Energy Supply

Proposed Appropriation Language

For Department of Energy expenses including the purchase, construction and acquisition of plant and capital equipment, and other expenses necessary for energy supply, and uranium supply and enrichment activities in carrying out the purposes of the Department of Energy Organization Act (42 U.S.C. 7101 et seq.), including the acquisition or condemnation of any real property or any facility or for plant or facility acquisition, construction, or expansion; and the purchase of not to exceed 17 passenger motor vehicles for replacement only, [$660,574,000] *$505,069,000* to remain available until expended [*Provided*, That, in addition, royalties received to compensate the Department of Energy for its participation in the First Of-A-Kind-Engineering program shall be credited to this account to be available until September 30, 2002, for the purposes of Nuclear Energy, Science and Technology activities]. *(Energy and Water Development Appropriations Act, 2001, as enacted by section 1(a)(2) of P.L. 106-377.)*

[For an additional amount for "Energy Supply", $800,000, to remain available until expended, for the Prime, LLC, of central South Dakota, for final engineering and project development of the integrated ethanol complex, including an ethanol unit, waste treatment system, and enclosed cattle feed lot.] *(Division A, Miscellaneous Appropriations Act, 2001, as enacted by section 1(a)(4) of P.L. 106-554.)*

Explanation of Change

Language deleted to permit a one-time retention of funds.

Energy Supply

Renewable Energy Resources

Executive Budget Summary

Mission

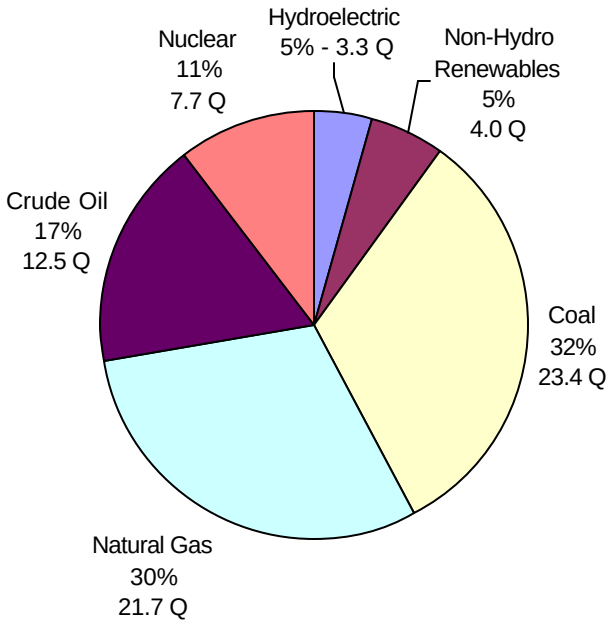
The Department of Energy's Office of Energy Efficiency and Renewable Energy (EERE) leads the Nation in the research and development (R&D) of advanced energy efficiency and clean power technologies and practices, providing Americans with a stronger economy, healthier environment, and more secure future. The overall goal of EERE'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, in order to meet growing energy needs, reduce our Nation's dependence on foreign energy imports, and increase our usage of environmentally-friendly fuels.

The Federal Government is working to ensure that the Nation's energy supplies remain reliable and secure, while also advancing a diverse portfolio of technologies that will enable those supplies to be cleaner and more affordable. EERE's energy programs are a key part of the DOE Energy Resources Business Line, accounting for about one-third of the Energy Resources R&D budget in FY 2002.

Background

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. Without a shift away from traditional fuels, the current imbalance will worsen since EIA estimates that only 2 percent of the

