thermochemical Production Integration activity from FY 2004.

The program conducts research, testing, integration, and feasibility studies on thermochemical conversion of biomass to provide the foundation for advanced and integrated systems that focus on syngas. This area demonstrates advanced gasification system technologies (feeding, cleanup/conditioning, system integration) that are suitable for use in biorefineries, the conversion of syngas into fuels and chemicals, and for combined heat and power generation in both large-scale and distributed applications.

In FY 2005, in collaboration with industrial partners, the program will demonstrate the continuous production, cleanup and conditioning of biomass syngas and pyrolysis oils suitable for conversion to fuels, chemicals or hydrogen. Gas cleanup and conditioning efforts will focus on the syngas and pyrolysis stream for the removal of particulates and other inorganic materials, on the conversion of

tars, improving syngas yields, and on shift reactions to adjust hydrogen ratios. These efforts will develop technologies compatible with the scale of biomass facilities. The program will examine the production of hydrogen from biomass via the synthesis gas pathway. The program will continue analysis and evaluation of the potential for biorefineries, at varying scale, to incorporate syngas systems.

In FY 2003 this activity was reduced by $158,000 for SBIR/STTR that was transferred to the Science Appropriation.

- **Congressionally Directed Activities, Thermochemical Platform R&D** **13,080** **5,017** **0**

The following projects were directed by Congress to be included in this program: Vermont Biomass Energy Center (FY 2003 $481,000, FY 2004 $392,429); Biomass Gasification Research Center - AL (FY 2003 $1,927,000, FY 2004 $0); Iowa Switchgrass Project[a] (FY 2003 $2,582,337, FY 2004 $1,962,143); Winona, MS Biomass Project (FY 2003 $2,889,000, FY 2004 $0); Gasification of Switchgrass – IA (FY 2003 $481,000, FY 2004 $735,804); Agricultural Mixed Waste Biorefinery - CO (FY2003 $2,408,000, FY2004 $0); University of North Dakota (FY2003 $385,000; FY 2004 $490,536); Combined Heat and Power Green Institution – MN (FY 2003 $1,927,000, FY 2004 $0); Biomass Cogeneration Project at North Country Hospital (FY 2004 $245,268); Biomass Gasification at Mount Wachusett Community College (FY 2004 $941,829); and Biomass Conversion in White Pine County, NV[b] (FY 2004 $245,268).

Bioconversion Platform R&D for Sugars **21,840** **19,639** **19,000**

- **Bioconversion Platform R&D for Sugars** **17,986** **14,440** **19,000**

In the FY 2004 budget request, this activity was called Bioconversion R&D within Advanced Biomass Technology R&D.

This work is comprised of four major elements: improved enzymes, advanced pretreatment, enhanced process integration capabilities, and development of enabling analytical tools.

The costs of enzymes and capital costs of pretreatment systems are high, and the nature of the pretreatment process impacts all downstream operations. For these reasons, evaluations of novel pretreatment systems and advanced enzymes will continue to identify improved, lower cost processes.

In FY 2005, the program will continue to work with industry on pretreatment and analytical technologies, and improved process integration capabilities that will enable industrial biorefineries. Through collaboration with universities and industry, efforts will focus on developing and

[a] FY 2004 amount shown is still under negotiation as of February 2004.
[b] Included in the Omnibus Appropriation bill.

(dollars in thousands)

FY 2003	FY 2004	FY 2005

understanding the fundamental principles of biomass depolymerization to aid in developing novel pretreatment.

Integration of improved fermentation micro-organisms with pretreatment will allow the testing of the micro-organisms using biomass hydrolysates that come out of the pretreatment process with varying levels of inhibitory compounds, acidity, etc. The program will continue to fund existing partnerships to develop more productive and lower-cost cellulase enzyme systems, and will form additional partnerships to accelerate the use of commercially available cellulase systems. These additional cost reductions will come from increasing enzyme activity and tolerance to inhibition by biomass sugars, and production process innovations.

The program will continue to improve analytical tools and approaches, including methods for monitoring the mass and component balances across pretreatment processes, increasing the understanding of the fine structure of the biomass (native or pretreated), identifying the reactions and mass transfer processes that occur during biomass pretreatment, and characterizing the interactions between pretreated biomass and enzymes.

- **Congressionally Directed Activities, Bioconversion R&D** **3,854** **5,199** **0**

The following projects were directed by Congress to be included in this program: Michigan Biotechnology Initiative (FY 2003 $1,927,000, FY 2004 $1,962,413); Consortium for Plant Biotechnology Research (FY 2003 1,927,000, FY 2004 $2,943,215); and Ethanol Production at University of Louisville (FY 2004 $294,321).

Total, Platforms Research and Development	**44,841**	**41,491**	**43,000**

Explanation of Funding Changes

FY 2005 vs. FY 2004 ($000)

Thermochemical Platform R&D

- **Thermochemical Platform R&D**

Increase research and development in the areas of gasification fundamentals and cleanup and conditioning of syngas to make it suitable for conversion to fuels, chemicals or hydrogen..... +7,165

	FY 2005 vs. FY 2004 ($000)
▪ **Congressionally Directed Activities, Thermochemical Platform R&D**	
No funds are requested because funds are being allocated to other activities more closely aligned with the Program's goal	-5,017
Total, Thermochemical Platform R&D	+2,148
Bioconversion Platform R&D for Sugars	
▪ **Bioconversion Platform R&D for Sugars**	
Increase collaboration with industrial and university partners on sugar production technology including feedstock pretreatment, enzymes and micro-organisms for sugar fermentation	+4,560
▪ **Congressionally Directed Activities, Bioconversion Platform R&D for Sugars**	
No funds are requested because funds are being allocated to other activities more closely aligned with the Program's goal	-5,199
Total, Bioconversion Platform R&D for Sugars	-639
Total Funding Change, Platforms Research and Development	+1,509

Utilization of Platform Outputs

Funding Schedule by Activity

(dollars in thousands)

	FY 2003	FY 2004	FY 2005	$ Change	% Change
Utilization of Platform Outputs					
Integration of Biorefinery Technologies					
Integration of Biorefinery Technologies	21,107	13,312	20,000	+6,688	+50.2%
Congressionally Directed Activities, Integration of Biorefinery Technologies	4,852	6,328	0	-6,328	-100.0%
Total, Integration of Biorefinery Technologies	25,959	19,640	20,000	+360	+1.8%
Products Development					
Products Development	7,745	206	7,596	+7,390	+3,587.4%
Congressionally Directed Activities, Products Development	4,333	22,922	0	-22,922	-100.0%
Total, Products Development	12,078	23,128	7,596	-15,532	-67.2%
Total, Utilization of Platform Outputs	38,037	42,768	27,596	-15,172	-35.5%

Description

The Utilization of Platform Outputs R&D subprogram consists of two components: Integration of Biorefinery Technologies and Products Development. Projects within the first component are conducted with industrial partners and thus each project may be different in terms of the feedstock, details of the processes or the suite of co-products. However, the common thrust of the Integration of the Biorefinery Technologies component is to support the integration of cellulosic conversion processes into existing starch-based ethanol plants. The Products Development component's focus is on the integration of programs and partnerships with colleges, universities, national laboratories, and Federal and State research agencies that fund R&D in bio-based products.

Benefits

This subprogram will provide essential benefits in the following areas:

- Accelerating the use of cellulosic feedstock in existing corn ethanol plants to expand domestic ethanol production while reducing the industry's overall carbon emission intensity. Indicators of progress toward that goal include the completion of a pilot plant project in partnership with a corn ethanol producer by 2008 and another by 2012.
- Increasing partnering activities with states, industry, universities, other Federal agencies, etc, will expand the necessary support structure needed for accelerated market transition. Indicators of progress toward that goal include annual collaborative activities.

Detailed Justification

(dollars in thousands)

	FY 2003	FY 2004	FY 2005
Integration of Biorefinery Technologies	**25,959**	**19,640**	**20,000**
▪ **Integration of Biorefinery Technologies**	**21,107**	**13,312**	**20,000**

In the FY 2004, budget request, this activity was called Bioconversion Production Integration within the Systems Integration and Production activity.

In FY 2005, in partnership with industry, the program will continue to integrate and test the handling, pretreatment, hydrolysis, and fermentation operations to allow for an evaluation of the performance and costs of converting corn fiber or corn stover to fuels and co-products. Industry partners will conduct developmental work at the bench-scale and/or pilot-scale, refine engineering and economic evaluations, and develop commercialization plans. National Laboratory personnel will assist with process simulation analysis using the latest energy and material balance information, development of advanced analytical tools for characterization of biomass and intermediates, and conceptual equipment cost estimates.

▪ **Congressionally Directed Activities, Integration of Biorefinery Technologies R&D**	**4,852**	**6,328**	**0**

The following projects were directed by Congress to be included in this program: On-Farm Small Scale Waste Energy Demonstration Project (FY 2004 $735,808); Iroquois Bioenergy Cooperative (FY 2003 $2,889,000, FY 2004 $0); Corn Bioproduct Research with the National Corn Growers Association (FY 2003 $1,000,000, FY 2004 $0); Oxygenated Diesel Emissions Testing in CA and NV (FY 2003 $963,000, FY 2004 $981,072); New Uses Info & Entrepreneur Development Center (FY 2004 $981,072); Gridley Rice Straw Project (FY 2004 $2,943,215); and Biorefinery at Louisiana State University (FY 2004 $490,536).

(dollars in thousands)

	FY 2003	FY 2004	FY 2005
Products Development	**12,078**	**23,128**	**7,596**
▪ **Products Development**	**7,745**	**206**	**7,596**

In the FY 2004 budget request, this activity was called Crosscutting Biomass R&D within the Systems Integration and Production activity. The focus is on the integration of programs and partnerships with colleges, universities, national laboratories, and Federal and State research agencies that fund R&D in biobased products. In prior years, the Small Modular Biopower activity was also part of Products Development.

In FY 2005, the Program will continue to work with other Federal agencies to identify opportunities for expanding the biomass R&D portfolio, and will conduct analyses of the potential for biobased processes not contained in the current portfolio. The program will investigate the use of platform outputs for the production of value-added products that will enable the development of commercial biorefineries. The State/Regional Partnerships activity ($4.0 M) will involve collaboration with States on technology transfer, research, development, field testing, and other needed efforts to overcome market barriers in order to achieve common goals of increasing domestic, clean energy supplies and reducing oil imports. States and the Federal government can benefit from collaboration and leveraging of funds aimed at accelerating and expanding biomass utilization. In FY 2003 this activity was reduced by $1,263,337 for SBIR/STTR that was transferred to the Science Appropriation.

