Corporate Context for
Energy Resources (ER) Programs

This section on Corporate Context that is included for the first time in the Department's budget is provided to facilitate the integration of the FY 2003 budget and performance measures. The Department's Strategic Plan published in September 2000 is no longer relevant since it does not reflect the priorities laid out in President Bush's Management Agenda, the 2001 National Energy Policy, OMB's R&D project investment criteria or the new policies that will be developed to address an ever evolving and challenging terrorism threat. The Department has initiated the development of a new Strategic Plan due for publication in September 2002, however, that process is just beginning. To maintain continuity of our approach that links program strategic performance goals and annual targets to higher level Departmental goals and Strategic Objectives, the Department has developed a revised set of Strategic Objectives in the structure of the September 2000 Strategic Plan.

Energy is the vital force powering business, manufacturing, and movement of goods and services throughout the country. The United States spends over one-half trillion dollars annually for energy, and our economic well-being depends on reliable, affordable supplies of clean energy.

The Energy Resources goal establishes the overarching purpose of the Department's energy programs. Focus of three of the Department's program offices is on energy technology R&D: Office of Fossil Energy (FE), Office of Nuclear Energy, Science and Technology (NE), and the Office of Energy Efficiency and Renewable Energy (EE). In addition to energy technology R&D the Department's Energy Information Administration (EIA) develops and publishes energy statistics and forecasts and the Department also delivers Federal hydroelectric power to consumers though the Power Marketing Administrations (PMAs).

Energy Resources (ER) Goal

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

Strategic Objectives

The Energy Resources business line goal is supported by the following strategic objectives. Offices requesting funding to achieve these objectives are identified with each objective:

ER1: Use public-private partnerships to promote energy efficiency and productivity technologies in order to enhance the energy choices and quality of life of Americans in 2020 relative to 2000

by: reducing the oil intensity of the U.S. economy by 25 percent (compared to 23 percent without EE programs); reducing energy intensity in the U.S. economy by 32 percent (compared to 28 percent without EE programs); and, reducing the need for additional electricity generating capacity by 10 percent (compared to the case without EE programs). (EE)

ER2: Use public private partnerships to bring cleaner, more reliable, and more affordable energy technologies to the marketplace, enhancing the energy choices and quality of life of Americans in 2020 relative to 2000 by: increasing the share of renewable energy to 10% (compared to 8 percent without EE programs); increasing the share of renewable-generated electricity to 12 percent (compared to 8 percent without EE programs); and, doubling the share of capacity additions accounted for by distributed power, which increases distributed generation to 11% of all electricity generation (compared to 8% without EE programs). (EE)

ER3: Reduce the burden of energy prices on low-income families by working with state and local agencies to weatherize at least 123,000 homes per year from 2003 through 2005. (EE)

ER4: Create public-private partnerships to provide technology to ensure continued electricity production from the extensive U.S. fossil fuel resource, including control technologies to permit reasonable-cost compliance with emerging regulations, and ultimately, by 2015, zero emission plants (including carbon) that are fuel-flexible, and capable of multi-product output and efficiencies over 60% with coal and 75% with natural gas. (FE)

ER5: By 2010, add over 1 million barrels a day of domestic oil production and almost 2 TCF per year of additional gas production as a result of technologies and practices from DOE supported research and development. (FE)

ER6: Maintain the Strategic Petroleum Reserve in a state of readiness to supply oil at sustained rate of 4.2 million barrels per day for 90 days within 15 days notice by the President. (FE)

ER7: Expand the capability of nuclear energy to contribute to the Nation's near and long-term energy needs by investing in our Nation's nuclear R&D infrastructure and promoting advanced research, such that by December 2004: the average capacity of existing U.S. nuclear power plants will increase from 90 to 92 percent; a new nuclear power plant construction project will be initiated in the United States; and a conceptual design will be developed for a nuclear energy system that addresses the technology issues hindering the worldwide expansion of nuclear power. (NE)

ER8: Provide national and international energy data, analysis, information and forecasts to meet the needs of the energy decision-makers and the public in order to promote sound policymaking, efficient energy markets and public understanding. (EIA)

ER9: Ensure Federal hydropower is marketed and delivered while passing the North American Electric Reliability Council's Control Compliance Ratings, meeting planned repayment targets, and achieving a recordable accident frequency rate at or below our safety performance standard. (PMA)

Budget Summary table

(dollars in thousands)

	FY 2001 Comparable Appropriation	FY 2002 Comparable Appropriation	FY 2003 Request
Office of Energy Efficiency and Renewable Energy (EE) Programs			
$ Energy Conservation excluding weatherization (272) ER1	$657,178	$685,470	$627,204
$ Renewable Energy Resources (271) ER2	370,453	386,406	407,720
$ Energy Conservation - Weatherization (272) ER3	152,664	230,000	277,100
Total EE	**1,180,295**	**1,301,876**	**1,312,024**
Office of Fossil Energy (FE) Programs			
$ Fossil Energy Research and Development (271), Clean Coal Technology (271), and Alternative Fuels (271) ER4 and ER5	545,982	627,626	534,155
$ Naval Petroleum and Oil Share Reserves (271), Elk Hill School Lands Fund (271), and Strategic Petroleum Reserve (274) ER6	187,312	233,525	281,823
Total FE	**733,294**	**861,151**	**811,509**
Nuclear Energy, Science and Technology (NE) Programs			
Office of			
$ Nuclear Energy Programs (271) ER7	277,105	293,928	250,659
Total NE	**277,105**	**293,928**	**250,659**
Environmental Information Administration (EIA)			
$ National Energy Information System (276) ER8	78,154	81,199	82,801
Total EIA	**78,154**	**81,199**	**82,801**
Power Marketing Administrations (PMA)			
$ Power Marketing Administrations (271) ER9	208,856	214,962	204,750
Total PMA	**208,856**	**214,962**	**204,750**
Total ER	**1,477,704**	**2,753,116**	**2,666,212**

Office of Energy Efficiency and Renewable Energy

Executive Summary

Mission

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

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

EE's research, development, demonstration, and deployment (RD^3) portfolio addresses three of America's most pressing energy security concerns; namely, over half of our nation's transportation system runs on imported oil; our nation's electricity infrastructure is vulnerable to natural or man-made failures; and, dramatically fluctuating energy prices and energy trade deficits harm the economic vitality of our nation. By developing cost-effective energy efficiency and renewable energy technologies, EE programs, in coordination with other public and private sector efforts, can significantly reduce these vulnerabilities in the years and decades ahead.

- In the transportation sector, EE's portfolio reduces the amount of oil required to keep America moving as well as develops options for clean and domestic alternative sources of transportation energy, such as hydrogen-based fuel cell vehicles. These efforts provide the energy and technological means to substantially reduce dependence on imported oil.
- In the industry sector, EE's portfolio addresses the energy intensity of the major energy-consuming US manufacturing and processing industries, such as steel, aluminum, chemicals, and agriculture. The specific projects are defined in partnership with industry using collaboratively-developed technology roadmaps and industry vision documents.
- In the buildings sector, the Department manages R&D and deployment programs to improve the energy efficiency of building materials, designs, and associated heating, cooling, and lighting equipment and other appliances. The programs are customized to the needs of new construction and retrofits of both residential and commercial buildings.
- EE renewable energy technologies diversify the types of domestic energy sources available to the United States, reducing reliance on any one type of energy. For example, EE efforts helped lower the cost of wind generated electricity by 90 percent over the past two decades, encouraging the development of nearly 1,700 megawatts of new U.S. wind capacity in 2001.
- EE also addresses the reliability of the electricity system and its ability to rebound from adverse events. These efforts include improving the efficiency of the transmission and distribution system, reducing the demand for peak electricity, and facilitating the growth of distributed generation systems. These efforts will not only reduce the strain on over-burdened transmission systems, but also provide local back-up power in the event of an emergency. Additionally, a

broad network of on-site power generators is much less susceptible to catastrophic sabotage. Lastly, the Federal Energy Management Program (FEMP) contributes to electricity system reliability by coordinating federal facility responses during energy emergencies, avoiding disruptions, and aiding service resumptions.

In addition to ***increasing U.S. energy security***, EE's portfolio directly and substantially supports the four additional goals of the President's National Energy Policy:

- ***Modernize energy conservation***. EE's energy efficiency programs constitute the majority of federal R&D efforts to improve the energy performance and energy productivity of the American economy.
- ***Modernize our energy infrastructure.*** EE's RD^3 portfolio employs an integrated supply and demand *systems* approach to improving the efficiency and reliability of our electricity and bio-energy infrastructure. EE is also leading federal efforts to examine the potential of a hydrogen-based energy system.
- ***Increase energy supplies.*** Although renewable energy resources already account for some 7 percent of domestic energy production, America's domestic renewable energy resource base is vast and provides a substantial opportunity for increasing and diversifying domestic production. EE focuses on promoting technological improvements necessary to allow the private sector to develop these domestic resources.
- ***Accelerate the protection and improvement of the environment.*** Virtually all of EE's programmatic areas provide new and innovative means of protecting and improving the environment, both by optimizing the amount of energy used by our economy and by developing cleaner sources of energy. This progress reduces health harming emissions such as SO_2, NO_x, CO, Hg, and particulate matter (PM). It also reduces releases of carbon dioxide.

Strategic Objectives

Three broad strategic objectives underlie EE's support of the Department of Energy's goals and the National Energy Policy, two in Energy Conservation and one in Renewable Energy Resources and related technologies.

Energy Conservation Objectives

ER1: Energy Efficiency. Use public-private partnerships to promote energy efficiency and productivity technologies in order to enhance the energy choices and quality of life of Americans in 2020 relative to 2000 by: reducing the oil intensity of the U.S. economy by 25 percent (compared to 23 percent without EE programs); reducing energy intensity in the U.S. economy by 32 percent (compared to 28 percent without EE programs); and reducing the need for additional electricity generating capacity by 10 percent (compared to the case without EE programs).

Energy efficiency contributes not only towards reduced energy costs and enhanced economic competitiveness, but also alleviates some of the environmental impacts associated with energy production. Additionally, improved energy efficiency lessens the strain on the nation's energy

infrastructure and our nation's reliance on imported energy resources. This Strategic Objective is supported by the following Program Strategic Performance Goals that address energy savings opportunities found throughout our economy:

Buildings

ER1-1: Residential Buildings Integration
R & D activities will provide the energy technologies and solutions that will catalyze a 20 percent increase in the energy efficiency of both new and existing prototype residential buildings by 2008 relative to the 1996 baseline.

ER1-2: Commercial Buildings Integration
R & D activities will provide the energy technologies and solutions that will catalyze a 15 percent increase in the energy efficiency of both new and existing prototype commercial buildings by 2008 relative to the 1996 baseline.

ER1-3: Equipment, Tools, and Materials
Introduce 5 new ready-for-transition-to-market products by 2008 through component and tool development R & D activities; will issue 13 formal proposals for enhanced product standards and test procedures by 2009.

ER1-4: Community Energy Program
Will retrofit an additional 400 million square feet of commercial and public/institutional space through Rebuild America activities, educate 20 million more consumers through delivery of appropriate energy conservation information, and achieve adoption of upgraded model residential and commercial building energy codes in 20 additional States between 2003 and 2008.

ER1-5: State Energy Program
Will award 280 grants to 56 States and Territories by 2008 to undertake energy technology activities appropriate for States' implementation.

ER1-6: Energy Star
Will achieve a 65 percent market share for ENERGY STAR windows and a 20 percent market share for ENERGY STAR appliances by 2010, compared with approximately 40 percent and 13 percent respectively in 1999.

Industry

ER1-7: Specific Vision Industries
Specific Vision Industries R&D activities will develop a portfolio of energy saving technologies and methods that will catalyze reduced energy use in the eight energy-intensive "Industries of the Future" of 329 trillion Btu of annual savings in 2005, 827 trillion Btu in 2010, and 2,377 trillion Btu in 2020, compared with the EIA conventional technology baseline.

ER1-8: Crosscutting Industrial Technologies
Crosscutting Industrial Technologies R&D activities will develop a portfolio of crosscutting energy saving technologies, methods, and assistance that will catalyze reduced energy use in energy-intensive "Industries of the Future" of 178 trillion Btu of annual savings in 2005, 590 trillion Btu in 2010, and 1,963 trillion Btu in 2020, compared with the EIA conventional technology baseline.

Power Technologies

ER1-9: Distributed Energy Resources
Distributed Energy Resources (DER) R&D activities will increase the share of new DER electricity-generating capacity from 5 percent in 2000 to 7 percent in 2005. (Distributed energy activities funded by the Energy and Water Development Appropriation are part of a coordinated and complementary effort with distributed energy R&D activities funded by the Interior and Related Agencies Appropriation, which jointly contribute to this goal.)

Transportation

ER1-10: Hybrid Systems R&D
Hybrid Systems R&D activities will reduce the production cost of a high power 25kW battery from $3,000 in 1998 to $500 in 2010, with an intermediate goal of $750 in 2006.

ER1-11: Fuel Cells R&D
Fuel Cell R&D activities will reduce the production cost of the 50 kW vehicle fuel cell power system from $275/kW in 2002 to $125/kW in 2005 and $45/kW in 2010.

ER1-12: Advanced Combustion Engine R&D
Advanced Combustion Engine R&D activities will reduce NOx emissions in light-duty diesel vehicles from 0.10 grams per mile (g/m) in 1998 to 0.05 g/m in 2006 and 0.03 g/m in 2010 and in heavy duty diesel engines from 4.0 grams per brake horsepower hour (g/bhp-hr) in 1998 to 2.4 g/bhp-hr in 2002 and 0.2 g/bhp-hr in 2005.

ER1-13: Electric Vehicles R&D
Electric Vehicles R&D activities will reduce the production cost of a 40kWh lithium ion battery from $365/kWh in 2001 to $295/kWh in 2004 and to $150/kWh in 2010.

ER1-14: Heavy Vehicle Systems R&D
Heavy Vehicle Systems R&D activities will reduce the parasitic losses, including aerodynamic drag from 39 percent in 1998 to 24 percent in 2006.

ER1-15: Fuels Utilization
Fuel Utilization R&D activities will decrease light truck and passenger vehicle engine-out emissions of particulate matter from 0.1 grams per brake horsepower hour (g/bhp-hr) in 2001 to 0.06 g/bhp-hr by 2008.

ER1-16: Transportation Materials Technologies
Transportation Materials Technologies R&D activities will reduce the production cost of carbon fiber from $12 per pound in 1998, to $3 per pound in 2006.

ER1-17: Transportation Technology Assistance
The Clean Cities program will increase the number of alternative fuel vehicles in the Clean Cities from 110,000 in 2001, to 250,000 in 2007 and to 400,000 in 2010; helping to create successful niche markets that will yield nationwide 1,000,000 alternative fuel vehicles, consuming 1 billion gallons of alternative fuel in 2010.

Federal Energy Management

ER1-18: Federal Energy Management Program
The Federal Energy Management Program activities will increase the energy security and reduce the environmental impact of the Federal government by decreasing energy intensity in standard Federal facilities by 30 percent by 2005, relative to 1985 levels.

ER3: Weatherization. Reduce the burden of energy prices on low-income families by working with State and local agencies to weatherize at least 123,000 homes per year from 2003 through 2005.

The Weatherization program makes a difference in the lives of low-income American families by improving the energy efficiency of their homes and reducing their energy bills. This Strategic Objective is supported by the following Program Strategic Performance Goal:

ER3-1: The Weatherization Assistance Program
Will complete weatherization upgrades for 770,900 low-income households from 2003 through 2008.

Renewable Energy Resources Objectives

ER2: Renewable and distributed energy. Use public-private partnerships to bring cleaner, more reliable, and more affordable energy technologies to the marketplace, enhancing the energy choices and quality of life of Americans in 2020 relative to 2000 by: increasing the share of renewable energy to 10 percent (compared to 8 percent without EE programs); increasing the share of renewable-generated electricity to 12 percent (compared to 8 percent without EE programs); and, doubling the share of capacity additions accounted for by distributed power, which increases distributed generation to 11 percent of all electricity generation (compared to 8 percent without EE programs).

The development of renewable and distributed energy resources provides the means to expand the quantity of energy services provided using domestic supplies while enhancing our environment and improving the reliability and security of our energy infrastructure. The clean and reliable energy sources addressed include renewable energy, fuel cells, and natural gas hybrid systems. This Strategic Objective

is supported by the following Program Strategic Performance Goals that address a range of renewable and distributed energy resources for the production of fuels and electricity:

ER2-1: Biopower
Biopower R&D activities will increase the testing, verification, and demonstration of the component systems of cost-effective and efficient biomass gasification combined-cycle systems from 0 percent in 2000 to 75 percent in 2006.

ER2-2: Biofuels
Biofuels R&D activities will reduce the production cost of cellulose-based ethanol to $1.20 per gallon by 2005, and to $1.07 per gallon in by 2010.

ER2-3: Geothermal Energy
Geothermal Energy R&D activities will result in twice as many States with geothermal electric power facilities.

ER2-4: Hydrogen
Hydrogen R&D activities will demonstrate a conversion technology that will improve the cost of hydrogen production from natural gas from $3.75 per kilogram in 2000, when produced in large quantities, to $2.50 per kilogram in 2006.

ER2-5: Hydropower
Hydropower R&D activities will ensure commercialization of a fish passage technology capable of reducing turbine-induced fish mortality to 2 percent or less by 2010 in new fish-friendly turbines.

ER2-6: Wind Energy
Wind Energy R&D activities will provide the technologies to reduce the cost of wind powered electricity generation in Class 4 wind areas (13 mph annual average) from 5.5 cents per kilowatt-hour in 2002 to 3 cents per kilowatt-hour by 2010.

ER2-7: Solar Technologies
Solar Technologies R&D will reduce the price paid for a photovoltaic system by the end user (including operation and maintenance costs) from a median value of $6.25 per Watt in 2000 to $4.50 per Watt in 2006 (equivalent to reducing from $0.25 to $0.18 per kilowatt hour).

ER2-8: High Temperature Superconductivity
High Temperature Superconductivity (HTS) R&D activities will develop HTS wire capable of carrying 100 times the power of comparable copper wire – with zero electrical resistance by 2007.

ER2-9: Distributed Energy Systems
Distributed Energy Storage Technology R&D activities will increase the share of new distributed energy electricity-generating capacity from 5 percent in 2000 to 7 percent in 2005. (Distributed

energy activities funded by the Energy and Water Development Appropriation are part of a coordinated and complementary effort with distributed energy R&D activities funded by the Interior and Related Agencies Appropriation, which jointly contribute to this goal.)

ER2-10: International Programs
International program activities will assist U.S. industry growth in export sales of renewable energy products and services as indicated by increasing PV export sales from approximately 50 MW in 2000 to over 130 MW in 2004.

ER2-11: Departmental Energy Management Program Team
The Departmental Energy Management Program Team activities will decrease the energy intensity in DOE facilities by 45 percent by 2005, relative to 1985 levels.

ER2-12: REPI, other support & implementation
The Renewable Energy Production Incentive will increase the total number of new renewable energy projects at publicly- and cooperative-owned electric utilities from 0 in 1993 to 75 in 2003.

Performance Standards: Progress towards the preceding Program Strategic Performance Goals (PSPGs) will be scored in future color-coded assessments according to the following standards:

Blue:	Significantly exceeding annual milestones/targets**.**
Green:	Effectively meeting (i.e. +/- 5 percent) all annual milestones/targets**.**
Yellow:	Effectively meeting all milestones/targets within program control, but behind on elements outside program control; put on "watch" list.
Red:	Missing a critical milestone.

Strategy

EE advances its mission and supports national energy priorities through a mix of short and long term efforts that help determine whether clean and efficient energy technologies are ultimately deployed in the Nation's energy system. Towards this end, EE seeks to improve energy technologies and practices through RD^3; formulate policies and standards in the public interest; and, facilitate private sector deployment of advanced energy technologies and practices.

The majority of EE's activities are in the area of fundamental technology R&D, efforts that are in our nation's interest but are too risky or long-term to be conducted by the private sector. EE also recognizes, however, that market factors and government policies significantly affect which technologies are purchased by consumers. Consequently, EE's portfolio includes efforts such as developing transmission interconnection protocols in conjunction with States and working with industry to create minimum appliance standards. The portfolio also provides consumers with a wider array of market opportunities via targeted technical assistance and consumer education, and by leading through example when purchasing energy services for government use (for example, FEMP coordinates President Bush's

Executive Order directing all federal agencies to purchase appliances that meet the "one-watt standard", wherever cost-effective).

EE's portfolio can evolve in order to meet the changing energy and public policy needs; reflect the opportunity to "graduate" or move-on from successful research efforts; and reduce the commitment of funding in areas with disappointing research results. EE also strives to improve the performance of those efforts that are critical for addressing key public policy needs, but for which management practices may be less than fully effective.

EE used four evaluation and planning tools, two of which are ongoing performance strategies and two of which are new this year to EE's planning and evaluation efforts. These tools were used to inform decision-makers, often when making difficult choices, to ensure that EE's portfolio focuses on the largest areas of need and opportunity and utilizes best practices to achieve those results.

R&D Investment Criteria. As part of the President's Management Agenda, the White House, in consultation with Congressional staff, DOE, independent experts, and non-governmental organizations, developed a set of objective investment criteria for funding federal R&D projects and asked the Department of Energy to pilot this initiative in FY 2003. EE was selected as one of three DOE offices to utilize the President's new criteria. These criteria help focus EE's R&D portfolio on technologies that address national energy policy goals, provide clear public benefits, and would not be developed by the private sector alone. The criteria also address the need for performance-based public private partnerships, well-defined comprehensive program plans, and clear "off ramps" or termination points. These performance-based metrics help ensure that program dollars are used effectively, and that funding is not continued beyond the need for public support.

Integrated, performance-based benefit estimates. Past experience has shown that the timeframe necessary to develop energy technological improvements (or R&D outputs) can be years or decades long, with additional decades required for markets to realize the benefits (or R&D outcomes) of adopting these technologies. In order to ensure that EE's portfolio is providing clear public benefits that meet energy policy goals, it is necessary to link the annual activities and milestones funded in each year's budget with resulting technology improvements and the likely market impacts of those improvements. Based on EIA forecasts of future energy prices and market conditions, EE programs annually estimate the role of improved technologies in their respective markets. The private consulting firm A.D.Little, Inc. reviews these program estimates.

A version of Energy Information Administration's National Energy Modeling System (NEMs) is used to ensure that underlying technology improvements (for example, overall increases in energy efficiency expected through typical private sector investment in R&D) are not counted as part of the benefits of the technology improvements pursued by EE programs. The model also helps ensure that benefits are not double counted when technologies developed by more than one sector could address the same market need. For the majority of EE R&D efforts pursued through public-private partnerships, the estimated benefits include the combined contributions of all partners. The chart below summarizes the results of EE's *FY 2003 GPRA Benefits Reports* estimating the energy savings, energy cost savings, and carbon

reduction benefits for the requested funding levels for FY 2003 (for the sake of analysis, funding levels are assumed to remain similar in subsequent years).

Office of Energy Efficiency and Renewable Energy
EERE Programs Projected Benefits by Sector through the Year 2020

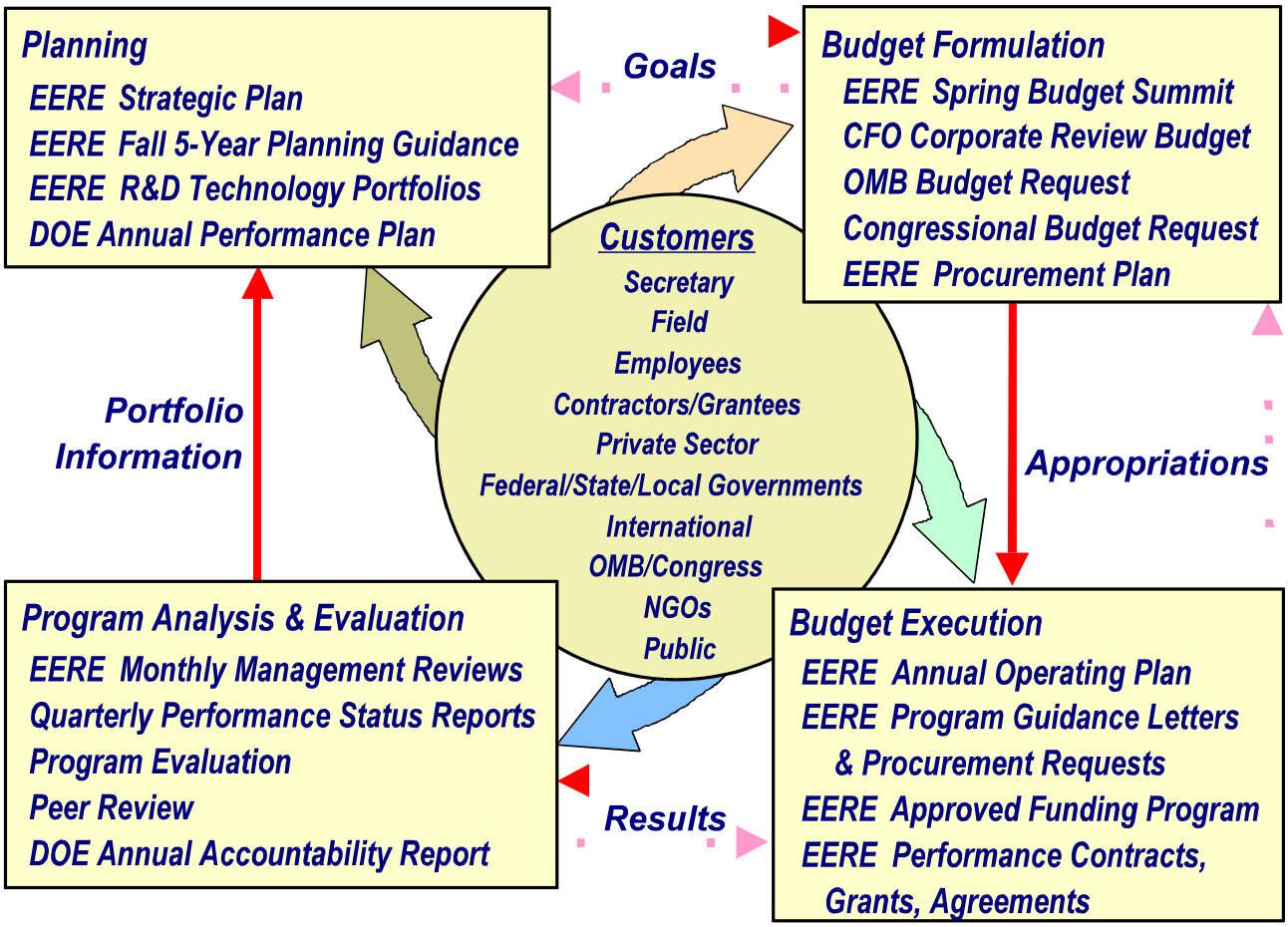
	Total Primary Energy Saved or Produced (quadrillion BTUs)			Energy Cost Savings ($ billions)			Carbon Reductions (million metric tons)		
	2005	2010	2020	2005	2010	2020	2005	2010	2020
Transportation *(equivalent barrels of oil saved, mbpd)*	0.03-0.04 *(0.06-0.14)*	0.5-0.7 *(0.3-0.5)*	2.8-4.7 *(1.5-2.5)*	0.8-3.9	9.4-19.8	31.5-61.5	0.7-2.3	8.9-14.4	54.5-92.1
Industry	0.5	1.3-1.4	3.4-4.3	1.8-1.9	5.4-5.5	16.6-18.0	7.9-8.4	23.0-24.5	54.6-82.7
Buildings	0.3	0.9	1.9-2.8	2.2	7.1-9.3	17.1-29.9	4.7-5.1	16.5-17.0	32.7-51.0
Federal	0.02	0.04	0.06	0.1	0.2	0.3	0.3	0.7	1.1
Power	0.3-0.7	1.0-2.2	2.0-4.9	1.6-2.1	4.2-4.8	10.6-15.2	6.5-28.5	20.4-62.5	36.0-122.6

Note: Program benefit projections are developed through an impact analysis process undertaken annually by EE, based on assumptions for future energy markets derived from EIA's annual energy outlook. EE's sectors analyze the impacts their programs will have on energy savings, energy cost savings, and carbon reductions if all program goals are met, and future energy markets develop as expected. A sample of program benefit estimates are externally reviewed by Arthur D. Little. An integrated analysis model run by an external contractor controls for interaction effects across sectors.

At the sector level, we report a range of estimates with or without these interactions. For example, reductions in required new electricity generation due to energy efficiency improvements would reduce the potential market for a range of electricity supply options. When integrated and non-integrated estimates are virtually the same, no estimate range is shown. Totals for Transportation include impacts from the Biofuels program funded under the Energy and Water Development Appropriation. The Federal Energy Management Program is not included in the integrated analysis and therefore does not have a range of estimates.

Managing for Results. Excellence in business management is essential to accomplishing EE's mission and objectives. This requires a transparent, integrated, and seamless approach that incorporates a proactive administration of EE functions and activities and underpins the specific planning and evaluation tools described above. The Federal government's fiscal cycles often involve managing up to four budget years at any one time. To effectively meet challenges such as these, and as part of an ongoing effort to "change the way EE does business," EE created the Strategic Management System (SMS) which institutionalizes its processes for planning, budget formulation, budget execution, and program analysis and evaluation (see figure below for more details). Implementing this system is the key to ensuring overall management excellence on par with the technological excellence of EE programs.

EERE STRATEGIC MANAGEMENT SYSTEM



Strategic Program Review. A detailed Strategic Program Review (SPR), undertaken in the summer of 2001 to fulfill a recommendation of the President's National Energy Policy, provided valuable additional input into the Department's internal FY 2003 budget development process. The draft SPR identified 20 EE activities that should be terminated because their expected outcomes did not constitute a sufficient return on investment, they lacked public support, or the technologies involved were mature enough to be "graduated" to the private sector.

The draft SPR also identified several activities that were central to the achievement of public benefits, and yet, need closer monitoring to ensure they advance effectively. These include the building sector demonstration and deployment programs and microturbine research efforts. Further, several programs that could achieve significantly greater benefit with additional funding were identified. These programs include R&D on hydrogen, building equipment R&D, fuel cell vehicles, low-wind speed turbines, and peak load reduction activities. Finally, the draft SPR identified a number of "best practices" currently used by some EE programs that could be usefully replicated in other programs. These "best practices"

include competitive solicitations, technology roadmapping, multi-year planning based on critical path milestones, and increasing the number of EE private sector partners.