Total U.S. Energy Production by Source - 1999

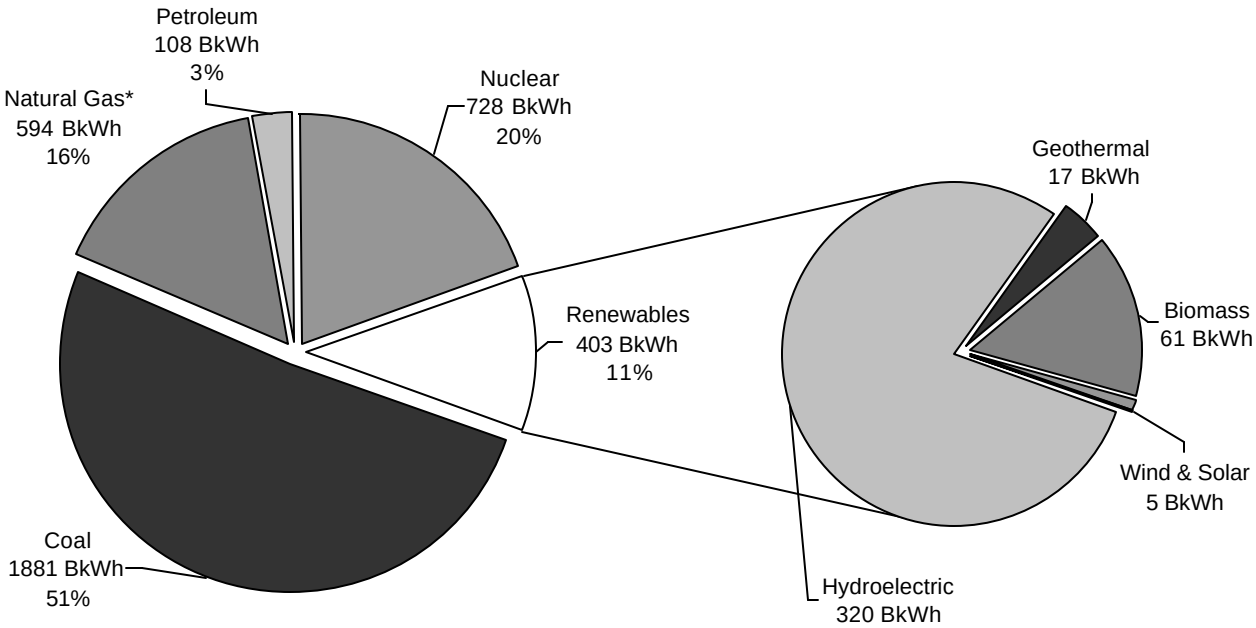


Source: EIA. Monthly Energy Review. February 2001. DOE/EIA-0035 (2001/02)

world's proven crude oil reserves are located in American territory. Our production-consumption imbalance, coupled with our dependence on fossil fuels, necessitates continued Federal R&D for our Nation to realize the tremendous opportunities available to develop domestic supplies of clean, renewable energy.

In addition to its role in primary energy generation, 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).

U.S. Electricity Generation by Source



Source: EIA Monthly Energy Review Feb 2001 (DOE/EIA-0035 (2001/02))
Totals do not equal 100% due to rounding

*Also includes other gases (approximately 11 billion kWh)

The U.S. electric power industry is in the process of restructuring to become more competitive and to offer consumers more choices. Congress, State legislatures, and Federal and State regulators have acknowledged that competition in electric supply is both possible and desirable. In response to increased competitive pressures, utilities and other companies that traditionally have invested significantly in power generation research

have reduced or eliminated these investments. At the same time, many power generators, either in response to public pressure or State and Federal regulatory trends, are seeking to diversify their fuel choices and add renewable energy resources to their fuel mix. To ensure that the Nation maintains an adequate, reliable, and environmentally responsible electric power supply in an evolving competitive market, EERE is pursuing research in advanced power systems, both larger high-efficiency systems, and smaller distributed power systems.

Strategy

EERE 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, EERE 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.

The bulk of EERE's energy program activities are in the area of technology R&D. EERE recognizes, however, that government policies and market factors significantly affect which technologies are purchased by consumers. Consequently, EERE's renewable energy and reliability R&D portfolio includes the development of key policies and the stimulation of critical end-use markets.

Activities funded under the Energy and Water Development Appropriation advance a broad range of emerging energy technologies, fuels, and related storage and power delivery systems including solar, wind, geothermal, hydropower, biomass/biofuels, hydrogen, natural gas, superconductivity, and advanced energy storage systems. In cost-shared partnerships with the Nation's manufacturers, utilities, and States, the Department of Energy promotes reliable, competitive, and environmentally responsible energy systems that serve the needs of the public.