▪ **Congressionally Directed Activities, Products Development**	**4,333**	**22,922**	**0**

The following projects were directed by Congress to be included in this program: Regional Biomass Energy Program (FY 2003 $2,889,000, FY 2004 $1,962,143); Fibrowatt Biomass Project – MS (FY 2003 $481,000, FY 2004 $0); Ag-Based Industrial Lubricants at the University of Northern Iowa (FY 2003 $963,000, FY 2004 $981,072); Biodiesel Demonstration with Missouri Soybean Association (FY 2004 $294,321); Mississippi State Biodiesel Production Project (FY 2004 $981,072); Improved Soybean Oil for Biodiesel in Nebraska (FY 2004 $490,536); McMinnville Biodiesel Project (FY 2004 $981,072); Bio-Based Products and Energy with Midwest Consortium (FY 2004 $1,962,143); Maine Forest Bio-Products R&D (FY 2004 $981,072); Center for Catalysis at Iowa State University (FY 2004 $981,072); E-Diesel Research with National Corngrowers Association (FY 2004 $981,072); and Fuels from Agricultural/Animal Wastes[a] (FY 2004 $12,326,840).

Total, Utilization of Platform Outputs	**38,037**	**42,768**	**27,596**

[a] Included in the Omnibus Appropriation bill.

Explanation of Funding Changes

	FY 2005 vs. FY 2004 ($000)
Integration of Biorefinery Technologies	
▪ **Integration of Biorefinery Technologies**	
Increase collaboration with ethanol producers on corn residue and corn fiber conversion technology, including bench-scale investigations and pilot plant development for scale-up testing	+6,688
▪ **Congressionally Directed Activities, Integration of Biorefinery Technologies**	
No funds are requested because funds are being allocated to other activities more closely aligned with the Program's goal	-6,328
Total, Integration of Biorefinery Technologies	+360
Products Development	
▪ **Products Development**	
Increase research and development on sugar-based and syngas-based products, including catalyst development, reactor testing and products characterization. Expand collaboration with States to overcome market barriers	+7,390
▪ **Congressionally Directed Activities, Products Development**	
No funds are requested because funds are being allocated to other activities more closely aligned with the Program's goal	-22,922
Total, Products Development	-15,532
Total Funding Change, Utilization of Platform Outputs	**-15,172**

Intergovernmental Activities

Funding Profile by Subprogram

(dollars in thousands)

	FY 2003 Comparable Appropriation	FY 2004 Original Appropriation	FY 2004 Adjustments[a,b]	FY 2004 Comparable Appropriation	FY 2005 Request
Intergovernmental Activities					
International Renewable Energy Program	3,853	6,000	-112	5,888	6,500
Tribal Energy Activities	5,780	5,000	-94	4,906	5,500
Renewable Energy Production Incentive	4,816	4,000	-74	3,926	4,000
Total, Intergovernmental Activities	14,449	15,000	-280	14,720	16,000

Public Law Authorizations:

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

Mission

Intergovernmental Activities are managed as part of the Weatherization and Intergovernmental Program (WIP) which addresses complementary subprograms included in the Energy Conservation Budget, all of which support the program's and Department's mission to develop, promote, and accelerate the adoption of energy efficiency, renewable energy, and oil displacement technologies and practices by providing customers with choices for improved energy utilization. Intergovernmental Activities promote the market transfer of clean energy innovations for sustainable development, trade, security, environment and climate.

Benefits

As part of WIP, Intergovernmental Activities support the DOE's Energy Strategic Goal 4 and the President's National Energy Policy (NEP) recommendations for market transfer of clean energy technologies and energy efficient products. The International Renewable Energy Program and the

[a] Programs in the Energy Supply appropriation were reduced by .59 percent as required by the Omnibus Appropriation Bill.

[b] Programs in the Energy Supply appropriation were proportionally reduced based upon the allocated General Reduction of $4,684,000.

Tribal Energy Program helps foster diverse supply of reliable, affordable and environmentally sound energy through the market transfer of clean energy technologies. The NEP calls for the promotion of market-based solutions to environmental concerns and the export of U.S. clean energy technologies. The Clean Energy Technology Exports Initiatives, which focuses on exporting clean energy technologies to developing and transitional countries and is supported within the International Renewable Energy Program, is in direct response to this National Energy Policy recommendation.

More detailed, integrated and comprehensive economic, energy and energy security benefits estimates are provided in the Expected Program Outcomes section at the end of the program level budget narrative.

Strategic and Program Goals

The Department's Strategic Plan identifies four strategic goals (one each for defense, energy, science, and environmental aspects of the mission) plus seven general goals that tie to the strategic goals. The Intergovernmental program supports the following goals:

Energy Strategic Goal

General Goal 4, Energy Security: Improve energy security by developing technologies that foster a diverse supply of reliable, affordable, and environmentally sound energy by providing for reliable delivery of energy, guarding against energy emergencies, exploring advanced technologies that make a fundamental improvement in our mix of energy options, and improving energy efficiency.

The Intergovernmental program has one program goal which contributes to General Goals 4 in the "goal cascade":

Program Goal 04.11.01.00: Intergovernmental Activities. Accelerate the adoption of clean, efficient and domestic energy technologies through efficient intergovernmental demonstration and delivery of cost-effective energy technologies which will benefit the public through improved energy productivity and reduced demand and particularly reduce the burden of energy cost on the disadvantaged.

Contribution to Program Goal 04.11.02.00 (Intergovernmental Activities)

The Weatherization and Intergovernmental Program contributes to General Goal 4 by providing appropriate technical assistance in targeted intergovernmental communities that provide high leverage and public policy responsive to acceleration of the adoption of cost-effective EERE technologies.

Annual Performance Results and Targets

FY 2000 Results	FY 2001 Results	FY 2002 Results	FY 2003 Results	FY 2004 Targets	FY 2005 Targets
Program Goal 04.11.01.00 (Intergovernmental Activities)					
International Renewable Energy					
		Implemented energy efficiency and renewable energy provisions of DOE's bi-lateral and multi-lateral agreements with Mexico, China, the EU, and other priority countries including work with APEC and NAEWG.	Expanded 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. Continued to work with APEC and NAEWG.	International Renewable Energy will strengthen and broaden activities supporting priority agreements, e.g. expanded the harmonization of standards to additional countries, ramped up implementation of the Energy Efficiency and Village Energy initiatives. Continue to work with APEC and NAEWG. Tribal Energy will conduct 6 technical and policy development workshops.	Provide technical analysis and reviews, data access, training and project support for 11 international clean energy projects which includes: developing 4 components for GIS tools to analyze U.S. EERE technology export markets; provide phase 1 and 2 technical assistance to secure access for EERE technologies to build 1000 MW of generation globally over 10 years. Tribal Energy will provide direct technical assistance to tribal nations including: 5 development workshops, 5 economic development projects, 15 "first steps" efforts, and 15 feasibility studies, working toward goal of 100 MW of generation in Indian country by 2010.
Tribal Energy					
		Tribal Energy funded technical assistance in the form of 4 feasibility studies and 14 economic development projects.	Tribal Energy funded technical assistance in the form of 5 workshops, 20 economic development projects and 4 feasibility studies.		
Renewable Energy Production Incentive (REPI)					
Processed applications for more than 508 million kWh total of qualified renewable energy produced during the prior fiscal year	Processed applications for more than 685 million kWh total of qualified renewable energy produced during the prior fiscal year	Processed applications for more than 701 million kWh total of qualified renewable energy produced during the prior fiscal year	Processed applications for more than 730 million kWh total of qualified renewable energy produced during the prior fiscal year		
Processed payments for $1.5M worth of qualified energy.	Processed payments for $3.991M worth of qualified energy.	Processed payments for $3.787M worth of qualified energy.	Processed payments for $4.815M worth of qualified energy.		

Contribute proportionately to EERE's corporate goal of reducing corporate and program uncosteds to a range of 20-25 percent by reducing program annual uncosteds by 10 percent in 2004 relative to the program uncosted baseline (in 2003) until the target range is met.	Contribute proportionately to EERE's corporate goal of reducing corporate and program uncosteds to a range of 20-25 percent by reducing program annual uncosteds by 10 percent in 2005 relative to the program uncosted baseline (2004) until the target range is met.

Means and Strategies

The Intergovernmental Activities Program will use various means and strategies to achieve its program goals as described below. "Means" include operational processes, resources, information, and the development of technologies, and "strategies" include program, policy, management and legislative initiatives and approaches. Various external factors, as listed below, may impact the ability to achieve the program's goals. Collaborations are integral to the planned investments, means and strategies, and to addressing external factors.

Intergovernmental Activities uses several means (processes, technologies and resources) and program, policy, management and market based strategic approaches to achieve its program goals. Significant external factors outside the control of the program are important to achieving the program goals and intended impacts. Collaboration with other agencies and experts are integral to the investments, means and strategies planned and to addressing the external factors.

Intergovernmental Activities will implement the program through the following means:

- 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 program will focus its efforts to promote these technologies.
- While tax credits exist to encourage private utilities to own and operate renewable energy 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 1.76 cents/kWh (FY 2003) 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.
- The Tribal Energy Activity supports and manages 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. Projects include resource assessments and development plans for energy efficient and renewable energy technologies. Technical assistance helps Native American Tribes, 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.

The following external factor could effect the Intergovernmental Activities achievement of its strategic goal:

President Bush, on June 11, 2001 and February 14, 2002, 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 and its central goal "to stabilize atmospheric greenhouse gas concentrations at a level that will prevent dangerous human interference with the climate." 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.

In carrying out the program mission, Intergovernmental Activities collaborates with Tribal governments and with international agencies and governments in several important activities including:

- The International Renewable Energy Program works with the multi-agency Climate Change Technology Program (CCTP), which organizationally is located within and led by DOE aims to evaluate the current state of U.S. climate change technology R&D and make recommendations for improvement and to enhance coordination across Federal agencies, and among the Federal Government, universities, and the private sector.
- Tribal Energy Subprogram maintains a close collaboration with the Bureau of Indian Affairs, with HUD and the Native American Housing Assistance and Self-Determination Act (NAHASDA) on building codes for Native American tribes. The sub-program coordinates closely with all other agencies that deal with tribes such as DOI, DOJ, HHS, and EPA.

Validation and Verification

To validate and verify program performance, the Intergovernmental Activities Program will conduct internal and external reviews and audits. These programmatic activities are subject to continuing review by, for example, the Congress, the General Accounting Office, the Department's Inspector General, the U.S. Environmental Protection Agency, and state environmental agencies. The table below summarizes validation and verification activities.

Data Sources:	The National Renewable Energy Laboratory's Renewable Electric Plant Information System (REPIS), the Energy Information Administration's (EIA) Annual Energy Review, Renewable Energy Annual and Annual Energy Outlook, The Gas Technology Institute Survey of Distributed Resources, EIA Form 860 data analyzed by the Resource Dynamics Corporation. Information collected directly from WIP performers and partners.
Baselines:	The baseline for non-hydro, non-pulp and paper renewable electricity is 7.0 gigawatts (1999); the baseline for distributed energy resources is 14.7 gigawatts (1997).
Frequency:	Annual.
Data Storage:	The EIA and other data sources store the data on their computers. WIP program output information is contained in various reports and memoranda.
Verification:	A trade association working group reviews REPIS renewable and DER data. The EIA uses and verifies the REPIS database. The November 2001 Distributed Energy Resources Peer Review verified the distributed generation data.