Complementary Appropriations

EE's budget is appropriated in bills managed by two Congressional Appropriation Subcommittees. The Interior and Related Agencies Appropriations Subcommittee supports EE's energy efficiency efforts under the Energy Conservation appropriation account. In FY 2003 the request in this account totals $902 million, or 69 percent of EE's budget. Additionally, the Energy and Water Development Appropriations Subcommittee supports EE's work on renewable energy under the Energy Supply appropriation account. In FY 2003, the request in this account totals $407 million, or 31 percent of EE's budget. Some crosscutting initiatives are funded jointly by both bills.

The complementary nature of these appropriations illustrates a recognition among Congressional appropriators that EE's dual efforts to make America more energy productive while simultaneously increasing and supporting America's domestic energy supply contribute towards the same set of public benefits. In our modern economy, distinctions between energy supply increases and energy efficiency improvements are increasingly blurred. For example:

- Automotive fuel cells increase energy efficiency while simultaneously providing a new means of operating automobiles on fuels other than petroleum.
- Buildings designed to include both advanced efficiency and renewable energy features can achieve greater overall energy savings (potentially producing more energy on-site then they use on average over the course of a year).
- Distributed generation systems provide new means of producing electricity supplies, but also afford improvements in efficiency by reducing transmission line losses and allowing for the capture and use of otherwise wasted heat produced when electricity is generated.
- Federal procurement can lead by example in purchasing cost-effective energy efficient products and renewable energy power supplies.

Combined, both funding sources contribute to these important benefits and are critical components of the Federal government's strategy of investing in high-risk, high-value RD^3 that is essential to the nation's future and would not be conducted independently by the private sector.

Significant Programmatic Shifts in FY 2003

The following describes significant programmatic shifts by EE in both its Interior and Related Agencies and Energy and Water Development Appropriation budget requests.

Interior and Related Agencies / Energy Conservation Appropriation

- *Transportation*: Requests funding for FreedomCAR, a new public-private partnership between the Department of Energy and U.S. automakers to develop cost-effective fuel cell vehicles.

FreedomCAR is not a "line item" in EE's request; rather, it represents a cross-cutting approach to managing multiple related R&D programs that will be coordinated with industry. This approach to funding follows the pattern set by FreedomCAR's predecessor, the Partnership for a New Generation of Vehicles.

- *Bioenergy:* Requests funding for bioenergy RD^3 activities to be directed towards a single crosscutting effort. This initiative will integrate programs funded out of both the Interior and the Energy and Water Development appropriations. The portion of funding derived from the Interior account will build upon biomass activities implemented through EE's industry and transportation programs.

Energy and Water Development / Energy Supply Appropriation

- *Hydrogen R&D*: Requests significant funding increases towards developing hydrogen as an energy carrier that can provide pollution-free, carbon-free power. Development of this clean and efficient energy source will lessen our dependence on imported fuels in both power and transportation applications. Although the additional funds will support efforts in EE's power program, the resulting RD^3 will inform and benefit all EE's programs. A portion of the hydrogen program is counted as part of the FreedomCAR initiative and will be managed to help achieve FreedomCAR's goals.

- *High Temperature Superconducting R&D:* Requests significant funding increases for this potential breakthrough technology. High Temperature Superconducting RD^3, led by EE's power program, can potentially revolutionize the manner in which electricity is transmitted to end-users and increase electrical capacity, reliability, and efficiency in electric power applications.

- *Wind Energy R&D:* Requests a shift in wind energy R&D towards the development of low wind speed technologies that will continue to lower generation costs and greatly expand the areas available for installation of wind energy systems.

David K. Garman
Assistant Secretary for Energy Efficiency and Renewable Energy

Date

Energy and Water Development
Renewable Energy Resources

Program Mission

Mission

The overall mission of EE's renewable energy program is to promote the development and use of clean power and heat technologies, including renewable and natural gas hybrids and biofuels.

Summary

Investments in research and development of renewable energy technology allow U.S. citizens to benefit from our Nation's renewable energy reserves -- in the same sense that significant oil or coal reserves add to our country's energy security and independence. Technological advances often make renewable energy systems economically competitive, and while these renewable technologies may not immediately enter the marketplace, they nevertheless become national assets. Unlike fossil fuel reserves, these renewable technology reserves will not be depleted.

R&D provides the technological advances needed to develop competitive new energy systems and creates the basis for industry investment in product development and market deployment. Although regulated utilities have traditionally invested in power generation R&D, increased competitive pressures resulting from the ongoing restructuring of the U.S. electric power industry have forced utilities and other companies to reduce or eliminate their R&D budgets. This reduction in R&D spending will adversely affect long-term clean energy technology advancements, thus presenting a clear role for federal intervention.

The table below describes projected aggregated benefits to the Nation resulting from the Renewable Energy Resources program investments that foster technology advancements through R&D. Our analysis suggests that EE programs will benefit the public while private sector investment in R&D is less than optimal. In the table, Primary Energy Displaced refers to fossil fuels not consumed because electricity production from renewable energy sources will have displaced them or because energy has been saved through the use of advanced system technologies.

	FY 2005	FY 2010	FY 2020
Primary Energy Displaced (Quads).	0.3 - 0.6	0.9 - 1.8	2.5 - 4.3
Energy Savings ($ Billions).	1.2 - 2.2	3.3 - 5.0	6.5 - 7.5
Carbon Displaced Millions Metric Tons Carbon Equivalent (MMTCE)	2.7 - 12.1	15.3 - 35.5	45.1 - 88.3
Oil Displacement (Million of Barrels per Day).	0.01 - 0.03	0.01 - 0.1	0.2 - 0.3

Note: Program benefit projections are developed through an impact analysis process undertaken annually by EE, based on assumptions for future energy markets derived from EIA's annual energy outlook. EE's sectors analyze the impacts their programs will have on energy savings, energy cost savings, and carbon reductions if all program goals are met, and future energy markets develop as expected. A sample of program benefit estimates are

externally reviewed by Arthur D. Little. An integrated analysis model run by an external contractor controls for interaction effects across programs and sectors.

At the sector level, we report a range of estimates that correspond to two modeling cases: with and without program interactions. For example, reductions in new electricity generation requirements due to energy efficiency improvements would reduce the potential market for a range of electricity supply options. When integrated and non-integrated estimates are virtually the same, no estimate range is shown.

Program and Management Strategy

EE's Renewable Energy Resources program advances its mission by addressing three areas that ultimately determine whether clean energy technologies are deployed in the Nation's energy system—technology, policy, and markets. In this context, EE is pursuing three principal strategies in pursuit of its mission:

1. Improving energy technologies and practices through R&D;
2. Formulating policies and standards;
3. Facilitating private sector deployment of advanced energy technologies and practices into their target markets.

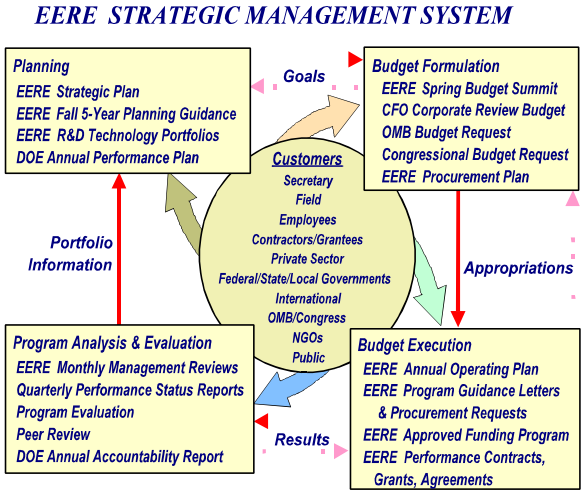
EE believes that program success depends upon industry's ultimate commercialization of the program's technologies under development, thus partnership with industry is essential. These partnerships include industry co-investment and cost-sharing at increasing levels as technologies near the pre-commercialization stage. The Renewable Energy Resources program also utilizes the talents found at the National Laboratories and within States, universities, and other research organizations across the United States in order to achieve its R&D objectives. This not only helps EE to accomplish its R&D mission, but also encourages all stakeholders to share "lessons learned" through their own peer network activities. Similarly, EE also partners with a variety of universities across the country to conduct both fundamental and applied R&D.

The selection of R&D activities will be guided by the President's Management Agenda initiative on R&D investment criteria, which emphasize the appropriateness of a government role, relevance to policy priorities, competitive and peer-reviewed awards, and maximizing the public benefit of Federal R&D funds.

Excellence in business management is essential to accomplishing EE's mission and goals. In the spring of 2000, EE published its Strategic Plan and cited "excellence in business management" as one of the Office's three major goals. The Federal government's fiscal cycles often involve the management of up to four budget years at any one time. To do this in the most effective manner, an orderly, systematic approach is needed that is transparent, integrated, and seamless.

As part of the business management improvement during the past two years, EE institutionalized its processes for planning, budget formulation, budget execution, and program analysis and evaluation with the creation of the Strategic Management System (SMS) (see figure for more details). SMS takes the complex processes of Federal management (including human resources, procurement, and information processing) and links them using common terms and definitions and a consistent set of principles,

procedures, and information management systems. This integrated, systematic approach envisions a deliberate and proactive approach to the management of EE. Implementing this system is the key to ensuring overall management excellence on par with the technological excellence of EE programs.



Strategic Context

The United States is the world's largest energy producer. In 1999, the United States produced over 72 quadrillion British thermal units (quads) of energy, about 19 percent of the worldwide total. The United States is also the world's largest energy consumer, using 25 percent of the world's primary energy, with the result that our Nation is consuming far more energy than it produces. This imbalance between consumption and production places continual stress on the Nation's energy system, giving rise to both energy and economic security concerns. The U.S. Energy Information Administration (EIA) estimates that without a shift away from traditional fuels, the current energy imbalance will worsen (only 2 percent of the world's proven crude oil reserves are located in American territory). This energy production-consumption imbalance, coupled with U.S. dependence on fossil fuels, suggests that Federal support for R&D on clean and renewable energy technologies, especially those that can be exploited domestically, is warranted.

Within the energy economy, the United States is also the world's largest producer of electricity, generating more than all of Western Europe, the Middle East, Central and South America, and Japan combined. More than half of all domestic electricity is generated by burning coal, with about 20 percent derived from nuclear power. Currently, renewable resources, including hydropower, biomass, wind, geothermal and solar, provide 11 percent, and the remainder is fueled by natural gas (16 percent) and petroleum (3 percent). In fact, the electric power sector is the largest direct consumer of energy in the United States. It used 36 percent of all primary energy consumed in the country in 2000, providing power worth approximately $200 billion annually to fuel a myriad of essential functions in our homes, businesses, and industries. Most energy projections show the United States requiring an increase of 100,000 to 200,000 megawatts of additional power generation capacity between now and the year 2010.

Currently, the U.S. electric power industry is in the process of restructuring, with the expectation that this will bring healthy competition to the electricity sectors, thus offering consumers more electricity choices. In preparation for this rapidly changing market environment, utilities and other companies that traditionally have invested significant resources into power generation R&D have reduced or eliminated these investments. Yet at the same time, many power generators, either in response to public pressure or State or federal regulatory trends, are seeking to diversify their fuel choices and add renewable energy resources to their fuel mix. Such a situation may reduce the capacity of electricity providers to meet both their economic and environmental objectives. The Federal Government, and EE in particular, is well equipped to address this market failure.

Program Strategic Performance Goals (PSPG)

ER1-9: Distributed Energy Resources
Distributed Energy Resources (DER) R&D activities will increase the share of new DER electricity-generating capacity from 5 percent in 2000 to 7 percent in 2005.

ER2-1: Biopower
Biopower R&D activities will increase the testing, verification, and demonstration of the component systems of cost-effective and efficient biomass gasification combined-cycle systems from 0 percent in 2000 to 75 percent in 2006.

ER2-2: Biofuels
Biofuels R&D activities will reduce the production cost of cellulose-based ethanol to $1.20 per gallon by 2005, and to $1.07 per gallon in by 2010.

ER2-3: Geothermal Energy
Geothermal Energy R&D activities will result in twice as many states with geothermal electric power facilities.

ER2-4: Hydrogen
Hydrogen R&D activities will demonstrate a conversion technology that will improve the cost of hydrogen production from natural gas from $3.75 per kilogram in 2000, when produced in large quantities, to $2.50 per kilogram in 2006.

ER2-5: Hydropower
Hydropower R&D activities will ensure commercialization of a fish passage technology capable of reducing turbine-induced fish mortality to 2 percent or less by 2010 in new fish-friendly turbines.

ER2-6: Wind Energy
Wind Energy R&D activities will provide the technologies to reduce the cost of wind powered electricity generation in Class 4 wind areas (13 mph annual average) from 5.5 cents per kilowatt-hour in 2002 to 3 cents per kilowatt-hour by 2010.

ER2-7: Solar Technologies
Solar Technologies R&D will reduce the price paid for a photovoltaic system by the end user (including operation and maintenance costs) from a median value of $6.25 per Watt in 2000 to $4.50 per Watt in 2006 (equivalent to reducing from $0.25 to $0.18 per kilowatt hour).

ER2-8: High Temperature Superconductivity
High Temperature Superconductivity (HTS) R&D activities will develop HTS wire capable of carrying 100 times the power of comparable copper wire – with zero electrical resistance by 2007.

ER2-9: Distributed Energy Systems
Distributed Energy Storage Technology R&D activities will increase the share of new distributed energy electricity-generating capacity from 5 percent in 2000 to 7 percent in 2005. (Distributed energy activities funded by the Energy and Water Development Appropriation are part of a coordinated and complementary effort with distributed energy R&D activities funded by the Interior and Related Agencies Appropriation, which jointly contribute to this goal.)

ER2-10: International Programs
International program activities will assist U.S. industry growth in export sales of renewable energy products and services as indicated by increasing PV export sales from approximately 50 MW in 2000 to over 130 MW in 2004.

ER2-11: Departmental Energy Management Program Team
The Departmental Energy Management Program Team activities will decrease the energy intensity in DOE facilities by 45 percent by 2005, relative to 1985 levels.

ER2-12: REPI, other support & implementation
The Renewable Energy Production Incentive will increase the total number of new renewable energy projects at publicly- and cooperative-owned electric utilities from 0 in 1993 to 75 in 2003.

The Department's progress toward meeting those goals will, in the future, be rated in a color-coded system according to the following Performance Standards:

Blue:	Significantly exceeding annual milestones and targets.
Green:	Effectively meeting (+/- 5 percent) all annual milestones and targets.
Yellow:	Effectively meeting all milestones and targets within program control, but behind on some others; put on "watch list."
Red:	Failing to effectively meet milestones and targets within the program's control.

Significant Accomplishments and Program Shifts

Resources provided in the FY 2001 budget allowed for a number of significant accomplishments towards the development of clean, competitive, and reliable renewable energy and power delivery technologies. Several programs have shifted resources in FY 2002 in order to more efficiently and effectively meet national energy needs. Indicators of recent progress and FY 2003 shifts by Renewable Energy Resources program include:

Biomass/Biofuels Energy Systems

- In FY 2001, in collaboration with the Department of Agriculture, completed a draft life cycle analysis of the environmental emissions and energy requirements associated with the production and use of fuel ethanol from corn harvesting residues (corn stover). The analysis includes residue collection, transportation, biochemical conversion to ethanol, distribution to wholesalers and retailers, and use in vehicles.
- In FY 2002, program is shifting away from technology demonstrations towards development of core technology needed to produce low-cost sugars that can be converted to fuels and chemicals.
- In FY 2003 Biomass Program development will focus on leveraging R&D investments with successfully proven technology platforms through public and private sector partnerships. This crucial step will shorten development cycles while providing technological solutions to operational challenges.

Geothermal Technology Development

- In FY 2001, demonstrated the use of slimhole drilling for geothermal exploration, thereby reducing exploration drilling costs by 30 to 50 percent relative to 1995 technology.
- In FY 2002, the Geothermal Program will complete the current Enhanced Geothermal Systems (EGS) activity in order to prepare for new solicitations.
- In FY 2003 the Program will initiate cost-shared EGS projects at two competitively selected sites.

Hydrogen Research

- In FY 2001, completed a hydrogen refueling station for transit buses that combined natural-gas reforming and renewable-generation powered electrolysis. Demonstrated steam reforming of biomass pyrolysis oils in a process development unit.
- In FY 2002, in consideration of recommendations from the fuel cell industry and the Hydrogen Technical Advisory Panel, the Hydrogen program will focus on storage and small-scale reformer development for distributed power applications and fuel cell vehicles.
- In FY 2003, significant increases are budgeted for hydrogen R&D, including the operation of a power park that co-produces hydrogen and electricity for a small industrial complex, and the acceleration of hydrogen storage research, including advanced hydride storage tank concepts. A portion of the hydrogen program will also be supporting the FreedomCAR initiative.

Hydropower

- In FY 2001, completed conceptual design of the Alden Research Laboratory “fish-friendly” turbine.
- In FY 2002, complete initial proof-of-concept testing of the Alden Research Laboratory advanced turbine conceptual design.
- In FY 2003, complete pilot-scale testing program for the Alden Research Laboratory advanced turbine conceptual design, and complete low-head/low-power resource and technology assessment.

Solar Energy

- In FY 2001, facilitated the installation of 20,000 solar energy systems. Identified a concentrating trough receiver able to reduce system costs by 20 percent and completed trough and concentrator designs under the USA Trough initiative. Selected and negotiated 16 Beyond the Horizon subcontracts with 11 universities and 5 companies to explore non-conventional, potential breakthrough solar-electric technologies. Completed design of polymer-based solar hot-water heaters in conjunction with two manufacturers. Concluded the PVMaT project, and re-competed all thin-film R&D contracts.
- In FY 2002, photovoltaic advanced materials R&D on silicon crystal growth was reduced, due to the maturity of silicon technologies. The advanced manufacturing activities will focus on high-throughput, large-area thin films not addressed in the former PVMaT project. The program will begin transferring the Million Solar Roofs project to the private sector, and will build and field test full-scale polymer-based solar hot-water heaters.
- In FY 2003 a new university research initiative will be started in the Photovoltaic program to develop next-generation materials capable of dramatic cost reductions. The Photovoltaic program will also begin a new effort to develop PV/thermal hybrids, and in the Thin Film Partnership program, at least one technology will make the transition from prototype production to multi-megawatt production. The Million Solar Roofs project will complete its transition to full industry funding and management. In Solar Buildings, Zero-Energy Home concepts will be developed in collaboration with industry. The Concentrating Solar Power subprogram will complete the evaluation of 25 kW dish systems at the University of Nevada and will terminate all other remaining activities.

Wind Energy Systems

- In FY 2001, the Next Generation Turbine technology entered its final development and testing stage. An advanced wind-hybrid control system technology that was jointly developed with USDA Agricultural Research Center was made commercially available.
- In FY 2002, program is shifting away from cooperative research and testing of wind turbines designed for high-wind-speed (Class 6) areas, and is concentrating on low-wind-speed (Class 4) turbine technology, which could increase the land area usable for wind power by a factor of twenty. Selected R&D partners under first low-wind-speed turbine solicitation. The Next Generation Turbine project will be completed with FY 2002 funding.
- In FY 2003 advanced small wind system technologies are expected to become commercially available, and the Next-Generation Turbine technology should enter commercial operation. Funding for the low-wind-speed turbine project will be significantly increased, becoming the primary focus of the turbine research program.

High Temperature Superconducting (HTS) R&D

- In FY 2001, the first superconducting cables to replace existing transmission cables were installed to service an area of Detroit, Michigan, and began operational testing. A prototype 1,000 hp superconducting electric motor produced 1,600 hp in sustained, full-load testing, significantly exceeding performance goals.

- In FY 2002, complete first year testing of Detroit 100 MW superconducting transmission cable and document operational costs and reliability. Will complete design and construction of an HTS flywheel energy system (10 kWh) system with Boeing. Will begin joint industry-lab development of wire fabrication technologies critical to the commercialization of second-generation HTS wire.
- In FY 2003, complete testing of the first HTS flywheel energy system (10 kWh) system and verify the capability of this system for premium power applications. National laboratories and industry will demonstrate the capability to reproducibly manufacture 10-meter lengths of 50-amp second-generation HTS wire and 1-meter lengths of 100-amp wire.

Electric Energy Storage

- In FY 2001, The ZBB-Waukesha advanced zinc-bromine battery systems successfully completed testing in a power-quality application with Detroit Edison. Initial testing of a 9 kWh lithium-ion battery module was completed.
- In FY 2002 a 67 kWh advanced lithium-ion battery system (which allows longer storage) will be field tested at a utility partner site. A pre-conceptual study for the design of a multi-megawatt, hydro-powered load leveling energy storage system for a Nevada utility will be completed. A feasibility study examining the secondary use of spent electric vehicle batteries for stationary applications will be published.
- In FY 2003 the Energy Storage Program will increase emphasis on supporting the reliability and power quality needs of the digital economy. The 67 kWh advanced lithium-ion battery system will be field tested at a utility partner site. The program will also continue work on integration of energy storage systems with distributed generation systems.

Transmission Reliability

- In FY 2001, prototype reliability tracking tools were installed in California and at the North American Electric Reliability Council (NERC). A market-analysis electric energy auction was completed that correctly predicted the response to new FERC market designs.
- In FY 2002, two additional prototype reliability tools will be installed to monitor and track the delivery of reliability services provided by individual generators under competitive markets, extend experimental/behavioral evaluation of market designs to additional electricity industry stakeholders, including regulators, and initiate public and private partnerships to demonstrate load as a reliability resource at customer facilities.
- In FY 2003, support installation of a suite of performance-monitoring tools at major transmission operating organizations to allow them to monitor compliance with reliability standards. Begin development of real-time measurement sensors.

DER Electric System Integration (formerly Distributed Power)

- In FY 2001, completed test plan for performance validation and testing of proposed IEEE Standard 1547 for connection of distributed energy resources. Completed four reports on various aspects of integrating distributed energy into the market.
- In FY 2002, publish a draft interconnection standard that can be used by regulatory agencies. Complete the draft UL 1741 safety standard for distributed resource interconnection equipment.

- In FY 2003, a prototype advanced DER interconnection device complying with the P1547 interconnection standard will be demonstrated. A certification methodology for type testing DER interconnection devices for compliance with the IEEE P1547 interconnection standard will be established.

Program Funding Profile

(dollars in thousands)

	FY 2001 Comparable Appropriation	FY 2002 Original Appropriation	FY 2002 Adjustments a,b/	FY 2002 Comparable Appropriation	FY 2003 Request
Renewable Energy Resources					
Biomass/Biofuels Energy Systems	85,371	90,396	-2,344	88,052	86,005
Geothermal Technology Development	26,623	28,026	-727	27,299	26,500
Hydrogen Research	26,594	29,960	-777	29,183	39,881
Hydropower	4,936	5,152	-134	5,018	7,489
Solar Energy	91,694	91,823	-2,381	89,442	87,625
Wind Energy Systems	39,132	39,626	-1,028	38,598	44,000
Electric Energy Systems & Storage	51,194	62,312	8,384	70,696	70,447
Renewable Support and Implementation	21,500	14,094	-366	13,728	23,866
National Renewable Energy Laboratory	3,991	5,000	-130	4,870	5,000
Program Direction	19,418	19,200	+320	19,520	16,907
Total, Renewable Energy Resources	370,453	385,589	+817	386,406	407,720
Total Excluding Full Funding for Federal Retirements, Renewable Energy Resources	369,694	385,589	0	385,589	407,000

a/ The FY 2001 and FY 2002 columns of the FY 2003 Congressional Request include funding in the amounts of $759,000 and $817,000, respectively, for the Department's share of increased costs associated with pension and annuitant health care benefits. These funds are comparable to FY 2003 funding of $720,000. (Note: The data is presented on a comparable basis as if legislation had been enacted and implemented in FY 2001).

b/ The FY 2002 Defense Appropriations Act authorized a $10 million pro-rata redistribution of funding among all Renewable Energy Resource programs to supplement Electric Energy Systems and Storage (EESS) funding (net $8,384,000 to EESS, zero net for EE).

Public Law Authorization:
P.L. 93-409, "Solar Heating and Cooling Demonstration Act" (1974)
P.L. 93-410, "Geothermal Energy Research, Development and Demonstration Act " (1974)
P.L. 94-163, "Energy Policy and Conservation Act" (ECPA) (1975)
P.L. 94-385, "Energy Conservation and Product Act" (ECPA) (1976)
P.L. 95-91, "Department of Energy Organization Act" (1977)
P.L. 95-618, "Energy Tax Act of 1978"
P.L. 95-619, "National Energy Conservation Policy Act" (NECPA) (1978)
P.L. 95-620, "Powerplant and Industrial fuel Use Act of 1978"
P.L. 96-294, "Energy Security Act" (1980)
P.L. 100-12, "National Appliance Energy Conservation Act of 1987"
P.L. 100-615, "Federal Energy Management Improvement Act of 1988"
P.L. 101-218, "Renewable Energy and Energy Efficiency Technology Competitiveness Act of 1989"
P.L. 101-549, "Clean Air Act Amendments of 1990"
P.L. 101-575, "Solar, Wind, Waste, and Geothermal Power Production Incentives Act of 1990"
P.L. 104-271, "Hydrogen Future Act of 1996"
P.L. 106-224, "Biomass Research and Development Act of 2000"

Federal Staffing at Field and Headquarters (FTEs)

Field and Headquarters Sites	FY 2001 Actual	FY 2002 Budgeted	FY 2003 Budgeted
Renewable Energy Resources			
Golden Field Office	18	20	18
Idaho Operations Office	1	1	1
Headquarters	85	95	83
Subtotal FTEs, Renewable Energy Resources	**104**	**116**	**102**
Energy Conservation Programs			
Building Technology, State and Community Sector			
Headquarters	75	76	73
Federal Energy Management Program			
Headquarters	27	27	27
Industry			
Headquarters	50	54	53
Idaho Operations Office	5	6	1
Subtotal	55	60	54
Transportation			
Headquarters	66	62	61
Oak Ridge Operations Office	1	1	1
Subtotal	67	63	62
Power Technologies (DER)			
Headquarters	5	5	6
Chicago Regional Office	6	3	4
Subtotal	11	8	10
Policy and Management			
Headquarters	58	58	61
Golden Field Office	36	34	37
Atlanta Regional Office	24	25	23
Boston Regional Office	17	18	16
Chicago Regional Office	17	17	18
Denver Regional Office	25	25	25
Philadelphia Regional Office	15	18	17
Seattle Regional Office	20	21	20
Subtotal	213	216	217
Subtotal FTEs, Energy Efficiency Programs	**448**	**450**	**443**
Total FTEs, Energy Efficiency and Renewable Energy	**552[a]**	**566**	**545**

[a] For comparability with FY 2002 and FY 2003 columns, budgeted FY 2001 FTE are: Renewable Energy Resources-Golden 22, Idaho 1, and Headquarter 98, 121 subtotal, Energy Conservation Programs subtotal 470, and total 591.

Funding Schedule

(dollars in thousands)

	FY 2001 Comparable Appropriation	FY 2002 Original Appropriation	FY 2002 Adjustments b/	FY 2002 Comparable Appropriation	FY 2003 Request
Renewable Energy Resources					
Biomass/Biofuels Energy Systems					
Power Systems	39,319	40,250	-1,044	39,206	33,000
Transportation	46,052	50,146	-1,300	48,846	53,005
Total, Biopower/Biofuels Energy Systems	85,371	90,396	-2,344	88,052	86,005
Geothermal Technology Development					
Geoscience and Supporting Technologies	7,300	7,100	-184	6,916	7,700
Exploration and Drilling Research	8,200	8,299	-215	8,084	12,100
Energy Systems Research and Testing	11,123	12,627	-328	12,299	6,700
Total, Geothermal Technology Development	26,623	28,026	-727	27,299	26,500
Hydrogen Research	26,594	29,960	-777	29,183	39,881
Hydropower	4,936	5,152	-134	5,018	7,489
Solar Energy					
Concentrating Solar Power	13,565	13,492	-350	13,182	1,932
Photovoltaic Energy Systems	74,260	73,554	-1,907	71,551	73,693
Solar Building Technology Research	3,869	4,777	-124	4,709	12,000
Total, Solar Energy	91,694	91,823	-2,381	89,442	87,625
Wind Energy Systems					
Applied Research	14,579	14,322	-372	13,950	10,800
Turbine Research	12,428	10,778	-280	10,498	18,900
Cooperative Research & Testing	12,125	14,526	-376	14,150	14,300
Total, Wind Energy Systems	39,132	39,626	-1,028	38,598	44,000
Electric Energy Systems and Storage					
High Temperature Superconducting R&D	36,426	28,547	3,841	32,388	47,838
Distributed Energy Systems	14,768	33,765	4,543	38,308	22,609
Total, Electric Energy Systems and Storage	51,194	62,312	8,384	70,696	70,447

(dollars in thousands)

	FY 2001 Comparable Appropriation	FY 2002 Original Appropriation	FY 2002 Adjustments b/	FY 2002 Comparable Appropriation	FY 2003 Request
Renewable Support & Implementation					
Departmental Energy Management Program	1,984	1,458	-37	1,421	3,000
International Renewable Energy Program	4,949	2,916	-76	2,840	6,500
Renewable Energy Production Incentive Program	3,991	3,888	-101	3,787	4,000
Renewable Indian Energy Resources	6,585	2,916	-76	2,840	8,307
Renewable Program Support	3,991	2,916	-76	2,840	2,059
Total, Renewable Support & Implementation	21,500	14,094	-366	13,728	23,866
National Renewable Energy Laboratory	3,991	5,000	-130	4,870	5,000
Program Direction					
Golden Field Office	2,779	2,910	0	2,910	2,295
Idaho Operations Office	100	105	0	105	105
Headquarters	16,539	16,185	320	16,505	14,507
Total, Program Direction	19,418	19,200	320	19,520	16,907
Total, Renewable Energy Resources	370,453	385,589	817	386,406	407,720
Total Excluding Full Funding for Federal Retirements, Renewable Energy Resources	369,694a/	385,589	0	385,589	407,000

a/ Includes adjustments for FY 2001 Consolidated Appropriations Act, Spread of General Reduction for Safeguards and Security, 0.22 percent Omnibus Recission, and SBIR transfers.

b/ The FY 2001 and FY 2002 columns of the FY 2003 Congressional Request include funding in the amounts of $759,000 and $817,000, respectively, for the Government's share of increased costs associated with pension and annuitant health care benefits. These funds are comparable to FY 2003 funding of $720,000. (Note: The data is presented on a comparable basis as if legislation had been enacted and implemented in FY 2001).