In order to increase reliability, the Distributed Energy Resources (DER) office focuses on power generation near or at the point of use and in support of the distribution system. Activities under the Energy and Water Development Appropriation are developing advanced highly efficient technologies to increase electric reliability and power quality to end-use customers without sacrificing the environment.

Electricity restructuring and an increasing demand for electricity in the United States are challenging the Nation's energy infrastructure. New technologies being pursued by EERE are designed to help protect, stabilize, and enhance the performance of this infrastructure. DOE's energy grid reliability efforts address electricity infrastructure reliability and availability issues, as well as natural gas pipeline system reliability and gas storage facility operational flexibility and protection of critical energy system infrastructures from physical and cyber threats.

Specific EERE program objectives include:

- **Contributing to the tripling of installed U.S. electricity generation capacity of non-hydroelectric renewable electricity resources by 2015 (relative to a 1997 level of 8,300 megaWatts of installed capacity, excluding wood waste by-products) and maintaining the viability of hydropower as an important renewable energy resource** - through performance improvements, such as advances in conversion technology, and reductions in capital costs for generation and infrastructure technologies.

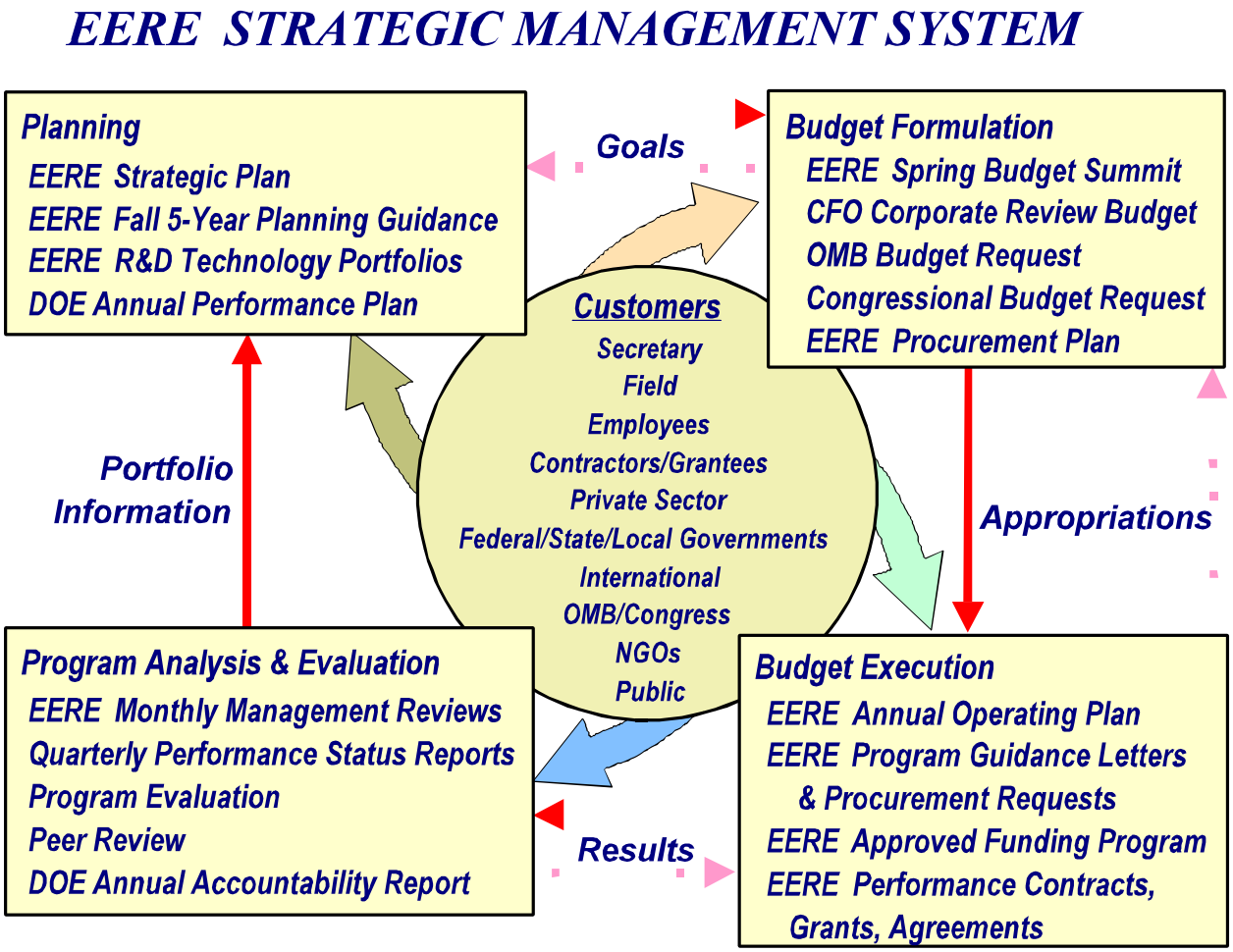
- **Overcoming barriers to distributed power to achieve a 20 percent market penetration of new generation capacity by 2012** - by such activities as facilitating the implementation of national standards for interconnecting distributed power with the grid.