Funding by General and Program Goal

(dollars in thousands)

	FY 2003	FY 2004	FY 2005	$ Change	% Change
General Goal 4, Energy Security					
Program Goal 04.11.01.00, Intergovernmental Activities					
International Renewable Energy Program	3,853	5,152	6,500	+1,348	+26.2%
Tribal Energy Activities	4,817	3,925	5,500	+1,575	+40.1%
Renewable Energy Production Initiative	4,816	3,926	4,000	+74	+1.9%
Total, Program Goal 04.11.01.00, Intergovernmental Activities	13,486	13,003	16,000	+2,997	+23.0%
All Other					
Congressionally Directed Activity, International Renewable Energy Program/Renewable Energy Policy Project	0	736	0	-736	-100.0%
Congressionally Directed Activity, Tribal Energy/Council of Renewable Energy Resource Tribes (CERT)	963	981	0	-981	-100.0%
Total, All Other	963	1,717	0	-1,717	-100.0%
Total, General Goal 4 (Intergovernmental Activities)	14,449	14,720	16,000	+1,280	+8.7%

Expected Program Outcomes

The Intergovernmental Program pursues its mission through integrated activities designed to improve the energy efficiency and productivity of our economy. We expect these improvements to reduce susceptibility to energy price fluctuations and potentially lower energy bills; reduce EPA criteria and other pollutants; enhance energy security by increasing the production and diversity of domestic fuel supplies; and provide greater energy security and reliability by improving our energy infrastructure. In addition to these "EERE business-as-usual" benefits, realizing the programs goals would provide the technical potential to reduce conventional energy use even further if warranted by future energy needs.

Estimates of annual non-renewable energy savings, energy expenditure savings, carbon emission reductions, oil savings, natural gas savings, and displaced need for electricity capacity additions that result from the realization of the Intergovernmental Program goals are shown in the table below through 2025. These results do not include benefits for the tribal and international intergovernmental activities, nor do they reflect the potential for this program to change consumer efficiency and renewable buying patterns over time.

The assumptions and methods underlying the modeling efforts have significant impact on the estimated benefits, and results could vary significantly if external factors, such as future energy prices, differ from the baseline case assumed for this analysis. A summary of the methods, assumptions, and models used in developing these benefit estimates that are important for understanding these results are provided at

www.eere.energy.gov/office_eere/budget_gpra.html Final documentation estimated to be completed and posted by March 15, 2004.

GPRA Benefits Estimates for the Weatherization and Intergovernmental Activities[a]

Mid-Term Benefits

	2010	2015	2020	2025
Primary Non-Renewable Energy Savings (Quads)	0.4	0.7	0.9	1.1
Energy Expenditure Savings (Billion 2001$)	5	8	11	17
Carbon Emission Reductions (MMTCE)	8	13	19	24
Oil Savings (MBPD)	0.0	0.0	0.1	0.1
Natural Gas Savings (Quads)	0.19	0.29	0.29	0.23
Total Displaced Need for New Electric Capacity (GW)	6	11	11	13

[a] Benefits reported are annual, not cumulative, for the year given. Estimates reflect the benefits associated with program activities from FY 2005 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. Mid-term program benefits were estimated utilizing the GPRA05-NEMS model, based on the Energy Information Administration's (EIA) National Energy Modeling System (NEMS) and utilizing the EIA's Annual Energy Outlook (AEO) 2003 Reference Case.

International Renewable Energy Program

Funding Schedule by Activity

(dollars in thousands)

	FY 2003	FY 2004	FY 2005	$ Change	% Change
International Renewable Energy Program					
International Renewable Energy Program.....	2,649	3,190	6,500	+3,310	+103.8%
Congressionally Directed Activities, International Renewable Energy Program.	1,204	2,698	0	-2,968	-100.0%
Total, International Renewable Energy Program	3,853	5,888	6,500	+612	+10.4%

Description

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).

Benefits

The IREP supports the program mission through technical assistance with National Laboratories and outside experts, helping meet DOE international goals and specific commitments contained in bilateral and multilateral agreements, which further WIP goals. It provides technical support to 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 help 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, thereby leveling playing fields for U.S. companies overseas, and reducing barriers to investment in EERE technologies. 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. IREP activities directly support this goal and the President's stated commitment to support "growth that provides the resources for investment in clean technologies."

Detailed Justification

(dollars in thousands)

FY 2003	FY 2004	FY 2005

International Renewable Energy Program..... **2,649** **3,190** **6,500**

International Renewable Energy supports bilateral and multilateral agreements and builds partnerships with international energy organizations and governments to foster information exchange on renewable energy and energy technology choices for consumers and businesses. These activities include technical and financial assistance projects. They are intended to promote better understanding and acceptance of energy efficiency and renewable energy technologies in other countries' to foster stronger public-private partnerships and to expand domestic and overseas markets for U.S. manufacturers of these technologies. These efforts include cost-shared field validation projects, 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 to develop plans for their appropriate application.

International Renewable Energy includes the following efforts: 1) Continued support for Energy Efficiency and Sustainable Development Centers in countries with transitional economies to gain access to U.S. technologies; 2) Support for establishment of Regional Centers in Africa and Latin America in countries with good governance to promote energy innovations in support of sustainable economic development and regional stability; 3) The Hemispheric Energy Initiative, which works with the energy ministers of member countries of the Organization of American States to support their renewable energy programs; 4) The US-China Renewable Energy Cooperation, which supports business development for U.S. renewable and energy efficiency enterprises in China; 5) Russian and other Eastern Europe programs, which cooperate with multilateral agencies on energy efficiency and renewable energy projects and policy development; 6) The Africa Project, which holds workshops and supports the Conference of Energy Ministers in Africa; 7) World Summit on Sustainable Development activities in selected countries; and 8) Clean Energy Initiative. These efforts provide technical assistance to support sustainable development and emerging market economies.

(dollars in thousands)

	FY 2003	FY 2004	FY 2005
Congressionally Directed Activities, International Renewable Energy Program	**1,204**	**2,698**	**0**

International Utility Energy Partnership, Inc. - The 2004 grant to IUEP will finalize projects sponsored under prior RFPs conducted by IUEP, open a new RFP for the IUEP and Power Partners' member companies interested in developing international GHG reduction projects, create new partnerships under the IPP initiative to incubate future development opportunities, and provide a program-mechanism for the U.S.-investor owned electric industry to partner with the developing world to take a leadership role in voluntary GHG reduction effort. FY 2003 ($1,204,000), FY 2004 ($1,962,143); Renewable Energy Policy Project - The grant to the Renewable Energy Policy Project (REPP) will fund the survey of all commercially viable domestic renewable energy technologies to determine the job and skill requirements relating to the manufacturing, installation, and operation and maintenance for each technology. FY 2004 ($735,804)

Total, International Renewable Energy Program	**3,853**	**5,888**	**6,500**

Explanation of Funding Changes

	FY 2005 vs. FY 2004 ($000)
International Renewable Energy Program	
The International Renewable Energy Program is being increased in order to improve the tools, technical services, and capacity to promote energy innovations that support climate change objectives, sustainable development, global security, trade and exports for the Clean Energy Initiatives follow-up to the World Summit on Sustainable Development, the U.N. Framework Convention on Climate Change, the Clean Energy Technology Exports Initiative, and other international agreements for renewable energy and efficiency, including membership and supporting activities in the Asian Pacific Economic Cooperation (APEC) organization. Tools include improved Geographical Information System support for analysis and mapping of clean energy resources in U.S. technology export markets	**+3,310**
Congressionally Directed Activities, International Renewable Energy Program	
International Utility Energy Partnership, Inc.: This activity is expected to be completed under the one-time grant issued in FY 2004. The results of the survey will need to be reviewed and assessed against programmatic priorities to determine the appropriateness of any separate follow on activities. Renewable Energy Policy Project: DOE is developing a public-private partnership to achieve	**-2,698**

	FY 2005 vs. FY 2004 ($000)
broader market transfer of clean energy innovations through collaborative work with industry	
Total Funding Change, International Renewable Energy Program.	**+612**

Tribal Energy Activities

Funding Schedule by Activity

(dollars in thousands)

	FY 2003	FY 2004	FY 2005	$ Change	% Change
Tribal Energy Activities					
Tribal Energy Activities.....	4,817	1,669	5,500	+3,831	+229.5%
Congressionally Directed Activities, Tribal Energy Activities.....	963	3,237	0	-3,237	-100.0%
Total, Tribal Energy Activities	5,780	4,906	5,500	+594	+12.1%

Description

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

Benefits

Tribal Energy Activities contribute to WIP's mission by building partnerships with Tribal governments to help assess Native American energy needs for residential, commercial, and industrial uses employing EERE technologies. Tribal Energy Activities develops, implements, and manages technical and financial assistance projects to promote energy, environmental, and economic development policy objectives for Native Americans.

Detailed Justification

(dollars in thousands)

	FY 2003	FY 2004	FY 2005
Tribal Energy Activities	**4,817**	**1,669**	**5,500**

The Tribal Energy activity supports the development of capacity within the 565 Federally recognized

(dollars in thousands)

FY 2003	FY 2004	FY 2005

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.

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 systems, 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.

The Tribal Energy activity will continue efforts to assist Tribes in developing Tribal Utility Authorities, where appropriate, to aid in obtaining private sector and other Federal funding. Capacity building and cost-shared deployment projects will continue.

(dollars in thousands)

	FY 2003	FY 2004	FY 2005
Congressionally Directed Activities, Tribal Energy Activities	**963**	**3,237**	**0**
Intertribal Council on Utility Policy - Will provide support and funding for wind projects. FY 2004 ($1,275,393); Pyramid Lake Paiute Tribe Renewable Energy Park - Will provide support and funding for projects. FY 2004 ($981,072); Tribal Energy/Council of Renewable Energy Resource Tribes (CERT) - The 2004 grant to the CERT will provide technical expertise and training of Native Americans in renewable energy resources development and electric generation facilities management. FY 2003 ($963,000), FY 2004 ($981,072)			
Total, Tribal Energy Activities	**5,780**	**4,906**	**5,500**

Explanation of Funding Changes

	FY 2005 vs. FY 2004 ($000)
Tribal Energy Activities	
Tribal Energy will focus resources on technical support and funding to Tribal energy projects selected from competitive solicitations.	**+3,831**
Congressionally Directed Activities, Tribal Energy Activities	
Intertribal Council on Utility Policy: Funds provided for in FY 2004 will complete contemplated activities and any additional technical assistance needed will be provided from within the planned Tribal Energy Activities efforts. Pyramid Lake Paiute Tribe Renewable Energy Park: Funds provided for in FY 2004 will complete contemplated activities and any additional technical assistance needed will be provided from within the planned Tribal Energy Activities efforts. Congressionally Directed Activity, Tribal Energy/Council of Renewable Energy Resource Tribes (CERT): Funds provided for in FY 2004 will complete contemplated activities and any additional technical assistance needed will be provided from within the planned Tribal Energy Activities efforts	**-3,237**
Total Funding Change, Tribal Energy Activities	**+594**

Renewable Energy Production Incentive (REPI)

Funding Schedule by Activity

(dollars in thousands)

	FY 2003	FY 2004	FY 2005	$ Change	% Change
Renewable Energy Production Incentive (REPI)					
Renewable Energy Production Incentive (REPI)	4,816	3,926	4,000	+74	+1.9%
Total, Renewable Energy Production Incentive (REPI).....	4,816	3,926	4,000	+74	+1.9%

Description

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.