The FY 2002 Defense Appropriations Act authorized a $10 million pro rata reduction among all Renewable Energy Resource programs to supplement Electric Energy Systems and Storage funding.

Funding by Site

(dollars in thousands)

	FY 2001	FY 2002	FY 2003	$ Change	% Change
Albuquerque Operations Office					
Los Alamos National Laboratory	9,110	5,750	9,200	3,450	60.0%
National Renewable Energy Laboratory	125,163	119,987	135,877	15,890	13.2%
Sandia National Laboratory	33,554	32,149	32,740	591	1.8%
Golden Field Office	41,632	55,720	45,530	-10,190	-18.3%
Atlanta Regional Office	823	373	175	-198	-53.1%
Boston Regional Office	2,130	2,074	345	-1,729	-83.4%
Chicago Regional Office	536	843	280	-563	-66.8%
Denver Regional Office	931	681	400	-281	-41.3%
Philadelphia Regional Office	346	295	350	55	18.6%
Seattle Regional Office	1,463	1,482	3,400	1,918	129.4%
Albuquerque Operations Office	5,300	8,427	8,500	73	0.9%
Total, Albuquerque Operations Office	220,988	227,781	236,797	9,016	4.0%
Chicago Operations Office					
Argonne National Laboratory	4,237	4,020	4,000	-20	-0.5%
Brookhaven National Laboratory	1,920	1,780	1,330	-450	-25.3%
Chicago Operations Office	955	3,958	0	-3,958	-100.0%
Total, Chicago Operations Office	7,112	9,758	5,330	-4,428	-45.4%
Idaho Operations Office					
Idaho National Engineering and Environmental Laboratory	3,522	3,500	3,900	400	11.4%
Idaho Operations Office	19,042	26,086	21,920	-4,166	-16.0%
Total, Idaho Operations Office	22,564	29,586	25,820	-3,766	-12.7%
Nevada Operations Office					
Nevada Operations Office	2,707	805	750	-55	-6.8%
Nevada Test Site	58	300	400	100	33.3%
Total, Nevada Operations Office	2,765	1,105	1,150	45	4.1%
Oak Ridge Operations Office					
Office of Scientific and Technology Information	104	99	88	-11	-11.1%
Oak Ridge National Laboratory	19,861	13,290	24,343	11,053	83.2%
Oak Ridge Operations Office	425	500	800	300	60.0%
Total, Oak Ridge Operations Office	20,390	13,889	25,231	11,342	81.7%

	(dollars in thousands)				
	FY 2001	FY 2002	FY 2003	$ Change	% Change
Richland Operations Office					
Pacific Northwest National Laboratory . .	745	1,605	2,182	577	36.0%
Oakland Operations Office					
Lawrence Berkeley National Laboratory	3,811	3,530	5,069	1,539	43.6%
Lawrence Livermore National Laboratory	2,920	2,780	3,574	794	28.6%
Oakland Operations Office	4,687	3,889	3,563	-326	-8.4%
Total, Oakland Operations Office	11,418	10,199	12,206	2,007	19.7%
National Energy Technology Laboratory.	11,665	8,339	11,061	2,722	32.6%
Savannah Operations Office	300	150	445	295	196.7%
Headquarters	72,506	83,994	87,498	3,504	4.2%
Total, Renewable Energy Resources [a]/	370,453	386,406	407,720	21,314	5.5%
Total, Excluding Full Funding for Federal Retirement	369,694	385,589	407,000	21,411	5.6%

a/ The FY 2001 and FY 2002 columns of the FY 2003 Congressional Request include funding in the amounts of $759,000 and $817,000, respectively, for the Government's share of increased costs associated with pension and annuitant health care benefits. These funds are comparable to FY 2003 funding of $720,000. (Note: The data is presented on a comparable basis as if the legislation had been enacted and implemented in FY 2001).

Site Description

Albuquerque Operations Office

Albuquerque Operations Office (ALO) is a Department of Energy Office located in Albuquerque, New Mexico. ALO provides procurement services and oversight of funding for work being conducted at Golden Field Office, Los Alamos National Laboratory, National Renewable Energy Laboratory, Sandia National Laboratories, and the six DOE Regional Offices located in Atlanta, GA, Boston, MA, Chicago, IL, Denver, CO, Philadelphia, PA, and Seattle, WA. The Regional Offices provide outreach for the Million Solar Roof Initiative. The Albuquerque Office serves as the funding office for Cooperative Agreements at the University of Alaska and MIT, respectively, to conduct Hydrogen research and development activities in fuel cells for remote power and plasma reforming.

Los Alamos National Laboratory

Los Alamos National Laboratory (LANL), located in Los Alamos, NM, conducts research on the Hydrogen and Electric Energy Systems High Temperature Superconductivity programs.

The Los Alamos National Laboratory serves as the lead laboratory for Hydrogen in the research and development of proton exchange membrane fuel cells for direct hydrogen applications. This includes the application of new material systems, components, and construction techniques to meet the efficiency and cost targets associated with their industry Cooperative Research and Development Agreements (CRADAs). LANL has identified a number of critical technologies to produce the most advanced fuel cell stacks with very low parasitic power requirements.

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

National Renewable Energy Laboratory

The National Renewable Energy Laboratory (NREL), located in Golden, Colorado, conducts research and development for the Solar Buildings Technology Research, Photovoltaic Energy Systems, Biomass/ Biofuels Energy Systems - Biopower Systems and Transportation, Wind Energy Systems, Geothermal, Hydrogen and Electric Energy Systems and Storage programs.

NREL serves as the lead laboratory for the Solar Buildings Technology Research Program. The goal of this program is to combine solar energy technologies with energy efficient construction techniques, and to create cost-effective buildings that have a zero net need for fossil fuel energy on an annual basis. NREL supports this by managing technical tasks subcontracted to universities and industry and the

development of low-cost solar collectors for water or space heating. In addition, NREL coordinates related technical activities with the Sandia National Laboratory, the Photovoltaics program, and the Office of Building Technology, State and Community Programs.

NREL is the lead laboratory for the National Photvoltaic R&D program. NREL conducts fundamental and applied materials research on photovoltaic devices, photovoltaic module reliability and systems development, data collection and evaluation on solar radiation, and implements 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.

NREL is the lead laboratory in support of Biomass/Biofuels Energy Systems - BioPower Program technologies including those based on combustion and gasification of biomass feedstocks. NREL is responsible for the development of advanced analytical methodologies (chemical and life-cycle) that are used to facilitate industry commercialization, including complete economic assessments of the relevant biomass technologies. NREL works with industry and academia to arrive at consensus points on technology costs and environmental performance. NREL also developed and operates a Thermochemical Users Facility. This state-of-the-art facility enables the private sector to cost-effectively test their power generating technologies in a fully-instrumented pilot facility.

NREL is the lead laboratory for the Biofuels-Transportation Program. The Laboratory conducts biotechnology research and engineering development of biological systems for the conversion of biomass to fuels and chemicals, such as ethanol. Also, the Biofuels Program has established the Alternative Fuels User Facility at NREL which includes laboratories, integrated bench scale process equipment, and a one ton per day process development unit.

NREL is the lead laboratory for the National Wind Energy Systems Program, performing research in aerodynamics, structural dynamics, and advanced components and control systems related to wind energy. The National Wind Technology Center, 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.

NREL provides assistance to the Solar Program Support Electric Restructuring Program by maintaining the Restructuring web site and by providing analyses on an as-needed basis on restructuring impacts on renewable technology development and deployment. NREL will provide technical support to field validation projects and Tribal Colleges under Open Solicitation.

NREL is 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 also 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.

NREL serves as the lead laboratory for the Geothermal Program's energy systems research and testing. NREL provides on-going research and development in energy conversion technologies. The laboratory also supports the Geothermal Program in the areas of education, outreach and systems analysis.

NREL serves as the lead laboratory in the Hydrogen research and development of technologies that will offer longer-term solutions to the production and storage of hydrogen for large scale use. 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 systems to split water into hydrogen and oxygen and the thermoconversion of biomass to hydrogen. This R&D is in collaboration with the Oak Ridge National Laboratory and the University of California at Berkeley. Additionally, NREL supports the design of new processes and facilities to produce and use hydrogen through engineering calculations and cost evaluations.

NREL serves as the lead laboratory for the Electric Energy Systems and Storage Transmission Reliability, Distributed Power Program. The laboratory works with industry to develop a uniform national standard for interconnection of distributed power resources with the electric grid and performs research to develop related test and certification procedures. NREL also performs analysis addressing regulatory and institutional barriers to distributed power and provides technical assistance to State agencies and others on these issues. EE serves as the landlord for NREL and manages facilities, operations and infrastructure funding.

Sandia National Laboratories

Sandia National Laboratories (SNL), located in Albuquerque, NM, Livermore, CA and Tonapah, NV, perform research for the Photovoltaic Energy Systems, BioPower, Wind Energy Systems, Geothermal, Hydrogen, and Electric Energy Systems and Storage programs.

SNL supports the Photovoltaic Energy Systems Program with the principal responsibility for crystalline cell research, systems and balance-of-systems technology development, and reliability. Cell research activities support promising new concepts and innovative device fabrication techniques. 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.

In support of the Biomass/Biofuels Energy Systems - BioPower Program, SNL provides technical expertise on the combustion processes involving biomass. Emphasis is on slagging and fouling in cofiring operations. Technical and field management support to the modular systems development program is provided as well.

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

Under Solar Program Support, SNL will provide technical support to field validation projects at Tribal Colleges from Open Solicitations.

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

For the Hydrogen Program, the Sandia National Laboratory in California serves as the lead laboratory in the development of metal hydride storage materials and systems for various end use applications. SNL performs a spectrum of research and development tasks and other technical support to produce an advanced class of reversible metal hydride materials that have over 5 percent by weight hydrogen stored at a low dehydriding temperature. SNL is capable of producing metal hydride materials for use in research and validation projects. SNL also servers as the lead for the design and implementation of hydrogen systems for remote power applications.

In the Electric Energy Systems and Storage Transmission Reliability Program, Sandia National Laboratories are part of a national laboratory/industry/university consortium that was formed to support research on Transmission Reliability. SNL is participating in planning and design of simulations and field testing on a distributed technologies test bed, developing and demonstrating computer simulation for distributed controls in the management of the operation of regional power systems, and developing risk-based analytical methods for assessing reliability in power systems.

SNL supports the Electric Energy Systems and Storage High Temperature Superconductivity Program by applying their ceramics expertise to developing advanced conductors based on chemical deposition process.

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

Golden Field Office

The Golden Field Office (GO) located in Golden, CO, provides procurement services and oversight of work being performed at the National Renewable Energy Laboratory.

GO administers the Solar Rating and Certification Corporation grant for the Solar Buildings Program. This grant enables the solar industry to develop voluntary standards on the performance and reliability of solar water heaters.

GO administers contracts for two projects for the Photovoltaic Energy Systems Program, which are designed to increase market penetration and integrate PV product development. These projects are the Technology Experience to Accelerate Markets in Utility Photovoltaics (TEAM-UP) and the close-out of Building Opportunities in the United States for Photovoltaics (PV:BONUS) programs. GO utilizes cooperative agreements and requests for proposals to help industry realize the benefits of using photovoltaic systems and devices.

GO administers and oversees day-to-day activities related to the Biomass/Biofuels Energy Systems - BioPower Program projects. These range from the Vermont gasifier project, to advanced technologies that convert biomass-wood and agricultural crops and waste to electricity. Many of these projects target currently unused, rural farmland for growing dedicated energy crops.

Working with Headquarters program staff, GO administers and manages cooperative agreements for the Biofuels Energy Systems - Transportation Program's cellulose to ethanol demonstration projects. GO also competitively procures, administers, and manages projects designed to develop innovative technologies for the production of ethanol and co-products.

The Golden Field Office will continue to provide support for existing and new cooperative agreements for regional field verification projects with both small and utility size wind turbines under the Wind Energy Systems Program.

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

GO will issue and administer competitive solicitations and, in conjunction with Denver Regional Office, manage projects for the Solar Program Support Open Solicitation.

GO has worked with DOE International Renewable Energy program managers in the overall operation and management of an African Initiative for capacity building and project identification and development. These activities included contractual relation with industry partner and educational institutions.

The Golden Field Office provides Hydrogen procurement services and technical oversight of the work conducted by the recipients of our Cooperative Agreements. This includes research and development in

the areas of production, storage and utilization, and validation of these technologies integrated into subscale systems.

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

GO is designated as a Head of Contracting Activity (HCA) and has been delegated personnel authority for it and six Regional Offices. The Golden Field Office reports directly to the Office of EE.

Chicago Operations Office

The Chicago Operations Office (CH), located in Argonne, IL, administers activities in the International Renewable Energy program. CH administers the competitive procurement for international project development and joint implementation initiatives in Eastern Europe and Latin America and Caribbean countries.

The Chicago Operations Office administers the Hydrogen program's Cooperative Agreements with recipients conducting research and development for advanced storage concepts and reformers.

Argonne National Laboratory

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

ANL is providing the lead program support for the BioEnergy Initiative's outreach efforts.

Brookhaven National Laboratory

Brookhaven National Laboratory (BNL), located on Long Island, NY, performs research and development for the Photovoltaic Energy Systems Program. 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.

BNL supports the HTS program by working with national laboratory/industry teams and universities to undertake research on fundamental wire processing and application issues.

For the International Renewable Energy Program, BNL has responsibility for providing technical assistance to developing and transition countries in the use of the MARKAL model which has been internationally accepted for use in analyzing the mitigation imports of various strategies under consideration by these countries. In addition, BNL has provided support to selected countries in establishing joint implementation offices.

Idaho Operations Office

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

Idaho National Engineering and Environmental Laboratory

Idaho National Engineering and Environmental Laboratory (INEEL), located in Idaho Falls, ID, performs research and development for the Hydropower and Geothermal Programs. INEEL has been the principal DOE laboratory for the Hydropower Program since the program's inception. INEEL serves as the engineering technical monitor for the Advanced Hydropower Turbine System Program and the Renewable Indian Energy Resources hydropower projects located in Alaska.

INEEL serves as the lead laboratory for coordination of the Geothermal Program's Geoscience and Supporting Technologies. In cooperative projects with the U.S. geothermal industry, INEEL performs research on fluid flow and solute transport modeling in hydrothermal reservoirs and conducts site investigations of geothermal resource potential. INEEL coordinates and interacts with other national laboratories, universities, and commercial research institutions to optimize and consolidate their contributions to technology development and thereby enable greater use of geothermal energy resources.

The Idaho National Engineering and Environmental Laboratory has been the principal DOE laboratory for the Hydropower Program since the program was initiated. INEEL has performed the engineering and economic analyses for the recent DOE hydropower environmental mitigation study, and developed the uniform criteria, standardized methodology and software for the DOE hydropower resource assessment activity. Currently, INEEL is serving as the engineering technical monitor for the Advanced Hydropower Turbine System Program and the Renewable Indian Energy hydropower projects in Alaska.

Nevada Operations Office

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

Oak Ridge Operations Office

The Oak Ridge Operations Office (OR), located in Oak Ridge, TN, provides procurement services and oversight of funding for the Oak Ridge National Laboratory and the Office of Scientific and Technology Information. OR also administers the Biomass/Biofuels Energy Systems Bioenergy Feedstock Development Program (BFDP) to develop new and improved sources of biomass feedstocks for biomass energy systems. This effort includes crop development, environmental research, residue and forest research, resource economics, demonstration project support and evaluation, and communication.

Office of Scientific and Technology Information

The Office of Scientific and Technology Information (OSTI), located in Oak Ridge, TN, performs standard distribution of information for all programs under the Office of Power Technologies including: Solar Energy Technologies; Biomass/Biofuels Energy Systems; Wind Energy Systems; Geothermal; Hydrogen Research; and the Electric Energy Systems and Storage programs. This distribution consists of publishing and maintaining on-line full text of eight electronic current awareness publications and the production of CD-ROM disks containing Photovoltaic reports.

Oak Ridge National Laboratory

Oak Ridge National Laboratory (ORNL), located in Oak Ridge, TN, helps implement the Bioenergy Feedstock Development Program (BFDP) to develop new and improved sources of biomass feedstocks for BioPower and Biofuels systems. ORNL provides technical leadership for the program and actively fosters alliances among universities, other government agencies and industry. Major current components of the BFDP include energy crop development, environmental research, residue and forests research, resource economics, technology validation project support and evaluation, and communication. These efforts are closely coordinated with the National Renewable Energy Laboratory and the Sandia National Laboratories' programs.

ORNL will provide technical support to field validation projects and Tribal Colleges for Open Solicitations under Renewable Program Support.

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.

ORNL performs Hydrogen research and development activities in photobiology and storage in support of the lead labs, NREL and SNL, respectively. ORNL has developed a collaboration with NREL and UC Berkeley to develop a microalgae system for the production of hydrogen. ORNL is using their expertise to integrate enginEered biological systems from NREL and UC Berkeley into a base organism that directly produces hydrogen.

ORNL recently provided the environmental analysis for the DOE hydropower environmental mitigation study, and the lab's ORNL 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 Hydropower Turbine System Program, including technical oversight of laboratory biological experiments on stresses experienced by turbine-passed fish.

In support of Electric Energy Systems Programs and Storage Transmission Reliability activities, ORNL is part of a national laboratory/industry/university consortium that was formed to support research in Transmission Reliability. ORNL is performing: electric power system studies related to the impact of distributed resources on electric power systems reliability, design assistance for a test bed for field or simulation testing of distributed resource concepts, analyses of alternative market designs for ancillary services in competitive markets, and analysis and planning to evaluate load as a reliability resource.

The Oak Ridge National Laboratory is the primary laboratory in the Electrical Energy Systems High Temperature Superconductivity (HTS) Program developing second generation HTS wires based on the rolling-assisted biaxially textured substrate process (RABiTS) patented by ORNL. Five private companies have licenced this technology and are working with ORNL to scale up these discoveries. ORNL's expertise in metals and ceramics is used to address materials science issues in doing this scale up. ORNL is also applying its expertise in cryogenic systems and power system technology in projects to develop superconducting transformers and transmission cables.

ORNL provides experimental data for the modeling and testing of chemical reactions in geothermal brines for the Geothermal Energy Systems Program.

Richland Operations Office

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

Pacific Northwest National Laboratory

Pacific Northwest National Laboratory (PNNL), located in Richland, WA, performs on-going research and technical assistance for the International Renewable Energy Program, the Advanced Hydropower Turbine System Program, and the Electric Energy Systems and Storage Program.

PNNL provides 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.

The Pacific Northwest National Laboratory is providing biological testing support for the Advanced Hydropower Turbine System 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.

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

Oakland Operations Office

The Oakland Operations Office (OAK), located in Oakland, CA, provides procurement services and oversight of funding for the Lawrence Berkeley and the Lawrence Livermore National Laboratories.

Lawrence Berkeley National Laboratory

Lawrence Berkeley National Laboratory (LBNL), located in Berkeley, CA, performs analyses of opportunities for Wind Energy applications in the restructured electricity market and administers various utility restructuring activities under Solar Program Support Electric Restructuring. 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.

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

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

Lawrence Livermore National Laboratory

Lawrence Livermore National Laboratory (LLNL), located in Livermore, CA, performs research and development for the Hydrogen program.

The Lawrence Livermore National Laboratory serves as the lead laboratory in the Hydrogen research and development of a high temperature solid oxide electrolyzer and two different systems for pressurized gas storage of hydrogen. LLNL is developing the materials, technical and engineering data on the preferred configuration for a solid oxide system that will simultaneously reform natural gas to hydrogen using the waste heat for a higher round trip efficiency. LLNL is capable of producing composite storage tanks for

environmental testing to verify the advantages of various engineering concepts to increase the storage capacity while reducing the cost of manufacturing.

National Energy Technology Laboratory

The National Energy Technology Laboratory (NETL), colocated in Morgantown, WV and Pittsburgh, PA, provides research and development on Renewable Energy Resources programs with a major emphasis on the Hydrogen Research Program and some on-going research for the Biomass/Biofuels Energy Systems Program. NETL will administer a cooperative agreement with Virginia Accelerator Corporation for an electron scrubbing demonstration project.

NETL provides research and development and technical support for the Biomass/Biofuels Energy Systems - BioPower Program with emphasis on the BioPower cofiring initiative.

Provides co-funding and co-management for a Hydrogen research and development effort to produce an advanced refueling option using catalyzed ceramics in accordance with a Memorandum of Agreement with the Office of Fossil Energy.

Headquarters and All Other Sites

The Office of Energy Efficiency and Renewable Energy (EE) funds research at six regional offices located in Atlanta, GA; Boston, MA; Chicago, IL; Denver, CO; Philadelphia, PA; and Seattle, WA, and also provides funding at DOE Headquarters for various Renewable Energy Resources procurements and interagency agreements in support of the EE mission.

Funds for the In-House Energy Management Program are at Headquarters pending allocation decisions for DOE projects in the field.

Integrated Biomass R&D

Mission Supporting Goals and Objectives

The EE Integrated Biomass R&D subprogram includes Biopower Systems and Biofuels Energy Systems in the Energy and Water Development Appropriations Bill and the Agriculture Vision of the Future, Black Liquor Gasification, and portions of the Forest Products Vision in Interior and Related Agencies Appropriations Bill. These programs collectively support the Biomass R&D Act of 2000 by providing base load renewable electricity, transportation fuel options, and industrial products and chemicals which offer a choice for substantial environmental benefits and national energy security. These efforts result in technologies which work toward industrial biorefineries that will make biomass energy and products competitive with conventional fossil-based options.

Integrated Biomass R&D, in partnership with industry, will assist in the development of an integrated biomass industry. This will be accomplished through the utilization of biopower technologies that are clean, reliable, and competitive with conventional power systems; and research, development, and validation of technologies that will reduce reliance on imported transportation fuels and chemical feedstocks. When successful, these technologies will promote rural economic development, reduce greenhouse gas emissions, and provide for productive utilization of agricultural residues and segregated municipal solid wastes.

The Integrated Biomass R&D subprogram is in the process of making a major transition to become more cohesive and focused on some areas while de-emphasizing other elements that are either deemed a lower program priority or should be performed by some other agency with a strong interest in biomass (such as the Department of Agriculture (USDA) and DOE's Offices of Science and Fossil Energy). EE biomass vision and roadmap documents have been drafted, a Biomass Technical Advisory Committee has been in place over a year, an EE Coordination Office is working closely with its counterparts at USDA, and a high-level EE Bio-Board has been established and has taken a leadership role in reorienting the biomass programs previously administered along end-use sector lines under Transportation Technologies, Power Technologies, and Industrial Technologies. This FY 2003 budget request is the culmination of efforts from all of these committees with final decisions at the corporate EE level made by managing EE Bio-Board. As a result, R&D priorities and project funding have been grouped into the areas of feedstock production, gasification, fuels and chemicals, processing and conversion, and crosscutting technologies. While the FY 2003 budget request is presented along the existing budget categories, it will likely change in FY 2004 to better reflect a more integrated framework.

The Draft Biobased Products and Bioenergy Roadmap has been used by the EE Bio-Board to prioritize R&D activities for FY 2003. Feedstock research supported by DOE focuses on pre-conversion "in field" processing of feedstocks to improve energy density and reduce costs of feedstocks at the plant gate. Other major areas identified as part of the roadmap that serve as the basis for the DOE leveraged program requested for FY 2003 include Processing and Conversion, and Product Uses and Distribution. Processing alternatives include both biochemical and thermochemical methods such as fermentation and gasification. Multiple value added products are viewed as enabling the overall increase in product use

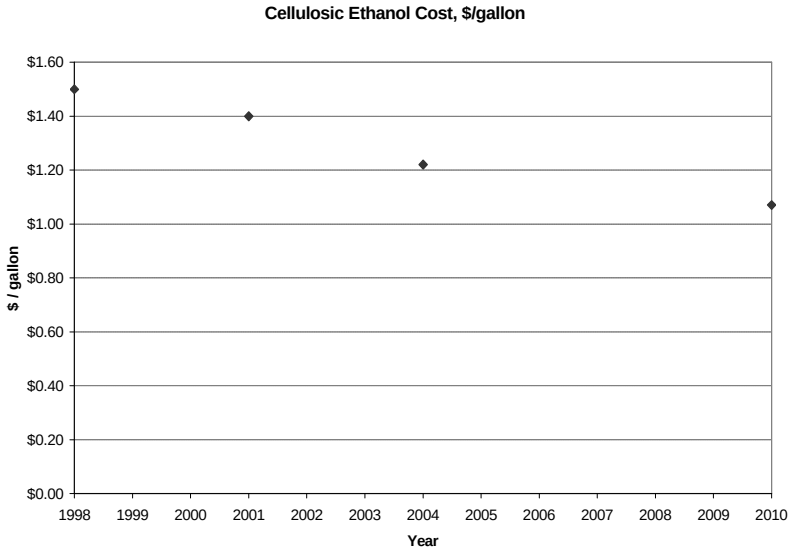
for the major energy applications – fuels and electricity. In addition, major changes in R&D include the curtailing of research to support agronomic feedstock development at DOE, eliminating support for the Regional Biomass Energy Program (RBEP), and the elimination of R&D related to co-firing.

Program Strategic Performance Goal

ER2-1: Biopower
Biopower R&D activities will increase the testing, verification, and demonstration of the component systems of cost-effective and efficient biomass gasification combined-cycle systems from 0 percent in 2000 to 75 percent in 2006.

ER2-2: Biofuels
Biofuels R&D activities will reduce the production cost of cellulose-based ethanol to $1.20 per gallon by 2005, and to $1.07 per gallon in by 2010.

Performance Indicator
Biomass - Percentage of component systems tested, verified and demonstrated.
Biofuels - The cost per gallon of ethanol from cellulosic matter is the indicator of performance for the biofuels activity.



Annual Performance Results and Targets

FY 2001 Results	FY 2002 Target	FY 2003 Proposed Target
• *Initiated a feasibility study and conceptual design of a gasifier-based cofiring process.* • *Conducted competitive solicitation and selected at least one partner for innovative biofuels production technologies and made awards to qualified research organizations.* • *Conducted competitive solicitation and selected at least one partner for demonstrating the conversion of cellulosic feedstock at a corn ethanol plant. (Met Goal)*	• *Initiate testing of – Small Modular BioPower Systems, which have both domestic and international applications.* • *Develop a prototype yeast capable of fermenting multiple biomass-derived sugars for ethanol production.*	• *Establish three R&D platforms for gasification system testing and integration, to support the program's gasification strategic plan and the Program Strategic Performance Goal (PSPG).* • *Evaluate an improved enzyme preparation developed by a leading enzyme manufacturer for reducing the cost of producing ethanol from biomass and update the Program's reference computer model of the production process.*

In the last ten years, total primary bioenergy use has increased from 2.6 Quads in 1990 to 3.2 Quads in 2000, but the use has shifted from heat-only to more high-value uses (electricity, fuels and combined heat and power (CHP)). Biomass primary energy use for power, fuels and products could grow between 40 and 100 percent by 2010 depending on the successful R&D coupled with aggressive policy measures.

Biopower Program supporting goals to help reach this projected potential include demonstrating high efficiency biomass gasification combined cycle systems and technologies for low-emission biorefinery options. Biofuels supporting goals include the technology for the production of low cost sugars, the development of optimized fermentation organisms, and the development of strong partnerships with industry leaders.

Objectives that support the Biopower Program mission and goals include the successful testing and verification of components and systems required for cost-effective and efficient biomass gasification combined-cycle systems including gasifiers, gas cleanup/conditioning, power generation technologies (gas turbines, fuel cells, etc.) and integration and control technologies.
By 2003, three R&D platforms will be established for gasification system testing and integration at the appropriate scale of development that support the Biopower Program's gasification strategic plan.

Objectives that support the Biofuels Program mission and goals outlined below rely upon the strengthening of existing and development of new industrial R&D partnerships, as well as policies that enable the demonstration technologies be conducted with reduced financial and market risk.

Biofuels

By 2004, at least one ethanol facility will be in operation using biomass wastes, and a partnership with the corn ethanol industry will complete testing of ethanol production from corn fiber.

By 2005, the cost of cellulase enzymes for conversion of cellulosic feedstocks will be reduced tenfold relative to Year 1999 baseline, to a cost of 5 to 10 cents per gallon of ethanol produced.

By 2010, technologies will be developed which can produce ethanol at a cost of $1.07 per gallon at the ethanol plant gate, excluding distribution, retail markup, and incentives. Year 2000 baseline for cellulosic ethanol is $1.40 per gallon.

Funding Schedule

(dollars in thousands)

	FY 2001	FY 2002	FY 2003	$ Change	% Change
Biopower Energy Systems					
Thermochemical Conversion	3,400	5,904	6,000	96	1.6%
Systems Development	25,284	29,024	23,625	-5,399	-18.6%
Feedstock Production	3,300	1,000	1,000	0	0.0%
Regional Biomass Energy Program	1,335	778	0	-778	-100.0%
Crosscutting Biomass R&D	6,000	2,500	2,375	-125	-5.0%
Subtotal, Biomass Power Systems	39,319	39,206	33,000	-6,206	-15.8%
Biofuels Energy Systems					
Bioconversion Platform	12,114	23,887	20,805	-3,082	-12.9%
Ethanol Production	21,026	19,932	27,325	+7,393	37.1%
Crosscutting Biomass R&D	6,350	2,500	2,375	-125	-5.0%
Renewable Diesel Alternatives	750	750	1,500	750	100.0%
Feedstock Production	3,600	1,000	1,000	0	0.0%
Regional Biomass Energy Program	2,212	777	0	-777	-100.0%
Subtotal, Biofuels Systems	46,052	48,846	53,005	4,159	8.5%
Total, Biomass R&D	85,371[a]	88,052	86,005	-2,047	-2.3%

[a] FY 2001 has been reduced by $897,000 to reflect SBIR/STTR Transfer.

Detailed Program Justification

(dollars in thousands)

	FY 2001	FY 2002	FY 2003
BIOPOWER ENERGY SYSTEMS			
Thermochemical Conversion	**3,400**	**5,904**	**6,000**

This effort conducts basic and applied research, testing, and feasibility studies in biomass gasification to provide the foundation for advanced and improved technology. This area of research is demonstrating advanced gasification and biosynthesis gas technology suitable for integrated use for combined heat and power generation on large scale and in distributed systems, in a biorefinery setting, and for the production of fuels and chemicals. The following project was directed by Congress to be included in this program in FY 2002: Biomass Research Gasification Center - AL (FY 2001 $0, FY 2002 $2,904, FY 2003 $0).

Performance targets include: by 2003-2004, complete integrated testing and emissions profiling of a microturbine coupled to a biomass gasifier; begin evaluation of required technologies for advanced multi-product biorefineries; by 2005-2007, complete comprehensive testing of a fuel cell on biomass-derived synthesis gas; complete verification of predictive models for biomass combustors and gasifiers; begin integration of biomass with advanced conversion systems; and by 2007-2010, complete development of a viable small-scale, medium Btu biomass gasifier in collaboration with industry.

FY2001: Completed engine testing and prepared a report on strategies for emissions reductions under the Thermochemical Conversion and Systems Integration effort. In addition, under the Lab Testing of Multi-Fuel combustor effort, a test report of fuels tested and evaluated was issued.

FY2002: By the end of FY 2002, a life cycle assessment of a distributed biopower system, including the determination of the benefits of avoiding transmission and distribution infrastructure and losses, will be completed. In addition, a final report on data analysis for the Vermont gasifier demonstration project will be issued.

FY2003: Efforts will continue the testing of cleanup and conditioning technologies and catalysts needed for coupling biomass gasifiers to fuel cells. The integration and emissions mapping testing of a mircoturbine coupled to a medium-Btu biomass gasifier will also be completed. Evaluation of the cost and efficiency of advanced gasification systems will be completed. Testing aimed at developing a small medium-Btu gasifier (offering higher efficiencies and lower emissions) will be completed in collaboration with industry. Models that allow prediction of combustor and gasifier performance and emissions will be completed and tested against field data. Evaluation of life cycle benefits and issues associated with biomass and competing systems will continue.

Systems Development	**25,284**	**29,024**	**23,625**
▪ **Co-firing with Coal**	11,584	0	0

Co-firing efforts will no longer be funded through the Biopower Program. This technology has reached a commercial level and therefore requires a minimal government role.

(dollars in thousands)

FY 2001	FY 2002	FY 2003

FY2001: Completed co-firing tests at Gadsden Station, AL. In addition, completed shakedown and short-term testing at Allegheny Power's Albright, WV power plant. SBIR Transfer has been reflected in this program in the amount of $328,000.

- **Biomass Power for Rural Development** 4,350 16,442 8,000

This Initiative includes the New York Willow project that will produce 30-40 MW of capacity through co-fired applications, and the Iowa Switchgrass project that will utilize up to 50,000 acres of switchgrass dedicated to co-firing operations. Additional efforts will include work at the Chariton Valley and New York Salix projects.

The following projects were directed by Congress to be included in this program in FY 2002: Tillamook Bay Port Authority (FY 2001 $1,000,000, FY 2002 $726,000, FY 2003 $0); Iowa Switchgrass Project (FY 2001 $2,750,000, FY 2002 $3,872,000, FY 2003 $0); A/D Methane Power Generation - CA (FY 2001 $0, FY 2002 $2,420,000, FY 2003 $0); Winona, MS Biomass Project (FY 2001 $0, FY 2002 $2,904,000, FY 2003 $0); Agricultural Mixed Waste Biorefinery - AL (FY 2001 $0, FY2002 $1,936,000, FY2003 $0); and University of North Dakota Energy and Environmental Research Center (FY 2001 $1,000, FY 2002 $484,000, FY 2003 $0).

Performance will be measured by completing two Biomass Power for Rural Development projects with more than 50 MW of new biopower generating capacity.

FY2001: The Chariton Valley Ottumwa Generating Station co-firing tests were completed.
FY2002: The Program will complete technical feasibility testing using closed-loop, short-rotation wood (fast-growing willows) as a dedicated fuel source for power generation at two retrofitted coal power plants in New York State.

FY2003: Efforts will continue to verify closed-loop biomass concepts in a utility setting. Activities will include testing of the various biomass feedstock and coal mixtures at two sites which include Chariton Valley and New York.

- **Small Modular Biopower** 3,950 4,000 5,000

This R&D effort will examine a broader range of feedstocks for Small Modular Biopower (SMB) systems. The program will develop, in partnership with industry, SMB systems that can exploit the vast agricultural and clean urban waste streams as well as high-moisture feedstocks to convert them into heat and electricity. Such hybrid systems significantly improve energy conversion efficiencies, and reduce harmful gaseous and particulate emissions. This effort will also investigate systems for efficient conditioning of the gases for coupling to advanced and clean power conversion devices. Funds are being leveraged with the U.S. Forest Service to demonstrate small modular systems in conjunction with the Forest Service's forest health/fire mitigation strategy by using the thinnings and underbrush as fuels for power production. Also, work is underway with USDA's Agricultural Research Service and the Environmental Protection Agency (EPA) in developing a program of work that addresses issues pertaining to the use of animal waste in power systems.

(dollars in thousands)

FY 2001	FY 2002	FY 2003

Performance targets include: by 2003-2004, complete field verification of systems in 5-7 locations; award competitive contracts for field verification of small biopower systems using high moisture feedstocks; define limitations of enhanced methane recovery techniques for landfills applications; by 2005-2007, demonstrate integration of biomass conversion and gas cleanup systems for advanced power cycle applications (microturbines, hybrid fuel cells); complete field validations of small biopower systems that use animal residues/high-moisture feedstocks; and by 2007-2010, complete field verification of competitively selected next-generation SMB generation systems (e.g. hybrid fuel cell/microturbine systems).

FY 2001: A SMB system met industrial partner performance criteria and was successfully demonstrated at a village in the Philippines.

FY 2002: By the onset of FY 2002, a detailed engineering design for a SMB system's modified turbine will be completed; down select to one or more projects to proceed to Phase III.

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

- **Gasification R&D** 5,400 8,582 10,625

Efforts will focus on the transition of R&D activities that leverage R&D investments against successfully proven technology platforms through public and private sector partnerships. This crucial step will shorten development cycles while providing operational solutions to technological challenges. The program will be working with USDA's Rural Utilities Service in an effort to provide gasification power for rural development. Laboratory R&D efforts will focus on gasification technologies to validate a more flexible use of a broad range of biomass feedstocks and will help to support interagency collaborations. Also included will be the examination of the process development of a catalytic gasification technology for recovery of energy from wet biomass including unconverted residuals from ethanol fermentation.

Research will also be conducted in thermochemical processes to produce biomass-derived fuels such as gasoline, diesel, and hydrogen and other products. Efforts will focus on gasification and pyrolysis as the processes for fuels/products development as an integral part of biorefinery systems. The following projects were directed by Congress to be included in this program in FY 2002: Vermont Biomass Energy Center (FY 2001 $0, FY 2002 $290,000 FY 2003 $0); McNeil Gasification Project - VT (FY 2001 $3,600,000, FY 2002 $2,904,000, FY 2003 $0); and Biorenewable Resource Consortium - IA (FY 2001 $0, FY 2002 $1,936,000, FY 2003 $0). SBIR Transfer has been reflected in this program in the amount of $95,000 in FY 2001.

(dollars in thousands)

FY 2001	FY 2002	FY 2003

Performance targets include: by 2003-2004, develop 3 to 4 partnerships that will provide gasification platforms; examine high moisture feedstock in gasification mode; by 2005-2007, confirm gas conditioning and gas clean-up systems; confirm 40 percent efficiencies in gasification process; and by 2007-2010, validate biorefinery concept, demonstrate co-products of fuels, chemicals, and power via biomass gasification systems.

FY 2001: A full-scale gas conditioning system was installed on the Vermont gasifier.

FY 2002: This will include examination of gas conditioning and gas clean up technologies. These efforts will focus on gas production, hot gas cleanup, gas preparation, and innovative and productive uses of gasifier waste streams. Performance will be measured through testing of mature advanced gas analysis instrumentation.

FY 2003:. These additional activities will include the initial development of a conceptual framework for biorefineries that will co-produce power, fuels and chemicals. In the longer-term, develop and demonstrate advanced gasification technology concepts that will be greater than 40 percent efficient utilizing advanced power cycles such as combustion turbines and fuel cells. Efforts that will lead to the production of liquid fuels from biomass gasification will also be undertaken**.**

Feedstock Production 3,300 1,000 1,000

Although plant science has been identified as a critical element to feedstock development, it has been determined that other agencies/organizations are better suited to handle the research. The Biopower Feedstock Development Program will be restructured to primarily explore infrastructure issues (e.g., collection and transport).

FY 2001: Established three new genetic selection trials for superior woody crops in locations which directly support biomass power generation projects under development.

FY 2002: By the onset of FY 2002, a database showing the availability (supply and cost) of biomass residues with high potential for competitive biopower markets will be completed.

FY 2003: Continue efforts to explore infrastructure issues.

Regional Biomass Energy Program 1,335 778 0

The Regional Biomass Energy Program (RBEP) will no longer be funded directly by the Biopower Systems.

FY2001: Southeast Regional Biomass Energy Program (SERBEP) completed proposal reviews for RFP. Western Regional Biomass Energy Program (WRBEP) held an Application Review meeting with technical and State representatives for solicitation for biomass projects.

(dollars in thousands)

	FY 2001	FY 2002	FY 2003
FY2002: Funding will support biopower R&D, cost-shared site studies for biopower facilities, outreach, and technology.			
Crosscutting Biomass R&D (formerly Integrated Biomass Program)	**6,000**	**2,500**	**2,375**
Provides highly leveraged funds in crosscutting biomass research and development that directly supports P.L. 106-224, Title III, The Biomass Research and Development Act of 2000. Enhances the integration of programs and partnerships among colleges, universities, national laboratories, Federal and State research agencies with programs funding R&D in biobased products. These efforts include education, outreach, analysis, and research and development activities targeting an expanded number of participants and innovative technologies not presently supported in current Biomass R&D activities. One example of this would be the support of crosscutting areas in the biorefinery concept. The development of integrated research and management plans based on visions, roadmaps, and life cycle analysis will provide cross program value.			
FY 2001: Conducted a broad-based solicitation that addressed bioenergy concepts. Efforts included examination of benefits derived from co-production of power, fuels and chemicals. In addition, supported crosscutting activities that include roadmap and visioning processes, analysis and outreach.			
FY 2002: Conduct a broad-based solicitation that examines innovative concepts for application in the gasification process. Also support efforts that are of a cross-cutting nature including outreach and analytical studies.			
FY 2003: Conduct a competitive solicitation, targeting new participants and innovative crosscutting technologies.			
Total, Biopower Systems	**39,319**	**39,206**	**33,000**
BIOFUELS ENERGY SYSTEMS			
Bioconversion Platforms	**12,114**	**23,887**	**20,805**
▪ **Fermentation Platform** (formerly Advanced Fermentation Organisms R&D)	3,000	6,596	4,000
Collaborate with industry and academia to develop organism platforms with increased stability, robustness, lower cost, and the ability to ferment mixed sugars from cellulosic wastes, agricultural residues, and energy crops such as switchgrass. The program will focus on the yeast platform initiated in FY 2002, a multi-year effort in collaboration with industry, that will develop advanced genetic engineering tools and genetic manipulation of promising yeast strains. The objective is to develop a yeast capable of converting 90 percent of total available sugars to ethanol by 2006. The yeast platform will provide the tools for the engineering of pathways for the production of other			

(dollars in thousands)

FY 2001	FY 2002	FY 2003

high value chemicals. This budget activity is restructured to reflect the intent of the Biomass Research and Development Act of 2000.

In FY 2001, the program reviewed the capabilities and limitations of the latest micro-organisms and obtained input from industry and academia through colloquies on high-priority R&D needs. In FY 2002, a competitive solicitation will be issued that will result in DOE's funding of R&D to achieve the desired traits in genetically engineered micro-organisms using clean biomass sugar solutions for fermentation testing. In FY 2003, prototypical hydrolyzate solutions will be used (containing impurities), and the program will attempt to make the micro-organisms capable of converting at least 55 percent of the sugars to ethanol. The following projects were directed by Congress to be included in this program in FY 2002: "continued funding for the Energy and Environmental Research Center at last years level" (FY 2001 $500,000, FY 2002 $470,000, FY2003 $0); Consortium for Plant Biotechnology Research (FY 2001, $0 FY 2002 $940,000, FY 2003 $0).

- **Sugars Platform** (formerly Advanced Cellulase and Pretreatment R&D) 9,114 17,291 16,805

Support existing partnerships to develop more productive and lower cost cellulase enzyme systems. Develop partnerships with enzyme, biomass ethanol, and other biochemical producers to accelerate the use of commercially available cellulase systems. Cost-effective cellulase systems remain the most significant barrier to the commercialization of enzymatic hydrolysis technology. Second only to cellulase systems, pretreatment methods remain the most challenging unit operation. Evaluations of novel pretreatment systems will continue. Past research and development has not yet led to cost effective solutions. The program is now focusing on developing and understanding the fundamental principles of biomass depolymerization to aid in developing novel pretreatment systems that are needed to improve process efficiency and reduce costs, in collaboration with academia and industry.

In FY 2001, we made a major award to a leading enzyme company (the first award to another leading enzyme company was made in FY 2000). The companies developed technical project plans and began R&D accordingly. In FY 2002, we will begin to test their interim enzyme products. More definitive performance will be measured in FY 2003 through our testing of their prototype cellulase enzymes and our economic evaluation using realistic plant design parameters and results from the concurrent research on pretreatment fundamentals. This budget element is restructured to reflect intent of the Biomass Research and Development Act of 2000.

The following projects were directed by Congress to be included in this program: Prime LLC of South Dakota integrated ethanol complex (FY 2001 $800,000, FY 2002 $2,820,000, FY 2003 $0), Michigan Biotechnology Initiative (FY 2001 $1,000,000, FY 2002 $1,880,000, FY 2003 $0) and the switchgrass project of the Great Plains Institute for Sustainable Development in Minnesota (FY 2001 $0, FY 2002 $940,000, FY 2003 $0).

(dollars in thousands)

	FY 2001	FY 2002	FY 2003
Ethanol Production	**21,026**	**19,932**	**27,325**
▪ **Integrated Biorefinery Process Development**	10,000	9,840	10,000

This activity includes the integration and optimization of biorefinery process unit operations with a focus on ethanol production and other chemicals. Conduct integrated bench-scale and pilot-scale testing of the hydrolysis process, i.e., handling, pretreatment, cellulose hydrolysis, and fermentation, to evaluate performance, efficiency, and costs for conversion of agricultural residues, such as corn stover (stalks and fibrous components). The main focus of this activity is the integration and validation of the enzymatic hydrolysis process for fuels and chemicals. Funding also provides technical and engineering support for industrial partners.

In FY 2001, a preliminary process configuration and computerized kinetic model of the process were developed and analyzed. The program also explored how corn stover reacted under different pretreatment conditions in a Sunds reactor vessel, and developed methods for assaying the sugar contents after pretreatment. In FY 2002, the program will conduct experiments to refine the kinetic model and process configuration, and evaluate residues from an interim process configuration. In FY 2003, the program will identify the best process options through process simulation analysis using the latest energy and material information and conceptual equipment cost estimates. The following projects were directed by Congress to be included in FY 2002: Iroquois Project in Indiana (FY 2001 $0, FY 2002 $2,820,000, FY 2003 $0); Micro-Combustion research at Oak Ridge National Laboratory (FY 2001 $0, FY 2002 $940,000, FY 2003 $0); and Oxygenated Diesel emissions testing (FY 2001 $0, FY 2002 $940,000, FY 2003 $0).

▪ **Cellulose to Ethanol Production Facilities**	11,026	10,092	17,325

Continues to develop partnerships to validate cost-effective conversion of corn stover and other residues to ethanol. The use of corn fiber for ethanol production offers a near term opportunity for integrating cellulosic ethanol into existing commercial facilities. Competitive solicitations will be conducted to support the integration of cellulosic conversion processes with existing starch-based commercial facilities. Performance is measured by demonstrating the feasibility of commercial production of ethanol and co-products from the corn fiber stream in partnership with a major ethanol producer.

In FY 2001, two industry partners were assisted in pilot and bench-scale testing of their acid-based hydrolysis processes. SBIR Transfer has been reflected in this program in the amount of $474,000 in FY 2001. In FY 2002, support a competitive solicitation to increase the cost-shared activities in collaboration with the current corn ethanol industry to demonstrate the integrated enzymatic hydrolysis and fermentation of cellulosic feedstocks to fuels and chemicals. Multiple partners will be selected. The following projects were directed by Congress to be included in FY 2002: Sealaska (FY 2001 $2,000,000, FY 2002 $1,880,000, FY 2003 $0), Black Belt Cooperative (FY 2001 $0, FY 2002 $1,452,000, FY 2003 $0), and Gridley Project in California (FY 2001 $0, FY 2002 $2,820,000, FY 2003 $0).

(dollars in thousands)

	FY 2001	FY 2002	FY 2003
Crosscutting Biomass R&D	**6,350**	**2,500**	**2,375**

Provides highly leveraged funds in crosscutting biomass research and development that directly support P.L. 106-224, Title III, The Biomass Research and Development Act of 2000. Enhances the integration of programs and partnerships among colleges, universities, national laboratories, Federal and State research agencies with programs funding R&D in biobased products. These efforts include education, outreach, analysis, and research and development activities targeting an expanded number of participants and innovative technologies not presently supported in current Biomass R&D activities. One example of this would be the support of crosscutting areas in the biorefinery concept. The development of integrated research and management plans based on visions, roadmaps, and life cycle analysis will provide cross program value.

FY 2001: Conducted a broad-based solicitation that addressed bioenergy concepts. Efforts included examination of benefits derived from co-production of power, fuels and chemicals. In addition, supported crosscutting activities that include roadmap and visioning processes, analysis and outreach.

FY 2002: Conduct a broad-based solicitation that examined innovative concepts for application in the gasification process. Also support efforts that were of a cross-cutting nature which included outreach and analytical studies.

FY 2003: Conduct a competitive solicitation, targeting new participants and innovative crosscutting technologies.

Renewable Diesel Alternatives (formerly Biodiesel Production)	**750**	**750**	**1,500**

Initiate the development of industrial partnerships to validate the production of low-cost mustard seed crops to produce biodiesel and organic pesticides. Continue mustard seed field trials evaluating its co-product potential as an organic pesticide. Conduct performance tests to validate alternatives for the diesel fuel pool (e.g. ethanol-diesel blends) and conduct research to reduce barriers to their expanded use.

Feedstock Production	**3,600**	**1,000**	**1,000**
▪ **Feedstock Development Centers**	2,700	650	0

Conduct research and development of model energy crops, such as switchgrass, and crop residues through coordinated regional networks of universities and other centers operating as virtual feedstock development centers in the Southeast, Midwest, and Northern Plains. Focus a critical mass of breeding, biotechnology, environmental, and crop management research on a limited number of model species, and conduct work simultaneously in several major crop production regions to improve yields and lower production costs. The residue management research, conducted in collaboration with the United States Department of Agriculture, is generating data on the impacts of harvesting residues on soil quality, including soil carbon and nutrient levels. The research activity is consistent with analyses indicating that agricultural residues, such as switchgrass, have

(dollars in thousands)

FY 2001	FY 2002	FY 2003

great potential as feedstocks for ethanol and biobased chemicals production in the near and mid-term. For FY 2003, it is assumed that these centers will be considered as part of the USDA feedstock program.

- **Switchgrass Variety Testing and Scale-up Research** 400 100 0

  Evaluate yields, operational issues, environmental impacts, and production costs on nine 10-20 acre scale-up planting of switchgrass established in FY 2000 and FY 2001 in three States in the Northern Plains. Continue to evaluate newly developed switchgrass lines in field trials established at five United States Department of Agriculture (USDA) National Plant Materials Testing Centers. It is assumed that full funding will be supported by USDA at their National Plant Materials Testing Centers in FY 2003.

- **Feedstock Composition and Multi-Product Use** 200 50 0

  Conduct research to develop the genetic tools required to alter the chemical composition of plants to facilitate more efficient production of biofuels and biobased chemicals. A framework linkage map developed in FY 1999-2001 will be incorporated into marker-aided selection in switchgrass breeding projects funded in other lines.

- **Feedstock Logistics and Engineering Systems** (formerly Mechanization Research) 300 200 1,000

  Develop efficient systems for delivering large and reliable quantities of high-quality biomass for processing into biofuels and biobased products. In FY 2001, a comprehensive literature search was conducted to establish baseline costs, and a workshop was held with industry experts and academic researchers to review strategies for reducing harvest, handling, storage, and transportation costs. Research was initiated through a competitive solicitation to document collection efficiencies, mass balances, and machine efficiencies when collecting corn residues using commercially available equipment. In FY 2002, the program will characterize the physical and mechanical properties of crop residues, and analyze alternative processes for densifying biomass to reduce bulk, fire hazards, and decompositional losses. In FY 2003, the program will support the development of novel harvesting equipment design., storage, and logistics for agricultural wastes will reduce feedstock cost for ethanol and co-products.

Regional Biomass Energy Program **2,212** **777** **0**

- **Utilize the Regional Biomass Energy Program** 1,712 777 0

  The State and local regional biomass networks developed as part of the management of the Regional Biomass Energy Program will be maintained in FY 2002, although funds are not provided to support regional biomass solicitations. In FY 2003, the Regional Biomass Energy Program (RBEP) will no longer be funded directly by Biofuels Energy Systems.

(dollars in thousands)

	FY 2001	FY 2002	FY 2003
▪ **Biodiesel Fuel Formulations**	500	0	0

Work with enhanced fuel performance of high efficiency engines, formerly a collaboration with the Office of Heavy Vehicle Technologies in the Office of Transportation Technologies, will no longer be supported by this program.

Total, Biofuels Energy Systems	**46,052**	**48,846**	**53,005**
Total, Biomass/Biofuels Energy Systems	**85,371**	**88,052**	**86,005**

Explanation of Funding Changes

	FY 2003 vs. FY 2002 ($000)
BIOMASS/BIOFUELS ENERGY SYSTEMS	
Biopower Energy Systems	
Thermochemical Conversion	
■ No significant change.	96
Systems Development	
■ The co-firing effort is closed-out due to being near commercialization. An increased emphasis is placed on gasification efforts	-5,399
Regional Biomass Energy Program.	
■ RBEP will no longer be funded through Biopower systems	-778
Crosscutting Biomass R&D	
■ Slight decrease due to restructuring of program activities	-125
Biofuels Energy Systems Program	
Bioconversion Platforms	
■ Fermentation Platform (formerly Advanced Fermentation Organisms R&D) - In FY 2002 research on bacterial fermentation organisms and second generation ethanologen (high temperature tolerant organisms) contracts will be completed	-2,596
■ Sugars Platform (formerly Advanced Cellulase R&D and Pretreatment R&D) - Prototype pretreatment testing unit will be completed in 2002.	-486
Total Funding Change, Bioconversion Platforms	**-3,082**
Ethanol Production	
■ Integrated Biorefinery Process Development - Increase is needed to integrate (bench and pilot scale) new enzyme systems into process	160
■ Cellulose to Ethanol Production Facility - Increase is needed to assist industrial partners to determine feasibility of producing ethanol and co-products from the corn fiber stream	7,233
Total Funding Change, Ethanol Production	**7,393**

	FY 2003 vs. FY 2002 ($000)
Crosscutting Biomass R&D	
■ Funding will support a broad competitive solicitation for biorefinery research and development	-125
Renewable Diesel Alternatives	
■ Initiate validation of multiple use feedstocks for renewable diesel	750
Feedstock Production	
■ Feedstock Development Centers -Activity will be considered part of the USDA Feedstock program	-650
■ Switchgrass Variety Testing and Scale-Up - No longer funded by this Program	-100
■ Feedstock Composition and Multi Product Use - No longer funded by this Program	-50
■ Feedstock Logistics and Engineering Systems (formerly mechanization research) - Evaluate and develop novel harvesting equipment designs	800
Total Change, Feedstock Production	0
Regional Biomass Energy Program	
■ Utilize the Regional Biomass Energy Program - No longer funded by this program.	-777
Total Funding Change, Biomass/Biofuels Energy Systems	**-2,047**

Geothermal Technology Development

Mission Supporting Goals and Objectives

The Geothermal Technology Development Program directly supports the organizational mission to develop clean, competitive, reliable power technologies for the 21st century. To this end, the program works in partnership with U.S. industry to establish geothermal energy as an economically competitive contributor to the U.S. energy supply, capable of meeting a significant portion of the Nation's heat and power needs. Current program goals include doubling the number of States with geothermal electric power facilities to eight by 2006; reducing the levelized cost of generating geothermal power to 3-5 cents/kWh by 2010; and supplying the electrical power or heat energy needs of 7 million homes and businesses in the United States by 2015. The goal of doubling the number of States with geothermal power facilities, and thereby broadening the base of geothermal development in the United States, is a Departmental Program Strategic Performance Goal (PSPG).

The program's approach to achieving its goals is to expand the use of known geothermal fields through near-term technology development; identify new cost-effective resources through integrated exploration techniques and tools; reduce both risk and cost through improved drilling technologies and surface systems; and broaden the resource base through development of Enhanced Geothermal Systems. Research activities are implemented through directed work at the national laboratories, competitive solicitations to universities and industry, and cost-shared public-private partnerships.

Capital costs associated with developing a typical geothermal well field range from $300 to $600 per kilowatt installed. These costs represent 30 to 50 percent of the total cost of the facility. The program is pursuing two strategies to reducing the absolute costs of the well field. One involves reducing the number of wells needed to produce a unit of energy through improved identification, understanding, and characterization of the geothermal resource. The other addresses reducing well costs through advanced technology.

Advances in exploration technology have the potential to significantly increase the availability of geothermal resources. Only one in five geothermal exploration wells succeeds in locating economically viable resources. The program has an objective of improving the success rate in exploratory drilling from 20 percent in 2000 to 40 percent by 2010.

At the same time, the economics of drilling individual wells can be improved by innovative drilling technology. To this end, the program has the objective that by 2004, the rate of penetration will be increased by 25 percent over drilling rates in 2000. This will contribute to the overall objective of reducing well costs from $300 per foot in 2000 to $150 per foot in 2008.

Finally, advanced materials and innovative technologies can improve the economics of future plant systems. The program is working to decrease the capital costs of surface systems by 20 percent relative to year 2000 technology by the year 2010.

As a baseload power generation technology with very high reliability, geothermal energy contributes to the nation's energy security, especially in stabilizing the electricity grid in remote areas. Geothermal

energy production emits negligible amounts of greenhouse gases, making the technology a viable alternative in addressing global climate change. As such, the program is responsive to these issues and many of the recommendations contained in the National Energy Policy (NEP) report.

Program Strategic Performance Goal

ER2-3: Geothermal Energy
Geothermal Energy R&D activities will result in twice as many States with geothermal electric power facilities by 2006.

Performance Indicator: The number of States with geothermal electric power facilities.

Annual Performance Results and Targets

FY 2001 Results	FY 2002 Target	FY 2003 Proposed Target
• *Selected industrial partners to build two cost-shared geothermal power plants using Enhanced Geothermal System (EGS) technology.*	• *Complete construction of a small-scale (300 kW to 1 MW) geothermal power plant for field verification. An FY 2000 NREL study revealed considerable opportunity for small-scale geothermal in several Western states.*	• *Begin operation of a small-scale geothermal power plant in the State of New Mexico, thereby increasing the diversity of the Nation's energy supply and the geographical distribution of geothermal electric power generation.*

Funding Schedule

(dollars in thousands)

	FY 2001	FY 2002	FY 2003	$ Change	% Change
Geoscience and Supporting Technologies . .	7,300	6,916	7,700	784	+11.3%
Exploration and Drilling Research	8,200	8,084	12,100	+4,016	+49.6%
Energy Systems Research and Testing	11,123	12,299	6,700	-5,599	-45.5%
Total, Geothermal Technology Development	26,623[a]	27,299	26,500	-799	-2.9%

[a] FY 01 has been reduced by $288,000 to reflect SBIR/STTR Transfer.

Detailed Program Justification

(dollars in thousands)

	FY 2001	FY 2002	FY 2003
Geoscience and Supporting Technologies	**7,300**	**6,916**	**7,700**
▪ **Core Research**	3,000	2,136	3,000

Understand complex natural geothermal processes and develop technology to facilitate geothermal resource production in an economical manner. Research activities include improving reservoir models, studying fracture dynamics, developing tracers, and conducting geochemical research. The funding provides for a continuation of projects supporting reservoir engineering and Enhanced Geothermal Systems that will result in new, reliable tools for reservoir analysis and production.

▪ **University Research**	2,600	3,200	1,200

Conduct competitively-selected research projects in earth science at universities to preserve a strong geothermal knowledge base. Knowledge gained from this work, in conjunction with complementary work in Core Research and Enhanced Geothermal Systems, will result in new and improved technology that will help reduce costs and expand the resource base. The following project was directed by Congress to be included in this program in FY 2002: University of Nevada-Reno Center for Geothermal Energy (FY 2001 $0, FY 2002 $936,000, FY 2003 $0).

▪ **Enhanced Geothermal Systems (EGS)**	1,700	1,580	3,500

Using previously completed designs, continue the development of EGS cost-shared projects at competitively selected sites. The development of next-generation EGS technology promises to more than double the amount of economically viable geothermal resources in the West. This work comports well with the NEP recommendations to develop next-generation technology and increase geothermal energy production on Federal lands.