Benefits

REPI supports the WIP program goal of deploying renewable energy technologies by providing Federal tax credits to encourage adoption of renewable energy systems 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.

Detailed Justification

(dollars in thousands)

	FY 2003	FY 2004	FY 2005
Renewable Energy Production Initiative (REPI).....	**4,816**	**3,926**	**4,000**
REPI will continue to review applications for renewable energy incentive payments and pay qualified energy as allowed under Section 1212 of the Energy Policy Act of 1992 for electricity from renewable energy generated by states, political subdivisions of states, or rural electric cooperatives.			
Total, Renewable Energy Production Initiative (REPI)	**4,816**	**3,926**	**4,000**

Explanation of Funding Changes

	FY 2005 vs. FY 2004 ($000)
Renewable Energy Production Incentive (REPI)	
The increase supports activities at an ongoing level	+74
Total Funding Change, Renewable Energy Production Incentive (REPI)	**+74**

Renewable Program Support

Funding Profile by Subprogram

(dollars in thousands)

	FY 2003 Comparable Appropriation	FY 2004 Original Appropriation	FY 2004 Adjustments[a,b]	FY 2004 Comparable Appropriation	FY 2005 Request
Renewable Program Support					
Renewable Program Support	0	4,000	+ 919[c]	4,919	0
Total, Renewable Program Support	0	4,000	+ 919	4,919	0

Public Law Authorizations:

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

Mission

This provides for the continued congressionally-directed efforts of the National Renewable Energy Laboratory (NREL) to develop renewable energy resources uniquely suited to the Southwestern United States through its virtual site office in Nevada. Additionally, this provides for congressionally directed projects (from the Consolidated Appropriations Act 2004) for the Energy Center of Wisconsin Renewable Fuels Project and the Lead Animal Shelter Animal Campus renewable energy demonstration project.

Benefits

These congressionally-directed, crosscutting activities do not measurably contribute to the goals of individual renewable energy programs or integrated renewable energy portfolio results.

[a] Programs in the Energy Supply appropriation were reduced by .59 percent as required by the Omnibus Appropriation Bill.

[b] Programs in the Energy Supply appropriation were proportionally reduced based upon the allocated General Reduction of $4,684,000.

[c] Renewable Program Support was provided increases by the Omnibus Appropriation Bill of $1,000,000. This amount was subject to the .59 percent reduction required by the Omnibus Appropriation Bill.

Funding Schedule by Activity

(dollars in thousands)

	FY 2003	FY 2004	FY 2005	$ Change	% Change
Renewable Program Support					
Southwestern Multi-Programs Virtual Site in Nevada	0	3,925	0	-3,925	-100.0%
Energy Center of Wisconsin Renewable Fuels Project	0	746	0	-746	-100.0%
Lead Animal Shelter Animal Campus Renewable Energy Demonstration Project	0	248	0	-248	-100.0%
Total, Renewable Program Support	0	4,919	0	-4,919	-100.0%

Description

Continues congressionally-directed efforts of the National Renewable Energy Laboratory (NREL) to develop renewable energy resources uniquely suited to the Southwestern United States through its virtual site office in Nevada. Additionally, this provides for congressionally directed projects (from the Consolidated Appropriations Act 2004) for the Energy Center of Wisconsin Renewable Fuels Project and the Lead Animal Shelter Animal Campus renewable energy demonstration project.

Benefits

Activities do not measurably contribute to goals of individual renewable energy programs or integrated renewable energy portfolio results.

Detailed Justification

(dollars in thousands)

FY 2003	FY 2004	FY 2005

Renewable Program Support

- **Southwestern Multi-Programs Virtual Site in Nevada** **0** **3,925** **0**

  Supports efforts of the National Renewable Energy Laboratory (NREL) to develop renewable energy resources uniquely suited to the Southwestern United States through its virtual site office in Nevada (FY 2004: $3,924,286). In FY 2003, $3,155,806 was provided by Congress and is displayed with the Office of Electricity Transmission and Distribution's Budget.

(dollars in thousands)

	FY 2003	FY 2004	FY 2005
▪ **Energy Center of Wisconsin Renewable Fuels Project**	**0**	**746**	**0**
Congressionally-directed funding for the Energy Center of Wisconsin Renewable Fuels Project. This activity is provided for with in the Consolidated Appropriations Act of 2004 (FY 2004: $745,475).			
▪ **Lead Animal Shelter Animal Campus Renewable Energy Demonstration Project**	**0**	**248**	**0**
Congressionally-directed funding to remain available until expended for the Lead Animal Shelter Animal Campus Renewable Energy Demonstration Project. This activity is provided for with in the Consolidated Appropriations Act of 2004 (FY 2004: $248,425).			
Total, Renewable Program Support	**0**	**4,919**	**0**

Explanation of Funding Changes

	FY 2005 vs. FY 2004 ($000)
Southwestern Multi-programs virtual site in Nevada	
Within the FY 2005 budget request, DOE has reallocated the funding for this directed activity to higher-priority, mission-supporting activities within the Renewable Energy Program portfolio in the Energy Efficiency and Renewable Energy	-3,925
Energy Center of Wisconsin Renewable Fuels Project	
Within the FY 2005 budget request, DOE has reallocated the funding for this directed activity to higher-priority, mission-supporting activities within the Renewable Energy Program portfolio in the Energy Efficiency and Renewable Energy	-746
Lead Animal Shelter Animal Campus Renewable Energy Demonstration Project	
Within the FY 2005 budget request, DOE has reallocated the funding for this directed activity to higher-priority, mission-supporting activities within the Renewable Energy Program portfolio in the Energy Efficiency and Renewable Energy	-248
Total, Funding Change, Renewable Program Support	-4,919

Departmental Energy Management Program

Funding Profile by Subprogram

(dollars in thousands)

	FY 2003 Comparable Appropriation	FY 2004 Original Appropriation	FY 2004 Adjustments[a,b]	FY 2004 Comparable Appropriation	FY 2005 Request
Departmental Energy Management Program					
Energy Management Project Support	1,084	1,500	-28	1,472	1,467
Energy Management Model Program Development	361	500	-9	491	500
Total, Departmental Energy Management Program	1,445	2,000	-37	1,963	1,967

Public Law Authorizations:

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

Mission

The mission of the Departmental Energy Management Programs (DEMP) is to promote energy security, environmental stewardship and cost reduction through energy efficiency and water conservation, the use of distributed and renewable energy, and sound utility management decisions at U.S. Department of Energy (DOE) Facilities.

Benefits

DEMP supports the mission of the Office of Energy Efficiency and Renewable Energy by improving the energy efficiency and productivity of DOE buildings and by bringing clean, renewable technologies to the DOE facilities. DEMP supports DOE's goals by protecting our national and economic security by

[a] Programs in the Energy Supply appropriation were reduced by .59 percent as required by the Omnibus Appropriation Bill.

[b] Programs in the Energy Supply appropriation were proportionally reduced based upon the allocated General Reduction of $4,684,000.

promoting a diverse supply and delivery of reliable, affordable, and environmentally sound energy to DOE facilities.

Accomplishing DEMP's mission contributes to several national energy and environmental priorities. DOE deployment leadership in its facilities provides valuable insight to other Federal agencies reducing change inertia. 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."

More detailed, integrated and comprehensive economic, energy and energy security benefits estimates are provided in the Expected Program Outcomes section at the end of the program level budget narrative.

Strategic and Program Goals

The Department's Strategic Plan identifies four strategic goals (one each for defense, energy, science, and environmental aspects of the mission) plus seven general goals that tie to the strategic goals. The DEMP program supports the following goal:

Energy Strategic Goal

General Goal 4, Energy Security: Improve energy security by developing technologies that foster a diverse supply of reliable, affordable and environmentally sound energy by providing for reliable delivery of energy, guarding against energy emergencies, exploring advanced technologies that make a fundamental improvement in our mix of energy options, and improving energy efficiency.

The DEMP program contributes to the FEMP program goal which contributes to General Goal 4 in the "goal cascade":

Program Goal 04.13.01.00: DEMP. The Federal Energy Management Program's goal is to provide the efficiency and renewable energy-related technical assistance Federal agencies need to lead the Nation by example through government's own actions, expressly increasing Federal renewable energy use by 2.5 percent by 2005 and reducing energy intensity in Federal buildings by 35 percent by 2010 (using 1985 as a baseline).

Contribution to Program Goal 04.13.01.00 (DEMP)

To lead other federal agencies by its example, DEMP has a higher goal than the overall FEMP goal. The Departmental Energy Management Program's goal is to provide direct funding and energy efficiency related technical assistance to Departmental facilities such that the energy intensity in standard buildings is reduced by 45% by 2010 (using 1985 as a baseline). [DOE Order 430.2A].

Because of its success, DEMP has already achieved the 2010 goal in 2003 (which is the year with the latest data available). The baseline (1985) energy intensity in standard buildings was 473,126 Btu per square foot, whereas the energy intensity in 2003 was 245,469 Btu per square foot, showing a 48 % reduction in energy intensity in that time period. Even though DEMP has already achieved its 2010

goal, it is setting even higher goals. Each year, DEMP has set a goal of reducing the energy intensity each year by 1 percent (using the previous year as the benchmark for comparison).

DEMP helps DOE site personnel reduce energy use and increase energy and water use efficiency at DOE facilities. This in-house program also works with designated site energy managers who are responsible for achieving energy management requirements and guides the ranking of retrofit projects. With improved energy management at DOE facilities, DOE can manage its energy loads during emergencies to the benefit of local authorities in the event of local energy supply constraints or emergencies.

Annual Performance Results and Targets:

FY 2000 Results	FY 2001 Results	FY 2002 Results	FY 2003 Target	FY 2004 Targets	FY 2005 Targets
Program Goal 04.13.01.00 (DEMP)					
Departmental Energy Management Program					
No funding in FY 2000	Decreased energy consumption intensity in DOE facilities by 36 percent from the 1985 baseline. Achieved 42 percent rate of Return on Investment (ROI) for energy projects.	Decreased energy consumption intensity in DOE facilities by 37 percent from the 1985 baseline. Achieved 29 percent ROI for energy projects.	Decreased energy consumption intensity in DOE facilities by 38 percent from the 1985 baseline. Achieved 25 percent ROI for energy projects.	Complete the selection for funding of 4 to13 energy efficiency projects through a competitive selection process that chooses those projects with the greatest return on investment.	Complete the selection for funding of 4 to13 energy efficiency projects through a competitive selection process that chooses those projects with the greatest return on investment.
Management of Funds					
				Contribute proportionately to EERE's corporate goal of reducing corporate and program uncosteds to a range of 20-25 percent by reducing program annual uncosteds by 10 percent in 2004 relative to the program uncosted baseline (in 2003) until the target range is met.	Contribute proportionately to EERE's corporate goal of reducing corporate and program uncosteds to a range of 20-25 percent by reducing program annual uncosteds by 10 percent in 2005 relative to the program uncosted baseline (2004) until the target range is met.

Means and Strategies

The DEMP Program will use various means and strategies to achieve its program goals as described below. "Means" include operational processes, resources, information, and the development of technologies, and "strategies" include program, policy, management and legislative initiatives and approaches. Various external factors, as listed below, may impact the ability to achieve the program's goals. Collaborations are integral to the planned investments, means and strategies, and to addressing external factors.

DEMP will implement the following means and strategies:

- Conduct an annual call among DOE sites and fund projects that support achievement of the goal.
- Provide funds or use private sector investments in energy efficiency and renewable energy technologies.
- Analyze opportunities for energy management improvements and conservation measures at selected DOE facilities.

These strategies will result in significant cost savings and a significant reduction in energy use while also achieving a 20 percent return on investment on funded retrofit projects.

The following external factors could affect DEMP's ability to achieve its strategic goal:

- Cost of energy purchased at DOE sites.
- Availability of energy management personnel at DOE sites.

In carrying out the program's mission, DEMP performs the following collaborative activities:

- Coordinates the review of alternative financing proposals from DOE sites with the appropriate DOE Program Offices.

Validation and Verification

To validate and verify program performance, the DEMP Program will conduct internal and external reviews and audits. These programmatic activities are subject to continuing review by the Department's Inspector General. The table below summarizes validation and verification activities.

Data Sources:	DOE facilities submit annual reports documenting energy use, cost, gross square footage, and exempt facilities. The reports are supplemented by FEMP's tracking and reporting and are submitted each year to Congress.
Baselines:	Federal energy management goals are measured from 1985 [473,126 Btu/ft^2] for standard buildings and 1990 [398,238 Btu/unit] levels for energy intensive buildings. Goals are expressed in BTU per gross square foot and are not normalized for other factors.
Frequency:	Annual.
Data Storage:	DEMP maintains a database of reported information.

Verification: External review is conducted annually. Reporting anomalies are identified and resolved during the annual reporting cycle.

Funding by General and Program Goal

(dollars in thousands)

	FY 2003	FY 2004	FY 2005	$ Change	% Change
General Goal 4, Energy Security					
Program Goal 04.03.01.00, DEMP					
Energy Management Project Support	1,084	1,472	1,467	-5	-0.3%
Energy Management Model Program Development	361	491	500	+9	+1.8%
Total, Program Goal 04.03.01.00, DEMP	1,445	1,963	1,967	+4	+0.2%
Total, General Goal 4 (DEMP)	1,445	1,963	1,967	+4	+0.2%

Expected Program Outputs

FEMP pursues its mission through integrated activities designed to improve the energy efficiency of, and renewable energy usage by, the Federal government. We expect these improvements to reduce susceptibility of federal agencies to energy price fluctuations and to lower their energy bills; reduce EPA criteria and other pollutants in the cities where agency operations are located; and enhance energy security by increasing the flexibility of local energy demand.

Estimates of annual non-renewable energy savings, energy expenditure savings, and carbon emission reductions that result from the realization of FEMP's goals are shown in the table below through 2025. In addition to these "EERE business-as-usual" benefits, realizing the FEMP goals would provide the technical potential to reduce conventional energy use by the federal government even further if warranted by future energy needs.

The assumptions and methods underlying the modeling efforts affect the estimated benefits, and results could vary if external factors, such as future energy prices, differ from the baseline case assumed for this analysis. A summary of the methods, assumptions, and models used in developing these benefit estimates that are important for understanding these results are provided at www.eere.energy.gov/office_eere/budget_gpra.html Final documentation estimated to be completed and posted by March 15, 2004.

[a] Benefits reported are annual, not cumulative, for the year given. Estimates reflect the benefits associated with program activities from FY 2005 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. Mid-term program benefits were estimated utilizing the GPRA05-NEMS model, based on the Energy Information Administration's (EIA) National Energy Modeling System (NEMS) and utilizing the EIA's Annual Energy Outlook (AEO) 2003 Reference Case.

FY 2005 GPRA Benefits Estimates for FEMP [a]

Mid-term benefits

	2010	2015	2020	2025
Primary Non-Renewable Energy Savings (Quads).....	0.03	0.04	0.05	0.07
Energy Expenditure Savings (Billion 2001$).....	0.2	0.3	0.5	0.6
Carbon Emission Reductions (MMTCE).....	1	1	1	1

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**.** By helping large Federal facilities quickly reduce their peak demand, FEMP benefited California and other western States during past electricity shortages.

Energy Management Project Support

Funding Schedule by Activity

(dollars in thousands)

	FY 2003	FY 2004	FY 2005	$ Change	% Change
Energy Management Project Support					
Energy Management Project Support	1,084	1,472	1,467	-5	-0.3%
Total, Energy Management Project Support	1,084	1,472	1,467	-5	-0.3%

Description

DEMP's 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. DEMP provides support through direct funding at various DOE facilities for energy projects to increase the energy efficiency of our facilities and reduce future utility and maintenance costs.

Benefits

DEMP supports the mission of the Office of Energy Efficiency and Renewable Energy by improving the energy efficiency and productivity of DOE buildings and by bringing clean, renewable technologies to the DOE facilities. DEMP supports DOE's goals by protecting our national and economic security by promoting a diverse supply of reliable, affordable, and environmentally sound energy to DOE facilities. It is expected that these activities will have returns on investment of greater than 20 percent based on the performance of DEMP projects previously funded.

Detailed Justification

(dollars in thousands)

	FY 2003	FY 2004	FY 2005
Energy Management Project Support	**1,084**	**1,472**	**1,467**

DEMP will 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 20 percent per dollar invested; and achieving annual savings of 20 billion Btus.

DEMP will fund approximately 4-13 energy projects including two to three renewable energy or other emerging technologies; projects provide a rate of return of at least 20 percent per dollar invested; and achieve annual savings of 20 billion Btus by 2006.

Total, Energy Management Project Support	**1,084**	**1,472**	**1,467**

Explanation of Funding Changes

	FY 2005 vs. FY 2004 ($000)
Energy Management Project Support	-5
Total Funding Change, Energy Management Project Support	**-5**

Energy Management Model Program Development

Funding Schedule by Activity

(dollars in thousands)

	FY 2003	FY 2004	FY 2005	$ Change	% Change
Energy Management Model Program Development					
Energy Management Model Program Development	361	491	500	+9	+1.8%
Total, Energy Management Model Program Development	361	491	500	+9	+1.8%

Description

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.

Benefits

Energy management model program development supports the mission of the Office of Energy Efficiency and Renewable Energy by improving the energy efficiency and productivity of DOE buildings. This program supports DOE's goal of achieving a reliable, affordable, and environmentally sound energy supply at DOE's facilities.

Detailed Justification

(dollars in thousands)

FY 2003	FY 2004	FY 2005

Energy Management Model Program Development

Analyze opportunities for energy management and conservation at selected DOE facilities. 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. Meter the energy consumption at 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 the minimum level Leadership in Energy and Environmental Design Building (LEED) Certification for one new sustainable building design.

Total, Energy Management Model Program Development	**361**	**491**	**500**

Explanation of Funding Changes

	FY 2005 vs. FY 2004 ($000)
Energy Management Model Program Development	+9
Total Funding Change, Energy Management Model Program Development	**+9**

National Climate Change Technology Initiative Competitive Solicitation

Funding Profile by Subprogram

(dollars in thousands)

	FY 2003 Comparable Appropriation	FY 2004 Original Appropriation	FY 2004 Adjustments	FY 2004 Comparable Appropriation	FY 2005 Request
National Climate Change Technology Initiative Competitive Solicitation					
National Climate Change Technology Initiative Competitive Solicitation.....	0	0	0	0	3,000
Total, National Climate Change Technology Initiative Competitive Solicitation	0	0	0	0	3,000

Public Law Authorizations:

P.L. 93-275, "Federal Energy Administration Act of 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. 95-91, "Department of Energy Organization Act" (1977)
P.L. 102-486, "Energy Policy Act of 1992"

Mission

The mission of the President's National Climate Change Technology Initiative (NCCTI) is to strengthen the Federal portfolio of climate change related research and technology development, demonstration and deployment (RDD&D) investments, make recommendations for realignments and priorities, as appropriate, and accelerate the development of technologies that can significantly reduce greenhouse gas emissions. The Competitive Solicitation Program (CSP) is a key component of the President's NCCTI. The mission of the CSP is to ensure that innovative, novel, high-impact potential climate change technology options in this area are explored. The CSP will focus on achieving specific climate change goals. The CSP will do so without designating *a priori* any one particular technology solution or another.

Benefits

The Competitive Solicitation Program is intended to complement and enrich the existing portfolio of climate change-related research and applied technology R&D exploring novel and potentially important research concepts not elsewhere funded. By stimulating and strengthening Federal research in this area, the President's NCCTI hopes to inspire private sector interest and international cooperation in a

sustained collaborative program of research investment aimed at accelerating technology development and advancing the Administration's climate change goals.

Funding Schedule by Activity

(dollars in thousands)

	FY 2003	FY 2004	FY 2005	$ Change	% Change
National Climate Change Technology Initiative Competitive Solicitation					
National Climate Change Technology Initiative Competitive Solicitation	0	0	3,000	+3,000	
Total, National Climate Change Technology Initiative Competitive Solicitation	0	0	3,000	+3,000	

Description

Through competitive solicitations of research grant proposals, the CSP will explore novel concepts, technologies or technical approaches, not elsewhere covered, that could, if successful, contribute in significant ways to the reduction, avoidance or permanent sequestration of greenhouse gas (GHG) emissions. The CSP will focus on: (1) reducing GHG emissions from energy-use and infrastructure; (2) reducing emissions from energy supply; (3) capturing and sequestering carbon dioxide (CO2) gas; (4) reducing emissions of other GHGs; (5) enhancing capabilities to measure and monitor GHG emissions; and (6) strengthening supporting or contributing research aimed at overcoming related technical barriers. A technical review committee, consisting of agency program officials for whom the research results might benefit, will oversee the CSP. Results will be reported annually.