Exploration and Drilling Research	**8,200**	**8,084**	**12,100**
▪ **Detection and Mapping**	2,700	3,000	6,000

Continue cost-shared, competitively-selected exploration projects initiated with industry to find and confirm new geothermal resources within the United States. These projects will bring new geothermal fields into production. Initiate studies to identify and confirm the geothermal resources of the Great Basin in collaboration with the U.S. Geological Survey. Continue to conduct geophysical, geological, and geochemical exploration research. These activities contribute to the program goals to double the number of States with electric power facilities by 2006 (PSPG) and generate enough power to serve seven million homes by 2015. The work also supports the NEP recommendation to increase geothermal energy production on Federal lands. Performance will be measured by confirming at least two new geothermal reservoirs in the United States during FY 2003.

(dollars in thousands)

	FY 2001	FY 2002	FY 2003
▪ **Innovative Drilling Subsystems**	4,800	4,784	6,000

Continue development of several major advanced drilling components including the Diagnostics-While-Drilling subsystem, advanced drill bits, a bit vibration suppression subsystem, and an enhanced lost circulation subsystem. These elements will ultimately be integrated into a complete advanced drilling system designed to reduce the overall cost of geothermal wells by an average of 50 percent by 2008 ($300 per foot in 2000 to $150 per foot in 2008). In FY 2003, progress will be measured by completing field verification of the Diagnostics-While-Drilling subsystem.

▪ **Near-Term Technology Development**	700	300	100

Continue research on near-term drilling technology improvements conducted via cost-shared contracts with industry partners.

Energy Systems Research and Testing	**11,123**	**12,299**	**6,700**
▪ **Advanced Heat and Power Systems . . . . . .**	3,000	3,300	3,300

Improve technology in heat conversion and power systems for application to a broad range of geothermal resources and environmental conditions. Conduct research on innovative systems, including heat exchangers, air-cooled condensers, and other components, for both low and high temperature applications. These advanced technologies enable the use of lower temperature resources for heat and power development. These activities contribute to the program objective of decreasing the capital costs of surface systems by 20 percent.

▪ **Systems Field Verification . . . . . .**	1,745	811	1,000

Continue support for three ongoing projects previously selected competitively. During FY 2003, the construction of at least one small-scale power plant project will be completed. This work directly supports the PSPG of doubling the number of states with geothermal power facilities by 2006.

▪ **Industry Support . . . . . .**	4,778	4,988	1,000

Provide technical, economic, and institutional analysis and support, including outreach and communication, for both low and high temperature applications. Funding in FY 2003 is decreased due to completion of the Lake County Basin Pipeline Project for which Congress directed funds (FY 2001 $2,000,000, FY 2002 $1,873,000, FY 2003 $0) and the Santa Rosa Pipeline Project, with funds also directed by Congress (FY 2001 $0, FY 2002 $1,873,000, FY 2003 $0). SBIR Transfer has been reflected in this program in the amount of $288,000 in FY 2001.

▪ **GeoPowering the West . . . . . .**	1,600	3,200	1,400

Conduct outreach activities addressing regional and state geothermal development barriers

(dollars in thousands)

	FY 2001	FY 2002	FY 2003

and opportunities. GeoPowering the West supports the PSPG of doubling the number of states with geothermal power facilities by addressing key issues with state and local agencies to facilitate development. Among other things, this work supports the NEP recommendation to develop educational programs that communicate the benefits of geothermal energy. Directed funding for GeoPowering the West was provided by Congress in FY 2002 (FY 2001 $0, FY 2002 $2,341, FY 2003 $0).

Total, Geothermal Technology Development	**26,623**	**27,299**	**26,500**

Explanation of Funding Changes

	FY 2003 vs. FY 2002 ($000)
Geoscience and Supporting Activities	
■ Core Research - The increase allows for greater emphasis on projects supporting EGS technology development	+864
■ University Research - The decrease results from the completion of large, multiyear grants	-2,000
■ Enhanced Geothermal Systems - The increase reflects a decision to move forward on projects with cost-sharing partners in areas that are currently incapable of producing geothermal energy in commercial amounts	+1,920
Total, Geoscience and Supporting Activities	**+784**
Exploration and Drilling Research	
■ Detection and Mapping - The increase will allow additional cost-shared exploration with industry to identify new fields and initiation of a comprehensive resource assessment of the Great Basin	+3,000
■ Innovative Drilling Subsystems - The increase allows for a much more aggressive development of the bit vibration suppression subsystem as well as an overall acceleration in the system integration activity	+1,216
■ Near-Term Technology Development - The decrease reflects a decision to focus resources on the advanced drilling system needed to achieve program goals	-200
Total, Exploration and Drilling Research	**+4,016**

	FY 2003 vs. FY 2002 ($000)
Energy Systems Research and Testing	
■ Systems Field Verification - The increase enables one project to begin field operations	+189
■ Industry Support - The decrease represents completion of funding for congressionally-mandated projects	-3,988
■ GeoPowering the West - The decrease reflects completion of outreach activities with selected western states and tribes	-1,800
Total, Energy Systems Research and Testing	**-5,599**
Total Funding Change, Geothermal Technology Development	**-799**

Hydrogen Research

Mission Supporting Goals and Objectives

The Hydrogen Program includes research and validation projects for the development of safe, cost-effective hydrogen energy technologies that support and foster the transition to a hydrogen economy. To enable a future that includes hydrogen energy, four strategies are pursued that will provide benefits in efficiency, environment and economy.

The use of hydrogen will be expanded in the near-term by working with industry, including hydrogen producers, to improve efficiency, lower emissions, and lower the cost of technologies that produce hydrogen from natural gas. Distributed refueling stations will be installed collaboratively with industry that will demonstrate a hydrogen production cost of $12 - $15 per million Btu for pressurized hydrogen from natural gas by 2015.

DOE will work with fuel cell manufacturers to develop hydrogen-based electricity storage and generation systems that will enhance the introduction and penetration of distributed, renewables-based utility systems. By 2010, a reversible hydrogen fuel cell system will be validated. By 2015, carbon emissions will be reduced by 1.3 MMTCE for less than $600 per kW and 13.7 MMTCE by 2020.

A portion of the hydrogen program will also support the FreedomCAR initiative and will be coordinated with the Department of Transportation and EE's Transportation programs to demonstrate safe and cost-effective fueling systems for hydrogen vehicles in urban non-attainment areas and to provide on-board hydrogen storage systems. By 2010, a safe, low-cost hydrogen storage system will be developed and validated for use on-board a vehicle to achieve a 350 mile range.

Finally, the Department will work with the national laboratories to lower the cost of technologies that produce hydrogen directly from sunlight and water. An integrated process development unit will be operational by 2020 that will continuously produce hydrogen from water and biomass.

Hydrogen, the most plentiful element in the universe, is the ideal fuel. Hydrogen can be oxidized in a fuel cell, combusted in a conventional engine, or simply burned. Its only byproduct is water. Hydrogen can be produced from fossil, nuclear, or renewable resources and as a transportable fuel, it has greater flexibility than electricity for a transportation vehicle and remote area use. Many scientists see it as the basis for the total sustainable clean energy economy of the future.

Program Strategic Performance Goal

ER2-4: Hydrogen
Hydrogen R&D activities will demonstrate a conversion technology that will improve the cost of hydrogen production from natural gas from $3.75 per kilogram in 2000, when produced in large quantities, to $2.50 per kilogram in 2006.

Performance indicator: Cost of hydrogen ($/kg) produced in large quantities.

Annual Performance Results and Targets

FY 2001 Results	FY 2002 Target	FY 2003 Proposed Target
■ *Produced 20 cubic meters per hour of hydrogen via steam reforming of biomass pyrolysis oil in a process development unit.*	■ *Construct process development unit of ceramic membrane system for membrane system tests for hydrogen production.*	■ *Complete the design, development and testing of the 10,000 psi hydrogen storage tank.*

Funding Schedule

(dollars in thousands)

Hydrogen Research	FY 2001	FY 2002	FY 2003	$ Change	% Change
Core Research and Development	14,438	14,426	19,331	4,905	34.0%
Technology Validation	9,009	10,320	15,000	4,680	45.3%
Analysis and Outreach	3,147	4,437	5,550	1,113	25.1%
Total, Hydrogen Research and Development	26,594[a]	29,183	39,881	10,698	36.7%

Detailed Program Justification

(dollars in thousands)

	FY 2001	FY 2002	FY 2003
Core Research and Development	**14,438**	**14,426**	**19,331**
■ **Thermal Processes**	5,500	5,233	5,530

Improve the efficiency and lower the cost of fossil-based and biomass-based hydrogen production processes to achieve $12 - $15 per million Btu for (5000 psi) pressurized hydrogen when reformers are mass produced. Performance will be measured by demonstrating the Ion Transport Membrane (ITM) process in a Process Development Unit at an equivalent of 150,000 standard cubic feet per day.

Continue the development of other advanced reformer concepts that can reduce the cost of hydrogen production by 25 percent and thereby reduce the cost of electricity generated using fuel cells. Phase 3 projects that produce hydrogen from biomass will be funded. Hydrogen program collaboration with the Office of Fossil Energy to convert coal to hydrogen will be supported.

The levels of FY 2002 funding for the following projects were directed by Congress to be included in this program: The ITM Syngas project (FY 2000 $0, FY 2001 $800,000, FY 2002 $1,410,000,

[a] The FY 2001 funding shown has been reduced by $287,000 for SBIR/STTR transfers.

(dollars in thousands)

	FY 2001	FY 2002	FY 2003

FY 2003 $0) and the Gasification of Iowa Switchgrass project (FY 2000 $0, FY 2001 $250,000, FY 2002 $470,000, FY 2003 $0).

▪ **Photolytic Processes**	2,597	2,706	2,230

Support research into biological systems and advanced semi-conductors which will directly split water to hydrogen and oxygen. Fabricate a modular photoelectrochemical (PEC) semi-conductor cell, perform characterization testing of a strain of algae producing large volumes of hydrogen from water, and perform characterization testing of a strain of organisms for high temperature fermentation of waste to produce hydrogen. Allows full funding of three laboratory and three university projects developing methods to produce hydrogen directly from water. SBIR Transfer has been reflected in this program in the amount of $287,000 in FY 2001.

▪ **Storage**	3,284	2,751	7,835

Develop and demonstrate safe and cost-effective storage systems for use in stationary distributed electricity generation and for stationary and vehicle applications in urban non-attainment areas. Performance will be measured by fabrication of several half-scale hydride storage tank concepts that can achieve 5.5 percent by weight hydrogen. Produce two full-scale thermo-compression systems for lab-scale demonstration. Design bulk storage systems to support refueling applications. Initiate material studies for transport systems (e.g. pipelines, rail cars, tube trailers, etc.). Study regeneration processes of chemical hydride systems.

▪ **Utilization**	3,057	3,736	3,736

In collaboration with the Distributed Energy Resources program and the Office of Transportation Technologies, the Hydrogen program will develop a technology blue print for new building codes and equipment standards for hydrogen technologies and work with industry to test hardware in the labs to provide the necessary data. Continues task for the development of low-cost fuel cell components, hydrogen engines, and hydrogen injection into natural gas fueled combustion turbines. Develop more efficient, accurate and lower cost sensors for leak detection and safety measurements, and continue the development of small proton exchange membrane fuel cells for battery applications. Complete second year of a three year CRADA for the development of a solid oxide electrolyzer system for the production of hydrogen.

Technology Validation	**9,009**	**10,320**	**15,000**
▪ **Renewable Energy Systems**	1,986	1,375	2,650

Continue testing of biomass pyrolysis system at the customer site, collaborate with South Coast Air Quality Management District to install and operate a state-of-the-art wind- hydrogen generation system to refuel bus fleets, and continue with demonstration of electrolyzer system that achieves an initial goal of $600/kW. Install and operate biomass to hydrogen and one wind-hydrogen generation and storage fuel cell system and validate the economic viability of these systems for remote and on-grid utility applications. Permits two industry cost-shared projects to continue the development of

(dollars in thousands)

	FY 2001	FY 2002	FY 2003
lower cost options for electrolysis systems to achieve reductions by a factor of two goals by FY 2005.			
▪ **Distributed/Remote Power**	1,153	2,571	5,850
Demonstrate the operation of a power park that co-produces hydrogen and electricity for a small industrial complex. Install and validate at user sites, several residential, power park and off-grid power systems that demonstrate multiple hydrogen production options with advanced storage systems and fuel cells. The following project was directed by Congress in FY 2002 to be included in this program: demonstration of fuel cells in Montana.(Big Sky Development Corp.) (FY 2000 $294,000, FY 2001 $350,000, FY 2002 $329,000, FY 2003 $0) and in Gallatin Montana (FY 2001 $0, FY 2002 $1,410,000, FY 2003 $0).			
▪ **Hydrogen Infrastructure**	5,870	6,374	6,500
Permits the funding for the second year of a three-year program of several industry storage and refueling projects selected in collaboration with the Office of Transportation Technologies and State agencies that will incorporate advanced components including reformers designed for mass production in integrated hydrogen production systems. Validate 10,000 - 12,000 standard cubic feet per day electrolysis systems for fueling of hydrogen vehicles . Complete safety tests on high pressure hydrogen storage tanks and cryogas tanks installed on light- and heavy-duty vehicles. The following projects ere directed by Congress in FY 2002 to be included in this program: Mluti-year demonstration of Underground Mining Locomotive and an Earth Loader Powered by Hydrogen at existing facilities within Nevada (FY 2001 $2,000,000 FY 2002 $940,000, FY 2003 $0) and Fuel Cell technology assessment and demonstration at the Univ. of Alabama (FY 2001 $0, FY 2002 $940,000, FY 2003 $0).			
Analysis and Outreach	**3,147**	**4,437**	**5,550**
Conduct economic analyses and technical assessments for technologies being developed and demonstrated. Performance will be measured by developing a comprehensive database on validation projects to initiate the implementation of codes and standards for the use of hydrogen in public buildings by local and State permitting officials and communicating the results to the officials and the public. Provides for education-related activities and allows completion of several outreach projects for use in the codes and standards activities. Supports an extensive set of analyses to guide the hydrogen research efforts.			
Total, Hydrogen Research	**26,594**	**29,183**	**39,881**

Explanation of Funding Changes

	FY 2003 vs. FY 2002 ($000)
Core Research and Development	
■ Increase support for membranes for hydrogen separation and purification	+297
■ Refocus effort to support new area of high temperature biological production of hydrogen using a new class of microorganisms	-476
■ Increase engineering support of storage technologies including the fabrication of several prototype hydride tanks	+5,084
Total, Core Research and Development	**+4,905**
Technology Validation	
■ Increase support for biomass and wind/reversible fuel cell projects	+1,275
■ Complete funding for locomotive and front end loader	+779
■ Completed refueling station and vehicle conversions	-653
■ Increase support for multiple power park developments	+1,329
■ Initiate Hydrogen Energy Development Initiative	+1,200
■ Complete Uninterrupted Power Source Systems	+750
Total, Technology Validation	**+4,680**
Analysis and Outreach	
■ Increase analysis on high-priority activities and complete several educational projects to certify technicians and inform Code Officials and Fire Marshals.	+1,113
Total Funding Change, Hydrogen Research	**+10,698**

Hydropower

Mission Supporting Goals and Objectives

Working with industry and other Federal agencies, the Hydropower Program's R&D activities support the development of a new generation of more environmentally-friendly hydropower turbines. The FY 2003 request will permit the Hydropower Program to facilitate the development of a commercially viable turbine technology capable of reducing the rate of fish mortality to 2 percent or lower by 2010 (compared with turbine-passage mortalities of 5 to10 percent for the best existing turbines and 30 percent or greater for some turbines), while maintaining downstream dissolved oxygen levels of at least 6 mg/L to ensure compliance with water quality standards. Developing more environmentally-friendly turbine technology will also help reverse the decline in hydroelectric generation, an important alternative to fossil fuel generation.

Efforts to develop and test innovative environmentally-friendly turbines designed specifically for low head/low power and micro-hydro applications could provide hydropower for many sites, such as canal drops, where dams would not be necessary.

The pilot-scale proof-of-concept testing of the Alden advanced turbine design will verify predicted biological and hydraulic performance and provide the basis for full-scale prototype testing. The FY 2003 request will provide for the accelerated testing of a full-scale prototype of this turbine at an operational hydropower site. Biological testing of additional turbine designs provided by industry will provide additional options for new projects or upgrades to existing projects. These activities, together with supporting biological research, will provide industry with technology capable of reducing turbine-induced fish mortality to 2 percent or less by 2010.

Testing of low-head/low-power turbine designs provided by industry, together with the resource and technology assessment activities, will provide industry with environmentally friendly designs and data on the resource base for this underutilized source.

Program Strategic Performance Goal

ER2-5: Hydropower
Hydropower R&D activities will ensure commercialization of a fish passage technology capable of reducing turbine-induced fish mortality to 2 percent or less by 2010 in new fish-friendly turbines.

Performance indicator: Percentage fish mortality of turbines in the current stage of the testing and development process.

Annual Performance Results and Targets

FY 2001 Results	FY 2002 Target	FY 2003 Proposed Target
■ *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.*	■ *Completion of pilot-scale testing, providing the basis for future full-scale testing at an operational site. Successful testing will provide industry with a proven design, helping attain the 2% mortality goal.*

Funding Schedule

(dollars in thousands)

	FY 2001	FY 2002	FY 2003	$ Change	% Change
Advanced Turbine Research and Development	4,936	5,018	7,489	2,471	49.2%
Total, Hydropower	4,936[a]	5,018	7,489	2,471	49.2%

Detailed Program Justification

(dollars in thousands)

	FY 2001	FY 2002	FY 2003
Advanced Turbine Research and Development	**4,936**	**5,018**	**7,489**
■ **Large Turbine Testing**	2,300	1,464	4,089

Conduct cost-shared testing and support of competitively selected environmentally-friendly large turbine (greater than 1 MW) designs developed by industry.

FY 2001: Plans were initiated for the issue of an RFP for large turbine testing in FY 2002. A notice of intent for a FY 2001 RFP received no satisfactory responses.
FY 2002: Issue two RFPs for large turbine testing; one for designs/turbine manufacturers, and one for sites.
FY 2003: Begin testing activities. Successful testing will provide industry with additional turbine options for retrofit or new development, and help attain the 2 percent fish mortality goal by 2010.

[a] FY 2001 has been reduced by $53,000 to reflect SBIR/STTR transfer.

(dollars in thousands)

	FY 2001	FY 2002	FY 2003
▪ **Low-Head/Low-Power Testing**	447	0	0

Conduct cost-shared testing and support of competitively selected environmentally-friendly low head/low power turbine designs developed by industry.

FY 2001: Plans were initiated for the re-issue of an RFP in 2002. A FY 2001 RFP received no satisfactory responses. SBIR Transfer has been reflected in this program in the amount of $53,000.
FY 2002: RFP for low-head/low-power testing issued, but will be deferred.
FY 2003: Combine with the mini-hydro RFP below.

▪ **Biological and Environmental R&D . . . . . .**	1,409	1,000	1,500

Develop biological experiments and instrumentation development to establish biologically-based performance criteria and conduct environmental mitigation studies.

FY 2001: Biological criteria published covering the effects of pressure and dissolved gas supersaturation on turbine-passed fish. Initiated in stream flow and fish passage mitigation studies.
FY 2002: Conduct additional biological criteria studies of the effects of turbulence on turbine-passed fish.
FY 2003: Conduct additional biological criteria studies of the effects of strike and cavitation on turbine-passed fish. Complete fish passage and in stream flow mitigation studies.

▪ **Advanced Turbine Pilot-Scale Testing . . . . . .**	700	223	1,000

Complete pilot-scale proof-of-concept testing of the Alden Research Laoratory advanced turbine conceptual design to verify predicted biological and hydraulic performance. Performance will be measure by successful completion of proof-of-concept testing activities.

FY 2001: Completed Alden test facility construction and pilot-scale turbine fabrication.
FY 2002: Initiate pilot-scale biological and hydraulic testing of the Alden turbine design. Based on initial test results, begin planning for full-scale prototype testing.
FY 2003: Complete pilot-scale proof-of-concept testing of the Alden turbine design. The funding request for FY 2003 will provide for the initiating of accelerated full-scale prototype testing at an operation hydropower site. Successful testing will provide industry with a proven design for retrofit or new development and help attain the 2 percent mortality goal by 2010.

(dollars in thousands)

	FY 2001	FY 2002	FY 2003
▪ **Low Head/Low Power Mini-Hydro Research and Development**	80	100	900

Assessment of potential mini-hydro through both cost-shared biological field verification of mini-hydro turbine systems to determine biological and hydraulic performance resource assessment and analysis activities.

FY 2001: Initiated low-head/low-power/mini-hydro resource assessment activities.
FY 2002: Continue resource assessment activities.
FY 2003: Complete low-head/low-power/mini-hydro resource assessment. Issue RFP for innovative mini-hydro designs.

▪ **Power Creek Project - Alaska**	0	1,843	0

Funding to cover project development costs.

FY 2001: This project was funded out of the Renewable Indian Energy Program.
FY 2002: Project should go online and begin O&M.
FY 2003: Legislation states that FY 2002 is the last year for funding.

▪ **Gustavus (Falls Creek) Project -Alaska**	0	388	0

Funding to cover Congressionally directed project for construction of a hydroelectric facility.

Total, Hydropower	**4,936**	**5,018**	**7,489**

Explanation of Funding Changes

	FY 2003 vs. FY 2002 ($000)
Advanced Turbine Research and Development	
Large Turbine Testing	
▪ Increased to accommodate accelerated testing of several designs and different sites	+2,625
Biological and Environmental R&D	
▪ Increased to accommodate R&D projects that were either put on hold or slowed down due to decrease in budget from prior year	+500
Advanced Turbine Pilot-Scale Testing	
▪ Increased to begin field verification of a full size prototype	+777
Low-Head/Low Power Mini-Hydro Research and Development	
▪ Increased to provide for increased testing costs	+800
Power Creek Project - Alaska	
▪ Congress has designated FY 2002 as the last year of funding for this project. No further funding anticipated	-1,843
Gustavus Fall Creek Project - Alaska	
▪ No further funding anticipated for this Congressionally directed project	-388
Total Funding Change, Hydropower	**+2,471**

Solar Energy

Mission Supporting Goals and Objectives

The United States has the best solar resource of any industrialized Nation in the world. Solar energy is clean, abundant, distributed, safe, and secure. The Office of Solar Energy Technologies leads the Federal research to develop next-generation technologies to harness this domestic energy resource, thereby providing a cleaner and more sustainable environment, guarding against fuel price volatility, and greatly enhancing both national energy and homeland security - all important goals of the National Energy Policy. The solar program supports R&D on a tremendous range of applications including on-site electricity generation, thermal energy for space heating and hot water, and large-scale power production.

Photovoltaics (PV) - Research is focused on increasing domestic capacity by lowering the cost of delivered electricity and improving the efficiency of modules and systems. Fundamental research at universities will be increased to develop non-conventional, breakthrough technologies. Laboratory and university researchers will work with industry on large volume, low-cost manufacturing, such as increasing deposition rates to grow thin film layers faster, improving materials utilization to reduce cost, and improving in-line monitoring to increase yield and performance. Specific goals by 2006 are to:

- Reduce the direct manufacturing cost of PV modules by 30 percent from the current average cost of $2.50/Watt to $1.75/Watt;
- Identify and begin prototype development of two new leapfrog technologies that have the potential for dramatic cost reduction;
- Establish greater than 20-year lifetime for PV systems by improving the reliability of balance-of-system components and reducing recurring costs by 40 percent;
- Work with the U.S. PV industry to facilitate achievement of their roadmap goals of 1 gigawatt cumulative U.S. sales (export and domestic) by 2006, and 30 gigawatts by 2020.

Solar Buildings - Emphasis will be placed on development of the "Zero Energy Building" concept and reducing the cost of solar water heating by using light-weight polymer materials that can replace the heavy copper and glass materials used in today's collectors. Specific goals are to:

- Integrate solar technology and energy efficient buildings resulting in an annual energy bill of less than $600 for an average size home by 2004, and "net-zero" by 2010;
- Complete R&D on new polymers and manufacturing processes to reduce the cost of solar water heating from today's 8 cents/kWh to 4 cents/kWh by 2004.

Concentrating Solar Power (CSP) - CSP systems currently offer the least expensive source of solar electricity (12-14 cents/kWh) with systems ranging in size from several kW distributed systems to multi-MW power plants. Several years ago the Department asked the National Research Council to conduct a review of its renewable energy programs. The Council findings cast doubt over the potential of large-scale solar plants, like troughs and towers, to achieve the technology advances required to penetrate broad domestic energy markets. Based on this report, the Department is focusing its solar R&D on priority distributed and building applications.

Program Strategic Performance Goal

ER2-7: Solar Technologies
Solar Technologies R&D will reduce the price paid for a photovoltaic system by the end user (including operation and maintenance costs) from a median value of $6.25 per Watt in 2000 to $4.50 per Watt in 2006 (equivalent to reducing from $0.25 to $0.18 per kilowatt hour).

Performance Indicator: Dollar per Watt paid by the end user, trendable from $9 per Watt in 2000.

Annual Performance Results and Targets

FY 2001 Results	FY 2002 Target	FY 2003 Proposed Target
■ *Developed a 14 percent efficient stable prototype thin-film photovoltaic module.*	■ *Reduce manufacturing cost of PV modules to $2.25 per Watt (equivalent to $0.20 to $0.30 per kWh price of electricity from an installed solar system)*	■ *Reduce manufacturing cost of PV modules to $2.10 per Watt (equivalent to $0.19 to $0.28 per kWh price of electricity from an installed solar system)*

Funding Schedule

(dollars in thousands)

	FY 2001	FY 2002	FY 2003	$ Change	% Change
Concentrating Solar Power					
Distributed Power System Development	6,275	5,224	1,932	-3,292	-63.0%
Dispatchable Power System Development	3,613	3,716	0	-3,716	-100.0%
Advanced Component Research	3,677	3,386	0	-3,386	-100.0%
Southwest Resource Opportunity	0	489	0	-489	-100.0%
Navajo Electrification Project	0	367	0	-367	-100.0%
Total, Concentrating Solar Power	13,565	13,182	1,932	-11,250	-85.3%
Photovoltaic Energy Systems					
Fundamental Research	17,560	21,700	30,400	8,700	40.1%
Advanced Materials and Devices	37,000	26,900	29,793	2,893	10.8%
Technology Development	19,700	17,555	13,500	-4,055	-23.1%
Southwest Resource Opportunity	0	3,083	0	-3,083	-100.0%
Navajo Electrification Project	0	2,313	0	-2,313	-100.0%
Total, Photovoltaic Energy Systems	74,260	71,551	73,693	2,142	3.0%
Solar Building Technology Research					
Solar Water and Space Heating	3,069	3,000	4,000	1,000	33.3%
Zero Energy Buildings	800	1,404	8,000	6,596	469.8%

(dollars in thousands)

	FY 2001	FY 2002	FY 2003	$ Change	% Change
Southwest Resource Opportunity	0	174	0	-174	-100.0%
Navajo Electrification Project	0	131	0	-131	-100.0%
Total, Solar Building Technology Research . .	3,869	4,709	12,000	7,291	154.8%
Total, Solar Energy	91,694[a]	89,442	87,625	-1,817	-2.0%

Detailed Program Justification

(dollars in thousands)

	FY 2001	FY 2002	FY 2003
Concentrating Solar Power			
■ **Distributed Power System Development**	6,275	5,224	1,932

Solar dish/engine systems range in size from 9kW for remote power applications (e.g., water pumping) to 25kW for grid connected applications (e.g., utility end-of-line). Because these systems are efficient (29.4 percent solar-to-electric conversion) and can be hybridized with other fuels (e.g., natural gas, hydrogen) they show great potential as a cost-competitive clean source of distributed power. With seven units currently under test and evaluation at utility, industry, and university sites in the Southwest, system reliability has improved from 10 to 100 hours between servicing over the past year. A similar (achievable) step increase in reliability will be required to ready the systems for distributed power markets.

FY 2001: Two 25kW grid-connected solar dish/Stirling systems were installed at the University of Nevada Las Vegas and a 2nd generation 9kW dish/engine was installed at the National Solar Thermal Test Facility (NSTTF) in Albuquerque, NM. The remote system was modified to operate off-grid for water pumping applications. Students at the University of Nevada Las Vegas and Native Americans in New Mexico are being trained to operate and maintain these systems.

FY 2002: As directed by Congress, the Concentrating Solar Power (CSP) program is issuing an RFP for a 1.0 MW Nevada Solar Dish Project. These installations, which are to occur over a 2 to 3-year period, will allow industry to reach the required reliability targets for market entry. A 9kW remote dish will be installed on an Indian reservation and used to pump water.

FY 2003: The program will complete evaluation of the 25 kW dish systems at the University of Nevada and terminate all remaining activities.

■ **Dispatchable Power System Development**	3,613	3,716	0

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

[a]FY 2001 has been reduced by $987,000 to reflect SBIR/STTR Transfer.

(dollars in thousands)

FY 2001	FY 2002	FY 2003

years. Over this time the cost of these systems has decreased by a factor of 3, and at 12-14 cents/kWh they are currently the least expensive source of solar electricity. Recent technology advancements such as molten-salt thermal storage, low-cost receiver tubes, and concentrators has revitalized the CSP industry and placed them in position to play a major role in near-term green power opportunities, both domestically and overseas, as costs are projected to drop into the 6-8 cents/kWh range.

FY 2001: A new solar trough receiver was identified as being able to reduce the overall system cost by 20 percent. Modular trough and advanced concentrator designs were completed under the USA Trough Initiative. Two near-term trough thermal storage systems were demonstrated. SunLab provided technical support to U.S. industry in evaluating next-generation components. SBIR Transfer has been reflected in this program in the amount of $145,000.

FY 2002: Both near-term and long-term storage technologies continue development. Advanced receiver and concentrator components will be tested at the operating trough plants in California. Technical support will be provided to U.S. industry for evaluating next-generation components.

FY 2003: All activities will be discontinued in order to focus on higher priority subprogram efforts.

- **Advanced Component Research** 3,677 3,386 0

Additional technology advances in CSP technologies have been identified that may result in system costs as low as 4cents/kWh and simpler system designs that will expand remote power possibilities with significant reductions in operation and maintenance costs. Technologies such as concentrating photovoltaics, solar-hydrogen hybrids, and higher-temperature CSP systems show great potential as power and even fuel sources of the future.

FY 2001: SunLab performed failure analysis on several optical materials in support of dish/engine systems. Industry continued development of ultra-thin glass. Two studies were conducted by non-advocates (RDI Consulting and AD Little) to provide objective analyses of CSP's market potential. Both studies concluded that CSP technologies could play a significant role in the deregulated marketplace of the 21st Century. A 2kW solar dish with a photovoltaic solid state engine was built and installed at the National Renewable Energy Laboratory (NREL). Several universities (Drexel and Cleveland State) completed Phase I evaluations of advanced converters for small dish systems.

FY 2002: A program peer review led by MIT was conducted in November 2001. The review affirmed the results of the two earlier studies, concluding that CSP technology offers great promise to convert the abundant solar resource of the Southwestern U.S. into low-cost electricity. At its request, the program will deliver a report to Congress detailing a plan for how 1000 MW of trough, power tower, and dish systems could be installed within the next five years. The National Solar Thermal Test Facility (NSTTF) is conducting additional advanced trough component testing. R&D for concentrating photovoltaics and free-piston Stirling systems are continuing as the university projects enter their second year and several industry partners begin testing prototype hardware.

(dollars in thousands)

	FY 2001	FY 2002	FY 2003
FY 2003: All activities will be discontinued in order to focus on higher priority subprogram efforts.			
■ **Southwest Resource Opportunity**	0	489	0
FY 2002: Congress directed funding to provide technical analysis, technical assistance and harmonization of multi-program activities that address the resource opportunities in electric power needs of the southwestern United States. Funding to support this directive is being derived proportionately from the three subprograms as they fall outside of the scope of Solar Energy Subprogram.			
■ **Navajo Electrification Project**	0	367	0
FY 2002: Congress directed funding to establish a 5-year program to assist the Navajo Nation to provide electric power to the estimated 18,000 occupied structures on the Navajo Nation that lack electric power. Funding to support this directive is being derived proportionately from the three subprograms as they fall outside of the scope of Solar Energy Subprogram.			
Total, Concentrating Solar Power	**13,565**	**13,182**	**1,932**
Photovoltaic Energy Systems			
■ **Fundamental Research**	17,560	21,700	30,400

Fundamental research is key to continued advancement of photovoltaic technology necessary to meet long-term goals of 6 cents/kWh electricity. Industry and university researchers work in partnership with national laboratories to improve the efficiency of cell materials and devices by investigating their fundamental properties and operating mechanisms. This teamed research works to identify efficiency limiting defects in cell materials and analyze their electrical and optical properties.

Fundamental research also investigates innovative new ideas and next-generation technologies. Two solicitations targeting the university community have recently been issued, *Beyond the Horizon* and *Future Generation PV Technologies*, to generate new ideas and conduct the exploratory research necessary to determine their potential. This activity opens the door to several new, non-conventional concepts that could dramatically improve cost effectiveness. The High Performance Advanced Research project supports research to substantially increase the efficiency of two key technologies: large-area, monolithically interconnected thin films and multi-junction concentrating cells. Fundamental research aimed at major innovations is required to essentially double the conversion efficiency of thin films from their current 8-10 percent to 15-20 percent, and to increase III-V-based multi-junction cells from 30 to 40 percent under 500X concentration. In-house laboratory expertise as well as competitive solicitations to universities and industry is used to conduct innovative research on thin films and provide insights into multi-junction concepts. Both avenues will yield dramatically reduced $/watt values for terrestrial photovoltaics.

(dollars in thousands)

FY 2001	FY 2002	FY 2003

FY 2001: In response to the Beyond the Horizon solicitation for new ideas, selected and negotiated 16 subcontracts with 11 universities and 5 companies to explore non-conventional solar electric technologies. This activity opens the door to several "blue sky" concepts that, with the excellent work of some of our nation's best university and industry researchers, could dramatically improve the photovoltaic effect. SBIR Transfer has been reflected in this program in the amount of $800,000.

FY 2002: Continue to identify efficiency-limiting defects to advance the fundamental understanding of both PV materials and devices using state-of-the-art characterization techniques. Only the most critical research in support of industry will be conducted in FY 2002. Continue funding for university basic research and analysis that improves the understanding of fundamental properties of novel materials and cell devices. Continue full funding for the High Performance Initiative to reach goals of doubling efficiencies for thin film modules and developing a 40 percent concentrating cell device by 2010. In partnership with universities and industry laboratories, continue research on materials and multi-junction concepts that can lead to higher efficiency thin film technologies and III-V multi-junctions.

FY 2003: In basic research, begin a new PV science initiative with universities to develop next-generation PV materials and devices that have the potential for dramatic cost reductions. This activity will continue funding the most promising university projects under the Beyond the Horizon and Future Generation projects to accelerate their development. A new PV science initiative will be initiated to more fully develop new ideas and concepts that can replace conventional technologies with a new generation of lower cost, easier to manufacture technologies. In Basic Research, begin new effort to develop high performance concentrating PV/thermal hybrids that provide electricity and high-temperature heat.

- **Advanced Materials and Devices** 37,000 26,900 29,793

The Advanced materials and Devices activity has three sub-activities: the Thin Film Partnership program; Crystalline Silicon R&D and Module Reliability; and Advanced Manufacturing R&D. The Thin Film Partnership Program is a government/industry/university partnership that uses 3-year cost-shared contracts to develop thin film PV technologies. Development of thin films is a major thrust of the program and receives strong industry support because most scientists agree that thin film technologies have the best chance for attaining the program's long-term goal of 6 percent/kWh.

Crystalline silicon (c-Si) is the workhorse of the industry comprising over 90 percent of the modules sold in the market today. Most of the commercial modules are 12 percent to 14 percent efficient and cost $5 to $6 per Watt. Goals are to use a small amount of program funding to leverage continued industry research to improve efficiencies from 15 percent to 18 percent and lower cost to $3.50 per Watt by 2006. Module reliability is key to attaining program goals of PV systems that can last 30 years in the field. The program has made significant progress in this area. However, the reliability of thin film modules is poor and improvements need to be made. Research will focus on analyzing degradation mechanisms for thin film modules that have been in the field for several

years as well as conducting accelerated lifetime tests.

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

FY 2001: All prior-year contracts were concluded and a new competitive solicitation was issued for new 3-year cost-shared contracts with industry to further develop thin film technology. In crystalline silicon R&D, industry and university research continued to develop innovative silicon growth methods with improved throughput, conversion efficiency and lower energy and materials cost than current methods. In Advanced Manufacturing R&D, the PVMaT project was successfully completed. All 3-year cost-shared contracts with industry awarded in 1998 to accelerate cost reductions and produce higher performance modules were concluded.

FY 2002: Begin first year of new thin film partnership 3-year cost-shared contracts with industry to develop thin film technologies. Aggressive goals have been established to transition at least two of the technologies from pilot plant status to multi-megaWatt production. Performance of ongoing research is measured by demonstrating a 19 percent efficient small-area thin film cell in the laboratory and 14 percent large area module. Due to the maturity of silicon technology, funding was reduced to support only the most innovative research on silicon crystal growth methods with improved throughput, conversion efficiency, and lower energy and materials cost as compared to current methods. Likewise, only the highest priority module reliability research is supported. In advanced manufacturing R&D, a new solicitation was issued in 2001 to develop in-situ process diagnostics and intelligent processing needed for integrated module manufacturing scale-up. All industry contracts will have 50 percent minimum cost sharing. The Advanced Manufacturing R&D activity will focus on high throughput, large area thin films and next generation high efficiency thin wafer silicon technologies not addressed in PVMaT.

FY 2003: In the thin film partnership program, provide full funding for most promising thin film technologies and continue industry cost-shared contracts on technologies making the greatest achievements. Performance will be measured by completing the transition of at least one thin film technology from prototype production to multi-megawatt scale production. Support the most innovative research on silicon crystal growth methods with improved throughput, conversion efficiency, and lower energy and materials cost as compared to current methods. Support the highest priority module reliability research. In Advanced Manufacturing R&D, begin second year

of three-year cost-shared industry contracts to develop in-line diagnostics and intelligent processing needed for manufacturing scale-up, increased yield, higher efficiencies and reduced cost. Performance will be measured by achieving module manufacturing processes capable of $2.15 per Watt direct manufacturing cost with 50-megawatt production capacity.

- **Technology Development** 19,700 17,555 13,500

The Technology Development activity involves three sub-activities: systems engineering and reliability; building integrated PV R&D; and outreach and analysis, which includes the Million Solar Roofs Initiative. Systems and reliability research focuses on the critical need to improve reliability of the entire PV system, including balance-of-system components such as inverters and battery charge controllers. This work is led by Sandia National Laboratories and is implemented in close partnership with industry and the Southeast and Southwest regional experiment stations. Emphasis is placed on four technical objectives: 1) reducing life-cycle costs; 2) improving reliability of systems and system components; 3) increasing and assuring the performance of fielded systems; and 4) removing barriers to the use of the technology. To help remove barriers, the engineering and reliability activity supports development of standards and codes, and procedures for certifying performance of commercial systems.

Building integrated photovoltaics (BIPV) is an exciting and rapidly growing solar application in which solar panels 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, the industry focus is now on 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.

Outreach and analysis activities are necessary for a national R&D program to remain viable in a rapidly changing energy sector. Activities include testing, verification and deployment activities for grid-connected applications and exploring commercialization options for the million solar roofs activity.

FY 2001: A viable system engineering and reliability program was maintained at Sandia and the regional experiment stations. A new system reliability plan was developed in concert with industry which includes an development of an expanded database for collection of nationwide reliability, sustainability and life-cycle cost data. The plan also identified opportunities for greatly accelerating the development of a new universal inverter that has a mean-time-to-first-failure of ten years with a cost less than 65 cents/Watt. Completed all remaining PV:BONUS cost-shared contracts with industry that resulted in five new BIPV products. Completed all TEAM-UP projects. Distributed million solar roofs funding to DOE regional offices to provide technical assistance to the partnerships at the State and local level. Provided general technical training to utilities, industry groups, financial institutions and government entities.

FY 2002: Maintain viable system engineering and reliability program at Sandia and the Southeast

(dollars in thousands)

	FY 2001	FY 2002	FY 2003

and Southwest regional experiment stations. Complete standard reliability database and conduct analysis to identify failure mechanisms impeding the 30-year lifetime goal and focus design improvements where they are needed most. Publish inverter status report that describes R&D requirements for a high-performance, long life inverter. The BIPV R&D activity will work closely with the Solar Buildings sub-program to develop the net-zero-energy building (ZEB) concept. Continue outreach activities to energy providers and assess deployment needs. Continue data collection and analysis from deployed systems. Increase funding for world-class, peer reviewed analysis studies aimed at informing program decisions. Continue to distribute Million Solar Roofs funding to DOE regional offices to provide technical assistance to the partnerships at the state and local level. Begin transfer of Million Solar Roofs activities to private sector.

FY 2003: Reduce systems engineering and reliability research to only the most critical needs. Continue work through regional experiment stations to improve reliability of distributed grid tied systems, especially in the buildings sector. Continue BIPV partnership with industry to more fully integrate PV into buildings. Address R&D needs of zero-energy homes concept. In outreach and analysis, begin new phase of "Solar Solutions Initiative" with Energy Service Providers partners - focusing on solving local grid related reliability issues with solar. Continue core technology analysis and outreach activities. Million Solar Roofs activity completed and transferred to private sector.

■ **Southwest Resource Opportunity**	0	3,083	0

FY 2002: Congress directed funding to provide technical analysis, technical assistance and harmonization of multi-program activities that address the resource opportunities in electric power needs of the southwestern United States. Funding to support this directive is being derived proportionately from the three subprograms as they fall outside of the scope of Solar Energy Subprogram.

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

FY 2002: Congress directed funding to establish a 5-year program to assist the Navajo Nation to provide electric power to the estimated 18,000 occupied structures on the Navajo Nation that lack electric power. Funding to support this directive is being derived proportionately from the three subprograms as they fall outside of the scope of Solar Energy Subprogram.

Total, Photovoltaic Energy Systems	**74,260**	**71,551**	**73,693**

Solar Building Technology Research

■ **Solar Water and Space Heating**	3,069	3,000	4,000

The Solar Water and Space Heating research activity develops solar technologies that provide hot water and space heating for residential and commercial buildings, in collaboration with industry partners. The research emphasizes low-cost, polymer-based solar water heaters to cut the cost of solar water heating by 50 percent to an equivalent of 4 cents per kilowatt hour by 2004. The initial

(dollars in thousands)

emphasis is for systems designed for mild climates, gradually shifting to systems for hard-freeze climates. These lower-cost heaters are expected to expand the market by 200 percent. The same polymer-based technology developed for low-cost water heaters can be developed to provide space heating.

FY 2001: Completed design of polymer-based solar water heaters in conjunction with two manufacturers. Continued materials durability research is designed to further develop advanced low-cost polymers and glazing that are able to withstand ultraviolet (UV) and temperature degradation. SBIR Transfer has been reflected in this program in the amount of $42,000.

FY 2002: Build and field test full-scale, polymer-based solar water heaters in conjunction with industry partners. Continue accelerated testing of glazing, durability testing of polymers, and measurement of scale in heat exchanger tubes. Assist industry in developing manufacturing processes amenable to the new polymer and existing materials used in solar water heaters.

FY 2003: Based on field tests, redesign and modify the low-cost solar water heaters as required. In collaboration with industrial partners the redesign will be evaluated by their potential for reducing the cost of energy to $.04/kWh by 2004. Initiate development of a low-cost solar water heater capable of operation in cold climates with potential sales of 100,000 units per year by 2010. Using the solar collector developed for low-cost water heaters, initiate development of a low-cost active solar system for space heating. Develop and test polymer-based "balance-of-system" components (storage tanks, heat exchangers, pumps) for solar thermal systems.

■ **Zero-Energy Building Design**	800	1,404	8,000

Zero Energy Buildings (ZEB), both residential and low-rise commercial, will be designed to optimally combine very energy-efficient building envelopes, appliances, lighting, advanced controls, and heating/cooling systems with solar water heating and solar electric systems to eliminate the need for offsite energy on an annual basis. Initially, the program will focus on marketable homes that are designed, constructed and monitored in conjunction with leading homebuilders, to achieve an annual energy bill of $600 for the average size home by 2004. R&D will be needed to achieve a true net-zero energy goal based on the initial evaluation of home types and recommendations by homeowners, builders, architects and engineers. Utilizing solar energy at the point of use will reduce the homes' summer peak demand by over 90 percent and achieve a zero energy bill by the year 2010. All activities under this subprogram are conducted in collaboration with the Office of Building Technologies.

FY 2001: Initiated system analysis of the energy efficiency and solar energy requirements for a first generation zero energy home. Selected four multi-disciplinary ZEB teams to design, build, and monitor ZEB homes designed for major subdivisions. These teams include several of the largest homebuilders in the Nation. Developed a proof-of-concept hybrid solar lighting collector and concentrator to bring sunlight into the interior of low-rise commercial buildings with fiber optics.

(dollars in thousands)

FY 2001	FY 2002	FY 2003

FY 2002: Complete prototype designs and start construction of the initial first generation ZEB homes designed to cut homeowner utility bills by 50 percent. Conduct market analysis to determine homeowner requirements for ZEB homes. Develop analytical tools to optimize the mix of energy efficiency and solar energy technologies. Evaluate and then modify the proof-of-concept hybrid solar light prototype into a full-scale system.

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

- **Southwest Resource Opportunity** 0 174 0

  FY 2002: Congress directed funding to provide technical analysis, technical assistance and harmonization of multi-program activities that address the resource opportunities in electric power needs of the southwestern United States. Funding to support this directive is being derived proportionately from the three subprograms as they fall outside of the scope of Solar Energy Subprogram.

- **Navajo Electrification Project** 0 131 0

  Congress directed funding to establish a 5-year program to assist the Navajo Nation to provide electric power to the estimated 18,000 occupied structures on the Navajo Nation that lack electric power. Funding to support this directive is being derived proportionately from the three subprograms as they fall outside of the scope of Solar Energy Subprogram.

Total, Solar Building Technology Research	**3,869**	**4,709**	**12,000**
Total, Solar Energy	**91,694**	**89,442**	**87,625**

Explanation of Funding Changes

	FY 2003 vs. FY 2002 ($000)
Concentrating Solar Power	
Distributed Power System Development	
■ The program will complete evaluation of the 25 kW dish systems at UNLV and terminate all remaining activities to focus Solar Program funding on higher priority solar R&D opportunities.	-3,292
Dispatchable Power System Development	
■ All activities will be discontinued in order to focus on higher priority Solar Program efforts.	-3,716
Advanced Component Research	
■ All activities will be discontinued in order to focus on higher priority Solar Program efforts.	-3,386
Southwest Resource Opportunity and the Navajo Electrification Project	
■ These are FY 2002 Congressionally-directed activities that are not requested as part of the Solar Program budget in FY 2003	-856
Total, Concentrating Solar Power	**-11,250**
Photovoltaic Energy Systems	
Fundamental Research	
■ Measurement and Characterization - Enhance world-class laboratory capabilities and upgrade facilities at universities to support basic research science initiative. Basic Research/University Programs - Begin new PV advanced science initiative with universities for next generation PV technologies.	+8,700
Advanced Materials and Devices	
■ Thin Film Partnership - Increase funding for the most promising thin film industry/university/laboratory teamed research.	+2,893
Technology Development	
■ Systems Engineering and Reliability - decrease funding for reliability R&D. Million Solar Roofs - Decrease funding to close-out activity and transfer to private sector.	-4,055
Southwest Resource Opportunity and the Navajo Electrification Project	
■ These are FY 2002 Congressionally-directed activities that are not requested as part of the Solar Program budget in FY 2003	-5,396
Total, Photovoltaic Energy Systems	**+2,142**

	FY 2003 vs. FY 2002 ($000)
Solar Building Technology Research	
Solar Water and Space Heating	
■ Increase R&D on low-cost polymers in colder climates.	+1,000
Zero Energy Buildings	
■ Increase funding for Zero-Energy Buildings R&D	+6,596
Southwest Resource Opportunity and the Navajo Electrification Project	
■ These are FY 2002 Congressionally-directed activities that are not requested as part of the Solar Program budget in FY 2003	-305
Total, Solar Building Technology Research	**+7,291**
Total Funding Change, Solar Energy	**-1,817**

Wind Energy Systems

Mission Supporting Goals and Objectives

The Wind Energy Systems Program has a strong history of success in delivering results for the R&D investment, with the cost of electricity generation from Wind reduced by a factor of 20+ over the past 20 years, while becoming the fastest growing energy supply source in the United States and worldwide. A key element of this success is attributable to effective cost-shared public-private partnerships with industry and a wide range of stakeholder organizations. The current generation of wind turbines, however, is limited to areas with high (class 5&6) wind speeds to be economic, which sharply restricts their use. The development of wind turbines that can operate cost competitively in areas with moderate (class 3&4) wind speeds will increase the wind resource that can be tapped by a factor of 20, and greatly broaden the areas of application. Low wind speed technology development is recognized in the National Energy Policy (NEP) as an opportunity for significantly expanding wind energy use, is supported by FY 2002 Congressional language, and is a Departmental Program Strategic Performance Goal (PSPG).

For large wind energy systems with rated turbine capacity over 100 kilowatts, the program's R&D activities focus on supporting U.S. industry efforts to reduce life cycle cost of energy to levels that will allow wind to compete in bulk electric power markets. The program also conducts R&D focusing on smaller wind energy systems for serving a broad range of distributed energy needs. Singular cost performance targets are not appropriate for distributed wind systems, which instead require an approach based on relative improvement within scale, application, and market segments. Current program goals include:

- Reduce cost of energy from large wind systems to 3 cents per kilowatt hour:
  - in Class 6 wind resources by 2004 (2002 baseline - 4 cents);
  - in Class 4 wind resources by 2010 (2002 baseline - 5.5 cents), PSPG ER 3-6.

- Reduce cost of energy from distributed wind systems to achieve same cost effectiveness in Class 3 wind resources by 2007, against Class 5 baseline costs in 2002 ranging from 10 to 15 cents per kilowatthour.

The Program leads research, testing, and field verification through laboratory and public-private partnerships to achieve these goals, which responds to the NEP recommendation to develop next generation technologies. The program also conducts activities with a broad range of stakeholders to overcome barriers to wind energy use. Based on independently peer-reviewed national energy modeling projections, achievement of the program's large wind systems cost goals would increase U.S. installed wind energy capacity by 11,000 megawatts in 2010, and by 45,000 megawatts in 2020, relative to projections of capacity growth without Federal investment in low wind speed technology. These projections assume no significant change from 2002 in policy relating to U.S. wind power development.

Program Strategic Performance Goal

ER2-6: Wind Energy
Wind Energy R&D activities will provide the technologies to reduce the cost of wind powered electricity generation in Class 4 wind areas (13 mph annual average) from 5.5 cents per kilowatt-hour in 2002 to 3 cents per kilowatt-hour by 2010.

Performance Indicator: Cost of wind powered electricity generation. Project 3 cents per kilowatt-hour in Class 4 winds (13 mph annual average) by 2010 compared with 5.5 cents in 2002.

Annual Performance Results and Targets

FY 2001 Results	FY 2002 Target	FY 2003 Proposed Target
■ *Advanced wind hybrid control system technology developed jointly with USDA Agricultural Research Center will be commercially available.*	■ *Initiate development of an improved resolution national wind resource atlas, focusing first on new maps for high priority regions for commercial projects.*	■ *Complete low wind speed turbine conceptual design studies, and fabricate and begin testing advanced wind turbine components optimized for low wind speed application initiated under industry partnership projects.*

Funding Schedule

(dollars in thousands)

	FY 2001	FY 2002	FY 2003	$ Change	% Change
Applied Research	14,579	13,950	10,800	-3,150	-22.6%
Turbine Research	12,428	10,498	18,900	+8,402	80.0%
Cooperative Research and Testing	12,125	14,150	14,300	150	1.0%
Total, Wind Energy Systems	39,132[1]	38,598	44,000	+5,402	14.0%

[1] FY 2001 has been reduced by $421,000 to reflect SBIR Transfer.

Detailed Program Justification

(dollars in thousands)

	FY 2001	FY 2002	FY 2003
Applied Research	**14,579**	**13,950**	**10,800**
■ **Core Research**	8,459	9,000	9,000

Continue research efforts in wind turbine aerodynamics, structures, materials, advanced components, and wind characteristics to support development of new or improved tools for advanced wind energy system design and applications. Core research also includes assistance to industry for mitigating avian issues and Small Business Innovation Research (SBIR) support. Core research efforts are focused on supporting development of low wind speed turbine technology. Performance in FY 2003 will be measured for core research activities using analytically-established targets linking contributions from each activity to meeting low wind speed technology program goals. SBIR Transfer has been reflected in this program in the amount of $421,000 in FY 2001.

■ **Wind Partnerships for Advanced Component Technologies (WindPACT)**	3,840	2,650	0

No activities planned. (Ongoing industry component partnership development projects transferred to Low Wind Speed Technology (LWST) project.)

■ **University Research**	790	1,000	1,000

Continue university projects competitively selected in FY 2002 for advanced wind turbine technology and systems research.

■ **Distributed Wind Applications** (formerly Wind Hybrid Systems)	1,060	1,100	800

Conduct monitoring and analysis of wind/diesel systems in Alaska, and systems engineering for other distributed small wind applications serving end user or stand-alone power needs, including advanced power electronics system design, development, and evaluation. Complete targeted research activities to address small wind turbine furling and acoustic issues. Funding allocated in FY 2002 supports the following project directed by Congress: Wind Generation Facility for St. Paul Island and Unalaska, Alaska. (FY 2001 $0, FY 2002 $234,200, FY 2003 $0).

■ **Avian Research**	430	200	0

No activities planned. (Activities for assisting industry with avian mitigation measures transferred to Core Research.)

(dollars in thousands)

	FY 2001	FY 2002	FY 2003
Turbine Research	**12,428**	**10,498**	**18,900**
■ **Next Generation Turbine**	5,115	3,340	0

No activities planned. (Final prototype turbine development stage of Next Generation Turbine Project modified to target low wind speed technology objective, and transferred to Low Wind Speed Technology activity.)

■ **Low Wind Speed Technology** 200 1,130 12,000

Cost effective wind technology for Class 4 wind resource areas will expand the economically viable land area for harnessing wind energy by a factor of more than twenty, while also relieving power transmission constraints by improving the proximity of usable wind resources to end users. Based on extensive stakeholder consultation, the Low Wind Speed Technology (LWST) project will support public-private partnerships for multiple pathways to achieve the objective of 3 cents per kilowatt-hour in Class 4 winds by 2010. 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.

Activities in the LWST portfolio include three major elements: 1) Fabricate and begin field testing two near-term LWST full turbine systems meeting a milestone of 4.5 cents per kilowatt-hour in Class 4 winds by 2005. The final prototype development stage of ongoing Next Generation Turbine partnerships will be modified to target this milestone. 2) Fabricate and begin testing innovative wind turbine components initiated under WindPACT industry partnerships, including drivetrain, rotor, and blade projects optimized for low wind speed. 3) Conduct conceptual design, component development, and full system design projects competitively selected in FY 2002 under the first LWST solicitation, targeting the Program Strategic Performance Goal of 3 cents per kilowatt-hour in Class 4 winds by 2010. The LWST portfolio and related Applied Research activities will be continuously coordinated to facilitate technology transfer and transition conceptual design and component projects into full system development. This activity is a key investment to fulfilling NEP recommendations for developing next generation technology and increasing use of renewable energy.

■ **Distributed Wind Technology** (formerly Small Wind Turbine) 1,000 1,500 2,000

Continue support for field testing final prototypes of advanced small wind turbines to confirm performance and reliability. Complete final project reports. Conduct Distributed Wind Technology (DWT) project through competitively-selected industry partnerships to achieve Class 3 (12 mph annual average measured at 10 meters) wind resource cost effectiveness for smaller wind systems used in distributed applications. The DWT project is a competitive, performance-based effort patterned after the LWST project. Performance will be measured by timely completion of project milestones established to support achievement of the program's 2007 goal for distributed wind systems.

(dollars in thousands)

	FY 2001	FY 2002	FY 2003
■ **Cold Weather Turbine**	200	180	0

No activities planned. (Support for ongoing field testing of prototype turbines at the National Wind Technology Center and in Alaska transferred to Supporting Research and Testing).

■ **Supporting Research and Testing**	5,913	4,348	4,900

Provide research, design review, analysis, and testing support to industry wind turbine research partnership efforts using wind program expertise, technology developments, and capabilities. This activity ensures program core research activities are closely coordinated with industry projects, supports project testing requirements using world-class testing facilities at the National Wind Technology Center, and provides close technical oversight to monitor and direct project performance.

Cooperative Research and Testing	**12,125**	**14,150**	**14,300**
■ **Wind Powering America**	3,315	3,100	3,100

Conduct national effort to accelerate the use of wind energy in the United States through regionally-based technical assistance and coordinated outreach activities, in partnership with Federal, State, and local organizations, utilities, rural landowners, Native American groups, and the wind industry. This work supports the NEP recommendation to develop educational programs that communicate the benefits of wind energy.

■ **Industry Support**	2,390	3,000	3,000

Assist industry efforts in resolving near-term technical and institutional issues, and develop targeted products for wind energy communications and outreach. Support cooperative activities with states and other stakeholder organizations to expand wind resource information and address technical and institutional barriers to wind power development.

■ **Regional Field Verification**	2,100	4,000	4,000

Complete installation of field verification projects initiated in FY 2002, and provide technical, data collection, analysis, and reporting support to cost-sharing project hosts. Issue competitive solicitation for field verification projects targeting machines emerging from Next Generation Turbine and Small Wind Turbine projects. The following wind projects were directed by Congress to be included in this program: Kotzebue Wind Project (FY 2001 $1,000,000, FY 2002 $936,700, FY 2003 $0), Turtle Mountain Community College (FY 2001 $100,000, FY 2002 $468,400, FY 2003 $0), Vermont- Washington Electric Cooperative (FY 2001 $0, FY 2002 $936,700, FY 2003 $0), Vermont-Department of Public Service (FY 2001 $0, FY 2002 $468,400, FY 2003 $0), and Toledo Harbor Lighthouse (FY 2001 $0, FY 2002 $468,400, FY 2003 $0).

(dollars in thousands)

	FY 2001	FY 2002	FY 2003
■ **Certification**	700	350	0
No activities planned. (Laboratory testing and design review services in support of U.S. wind turbine certification agent transferred to National Wind Technology Center Operations.)			
■ **Wind Integration (Utility Analysis)**	2,450	2,400	2,400
Continue focus on analytical support to facilitate integration of wind energy into power delivery systems, including targeted studies of electric power transmission system barriers and assessment of ancillary service requirements for wind energy.			
■ **National Wind Technology Center Operations**	1,170	1,300	1,800
Operate the National Wind Technology Center facilities at the National Renewable Energy Laboratory to provide testing and certification support to industry.			
Total, Wind Energy Systems	**39,132**	**38,598**	**44,000**

Explanation of Funding Changes

	FY 2003 vs. FY 2002 ($000)
Applied Research	
■ Wind Partnerships for Advanced Component Technologies – Decrease reflects transfer of ongoing component development projects to Low Wind Speed Technology (LWST) project.	-2,650
■ Small Turbine Applications – Decrease reflects no further support for FY 2002 Congressionally directed project, and reduced needs for support of wind/diesel system monitoring activities	-300
■ Avian Research – Decrease reflects transfer of activities to Core Research.	-200
Total, Applied Research	**-3,150**
Turbine Research	
■ Next Generation Turbine – Decrease reflects transfer of final prototype development to Low Wind Speed Technology project.	-3,340
■ Low Wind Speed Technology – Increase supports high priority activity for responding to National Energy Policy, Departmental Program Strategic Performance Goal, and Congressional support.	+10,870

	FY 2003 vs. FY 2002 ($000)
■ Distributed Wind Technology – Increase supports completion of testing for Small Wind Turbine project prototypes, and initiation of Distributed Wind Technology project to support low wind speed application of small wind turbines for distributed applications.	+500
■ Cold Weather Turbine – Decrease reflects completion of development activities in FY 2002.	-180
■ Supporting Research and Testing – Increase reflects funding requirements for high priority low wind speed technology development activities.	+552
Total, Turbine Research	**+8,402**
Cooperative Research and Testing	
■ Certification – Decrease reflects transfer of activities to National Wind Technology Center Operations.	-350
■ National Wind Technology Center Operations – Increase due to transfer of certification activities and increased testing support for industry.	+500
Total, Cooperative Research and Testing	**+150**
Total Funding Change, Wind Energy Systems	**+5,402**

Electric Energy Systems and Storage

Mission Supporting Goals and Objectives

High Temperature Superconducting R&D

The High Temperature Superconductivity (HTS) program works in partnership with industry to conduct the pre-commercial R&D required for U.S. companies to commercialize HTS electric power applications. The program has two mission supporting goals: 1) develop an alternative to conventional electric wire with 100 times the capacity and no resistance; and 2) develop advanced electrical equipment using these wires that is typically half the size of conventional alternatives and has only half the energy losses. The HTS program goals focus on development of the next generation of superconducting wire that will be fundamental to all electrical systems and on the HTS electrical system technology to utilize superconductivity to increase capacity, reliability, and efficiency.