Detailed Justification

(dollars in thousands)

FY 2003	FY 2004	FY 2005

National Climate Change Technology Initiative Competitive Solicitation **0** **0** **3,000**

In order to complement existing R&D programs, address structural issues that tend to discourage some meritorious concepts from being explored, and ensure that important technology options are considered, the CSP will solicit research proposals for grants on innovative climate technologies. Proposals may focus on any concept, technology, or technical approach that can be shown to be relevant to the stated research goals and meet other criteria outlined below; and must not duplicate already completed or ongoing R&D. Areas for funding would include: strategic research; advanced concepts; integrative concepts; novel concepts; greenhouse gases other than CO2; measuring and monitoring systems; novel

(dollars in thousands)

FY 2003	FY 2004	FY 2005

process feedstocks, materials and materials substitutes; and enabling technologies. The solicitation would be open to all proposers and subject to merit review with peer evaluation. In keeping with the nature of the solicitation, which is focused on novel concepts and exploratory research, each award would be relatively small.

Awards would be evaluated on the basis of the following four criteria: (a) potential contributions to the research goal; (b) novelty; (c) technical merit; and (d) quality of the research team and institutional support. A technical review committee (TRC), composed of Federal members from the DOE R&D programs, other Federal R&D agencies, and experts in climate change technology and related research, would provide overall guidance for each year's solicitation and periodically review the activities of the program to ensure coordination, non-duplication, and efficacy of administrative procedure. The competitive solicitation would be administered by the DOE-led, U.S. Climate Change Technology Program (CCTP).

Total, National Climate Change Technology Initiative ...	**0**	**0**	**3,000**

Explanation of Funding Changes

	FY 2005 vs. FY 2004 ($000)
NCCTI Solicitations	
In FY 2005, the NCCTI Competitive Solicitation Program represents a new activity.....	+3,000
Total, Funding Change, National Climate Change Technology Initiative	+3,000

Facilities and Infrastructure

Funding Profile by Subprogram

(dollars in thousands)

	FY 2003 Comparable Appropriation	FY 2004 Original Appropriation	FY 2004 Adjustments[a,b]	FY 2004 Comparable Appropriation	FY 2005 Request
Facilities and Infrastructure					
National Renewable Energy Laboratory	5,297	13,200	-250	12,950	11,480
Total, Facilities and Infrastructure	5,297	13,200	-250	12,950	11,480

Public Law Authorizations:

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

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 Laboratory (NREL).

Benefits

The National Renewable Energy Laboratory is a central part of EERE's programs. It provides in-house research, user facilities, analysis, and management of R&D contracts for the Solar, Wind, Geothermal, Biomass, and Hydrogen programs within the Energy Supply budget, and does the same for the Vehicles, Fuel Cells, Buildings, and Distributed Energy programs in the Energy Conservation budget. It also supports superconductivity research in the Office of Electricity Transmission and Distribution. It is home to 1,100 researchers, engineers, analysts, and administrative staff, plus visiting professionals, graduate students, and interns on a 300-acre campus in Golden, CO, occupying 5 large research buildings (with another about to begin construction), a dozen or so smaller facilities, and over 200,000 square feet of research and administrative space in a neighboring office park.

Maintaining state-of-the-art research facilities at NREL permits the EERE programs to advance the basic materials technologies, biosciences, aerodynamics, systems analysis, and structural engineering

[a] Programs in the Energy Supply appropriation were reduced by .59 percent as required by the Omnibus Appropriation Bill.

[b] Programs in the Energy Supply appropriation were proportionally reduced based upon the allocated General Reduction of $4,684,000.

that underpin the advancements made by our R&D programs. The concentration of expertise also makes NREL a central player in EERE's deployment programs.

National Renewable Energy Laboratory

Funding Schedule by Activity

(dollars in thousands)

	FY 2003	FY 2004	FY 2005	$ Change	% Change
National Renewable Energy Laboratory					
Operation and Maintenance					
General Plant Projects....	2,504	2,060	2,400	+340	+16.5%
General Purpose Equipment.....	2,023	2,060	2,400	+340	+16.5%
Congressionally Directed Activity, National Center on Energy Management and Building Technologies	0	4,905	0	-4,905	-100.0%
Total, Operation and Maintenance.....	4,527	9,025	4,800	-4,225	-46.8%
Construction (02-NREL-001)	770	3,925	6,680	+2,755	+70.2%
Total, National Renewable Energy Laboratory	5,297	12,950	11,480	-1,470	-11.4%

Description

Within Operations and Maintenance, general plant projects (GPP) serve to address rising maintenance expenses and to address a backlog of maintenance needs that has built up, while general purpose equipment (GPE) acquisitions promote better operational efficiencies and maintain first-rate lab and user-facility capabilities. Funding to begin construction of the 71,000 square foot Science and Technology Facility was provided in the FY 2004 appropriation, and funds to continue the work are included for FY 2005.

Detailed Program Justification

(dollars in thousands)

FY 2003	FY 2004	FY 2005

Operations and Maintenance **4,527** **9,025** **4,800**

These funds provide for general infrastructure upgrades and maintenance that address NREL's general capital needs (general purpose projects, general purpose equipment). This does not include technology-specific capital equipment funded by individual program budgets. The funding includes: 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; and 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 Plant Projects** **2,504** **2,060** **2,400**

  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 are 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; 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; and Walkway, landscaping, water management, water treatment, and other site improvements to enhance the sustainability, cohesiveness, and pedestrian nature of the site.

- **General Purpose Equipment**..... **2,023** **2,060** **2,400**

  This investment replaces and upgrades NREL's general capital equipment at a regular annual rate of approximately 4 percent. 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; and 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 state-of-the-art in capability.

(dollars in thousands)

FY 2003	FY 2004	FY 2005

- **Congressionally Directed Activity, National Center on Energy Management and Building Technologies** **0** **4,905** **0**

  In FY 2003, funding for this activity was included by Congress in the Zero-Energy Buildings program.

Construction: NREL Science and Technology Facility..... **770** **3,925** **6,680**

FY 2005 continues construction of the Science and Technology Facility (S&TF) at NREL, which is beginning in FY 2004. The S&TF will allow the NREL photovoltaics program and other activities to address complex processing and system manufacturing problems that are common to all thin-film and nanostructure energy technologies and that are beyond the capability of the industry to solve. The lab will institute a transformational research approach that will lower manufacturing costs and reduce time-to-market of next-generation thin-film and nanostructure technologies.

The S&TF will provide nine advanced material synthesis and general support laboratories, a unique process development and integration laboratory, and office space for 55 researchers. The S&TF has been designed to be a showcase facility for energy savings and sustainability in an R&D laboratory, with a goal of achieving a "Gold" LEED rating, and will be designed and built to incorporate all ES&H requirements for the intended research activities. The S&TF will be linked with the existing Solar Energy Research Facility.

Total, Facilities and Infrastructure **5,297** **12,950** **11,480**

Explanation of Funding Changes

FY 2005 vs. FY 2004 ($000)

Operations and Maintenance

- **General Plant Projects**

  The FY 2005 budget includes a modest increase in GPP funding to address an existing backlog of maintenance and upgrade projects..... + 340

- **General Purpose Equipment**

  The FY 2005 budget includes a modest increase in GPE funding to keep up with expanded program activities at the lab. The funds provide for a 3-4 year replacement cycle for IT equipment and upgraded scientific equipment to address + 340

the lab's advancing technical programs and the needs of user facilities	
▪ **Congressionally Directed Activity, National Center on Energy Management and Building Technologies**	
No funds are requested because funds are being allocated to other activities more closely aligned with the Program's goal.	- 4,905
Total, Operations and Maintenance	**- 4,225**
Construction (02-NREL-001)	
Continues with second-year construction of the Science and Technology Facility (S&TF). This facility will be crucial to the commercialization of next-generation thin-film and nanostructure photovoltaics systems and related energy technologies	+ 2,755
Total Funding Change, National Renewable Energy Laboratory	**- 1,470**

02-NREL-001, Science and Technology Facility, National Renewable Energy Laboratory, Golden, Colorado

Significant Changes

This is the initial inclusion of the capital construction budget request for the DOE National Renewable Energy Laboratory's (NREL) Science and Technology Facility in Golden, CO. $6,680,000 is requested to fund the second year of construction.

Critical Decision 1 ("Approve Preliminary Baseline Range") was received on June 6, 2002. This project was baselined and received Critical Decision 2 ("Approve Performance Baseline"), approval on September 16, 2003, following an External Independent Review (EIR) and completion of corrective actions for 10 essential findings. One additional corrective action was completed for the last of the essential findings (total of 11) by September 30, 2003, and corrective actions were completed for the remaining nine lesser findings by October 31, 2003. This project received Critical Decision 3 ("Approve Start of Construction"), on December 12, 2003.

1. Construction Schedule History

	Fiscal Quarter				Total Estimated Cost ($000)	Total Project Cost ($000)
	A-E Work Initiated	A-E Work Completed	Physical Construction Start	Physical Construction Complete		
FY 02 Budget Request *(A-E and technical design only)*	1Q 2002	4Q 2002	--	--	800	1,195
FY 03 Budget Request *(A-E and technical design only)*	1Q 2002	3Q 2003	--	--	1,600	2,020
FY 04 Budget Request *(Acquisition performance baseline)*	No Construction Data Sheet was included in the FY 2004 Budget.					
FY 05 Budget Request *(Acquisition performance baseline)*	1Q 2002	4Q 2003	4Q 2004	4Q 2006	21,190	28,386

2. Financial Schedule

(dollars in thousands)

	Appropriations	Obligations	Costs
Design and Construction			
FY 2002	800	800	272
FY 2003	770	770	1,259
FY 2004[a]	3,925 [b]	3,925	1,114
FY 2005[a]	6,680	6,680	9,193
FY 2006[a]	9,015	9,015	9,352
Total, Design and Construction	21,190	21,190	21,190

3. Project Description, Justification and Scope

This project provides for the design, engineering and construction of a new facility for the National Renewable Energy Laboratory (NREL) in Golden, Colorado. This is the second inclusion of the capital construction budget request for this project, the Science and Technology Facility (S&TF). The TEC is based on the final design cost estimate as verified through an Independent Cost Review and Constructability Analysis.

The purpose of the S&TF is to provide a facility to expand the research capabilities to enable DOE to achieve its strategic goals, as outlined in the National Energy Policy (NEP). The S&TF will do this by addressing complex processing and system manufacturing problems that are common to all hydrogen production and storage, fuel cells, advanced solid-state lighting, thin-film energy coatings/devices, electrochromics, photovoltaics, and related thin-film and nanostructure energy technologies. These processing and system manufacturing issues are beyond the capability of industry to economically resolve.