In response to the National Energy Policy recommendation to expand research and development on transmission reliability and superconductivity, the HTS program objectives focus on electrical grid needs, for example, developing pre-commercial superconducting power cables by 2006 that relieve urban bottlenecks, and developing superconducting high-capacity transformers that improve electricity distribution by 2007. Several aggressive, industry-led public-private partnership projects are designing, building, and testing advanced technologies such as generators, transformers, motors, transmission cables, and flywheel energy systems in the Superconductivity Partnership Initiative subprogram. The industry-led, Second Generation Wire Development subprogram exploits breakthroughs at DOE national laboratories that promise unprecedented current-carrying capacity in HTS wires. Industry teams are working with national laboratory scientists to scale-up the discoveries to commercial processes. The Strategic Research subprogram, led by the national laboratories, provides the underlying knowledge base needed to accomplish superconducting systems.

Distributed Energy Systems

DOE's Distributed Energy Systems activities are implemented within the EE Office of Distributed Energy Resources (DER) and support efforts to achieve the Department's distributed energy goal of at least 20 percent of new installed capacity by 2020 (non-renewable < 50 MW). Strategies address technology development, standards making, infrastructure, energy delivery, technical, institutional, and regulatory needs. The strategy is accomplished through three subprogram activities: Energy Storage Research, Transmission Reliability, and DER Electric System Integration (formerly Distributed Power). These three subprograms focus on improving the reliability of electric power generation and distribution system through the integration and interconnection of distributed energy resources. Transmission Reliability research develops and integrates real-time measurement and control networks, and electric system models and tools for high voltage transmission systems. This research ensures reliable and efficient grid operations and markets while integrating distributed energy in the competitive marketplace. Energy Storage Research seeks to develop advanced energy storage systems with an energy density greater than 5kWh per square foot at a cost below $700/kWh. The subprogram funds the design of integrated systems, research on advanced storage system components, and development of economic and performance models. DER Electric System Integration addresses technical, regulatory and institutional

barriers and develops interconnection standards for deployment of DER near the potential users. Performance targets include: a certification process for certifying compliance of interconnection equipment with the national interconnection standard by 2003; prototype interconnection technology that reduces the installed cost of interconnection systems for small distributed generation and storage (300 kW or less) by 30 percent from today's $150/kW to $100/kW by 2005; next generation intelligent autonomous plug-and-play interface and control by 2010. These activities support Chapter 7 NEP recommendations to develop a comprehensive energy delivery system. The Department partners with the Electric Power Research Institute (EPRI), the National Rural Electric Cooperative Association (NRECA), the American Public Power Association (APPA), the electricity industry, national laboratories and universities to implement research and development activities.

Program Strategic Performance Goals

ER2-8: High Temperature Superconductivity
High Temperature Superconductivity (HTS) R&D activities will develop HTS wire capable of carrying 100 times the power of comparable copper wire – with zero electrical resistance by 2007.

Performance Indicator: Wire power carrying capacity.

Annual Performance Results and Targets

FY 2001 Results	FY 2002 Target	FY 2003 Proposed Target
■ *Documented 6,000 hours (100% load) operation of the first successful high-temperature superconducting power delivery system to power an industrial use.* ■ *Installed first of a kind superconducting electrical transmission cables to replace existing delivery to an urban substation serving 14,000 customers in Detroit, Michigan and began testing operation and reliability.*	■ *Complete initial testing of Detroit superconducting transmission cable and document operational costs and reliability.*	■ *Increase the capability to reproducibly fabricate 10-meter length of Second Generation HTS wire to carry 50 amps of electricity and 1-meter lengths that carry 100 amps from a 40 amp base.*

ER2-9: Distributed Energy Systems
Distributed Energy Storage Technology R&D activities will increase the share of new distributed energy electricity-generating capacity from 5 percent in 2000 to 7 percent in 2005. (Distributed energy activities funded by the Energy and Water Development Appropriation are part of a coordinated and

complementary effort with distributed energy R&D activities funded by the Interior and Related Agencies Appropriation, which jointly contribute to this goal.)

Performance Indicator: MegaWatts of interconnected distributed energy generating capacity (located at point of use and including distributed renewables such as PV and biomass).

Baselines: 1997: <15,000 megaWatts
2002: ~20,000 megaWatts
Projected: 2005: ~25,000 megaWatts

Annual Performance Results and Targets

FY 2001 Results	FY 2002 Target	FY 2003 Proposed Target
■ *Advanced zinc-bromine battery systems successfully completed testing in a power quality application in partnership with Detroit Edison.* ■ *Prototype reliability monitoring tools were installed in California to track reactive power, and at the North American Electric Reliability Council (NERC) to monitor load flow between control areas.* ■ *First ballot action held on IEEE P1547 Draft Standard for Distributed Resources Interconnected with Electric Power Systems, and completed test plan for the standard.*	■ *In Partnership with DOE, IEEE will publish draft P1547 Standard for Distributed Resources Interconnected with Electric Power Systems.* ■ *Complete 300 hrs testing of the ZBB advanced bromine battery system in partnership with Detroit Edison.*	■ *Complete draft UL1741 safety performance standard to cover interconnection equipment for all distributed resources.* ■ *Field Test 100kW lithium battery system for 700 hrs at a utility site.* ■ *Install three prototype monitors and/or tools to benefit transmission reliability.* ■ *Build and test for 150 hrs a 10kW composite flywheel with superconducting bearings with Boeing.*

Funding Schedule

(dollars in thousands)

	FY 2001 Appropriation	FY 2002 Appropriation	FY 2003 Request	$Change	%Change
High Temperature Superconducting R&D . . .	36,426	32,388	47,838	15,450	47.7%
Distributed Energy Systems	14,768	38,308	22,609	-15,699	-41.0%
Total, Electric Energy Systems and Storage	51,194[a]	70,696	70,447	-249	0.0%

Detailed Program Justification

(dollars in thousands)

	FY 2001	FY 2002	FY 2003
High Temperature Superconducting R&D	**36,426**	**32,388**	**47,838**

The High Temperature Superconductivity (HTS) R&D program exploits the property of crystalline materials that become free of electrical resistance at liquid nitrogen temperature. The absence of electrical resistance makes possible super-efficient electrical power systems, generators, transformers, and transmission cables, that reduce energy losses by half and allow equipment to be half the size of present electrical systems. Electrical wires from high temperature superconductivity ceramic materials have the potential to carry 100 times the amount of electricity compared to the same diameter conventional copper wires. In the near-term, the superconductive transmission cables that carry 3 to 5 times more power than present technology will enable direct replacement of existing underground power cables by urban utilities to meet demand growth without costly, disruptive construction. These activities support Chapter 7 NEP recommendations to develop a comprehensive energy delivery system.

Performance targets for the High Temperature Superconductivity R&D program include: the national laboratories and industry will demonstrate the capability to reproducibly fabricate 10-meter lengths of Second Generation Wire that carry 50 amps of electricity and 1-meter lengths capable of carrying 100 amps of electricity in 2003; the HTS program will increase capacity, reliability, and efficiency through development of pre-commercial superconducting power cables by 2006 that relieve urban bottlenecks; and the HTS program will develop superconducting high-capacity transformers that improve electricity distribution by 2007 without the potential pollution from any cooling oil**.**

FY 2001: The prototype 3-phase, 25-MW HTS power cable designed and constructed by Southwire Company in Carrollton, GA, exceeded 10,000 hours of continuous operational testing. The prototype 1,000 horsepower HTS motor designed and constructed by Rockwell-Reliance produced 1,600 horsepower in sustained testing under full load conditions. Prototype 100-MW, 3-phase HTS cable was installed in downtown Detroit for testing in FY 2002. Los Alamos and Oak Ridge National Laboratories began development of “industrial park” facilities to provide a fully supportive

[a] FY 2001 has been reduced by $552,000 to reflect SBIR/STTR transfer.

environment for joint research with industry to accelerate the development of fabrication technologies that are critical to commercial production of second generation HTS wire.

FY 2002: Complete first year of testing and evaluation for the prototype 100-MW, 3-phase, HTS cable was installed in downtown Detroit. Complete design and construction of the prototype reciprocating magnetic separator with DuPont, and begin testing. Complete the design and construction of the HTS-bearing energy-storage flywheel with Boeing. Begin new 3 to 4 year competitively-selected, cost-shared projects with industrial consortia to develop and test prototype HTS power systems. Begin full operation of Los Alamos and Oak Ridge National Laboratories "industrial parks" as joint research facilities with industry, and begin joint industry-lab development of fabrication technologies that are critical to commercial production of second generation HTS wire.

FY 2003: Complete final testing and evaluation for the prototype 100-MW, 3-phase, HTS cable installed in downtown Detroit. Complete final testing and evaluation for the prototype reciprocating magnetic separator and the HTS-bearing, energy-storage flywheel. Begin construction of new prototypes of generators, power cables, and other HTS systems under cost-shared projects with industrial consortia. The national laboratories and industry will demonstrate the capability to reproducibly fabricate 10-meter lengths of Second Generation Wire that carry 50 amps of electricity and 1-meter lengths that carry 100 amps of electricity.

- **Superconductivity Partnership Initiative** 14,000 12,000 17,838

  Public-private partnerships, selected competitively, provide DOE 50 percent cost-share to multi-year projects with industry to develop first-of-a-kind high temperature superconducting electrical systems using the latest high temperature superconducting wire. The design of these new systems includes Second Generation Wire so that new prototypes can be tested when the wire becomes commercially available. These projects provide a complete portfolio of advanced electric grid technologies (including power cables, transformers, and generators) needed to rebuild the U.S. electricity system over the next 5 to15 years. Most of the existing power equipment must be replaced during this period because of age, and additional electric capacity must be added to accommodate the larger power transfers as the industry is deregulated. Additional projects selected as partnership projects are to develop prototype superconducting magnetic mineral separators, superconducting flywheel electricity storage systems, and open-structure MRI medical equipment.

- **Second Generation Wire Development** 12,000 11,000 20,000

  Industrial consortia will work with national laboratories to develop high-performance, low-cost, second-generation, high temperature superconducting wire. Specific national laboratories are being provided with cutting-edge facilities and instrumentation where industry researchers can be stationed for extended periods to work with national laboratory scientists in accelerating the development, commercialization, and application of second-generation, high temperature superconductor wires. These partnerships will enable scale-up of discoveries in materials laboratory processes that give unprecedented ability to carry large electric currents. A performance measure is

(dollars in thousands)

	FY 2001	FY 2002	FY 2003

achieving industry production of kilometer lengths of second-generation, high temperature superconducting wire by 2005.

- **Strategic Research** 10,426 9,388 10,000

Advanced, cost-shared, fundamental research activities are conducted to better understand relationships between the microstructure of HTS materials and their ability to carry large electric currents over long lengths. New projects will be added to investigate the varied technical aspects of this key problem. The benefit will be higher performance wires and inherently lower manufacturing costs. Also, work on enabling technologies such as joining HTS conductors to normal conductors will be supported as well as additional research on electrical losses due to alternating currents. These losses can be reduced through better understanding of technical parameters. This research will support new discoveries and innovations for the Second Generation Wire Development. These efforts leverage research of complementary work funded by the DOE Office of Science. This subprogram includes work on planning and analysis of potential program benefits as well as communication and outreach to gather information on future requirements for the HTS technologies and to maintain contact with stakeholders. SBIR Transfer has been reflected in this program in the amount of $393,000 in FY 2001.

Distributed Energy Systems **14,768** **38,308** **22,609**

- **Energy Storage Research** 5,923 9,159 7,640

Energy Storage, together with distributed energy resources technologies, provides the high "nines" of reliability required by the digital economy, telecommunication, and high tech manufacturing. While today's grid can at best give three nines of reliability (i.e., 99.9 percent reliability), energy storage provides seamless power during micro outages, voltage sags, and frequency disturbances and after the equivalent of seven to nine "nines" of reliability.

Such disturbances are estimated to cost U.S. industry up to $150 billion per year. Energy storage systems, backed up by distributed generation, are the cost effective way to provide required reliability for the consumer. The energy storage program is involved with battery systems, flywheels, and supercapacitors. Large scale (MW) energy storage systems can significantly reduce transmission system congestion, help manage peak loads and increase the reliability of the overall electric network.

The program funds the design of systems with integrated power electronics and controls, contributes to research on advanced storage components, and performs strategic research analysis by developing economic and performance models.

Performance Targets include:

- achieving energy storage technologies with a cost of $700/kW by 2003 (vs. $1800/kW in 2000);
- having energy densities of 5kWh/cubic foot by 2003 (vs. approx. 2 kWh/square foot in 2000);
- achieving 10 MW of installed advanced storage devices by 2005 (vs. 0 MW installed in 2000);

(dollars in thousands)

FY 2001	FY 2002	FY 2003

- 100 MW of utility level energy storage installed by 2007 (vs. 25 MW installed in 2000); and 75 MW of installed energy storage with renewable generation sources by 2010 (vs. 0 MW in 2000, excluding small PV/battery systems).

FY 2001: The ZBB-Waukesha advanced zinc-bromine battery systems successfully completed testing in a power quality application in partnership with Detroit Edison. The system entered testing in a peak shaving application during the fourth quarter of FY 2001. The advanced hybrid controller completed factory acceptance testing and will be shipped to Sandia National Laboratories for field testing in FY 2002. Initial testing of a 9kWh lithium battery module designed for stationary applications was completed at SAFT-America.

FY2002: Complete peak shaving testing of the ZBB-Waukesha advanced zinc-bromine battery system. Test the advanced hybrid controller at Sandia National Laboratories demonstrating operation with hybrid energy storage, diesel and PV operation. Assemble and perform initial testing on 67 kW lithium ion battery energy storage system including the power conditioning system and system controls. Complete system design of a 10kWh advanced composite flywheel with Boeing in collaboration with the DOE Superconducting Project Initiative. Acquire and test supercapacitor energy storage system in collaboration with EPRI Power Electronics Applications Center.

The following projects were directed by Congress to be included in the FY2002 program:
1.) Nickel metal hydride battery development (FY 2001 $0, FY 2002 $970,000, FY 2003 $0); 2.) Thermal energy storage (FY 2001 $0, FY 2002 $2,910,000, FY 2003 $0)

FY2003: Test 67 kW lithium battery energy storage system at a utility site with a partnering utility. Build and test 10kWh advanced composite flywheel with Boeing. Break ground on construction of multi-megawatt utility battery energy storage system in collaboration with industry. Begin construction of a multi-megawatt power conditioning system in a cost-shared project with industry.

- **Storage System Integration** 2,600 5,400 3,320

  Develop and test integrated energy storage systems while encouraging factory level integration. Continue development of Intermediate-State-of-Charge battery management in field test; collaborate with manufacturer on the next phase of development of the zinc-bromine battery systems; collaborate with utility partner on deployment of a multi-megawatt energy storage system for transmission and substation applications; continue field testing and evaluation of a 100 kW size remote battery/diesel hybrid system for an Alaskan village mini-grid; and continue field testing and energy balance analysis for a hybrid, renewable community theater. Collaborate with the Electric Vehicle Association of America (EVAA) to evaluate the secondary use of electric vehicle batteries in stationary applications. These activities support Chapter 7 NEP recommendations to develop a comprehensive energy delivery system.

- **Subsystem Development Components R&D** 2,400 3,059 2,945

(dollars in thousands)

FY 2001	FY 2002	FY 2003

Develop individual storage devices, power electronics, and control systems for all sizes of storage systems; test an advanced flywheel storage device in collaboration with the Superconducting Projects Initiative and a utility partner. Begin field testing of an advanced lithium-ion battery system deployed at an e-commerce site with a utility partner. Begin design of an energy storage system utilizing a new megawatt level semiconductor power electronic switch with a utility partner. Extend advanced hybrid system controller to 3 phase, utility interconnected system. These activities support Chapter 7 NEP recommendations to develop a comprehensive energy delivery system.

- **Strategic Research** 923 700 1,375

  Develop advanced performance, economic and benefits analysis of storage systems to include distributed energy system applications; study potential strengths, weaknesses and applications of new storage technologies. Collaborate on the organization of an International Conference on Energy Storage and other communication tools. These activities support Chapter 7 NEP recommendations to develop a comprehensive energy delivery system. SBIR Transfer has been reflected in this program in the amount of $64,000 in FY 2001.

- **Transmission Reliability Research** **4,912 18,307 7,720**

Transmission Reliability (TR) efforts will be implemented through a national laboratory/electricity industry/university partnership to conduct research to enhance the reliability of the Nation's electricity infrastructure. The program will develop advanced transmission technologies that promote competitive markets, ensure system reliability, increase network capacity for large scale, long distance power transfers. The program includes development and support for the application of reliability tools to two additional transmission systems.

The Transmission Reliability subprogram also develops information management, wide area measurement, disturbance recognition, and reliability compliance monitoring systems to enable reliable system operation, efficient electricity markets, and compliance with electric reliability and security standards. The subprogram collaborates closely with independent transmission system operators and other electricity industry stakeholders to identify electric transmission and distribution technology research needs. This activity will support the integration of advanced transmission monitoring and control systems, in addition to composite conductors, into the national grid, and initiate their wide deployment in support of a reliable, secure grid under efficient electricity markets. TR also provides technical support to allow all customers to control their own loads and participate in competitive electric markets; and performs reliability market monitoring and design analysis to identify market participant behavior and impacts, and present unbiased, third party options for more efficient, fair competitive markets. Performance is measured by the acceptance and effective utilization of reliability adequacy tools by independent system operators and utility control centers, and by partnerships initiated to evaluate load as a reliability resource. The increase efforts in this subprogram support, new deployment support, model enhancements, sensor development, and dynamics evaluation under the real-time control activity.

(dollars in thousands)

FY 2001	FY 2002	FY 2003

The following projects were directed by Congress in FY 2002 to be included in this program: field testing of aluminum ceramic fiber composite conductors (FY 2001 $0, FY 2002 $3,878,000, FY 2003 $0); Glenallen power generation upgrades, including extension of electricity to residents of Lake Louise (FY 2001 $0, FY 2002 $1,939,000, FY 2003 $0); Kachemak Bay Power System to extend and upgrade marine power cabling to provide power to the villages of Seldovia, Nanwalek, and Port Graham (FY 2001 $0, FY 2002 $1,939,000, FY 2003 $0); Swan Lake-Lake Tyee electrical intertie pursuant to the Southeast Alaska intertie authorization enacted into law last year (FY 2001 $0, FY 2002 $2,908,000, FY 2003 $0); complete Prince of Wales Island electrical intertie (FY 2001 $0, FY 2002 $2,908,000, FY 2003 $0). SBIR Transfer has been reflected in this program in the amount of $53,000 in FY 2001.

FY 2001: Prototype reliability monitoring, performance and tracking tools were installed in California to track reactive power, and at the North American Electric Reliability Council (NERC) to monitor load flow between control areas. A post-disturbance engineer's workstation was installed at the California Independent System Operator to evaluate disturbances using satellite-synchronized phasor measurements. A market analysis electric energy auction experiment was completed under the reliability and markets activity and the results that correctly predicted the response to new FERC market designs was reported to a blue ribbon panel in California reviewing the proposed design. Complete draft report on the functional requirements for power electronics to perform system protection and load sharing functions for distributed generation. TR program research performers were selected to staff the Secretary's National Energy Policy (NEP) National Transmission Grid Study.

FY 2002: Install a prototype area interchange error monitor in a NERC reliability region that sums the difference in actual versus scheduled power flow between control areas, install a prototype ancillary services compliance monitor system in California that verifies that generators are delivering the services which they contracted to provide. Install real time post disturbance workstations at two additional major utilities. Extend the energy experimental auction to include ancillary services markets, and initiate work on including load as a reliability resource in the auction. Complete a distribution system three phase model to be used for distributed generation integration into microgrids. Accelerate planning for an expanded Federal transmission system reliability research and development activity in response to recommendations in the NEP National Transmission Grid Study final report.

FY 2003: Support installation of a suite of performance monitoring tools at major transmission operating organizations to allow operators to monitor compliance with reliability standards. Expand the real time workstation for engineers to a workstation for transmission operators, and support linking operator work stations for more than one region to share system conditions on a regional basis. Complete integration of load as a resource in the experimental market auctions, and expand development of the characterization and aggregation of customer loads to respond to the energy and ancillary services markets. Initiate work on verifying transmission system model changes required to conform to real time system data analysis, and on identifying signature oscillations that are

(dollars in thousands)

FY 2001	FY 2002	FY 2003

precursors to voltage collapse. Begin development of real time measurement sensors hardware and software enhancements.

- **DER Electric System Integration** (formerly Distributed Power) **3,933** **10,842** **7,249**

DER Electric System Integration (formerly Distributed Power) develops concepts, technologies, standards for the integration of DER with electric systems. Provides for completion, field validation and implementation of a national interconnection standard for DER; and R&D of system integration technology for the interface and control of DER with local energy systems including application to power parks and other microgrids. The program will also support high reliability for the merchant industry; hybrid technologies; and the development of plug-and-play interface and control technologies for next-generation intelligent autonomous grid-connected and grid-independent local energy systems.

In FY 2003 the program will initiate research on distribution system architectures, operational concepts and technologies. These technologies are key to realizing the full value of DER and for achieving the functionality for DER necessary for their effective utilization for reliability support and ancillary services to the grid. The DER Electric System Integration subprogram will also champion the removal of regulatory and institutional barriers to DER and communication tools and market analysis.

Modeling and testing in the development of the interconnection standard has highlighted the need for changes in utility distribution system operation and technology in order to achieve the benefits of significant DER penetration. The subprogram will apply existing technology and develop advanced technologies to implement new distribution system architectures and operational concepts to allow the grid to integrate and exploit the benefits of significant penetrations of DER.

The subprogram will conduct R&D on the microgrid concept, system architectures, power system issues, such as interactions with other elements on the microgrid, system protection and safety.

The following projects were directed by Congress in FY 2002 to be included in this program: fuel cell powered home using Smart Energy Management Control System in Alabama (FY 2001 $0, FY 2002 $969,000, FY 2003 $0); UA Dispatch Outage Management System in Alabama (FY 2001 $0, FY 2002 $1,938,000, FY 2003 $0); distributed generation projects in Indiana (FY 2001 $0, FY 2002 $2,907,000, FY 2003 $0); joint effort between New Mexico Tech and the National Energy Laboratory in Hawaii to integrate, demonstrate, and deploy distributed energy systems (FY 2001 $0, FY 2002 $484,000, FY 2003 $0). SBIR Transfer has been reflected in this program in the amount of $42,000 in FY 2001.

FY 2001: First ballot action held on IEEE P1547 Draft Standard for Distributed Resources Interconnected with Electric Power Systems. Completed test plan for performance validation and testing of the IEEE Standard 1547. Completed plan for distributed resources integration field testing to investigate impacts of amount and variety of DER penetration. Assisted the State of

(dollars in thousands)

	FY 2001	FY 2002	FY 2003

Texas in developing a Distributed Generation Interconnection Manual which was used to support implementation of the Texas rules on the interconnection of distributed generation. Completed reports on simplified methods for analyzing distribution system costs; a system of de-averaged distribution credits for DER in high cost areas; reliability applications of DER; and evaluating approaches for accommodating DER in wholesale markets. Completed proposed draft requirements for a model emissions performance standard for distributed generation. Conducted two workshops to work with States, utilities and regulators to remove barriers to distributed resources deployment.

FY 2002: Publication of a draft interconnection standard that can be used by regulatory authorities. Complete pilot interconnection field test and distributed generation demonstration at the Nevada Test Site and begin Phase I interconnection standard validation tests. Complete case study modeling of distributed generation penetration impacts on grid power stability and system protection. Complete draft UL1741 safety performance standard to cover interconnection equipment for all distributed resources.

FY 2003: Conduct interconnection field validation testing. Complete draft of application guide for interconnection standard. Establish process for certifying compliance of interconnection systems with national standards. Develop prototype improved interconnection technology reducing installed interconnection costs by 15 percent from 2001 costs. Initiate distributed energy resources integration field tests with multiple distributed generation and storage technologies and high feeder penetration.

Total, Electric Energy Systems and Storage	**51,194**	**70,696**	**70,447**

Explanation of Funding Changes

	FY 2003 vs. FY 2002 ($000)
High Temperature Superconducting R&D	
▪ Superconductivity Partnership Initiative - Portfolio of technologies expanded to include generators, magnetic resonance imaging, and new power cable design	+5,838
▪ **Second Generation Wire Development -** Increased laboratory/industry joint scale-up activities in state-of-the-art laboratory research facilities.	+9,000
▪ **Strategic Research** - Completion of first-generation wire activities	+612
Total, High Temperature Superconducting R&D	**+15,450**

	FY 2003 vs. FY 2002 ($000)
Distributed Energy Systems	
▪ **Energy Storage Research** - Decrease due to completion of directed activities in FY2002 appropriation (-$4,000,000). Initiate development of megaWatt level semiconductor power electronics with utility partner and collaborate with utility partner on multi-megaWatt energy storage system for transmission applications (+$2,481,000)	-1,519
▪ **Transmission Reliability** - Funding for composite conductor evaluation and intertie extensions were one time projects in FY 2002 (-$14,000,000). This is offset by increases in reliability compliance and real time monitoring systems development and deployment support, as well as research on load as a resource (+$3,413,000)	-10,587
▪ **DER Electric Systems Integration** - Decrease is due to directed activities in FY2002 appropriations not carried forward to FY2003 (-$6,298,000); an increase in field validation testing and other activities necessary for implementation of the national standard for distributed resources interconnected with electric power systems, and the initiation of distribution system R&D (+$2,705,000).	-3,593
Total, Distributed Energy Systems	**-15,699**
Total Funding Change, Electric Energy Systems and Storage	**-249**

Renewable Support and Implementation

Mission Supporting Goals and Objectives

Departmental Energy Management Program

The Departmental Energy Management Program will accomplish significant energy and dollar savings. By 2005, the costs to the Department of Energy for energy and utilities will decline by 10 percent or $30 million annually. Overall DOE will reduce its energy use per square foot by 45 percent by 2005 as a result of energy conservation measures.

The Departmental Energy Management Program is administered by the Federal Energy Management Program's (FEMP) Departmental Utility and Energy Team (DUET). DUET targets FEMP services at DOE facilities to improve energy and water efficiency, promote renewable energy use, and manage utility costs in DOE's facilities and operations. DUET is the corporate leader for DOE's $220 million annual utility service contract portfolio. With planning as its cornerstone, DUET ensures that utility services are economical, efficient, and reliable.

Program Strategic Performance Goal

ER2-11: Departmental Energy Management Program Team
The Departmental Energy Management Program Team activities will decrease the energy intensity in DOE facilities by 45 percent by 2005, relative to 1985 levels.

International Renewable Energy

The mission of the International Renewable Energy Program (IREP) is to encourage acceptance and use of renewable energy and energy efficiency technologies and to work more closely with industry to foster public-private partnerships to expand the overseas market for U.S. technologies. The IREP provides technical and information dissemination assistance to inform and assist developed and developing countries in energy policy development and implementation; and technology development assistance where appropriate. The IREP supports leveraged field validation projects in order to educate regional energy decision makers on the benefits of U.S. technologies with a view toward replication using private sector and multi-lateral funding. The Program also provides support for Administration and Secretarial priorities consistent with the National Energy Policy and for multi-lateral and bilateral agreements.

Program Strategic Performance Goal

ER2-10: International Programs
International program activities will assist U.S. industry growth in export sales of renewable energy products and services as indicated by increasing PV export sales from approximately 50 MW in 2000 to over 130 MW in 2004.

Performance Indicator: Number of renewable and energy efficient products identified for export (new initiative - data not yet available).

Annual Performance Results and Targets

FY 2001 Results	FY 2002 Target	FY 2003 Proposed Target
■ *Facilitated more comprehensive information exchange from developed to developing countries on renewable energy and energy efficiency technologies.*	■ *Prepare 1st Annual Report on indicators of progress and baseline for export opportunities.*	■ *Establish the National Energy Policy mandated initiative to promote Clean Energy Technology Exports (CETE) to developing countries and countries in transition. The CETE Working Group is to be co-chaired by DOE, the Department of Commerce, and the U.S. Agency for International Development.* ■ *Prepare 2nd Annual Report which would provide indicators of progress against*

Renewable Energy Production Incentive (REPI)

The principal goal of the Renewable Energy Production Incentive (REPI) program is to stimulate electric energy production from renewable sources owned by States or smaller political subdivisions -- typically publicly-owned and electric cooperative utilities. The REPI program directly supports the recommendation of the President's National Energy Policy to increase America's use of renewable and alternative energy.

Electric energy production from renewable energy sources is the primary output of the REPI program and incentives are based on each year's electricity generation levels. In FY 1994, the program's first year, 45 million kWh were produced for which incentive payments were made in the following fiscal year. By 1997, eligible production had reached 458 million kWh. In 2000, the most recent year for which data is available, renewable energy output eligible to receive incentives totaled 685 million kWh.

In FY 1994, five utilities participated in REPI. In the year 2000, for which payment was made in FY 2001, 30 utilities produced qualifying electricity from renewable energy sources.

Program Strategic Performance Goal

ER2-12: REPI, other support & implementation
The Renewable Energy Production Incentive will increase the total number of new renewable energy projects at publicly- and cooperative-owned electric utilities from 0 in 1993 to 75 in 2003.

Performance Indicator: See Table below:

Annual Energy Production by Qualified Facilities and Number of Projects

	Fiscal Year of Qualified Energy Production									
	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Cumulative Projects:	7	11	18	26	36	52	61	72	74	75
Energy Production (Annual 1,000 mWh):	42	153	177	458	529	506	685	701	n/a	n/a

Annual Performance Results and Targets

FY 2001 Results	FY 2002 Target	FY 2003 Proposed Target
■ *Received applications for 685 million kWh total of qualified renewable energy produced during the prior fiscal year.*	■ *Receive applications for more than 800 million kWh total of qualified renewable energy produced during the prior fiscal year.*	■ *Stimulate at least 75 new renewable energy projects at publicly- and cooperative-owned electric utilities by 2003, the legal closing date for new entrants.*

Indian Renewable Energy Resources Program

The mission of the Indian Renewable Energy Resources Program is to provide assistance, on a "government to government" basis to U.S. Native American Tribes and Tribal entities in assessing energy resources and developing culturally compatible energy plans based on Tribal priorities. The activities of the program in furtherance of its mission will focus on: 1) capacity building within Tribal leadership to build greater understanding of available Tribal energy resources and needs; and 2) technical assistance through 8-12 competitively selected cost-shared field validation projects. The program will conduct consultations with Tribal representatives, resource assessments, conduct workshops, and training. Assistance will be coordinated with other Federal agency partners, and Regional and State Energy Offices. Program activities will include planning and implementation of comprehensive development models which include power, water, energy efficiency, telecommunications, and health concerns within a framework that is consistent with cultural and Tribal sensitivities.

Renewable Program Support

Renewable Program Support includes activities which promote the use of renewable technologies, improved energy efficiency measures, and better management of utility costs at Department of Energy facilities through the country.

The goal of the Electric Restructuring program is to work with States and the electric power industry to either maintain or expand energy efficiency and renewable energy, whether in States that have chosen to restructure their electric markets, or those that have not.

The program directly supports the recommendation of the President's National Energy Policy to increase America's use of renewable and alternative energy as well as increasing energy conservation and efficiency. The program also supports the National Energy Policy recommendation to work with the National Governors Association and regional governors associations.

The key objective for Electric Restructuring is to provide unbiased assessments to State, regional and Federal decision makers of the costs and benefits of demand response (peak load management), market-based, and other types of energy efficiency programs; public benefits funds; electric utility green marketing programs; distributed generation concepts; renewable portfolio standards; and other policy and market mechanisms for energy efficiency and renewable energy technologies in electricity markets.

The mission of the Competitive Solicitation program is to overcome the perceptions of risk in selecting renewable energy and hybrid renewable energy generation systems for use in the competitive electric market. The activities of the program will focus on obtaining, analyzing and disseminating essential cost and operational information. In FY 2003, the Competitive Solicitation program will competitively select 2-4 field validation projects which can reduce the uncertainties regarding the applicability and reliability of renewable energy technologies in remote or under-served locations. These field validation projects will be selected based, in part, on diversity of geographic locations and climatic conditions with performance data collected over a six year period.

Funding Schedule

(dollars in thousands)

	FY 2001	FY 2002	FY 2003	$ Change	% Change
Departmental Energy Management	1,984	1,421	3,000	1,579	111.1%
International Renewable Energy Program	4,949	2,840	6,500	3,660	128.9%
Renewable Energy Production Incentive Program	3,991	3,787	4,000	213	5.6%
Renewable Indian Energy Resources	6,585	2,840	8,307	5,467	192.5%
Renewable Program Support	3,991	2,840	2,059	-781	-27.5%
Total, Renewable Support and Implementation	21,500	13,728	23,866	10,138	73.8%

Detailed Program Justification

(dollars in thousands)

	FY 2001	FY 2002	FY 2003
Departmental Energy Management	**1,984**	**1,421**	**3,000**

The Departmental Energy Management Program funds leadership activities to improve energy and water efficiency, promote the use of renewable energy and manage utility costs in DOE's facilities and operations.

(dollars in thousands)

FY 2001	FY 2002	FY 2003

FY 2001. Launched the Model Programs initiative and provided direct project support and leveraged cost sharing for the installation of energy efficiency and renewable energy technologies at DOE sites. The projects will save $300,000 in annual utility costs when completed. Annual energy savings from the projects are 9,145,000 kWh, 2,400 million Btus of natural gas. Used prior-year balances to fund most of the Project Support activities.

FY 2002. Provide support at various DOE facilities to develop model programs for energy management in areas that have not previously been emphasized. Fund one to two renewable energy projects or other emerging technologies, providing a rate of return of at least 25 percent on the dollars invested and achieving an annual savings of 10 billion Btus.

FY 2003. Provide support at various DOE facilities to develop model programs for energy management in areas that have not previously been emphasized. Fund of two to three renewable energy projects or other emerging technologies; providing a rate of return of at least 25 percent on the dollars invested; and achieving an annual savings of 30 billion Btus.

■ **Energy Management Project Support**	558	1,068	2,250

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 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: funding of two to three renewable energy projects or other emerging technologies; providing a rate of return of at least 25 percent on the dollars invested; and achieving an annual savings of 30 billion Btus.

■ **Energy Management Model Program Development**	1,426	353	750

Provide support at various DOE facilities to develop model programs for energy management in new areas that have not been previously emphasized. Expand the use of private sector financing by identifying candidate sites to replace chillers using ozone depleting substances and reduce energy consumption in surplus facilities. Evaluate DOE office buildings for ENERGY STAR labels, and assist in the design of sustainable new buildings. Performance will be measured by the following: acquiring ENERGY STAR labels for six office buildings; and acquiring Leadership in Energy and Environmental Design Building Certification for two new sustainable building design.

International Renewable Energy Program	**4,949**	**2,840**	**6,500**
■ **International Renewable Energy Program**	4,449	2,840	6,500

The International Renewable Energy Program (IREP) activities are focused in three broad areas: market and trade development; U.S. energy security; and global environmental and energy issues. To address these needs, IREP provides technical assistance, disseminates information, conducts trade missions and reverse trade missions. The IREP promotes the use of U.S. renewable energy

technologies; assists sector project development; and helps reduce non-technical barriers (e.g., financing, resources, tariffs, and local prohibitions).

The following projects were directed by Congress to be included in this program in FY 2002: International Utility Efficiency Partnership, Incorporated (FY 2001: $1,000,000, FY 2002: $969,000, FY 2003: $0)

FY 2001: The IREP conducted a renewable energy forum and supported three bilateral annexes in China; supported two bilateral annexes in Mexico and two working group meetings; and provided policy development and technical assistance to clean energy projects in seven targeted countries.

FY 2002: The IREP will facilitate the development of the Clean Energy Technology Export (CETE) initiative; close out U.S. Joint Implementation activities; and provide technical assistance, information dissemination, and policy reformation assistance in targeted developing and developed regions.

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

- **Office of Arctic Energy** 500 0 0

No funding is being requested for this Congressionally directed actiity in FY 2003. This effort has been fully transferred to the Fossil Energy program.

Renewable Energy Production Incentive Program 3,991 3,787 4,000

For over a decade, in recognition of renewable energy's 100 percent reliance on domestic sources and favorable environmental attributes, the U.S. has had federal tax credits to encourage adoption of renewable energy systems. While tax credits exist to encourage private utilities to own and operate renewable energy systems, they have no effect on 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 incentives for adoption of the renewable technologies most needing federal assistance. Importantly, all qualifying projects are planned, bid, purchased, built, and operated following normal commercial practices. Payments are energy output-based and occur only after electricity from renewable sources actually enters U.S. electricity markets.

From the outset, the program's principal thrust has been to encourage increasing utility participation and growth in renewable energy output. The number of utilities has grown during each year of the

(dollars in thousands)

FY 2001	FY 2002	FY 2003

REPI program and eligible electricity output has increased in seven of the eight years. FY 2003 appropriations are expected to sustain these growth trends.

FY 2001: Received applications for 685 million kWh total of qualified renewable energy produced during the prior fiscal year.

FY 2002: Receive applications for more than 800 million kWh total of qualified renewable energy produced during the prior fiscal year.

FY 2003: Receive applications for more than 900 million kWh total of qualified renewable energy produced during the prior fiscal year.

Indian Renewable Energy Resources	**6,585**	**2,840**	**8,307**

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

FY 2001: Congress mandated specific grants for energy projects in Alaska.

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

FY2003: The Indian Renewable Energy Program will initiate a comprehensive strategy to build Tribal capacity, develop Tribe specific energy plans, and competitively select cost-shared deployment projects to enhance use of renewable technologies on Tribal lands.

Renewable Program Support	**3,991**	**2,840**	**2,059**
■ **Electric Restructuring**	998	1,220	1,000

Technical Analysis and Assistance – Perform technical analyses in demand response, market-based, and other types of energy efficiency programs; public benefits funds; electric utility green marketing programs; distributed generation; renewable portfolio standards; and other policy and market mechanisms for energy efficiency and renewable energy technologies in electricity markets. Particular emphasis this year will be on market-based mechanisms, such as demand response programs that reduce peak loads, that provide near-term assistance to electricity-short regions of the United States. A substantial effort is placed on quickly and cost effectively disseminating findings of sponsored technical analyses, which is accomplished in collaboration with State, regional, and

national organizations that have roles in utility restructuring legislation and regulation. Expert technical assistance on an as-requested basis is also given to State public utility commissions, State legislatures, Federal officials and Governors' offices. The program does not advocate, but serves as a clearinghouse to state-based policymakers on policies and programs that work/don't work if a State wants to use, maintain or expand energy efficiency and/or renewable energy in electric markets. Performance will be measured by establishing technical analysis and information dissemination partnerships with 5 to 15 national, State, and regional organizations that have roles in utility restructuring legislation and regulation. Additionally, the program will perform an assessment of the private sector energy efficiency services industry under electric restructuring.

FY 2001: Established and maintained technical analysis and information dissemination partnerships with 12 national, State, and regional organizations that have roles in utility restructuring legislation and regulation. In response to electricity problems in a number of areas of the U.S., provided emergency analysis and technical assistance to targeted States, regions, and independent system operators (ISOs) to help reduce load through demand response programs in the very near-term, as well as in the next few years.

FY 2002: Establish and maintain technical analysis and information dissemination partnerships with 10 to 15 national, State, and regional organizations that have roles in utility restructuring legislation and regulation. Perform an assessment of the private sector energy efficiency services industry under electric restructuring.

FY 2003: Establish and maintain technical analysis and information dissemination partnerships with 10 to 15 national, State, and regional organizations that have roles in utility restructuring legislation and regulation. Identify and distribute results of 15 successful demand response programs offered by utilities or Independent System Operators (ISOs).

- **Competitive Solicitation** 1,494 1,620 1,059

The Competitive Solicitation Program solicits cost shared projects in remote and under served areas of the country to validate differing applications of renewable energy technologies in varying climatic and geographical locations.

FY 2001: The Competitive Solicitation Program conducted Phase II selection projects from seven feasibility studies undertaken by Tribal Colleges and Universities under grants issued in FY 2000.

FY 2002: The Competitive Solicitation Program will conduct a project solicitation to competitively select two to four cost shared projects. The following project was directed by Congress to be included in this program: National Alliance for Clean Incubators (FY 2001 $0, FY 2002 $1,459,000, FY 2003 $0).

FY 2003: The Competitive Solicitation Program will conduct a project solicitation to competitively select two to four cost shared projects.

	(dollars in thousands)		
	FY 2001	**FY 2002**	**FY 2003**
■ **Indoor Air Quality**	999	0	0
No funding is being requested for this Congressionally directed activity in FY 2003.			
■ **Office of Arctic Energy**	500	0	0
No funding is being requested for this Congressionally directed activity in FY 2003. Responsibility for this effort has been fully transferred to the Fossil Energy program.			
Total, Renewable Support and Implementation	**21,500**	**13,728**	**23,866**

Explanation of Funding Changes

	FY 2003 vs FY 2002 ($000)
Departmental Energy Management	
■ Increase provides for 2 to 3 renewable energy projects and 8 additional energy projects or model programs	+1,579
International Renewable Energy Program	
■ Increase supports Departmental strategic plan to focus on emerging energy issues and market development. Implements the Clean Energy Technologies Export (CETE) Initiative in Latin America and other activities consistent with the National Energy Plan.	+3,660
Renewable Energy Production Incentive Program	
■ No significant change to the program	+213
Renewable Indian Energy Resources	
■ Increase will commence competitively awarded efforts to develop new power supplies for export to 553 Federally recognized Native American Tribes.	+5,467
Renewable Program Support	
■ No significant change to the Electric Restructuring or Competitive Solicitation programs.	-781
Total Funding Change, Renewable Support and Implementation.	**+10,138**

National Renewable Energy Laboratory

Mission Supporting Goals and Objectives

Strategic Context

Approximately $0.6 billion of the FY 2001 DOE Energy Efficiency and Renewable Energy budget was directed to Department-owned laboratories. Within this context, NREL received $0.2 billion in funding, Renewable Energy $0.15 billion and Energy Efficiency $0.05 billion. This total represented nearly 92 percent of the Laboratory's operating funds. With these resources, NREL conducts in-house research and manages subcontracted projects. Where research has near term potential and a reasonable level of risk, cost-sharing with industry and universities is used for both financial partnering and promoting technology transfer into the marketplace.

The National Renewable Energy Laboratory (NREL) is leading the Nation toward a sustainable energy future by developing renewable energy technologies, improving energy efficiency, advancing related science, and engineering, and facilitating technology commercialization. NREL's research efforts cover nearly 50 areas of scientific investigation including biomass-derived fuels and chemicals, hydrogen fuel cells, energy-efficient buildings, wind energy, photovoltaics, advanced vehicles, solar manufacturing, industrial processes, solar thermal systems, superconductivity, geothermal, and waste-to-energy technologies.

Proposed funds supporting NREL's infrastructure needs include necessary repairs, maintenance, calibration, equipment replacement, new construction, and facility modifications. These expenditures protect the Federal Government's cumulative investment, support of the domestic renewable energy industry, and ensure that NREL remains the Nation's preeminent center for research, development, and demonstration of renewable energy and energy efficiency technologies.

The Department's FY 2003 budget request includes separate facility project engineering design (PED) funds to complete the design of a research laboratory and office space in an envisioned NREL- Science and Technology Facility.

Capital Operating Expenses & Construction Summary

Capital Operating Expenses

(dollars in thousands)

	FY 2001	FY 2002	FY 2003	$ Change	% Change
General Plant Projects	1,781	1,970	2,100	130	6.6%
General Purpose Equipment	2,210	2,100	2,100	0	0.0%
Total, Capital Operating Expenses	3,991	4,070	4,200	130	3.2%

Construction Projects

(dollars in thousands)

	Total Estimated Cost (TEC)	Prior Year Appropriations	FY 2001	FY 2002	FY 2003	Unappropriated Balances
02-EE-001 PED, NREL Science and Technology Facility	14,500[a]	0	0	800	800	12,900
Total, Construction	14,500	0	0	800	800	12,900

a/ National Renewable Energy Laboratory (NREL)- Science and Technology Facility Total Estimated Cost (TEC) and Total Project Cost (TPC) estimates will be determined when the facility construction cost and schedule baselines are established at the completion of Title I preliminary design, which is expected to occur during the Fourth Quarter of FY 2002. The preliminary total project cost estimate now is $14,920,000.

NREL-001 - National Renewable Energy Laboratory, Infrastructure Project, Golden, CO

1. Construction Schedule History

N/A – See subproject details

2. Financial Schedule

(dollars in thousands)

Fiscal Year	Appropriations	Obligations	Costs
Design and Construction			
FY 2001	3,991	3,991	3,300
FY 2002	4,070	4,070	3,900
FY 2003	4,200	4,200	4,200
FY 2004	4,200	4,200	4,200
FY 2005	4,200	4,200	4,200
FY 2006	4,200	4,200	4,200
FY 2007	4,200	4,200	4,200

3. Project Description, Justification and Scope

This infrastructure budget funds two subprojects:

- Replaces and upgrades NREL general purpose capital equipment.
- Updates and expands capabilities of facilities and infrastructure already in use at NREL.

The following section addresses general infrastructure that constitute's NREL's general capital needs (general purpose projects, general purpose equipment). This does not include technology-specific capital equipment funded by individual program budgets.

- Projects to correct environmental, safety and health deficiencies including fire safety and roadway improvements.
- Projects that renovate or replace inefficient and unreliable facilities including utility systems, roads, general purpose research and support facilities, general purpose research, and support equipment.
- Projects that improve or enhance general purpose facilities or capabilities including utility systems, energy efficiency, renewable energy use, roads, site improvements, general purpose research and support facilities, general purpose research and support equipment.

a. Subproject 01 - General Purpose Equipment

TEC	Prev.	FY 2001	FY 2002	FY 2003	Outyear 2004-2007	Construction Start / Completion Dates
2,100/yr	450 a/	2,210	2,100	2,100	8,400	Not Applicable

a / Previous year (FY 2000) funding level.

This investment replaces and upgrades NREL's general capital equipment at a regular annual rate of approximately 4 percent. Currently 20 percent of NREL's capital equipment, general purpose and program-specific, currently in operation is beyond its useful life. Specific equipment needs are initially identified at the time of 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 these systems near state-of-the-art.
- Upgrades and additions to NREL's scientific instrumentation shared by several programs or projects, to replace equipment that is no longer reliable or serviceable, meet changing research needs, and to keep these instruments near the state-of-the-art in capability.

b. Subproject 02 - General Plant Projects

TEC	Prev.	FY 2001	FY 2002	FY 2003	Outyear 2004-2007	Construction Start / Completion Dates
2,100/yr	650 b/	1,781	1,970	2,100	8,400	1Q 2000 - 4Q 2007

b/ Previous year (FY 2000) funding level.

This investment serves to renovate and extend the capabilities of the buildings and infrastructure already in place at the NREL sites. These projects apply to both the South Table Mountain (STM) and National Wind Technology Center sites. Specific projects are initially identified at the time of budget submission, then reevaluated as funding becomes available in the requested execution year. These projects include:

- Upgrades to utilities, HVAC systems, and related systems within buildings.
- Energy efficiency improvements within buildings.
- Safety and security 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.
- Walkway, landscaping, water management, water treatment, and other site improvements to enhance the sustainability, cohesiveness, and pedestrian nature of the site.

4. Details of Cost Estimate

N/A

5. Method of Performance

Designs will be negotiated by architect-engineer contracts or laboratory personnel. To the extent feasible, construction and procurement will be accomplished by fixed-price contracts awarded on the basis of competitive bids.

6. Schedule of Project Funding

N/A

7. Related Annual Funding Requirements

N/A

02-EE-001, National Renewable Energy Laboratory, Project Engineering and Design (PED), Golden, CO

Significant Changes

- Completion of Project Engineering and Design budget requirement for the DOE National Renewable Energy Laboratory (NREL). A proposed $800,000 will finish final design of the planned Science and Technology Facility in Golden, CO.

1. Construction Schedule History

	Fiscal Quarter				
	A-E Work Initiated	A-E Work Completed	Physical Construction Start	Physical Construction Completed	Total Estimated Cost ($000)
FY 2003 Budget Request (*A-E and technical design only*)	1Q 2002	3Q 2003	N/A	N/A	1,600

2. Financial Schedule

(dollars in thousands)

Fiscal Year	Appropriations	Obligations	Costs
FY 2002	800	800	800
FY 2003	800	800	800

3. Project Description, Justification and Scope

This budget request allows a planned $14.5 million NREL-Science and Technology Project to proceed into final design (Title II). The design effort will be sufficient to assure project feasibility, define scope, provide detailed estimates of construction costs based on approved design and working drawings and specifications, as well as produce a construction schedule, including procurement items. It is anticipated that a detailed estimate of construction cost can be submitted to DOE Chief Financial Officer, OMB, and the Congress by August 2002.

Application of a PED line item enables this NREL project to proceed immediately from preliminary into final design. A subsequent decision regarding subsequent site construction will be made based upon completed design, as well as other options and funding priorities.

FY 2003 Design Project

02-01: National Renewable Energy Laboratory, Science and Technology Facility, Golden, CO

Fiscal Quarter					
A-E Work Initiated	A-E Work Completed	Physical Construction Start	Physical Construction Completed	Total Estimated Cost (Design Only) ($000)	Preliminary Full total Estimated Cost Projection ($000)
1Q 2002	3Q 2003	N/A	N/A	1,600	14,500

Design TEC	Previous	FY 2003	FY 2004	FY 2005	Outyears	Design Completion
1,600	800	800	0	0	0	3Q 2003

The envisioned Science and Technology Facility in Golden, CO is intended to relieve overcrowding at NREL's current Solar Energy Research Facility (SERF). That structure was designed for 160 persons, but now is accommodating over 200 individuals.

The conceived 52,000 square feet (sf) Science and Technology Facility would consist of: six material science laboratories (8,700 sf), four general purpose chemistry labs (5,000 sf) and open bay (11,500 sf), as well as office/administrative (16,100 sf), mechanical/utility (10,700 sf) space. This installation will benefit photovoltaic, hydrogen, and fuel cell research activities at NREL.

4. Details of Cost Estimate

	(dollars in thousands) Current Estimate
Design Phase	
Preliminary and Final Design Costs (Design Drawings and Specifications	1,200
Design Management Costs (15.6% of TEC)	250
Project Management Costs (9.4% of TEC)	150
Total, Design Costs	1,600
Total, Line Items (TEC)	1,600

5. Method of Performance

Design services will be obtained through competitive and/or negotiated contracts. M&O contractor staff may be utilized in areas involving security, production, proliferation, etc. concerns.

6. Schedule of Project Funding

(dollars in thousands)

	FY 2002	FY 2003	Total
Project Cost			
Facility Costs			
Design	800	800	1,600
Construction	0	0	0
Total, Line Item (TEC)	800	800	1,600
Total Facility Costs (Federal and Non-Federal)	800	800	1,600
Other Project Costs			
Conceptual design costs	380	0	380
Other project-related costs	40	0	40
Total, Other Project Costs	420	0	420
Total Project Cost (TPC)	1,220	800	2,020

Renewable Energy Resources Program Direction

Mission Supporting Goals and Objectives

This Program Direction budget component provides the Federal staffing resources as well as associated properties, equipment, supplies and materials required for supporting the responsive management and oversight of the Department's Renewable Energy programs. Activities include necessary funds for support service contractors, equipment, travel, crosscutting activities and Assistant Secretary for Energy Efficiency and Renewable Energy (EERE) initiatives.

Information technology gains have lead to productivity increases of the Federal staff. However, this progress comes with the requirement of added support expenses for individual Full-Time Equivalent (FTE) positions. Every fiscal year, the costs for sustaining real salary levels, information technology, office space, office supplies, equipment and travel have increased because of nominal inflation. The FY 2003 budget request makes provision for these normal expense considerations, but with a decrease in staffing levels. In addition, a provision has been made to earmark funds for accruing Civil Service Retirement System (CSRS) and post retirement health benefits of current federal employees on an individual agency program budgets.

This Program Direction budget will focus on continued realization of Renewable Energy goals and objectives while implementing the President's management reform agenda. Five key concerns from that Presidential agenda are: human capital, an expanded electronic government, more competitive sourcing, improved financial performance, as well as better integration of budgeting with performance targets and results. In addition, sustained progress is expected in addressing management opportunities identified by a 2000 National Academy of Public Administration (NAPA) report on Office of Energy Efficiency and Renewable Energy (EERE) operations.

Funding Schedule

(dollars in thousands, whole FTEs)

	FY 2001	FY 2002	FY 2003	$ Change	% Change
Golden					
Salaries and Benefits	2,181	2,105	1,718	-387	-18.4%
Travel	125	130	125	-5	-3.8%
Support Services	370	390	347	-43	-11.0%
Other Related Expenses	103	285	105	-180	-63.2%
Total, Golden	2,779	2,910	2,295	-615	-21.1%
Full Time Equivalents	18	20	18	-2	-10.0%

(dollars in thousands, whole FTEs)

	FY 2001	FY 2002	FY 2003	$ Change	% Change
Idaho					
Salaries and Benefits	100	105	104	-1	-0.9%
Travel	0	0	1	1	N/A
Support Services	0	0	0	0	0.0%
Other Related Expenses	0	0	0	0	0.0%
Total, Idaho	100	105	105	0	0.0%
Full Time Equivalents	1	1	1	0	0.0%
Headquarters					
Salaries and Benefits	11,305	11,160	9,410a/	-1,750	-15.7%
Travel	380	380	500	120	31.6%
Support Services	3,079	3,185	2,883	-302	-9.5%
Other Related Expenses	1,775	1,780	1,714	-66	-3.7%
Total, Headquarters	16,539	16,505	14,507	-1,998	-12.1%
Full Time Equivalents	85	95	83	-12	-12.6%
Total Renewable Energy Resources					
Salaries and Benefits	13,586	13,370	11,232	-2,138	-16.0%
Travel	505	510	626	116	22.7%
Support Services	3,449	3,575	3,230	-345	-9.7%
Other Related Expenses	1,878	2,065	1,819	-246	-11.9%
Total, Program Direction	19,418	19,520	16,907	-2,613	-13.4%
Total Excluding Full Funding for Federal Retirements, Program Direction	18,659	18,703	16,187	-2,516	-13.5%
Total, Full Time Equivalents	104 b/	116	102	-14	-12.1%

a/ The FY 2002 and FY 2002 columns of the FY 2003 Congressional Request include funding in the amounts of $759,000 and $817,000, respectively, for the Government's hare of increased costs associated with pension and annuitant health care benefits. These funds are comparable to FY 2003 funding of $720,000. (Note: The data is presented on a comparable basis as if the legislation had been enacted and implemented in FY 2001.)

b/ Actual Full-Time Equivalent (FTE) usage is cited for FY 2001 while budgeted staffing numbers are displayed in the FY 2002 and FY 2003 columns. For comparability purposes, budgeted FY 2001 FTE were Golden 22, Idaho 1, Headquarters 98 and total 121.

Detailed Program Justification

(dollars in thousands)

	FY 2001	FY 2002	FY 2003
Salaries and Benefits	**13,586**	**13,370**	**11,232**

Staff funded in this decision unit provide the executive management, program oversight, analysis, and information required for the effective implementation of the Renewable Energy Resources Programs. The DOE Headquarters staff, consisting of 83 FTEs in FY 2003, are also 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. This Program Direction account also supports a Golden Field Office personnel level of 18 FTEs. In addition, the budget continues to fund 1 FTE at the Idaho Operations Office. Current and future staff performance is measured by responsiveness to national energy policy goals and objectives; 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 electronic government information systems, improved financial performance; and better integration of program metrics into budgeting processes.

This also budget reflects a Bush administration initiative reallocating funds for accruing Civil Service Retirement System (CSRS) and post retirement health benefits of current federal employees to individual agency program budgets. An added $720,000 has been included in the FY 2003 Renewable Energy Resources Program Direction budget for these benefits. To facilitate equitable year-to-year comparisons, FY 2001 and FY 2002 budget amounts have also been adjusted by $759,000 and $817,000 respectively.

Travel	**505**	**510**	**626**

Travel reflects continuing escalation of trip costs, as well as added travel to support rising priorities of Renewable Energy's hydrogen, biofuels, wind, superconducting and transmission reliability program activities on a dispersed national scale.

Support Services	**3,449**	**3,575**	**3,230**

Includes all funding for support service contractors, equipment, crosscutting activities, and Assistant Secretary initiatives to support all of the Renewable Energy Resources Programs. This provides the minimum level of support services needed for mail room operations; travel management; environment, safety and health support; safeguards and security; computer systems development; as well as hardware and software installation, configuration, and maintenance activities.

Other Related Expenses	**1,878**	**2,065**	**1,819**

This activity includes the Headquarters Working Capital Fund (WCF) and contractual services associated with landlord support of the Golden Field Office. Funding for the WCF in FY 2001 through FY 2003 is $1,775,000, $1,720,000 and $1,725,000 respectively. Rent is the largest Working Capital

(dollars in thousands)

	FY 2001	FY 2002	FY 2003

Fund component (FY 2001 through FY 2003 is $985,000, $990,000 and $995,000 respectively). The balance of Other Related Expenses is for Golden landlord requirements such as rental payments to GSA, expendable office supplies and materials, telecommunications and utilities, training, purchase of goods and services from Government accounts, printing and graphics, postage, maintenance and service agreements, and publications. Total costs for the Golden Field Office are funded between the Energy & Water Development and Interior & Related Agencies Appropriations.

Total, Renewable Energy Resources Program Direction	**19,418**	**19,520**	**16,907**

Explanation of Funding Changes

	FY 2003 vs. FY 2002 ($000)
Salaries and Benefits	
■ Decreases for salaries and benefits (-12 FTE or 12 percent of staff allocation)	-2,138
Travel	
■ Provisions have been made for escalating airfare and lodging expenses, as well as added trips.	+116
Support Services	
■ Reflects a decreased level of assistance for preparation of program planning materials implementing the administration's evolving National Energy Policy	-345
Other Related Expenses	
■ Expect prior year office acquisitions will be sufficient to allow for a FY 2003 funding decrease while still maintaining work productivity	-246
Total Funding Change, Renewable Energy Resources Program Direction	-2,613

Support Services

(dollars in thousands)

	FY 2001	FY 2002	FY 2003	$ Change	% Change
Technical Support Services					
Economic and Environmental Analysis	959	1,245	1,000	-245	-19.7%
Management Support Services					
ADP Support	360	200	296	96	48.0%
Administrative Support Services	2,130	2,130	1,934	-196	-9.2%
Total, Management Support Services	2,490	2,330	2,230	-100	-4.3%
Total, Support Services	3,449[a]	3,575[a]	3,230	-345	-9.7%

[a]/ Includes all funding for support services contractors, ADP equipment, crosscutting activities, and Assistant Secretary initiatives.

Other Related Expenses

(dollars in thousands)

	FY 2001	FY 2002	FY 2003	$ Change	% Change
Training	5	5	5	0	0.0%
Working Capital Fund (Excluding HQ Rent)	790	730	730	0	0.0%
Printing and Reproduction	0	0	0	0	0.0%
Rental Space (HQ)	985	990	995	5	0.5%
Software Procurement/Maintenance Activities/Capital Acquisitions	5	5	5	0	0.0%
Other	93	335	84	-251	-74.9%
Total, Other Related Expenses	1,878	2,065	1,819	-246	11.9%