The expected results of constructing the S&TF include the following:

- The S&TF is designed to provide the capability to accelerate renewable energy technology advancement through performance-based R&D programs and public-private partnerships involving solar technologies, hydrogen technologies, fuel cell components, and distributed energy technologies.
- The research that can only be accomplished in the S&TF will fill a critical knowledge gap that will help accelerate the introduction of new thin-film and nanostructure technologies and lower their cost.
- The S&TF will provide for a transformational research capability and approach that does not exist in the United States at this time. When fully outfitted and commissioned, the S&TF will combine

[a] The financial schedule for FY 2004, FY 2005, and FY 2006 has been modified to reflect the unanticipated and unbudgeted appropriation of $3,925,000 to start construction of this project in FY 2004 instead of FY 2005. Out-year financial data have been adjusted to maintain the TEC.

[b] The FY 2004 appropriation shown here includes a reduction of $23K in anticipation of the 0.59 percent across-the-board reduction contained in the FY 2004 Omnibus appropriations bill.

process integration, diagnostics, and simulation with the fundamental and applied research and development that is currently conducted in the adjacent NREL Solar Energy Research Facility in ways that have not been done before.

- The S&TF has been designed to support the technology roadmaps and multiyear plans for photovoltaics, hydrogen, and buildings industries. In photovoltaics, for instance, the National Research Council has said, "The Solar Photovoltaics Program should give top priority to the development of sound manufacturing technologies for thin-film modules. Much more attention should be paid to moving the technology from the laboratory through integrated pilot-scale experiments to commercial-scale design." The Process Development and Integration Laboratory (PDIL) that the S&TF makes possible will directly address that concern.
- The research and development conducted in the S&TF will provide vital process information that is needed by US industry in the highly competitive international marketplace. This will enable the United States to maintain a leadership position in the international marketplace for near-term and next-generation thin-film and nanostructure technologies.
- The S&TF is designed to promote energy efficiency by providing the facilities in support of the development of new advances in solid-state lighting, building-integrated photovoltaics, thin-film energy coatings/devices, electrochromic films for smart windows and related building technologies, and superconducting wires, tapes, and materials.
- The S&TF design will demonstrate dramatic energy savings for National Laboratory facilities.
- The S&TF is designed to provide the research and development capability for improving the environment by reducing pollutants from today's electric power generators.

With the construction of the Science and Technology Facility at NREL and the process improvement knowledge that will be gained, EERE estimates that the time from laboratory to marketplace can be significantly shortened (from 25% to 65%) for these technologies. U.S. industry will have a totally new capability to aid them in competing in the international energy marketplace. The additional laboratory space and new capabilities of the Science and Technology Facility will greatly facilitate the successful accomplishment of DOE missions in photovoltaics, hydrogen, solar, buildings, solid-state lighting, thin-film energy coatings/devices, electrochromics, and nanotechnologies. The program impact is broad because the current Solar Energy Research Facility (SERF) at NREL, and the proposed S&TF, have been designed to be an integrated set of research facilities, enhancing the value from research currently conducted in the existing SERF. Achieving DOE goals for advancing renewable energy technologies based on thin-film and nanostructure technologies will require expanded laboratory facilities such as those in the STF, and the facility will help U.S. manufacturers to keep pace with foreign competitors in Japan and Europe.

Programmatic impacts include:

Solar. U.S. industry has clearly indicated that the capabilities of the unique Process Development and Integration Laboratory in the S&TF are critical for competing with foreign firms. European firms have now become aware of the value of this integrated process research approached and they have started prototype operations at their university partners to begin their own work. This facility also supports the fundamental work for next-generation PV products, which is also under threat from strong research investments in Germany and Japan. Timely construction of the Science and Technology Facility will provide U.S. research and industry with a competitive edge internationally.

Hydrogen. When the S&TF is constructed, hydrogen production research (photoelectrochemical and photovoltaic electrolysis) will gain valuable research space in the SERF, specially designed for toxic materials and explosive gases, to better conduct and expand hydrogen production research. Hydrogen storage research will also gain valuable space. The S&TF itself will also provide unique capabilities in engineering research for both hydrogen production and hydrogen storage technologies that cannot be done without the facility.

Buildings, Solid-State Lighting, Nanotechnologies. The S&TF will enable scale-up and process R&D on all thin-film technologies, including electrochromic films for smart windows, photovoltaic films integrated into architectural glass, and other thin-film technologies for the reduction of energy use in buildings; next generation solid-state lighting; nanostructure solar cells using quantum dots; and nanotubes for the storage of hydrogen.

A Life Cycle Cost Analysis (LCCA) has been completed to determine if needs can be met by modifying existing facilities. Six different options, including leasing and renovating commercial space and renovating abandoned government buildings, have been considered; however, life cycle cost analysis indicates these options to be less cost effective. There are currently no facilities in either the public or private sector that allow for the accelerated development and deployment of hydrogen and renewable energy technologies proposed for the S&TF. The recommended alternative with the greatest cost benefit is to construct the S&TF at NREL adjacent to the existing Solar Energy Research Facility.

The Science and Technology Facility, as designed, is a 71,000 sf. two story building with a third story mechanical penthouse. The laboratory block is 300 ft. long and varies between 60 ft. and 115 ft. wide on the two lower floors with a ceiling height of 18 ft. The office block is 165 ft. long and 72 ft. feet wide with a sloping roof structure that is 14 ft. tall at its highest point. The laboratories are constructed using structural concrete slabs with steel framing and are designed for H-5 (International Building Code - Semiconductor Fabrication Facilities Using Hazardous Production Materials) occupancy due to the use of hazardous production materials (HPM). The office section is constructed using slab-on-grade concrete floors with structural steel framing. The ventilation system for the laboratories is a variable air volume single pass system. The laboratories are similar in use to semiconductor fabrication facilities and have HPM and specialty gases distributed throughout with a toxic gas monitoring system. The facility has complete fire detection and suppression systems including standpipe configurations. The facility will be fully commissioned as a prerequisite for U.S. Green Building Council LEED™ certification at the Gold level. (Gold certification is the second highest out of 4 possible certifications for new commercial construction, major renovations and high-rise residential buildings. Gold certification requires the attainment of 39 to 51 out of a possible 69 points for sustainable siting, energy and water efficiency, sustainable design in materials and resources, indoor environmental quality, and innovation.) Laboratory utility systems include compressed air, nitrogen, hydrogen, argon, and silane gas. Standard equipment for the facility includes office landscape furniture and laboratory casework and fume hoods.

Improvements to the land and utility connections for this project include roads, sidewalks, fire/potable water, sewer, electrical and natural gas utilities, and landscaping/water management. This project will also install equipment in the central plant of the existing Solar Energy Research Facility to support heating and cooling water requirements in the S&TF.

The proposed funding for BY2005 of $6,680,000 for this project will provide for the continued build-out of the building shell, and site-work/ and utility work and the start of interior construction and finishes. Additional funding in BY2006 of $9,015,000 will be required to complete the construction effort for this project.

Facility operating costs are included in Item 7, Related Annual Funding Requirements, shown below.

4. Details of Cost Estimate

(dollars in thousands)

	Current Estimate	Previous Estimate
	Construction Line Item	Construction Line Item
Design Phase		
Preliminary and Final Design costs	1,332	1,332
Design Management costs (0.2% of TEC)	48	48
Project Management costs (0.1% of TEC)	12	12
Total, Design Costs (6.6% of TEC)	1,392	1,392
Execution (Construction) Phase		
Improvements to Land	1,152	1,152
Buildings	13,959	13,959
Utilities	674	674
Standard Equipment	692	692
Inspection, Design and Project Liaison, Testing, Checkout and Acceptance	589	589
Construction Management (2.3% of TEC)	478	478
Project Management (1.5% of TEC)	328	328
Total, Execution Costs	17,872	17,872
Contingencies		
Design Phase (0.7 % of TEC)	139	139
Execution Phase (8.4 % of TEC)	1,787	1,787
Total, Contingencies (9.1% of TEC)	1,926	1,926
Total, Estimated Costs	21,190	21,190

5. Method of Performance

Design and inspection are being performed under a negotiated fixed price, design to budget, subcontract awarded on the basis of competitive bidding and best value selection. Construction execution and procurement will be accomplished by fixed-price subcontracts awarded on the basis of competitive bidding and best value selection. All subcontracts will be managed by the M&O Contractor with oversight by the Department of Energy.

6. Schedule of Project Funding (Cost Schedule)

(dollars in thousands)

	Prior	FY 2002	FY 2003	FY 2004	FY 2005	FY 2006	FY 2007	FY 2008
Facility Costs								
Design (PED)[a]	0	272	1,259	39	0	0	0	1,570
Execution (Construction)	0	0	0	1,075	9,193	9,352	0	19,620
Total, Line item TEC	0	272	1,259	1,114	9,193	9,352	0	21,190
Total Facility Costs (Federal and Non-Federal)	0	272	1,259	1,114	9,193	9,352	0	21,190
Other Project Costs								
Conceptual design cost[b]	380	0	0	0	0	0	0	380
NEPA documentation costs[c]	0	10	10	0	0	0	0	20
ES&H costs[d]	0	5	5	0	5	5	0	20
Experimental equipment (Process Development and Integration Lab)[e]	0	0	0	0	3,100	2,590	790	6,480
Other Project-Related costs[f]	0	0	57	10	104	112	13	296
Total, Other Project Costs (OPC)	380	15	72	10	3,209	2,707	803	7,196
Total, Project Cost	380	287	1,331	1,124	12,402	12,059	2,543	28,386

[a] Preliminary design was completed in December of 2002. Final design was completed in September of 2003.

[b] The Final Conceptual Design Report was completed in the second quarter of FY 2002 to support the CD-1 Authorization.

[c] Preparation of the National Environmental Policy Act (NEPA) documentation for the proposed facility was completed as part of the update of the existing Environmental Assessment (EA) for the NREL South Table Mountain Site. This EA was completed and a Finding Of No Significant Impact (FONSI) determination was signed July 1, 2003.

[d] ES&H costs represent the cost of preparing the Hazard Analysis Report for the proposed facility.

[e] Eleven items of scientific equipment, purchased by the Solar Energy Program, will be installed following building construction and acceptance utilizing program capital funds to be allocated in FY 2005, 2006, and 2007.

[f] Other Project-Related costs include building commissioning, integrated project team support, and independent assessment of construction progress.

7. Related Annual Funding Requirements

(dollars in thousands)

Annual Operating Costs[a] (Operating from FY 2007 through FY 2057)	Current Estimate	Previous Estimate
Maintenance and Repair costs	341	N/A
Utility costs	250	N/A
Other costs	66	N/A
Total, Annual Operating Costs	657	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.

- The project will be located in an area not subject to flooding determined in accordance with Executive Order 11988.

- DOE has reviewed the GSA inventory of Federal Scientific laboratories and found insufficient space available, as reported by the GSA inventory.

[a] Maintenance and Repair costs reflect historical site costs; Utility costs are based on the energy analysis completed during Final Design for the proposed facility; and other costs include custodial costs for the proposed facility. No costs are included for future facility upgrades, general-purpose equipment (GPE), or costs associated with possible changes in current mission.

Capital Operating Expenses and Construction Summary

Capital Operating Expenses

(dollars in thousands)

	FY 2003	FY 2004	FY 2005	$ Change	% Change
Capital Operating Expenses					
General Plant Projects	2,504	2,060	2,400	+ 340	+ 16.5%
Capital Equipment					
General-Purpose Equipment, NREL	2,023	2,060	2,400	+ 340	+ 16.5%
Solar Energy Program/NREL STF	0	0	3,100	+ 3,100	
Wind Energy Program	450	400	450	+50	+12.5%
Subtotal, Capital Equipment	2,473	2,460	5,950	+ 3,490	+ 141.9%
Total, Capital Operating Expenses	4,977	4,520	8,350	+ 3,830	+ 84.7%

Construction Projects

(dollars in thousands)

	Total Estimated Cost (TEC)	Prior-Year Appropriations	FY 2003	FY 2004	FY 2005	Unappropriated Balance
NREL Science & Tech Facility	21,190	800	770[a]	3,925	6,680	9,015
Total, Construction	21,190	800	770	3,925	6,680	9,015

[a] Net after required use of $19,000 in prior-year balances.

Program Direction

Funding Profile by Category

(dollars in thousands/whole FTEs)

	FY 2003[a]	FY 2004[b,c]	FY 2005	$ Change	% Change
Golden Field Office					
Salaries and Benefits	1,631	1,642	3,601	+1,959	+119.3%
Travel	64	79	124	+45	+57.0%
Support Services	100	300	401	+101	+33.7%
Other Related Expenses	82	281	581	+300	+106.8%
Total, Golden Field Office	1,877	2,302	4,707	+2,405	+104.5%
Full Time Equivalents	15	15	31	+16	+106.7%
Idaho Operations Office					
Salaries and Benefits	109	0	0	0	0.0%
Travel	4	0	0	0	0.0%
Total, Idaho Operations Office	113	0	0	0	0.0%
Full Time Equivalents	1	0	0	0	0.0%
Headquarters					
Salaries and Benefits	8,079	7,663	9,013	+1,350	+17.6%
Travel	190	180	276	+96	+53.3%
Support Services	1,138	1,146	4,980	+3,834	+334.6%
Other Related Expenses	1,218	1,073	1,735	+662	+61.7%
Total, Headquarters	10,625	10,062	16,004	+5,942	+59.1%

[a] FY 2003 figures reflect a comparability adjustment as a result of the splitting-off of the Office of Electricity Transmission and Distribution (OETD). The adjustment includes a total reduction of $2.799 million, from $15,785 million to $12.615 million, and a reduction of 17 FTE, from 109 to 92.

[b] Programs in the Energy Supply appropriation were reduced by .59 percent as required by the Omnibus Appropriation Bill.

[c] Programs in the Energy Supply appropriation were proportionally reduced based upon the allocated General Reduction of $4,684,000.

Full Time Equivalents	76	69	75	+6	+8.7%
Total Program Direction					
Salaries and Benefits	9,819	9,305	12,614	+3,309	+35.6%
Travel	258	259	400	+141	+54.4%
Support Services	1,238	1,446	5,381	+3,935	+272.1%
Other Related Expenses	1,300	1,354	2,316	+962	+71.0%
Total Program Direction	12,615	12,364	20,711	+8,347	+67.5%
Total, Full Time Equivalents	92	84	106	+22	+26.2%

Mission

This Program Direction budget component provides the Federal staffing resources and associated costs for supporting the responsive management and oversight of the Office of Energy Efficiency and Renewable Energy (EERE) programs funded by the Energy Supply appropriation. Activities also include necessary funds for support service contractors, equipment, travel, and crosscutting analysis and activities.

Adequate Program Direction funding is essential to the realization of the Department's renewable energy goals and objectives and implementation of the President's Management Agenda. Since the reorganization in 2002, supporting business management functions are now centralized to eliminate overlap of responsibilities and reinforce program customer focus. EERE business operation model is aimed at removing stovepiped and fragmented administrative practices and expenses; eliminating 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; 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.

As stated in the Departmental Strategic Plan, DOE's Strategic and General Goals will be accomplished not only through the efforts of the major programs in the Department but with additional effort from offices which support the programs in carrying out the mission. Through its Program Direction activities, EERE performs critical functions which directly support the mission of the Department. These functions include managing information technology, ensuring sound legal and policy advice and fiscal stewardship, developing and implementing uniform program policy and procedures, maintaining and supporting our workforce, providing security at our Golden Field Office, and providing Congressional and public liaison and information.

Detailed Justification

(dollars in thousands)

FY 2003	FY 2004	FY 2005

Salaries and Benefits **9,819** **9,305** **12,614**

Salaries and Benefits funds a total of 106 full time equivalent employees in FY 2005, 22 more than the FY 2004 planned level. 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 76 FTEs in FY 2005, 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 30 FTEs. This represents an increase of 10 from the FY 2004 planned level, and continues the development of a centralized EERE Project Management Office at Golden, with a particular emphasis on increasing the program execution support for the President's Hydrogen Fuel Initiative. One of the 10 FTE will be stationed at the NNSA Service Center in Albuquerque, NM, to provide dedicated financial services to the Golden Field Office and EERE.

The funding request includes a technical adjustment to account for true personnel costs that have been higher than embodied in past budgets, as well as for expected FY 2005 pay raises.

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.

Travel **258** **259** **400**

The increased staff and project management responsibilities at the Golden Field Office will require increased travel for contractor oversight. Similarly, the increased emphasis on program management at headquarters will require increased travel by headquarters personnel. The FY 2005 request raises the per-capita travel budget to a level that will allow proper management of the programs.

Support Services **1,238** **1,446** **5,381**

Includes funding for support service contractors, including IT (LAN and PC) support and e-mail service; crosscutting planning, analysis, and evaluation; and general Assistant Secretary initiatives that support all renewable energy resources programs. The requested increase reflects more comprehensive budgeting under Program Direction for the full "costs of doing business" of the renewable energy programs, as well as support for the Hydrogen initiative, and increased efforts to

(dollars in thousands)

implement the President's Management Agenda. The increase also will allow EWD-funded staff to receive computer and e-mail support and more reliable servers.

By Congressional direction, not only are management support services funded within this line-item, but also technical program support for planning, road-mapping, market studies, etc. The proposed increase provides support services needed for advice on critical science, engineering, environmental, economic, and legal issues; as well as business management systems development; safety and health support; facility safeguards and security; and computer hardware and software installation, configuration, and maintenance activities. The increase proposed for FY 2005 provides full funding for the renewable energy programs' share of landlord services at the Golden Field Office and for their share of IT services and local-area network operations, and would permit some program and project management activities to be directly funded and managed through the Golden Field Office and DOE headquarters, rather than having management delegated to national laboratories.

Three million dollars of the proposed increase in EERE Program Direction will be used to provide analytical and technical support for the U.S. Climate Change Technology Program (CCTP). The U.S. CCTP is a multi-agency research planning and coordination activity, chartered by President Bush and led by DOE, aimed at accelerating the development of technologies that can significantly reduce greenhouse gas emissions. It also serves as the administrative and implementing arm of the President's National Climate Change Technology Initiative (NCCTI). Specific CCTP activities will include strategic R&D planning; developing planning scenarios with supporting technology analyses and long-term modeling; and identifying, documenting and helping to prioritize related R&D investments across participating Federal agencies.

Other Related Expenses	**1,300**	**1,354**	**2,316**

This activity encompasses the Headquarters Working Capital Fund (WCF), IT equipment purchases and maintenance (such as a 3-year replacement cycle for desk-top PCs) at both Headquarters and the Golden Field Office, and contractual services associated with landlord support of the Golden Field Office (GO). Rent is the largest component of the WCF, but it also includes telephones, copying, network operations, payroll and other employee services, printing, etc. The requested increase includes the Energy Supply programs' full share of rent and utilities at the Golden Field Office, which have previously been paid by the Subcommittee on Interior and Related Agencies. The FY 2005 figure also includes an increase of $211,000 to adjust for the fact that $211,000 in balances will be used to supplement the amount shown above for FY 2004 (balances will be used in the WCF).

Total, Program Direction	**12,615**	**12,364**	**20,711**

Explanation of Funding Changes

	FY 2005 vs. FY 2004 ($000)
Salaries and Benefits	
The increase supports 22 additional FTEs who will support the Hydrogen and other R&D programs or will provide project management at the Golden Field Office for some activities now managed by national laboratories. It also reflects the full effect of the FY 2004 pay raise and the partial effect of the FY 2005 pay raise	+3,309
Travel	
Increase reflects additional travel by existing and new FTEs in support of more diligent project management.	+141
Support Services	
Three million dollars of this increase will support analysis of technology impacts on climate change and management support for an integrated R&D response to climate change. The remainder of the increase provides support for increased staff at the Project Management Office in Golden, and to pay the Energy Supply programs' staffing of existing support activities at the Golden Field Office. Also will allow the transition of some supporting functions from national laboratories to lower-cost contractors, for activities such as multi-year plans, technology roadmaps, development of deployment and outreach materials, and market studies.....	+3,935
Other Related Expenses	
Reflects latest estimates of Other Related Expenses at Golden and the Headquarters Working Capital Fund, Energy Supply share of GO landlord expenses, and training expenses. Also reflects the use of $211K in balances in FY04, which reduces the FY04 base amount in this line.....	+962
Total Funding Change, Program Direction.....	+8,347

Support Services by Category

(dollars in thousands)

	FY 2003	FY 2004	FY 2005	$ Change	% Change
Technical Support					
Economic and Environmental Analyses	300	300	1,800	+1,500	+500.0%
Management Support					
IT Support	638	846	1,000	+154	+18.2%
Administrative Support Services	300	300	2,581	+2,281	+760.3%
Total, Management Support	938	1,146	3,581	+2,435	+212.5%
Subtotal, Support Services	1,238	1,446	5,381	+3,935	+272.1%
Total, Support Services	1,238	1,446	5,381	+3,935	+272.1%

Other Related Expenses by Category

(dollars in thousands)

	FY 2003	FY 2003	FY 2005	$ Change	% Change
Other Related Expenses					
Rent to GSA	0	0	381	+381	
Communications, Utilities, Misc.	37	160	225	+65	+40.6%
Printing and Reproduction	0	15	25	+10	+66.7%
Other Services	0	35	56	+21	+60.0%
Operation and Maint. of Equip.	29	101	265	+164	+162.4%
Supplies and Materials	16	20	29	+9	+45.0%
Equipment	0	50	100	+50	+100.0%
Working Capital Fund	1,218	973 [a]	1,235	+262	+26.9%
Total, Other Related Expenses	1,300	1,354	2,316	+962	+71.0%

[a] In FY 2004, $211K of prior-year balances will applied to the Working Capital Fund, in addition to the appropriation shown here.