- **Maintaining the present high reliability of the Nation's transmission and distribution systems during a period of increased consumer demand for electricity and while enduring numerous constraints on siting and building new transmission and distribution systems** - by providing an integrated approach for the electricity component of the Energy Grid Reliability Initiative. (Electric Energy Systems and Storage R&D Program).

Managing for Results

Excellence in business management is essential to accomplishing EERE's mission and goals. In the spring of 2000, EERE 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, EERE 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 EERE. Implementing this system is the key to ensuring overall management excellence on par with the technological excellence of EERE programs.



Federal Staffing at Field and Headquarters

(FTEs)

Field and Headquarters Sites	FY 2000	FY 2001	FY 2002
Renewable Energy Resources			
Golden Field Office	17	22	20
Idaho Operations Office	1	1	1
Headquarters	92	98	95
Subtotal FTEs, Renewable Energy Resources	**110**	**121**	**116**
Energy Conservation Programs			
Building Technology, State and Community Sector			
Headquarters	71	81	76
Federal Energy Management Program			
Headquarters	20	32	27
Industry			
Headquarters	52	59	54
Chicago Operations Office	4	0	0
Idaho Operations Office	4	7	6
Subtotal	60	66	60
Transportation			
Headquarters	56	62	62
Oak Ridge Operations Office	1	1	1
Subtotal	57	63	63
Power Technologies (DER)			
Headquarters	5	5	5
Chicago Regional Office	3	3	3
Subtotal	8	8	8
Policy and Management			
Headquarters	64	59	58
Golden Field Office	31	30	34
Atlanta Regional Office	22	25	25
Boston Regional Office	15	18	18
Chicago Regional Office	16	20	17
Denver Regional Office	24	27	25
Philadelphia Regional Office	18	19	18
Seattle Regional Office	21	22	21
Subtotal	211	220	216
Subtotal FTEs, Energy Efficiency Programs	**427**	**470**	**450**
Total FTEs, Energy Efficiency and Renewable Energy	**537**	**591**	**566**

Program Funding Detail

(dollars in thousands)

	FY 2000 Comparable Appropriation	FY 2001 Comparable Appropriation	FY 2002 Request	Funding Change
Renewable Energy Resources				
Biomass/Biofuels Energy Systems				
Power Systems	31,280	39,742	37,084	-2,658
Transportation	38,099	46,526	43,416	-3,110
Total, Biopower/Biofuels Energy Systems	69,379	86,268	80,500	-5,768
Geothermal Technology Development				
Geoscience and Supporting Technologies	10,071	7,300	3,500	-3,800
Exploration and Drilling Research	6,975	8,200	6,900	-1,300
Energy Systems Research and Testing	6,287	11,411	3,500	-7,911
Total, Geothermal Technology Development	23,333	26,911	13,900	-13,011
Hydrogen Research	24,287	26,881	13,900	-12,981
Hydropower	4,861	4,989	2,500	-2,489
Solar Energy				
Concentrating Solar Power	14,924	13,710	1,932	-11,778
Photovoltaic Energy Systems	64,571	75,060	39,000	-36,060
Solar Building Technology Research	1,915	3,911	2,000	-1,911
Total, Solar Energy	81,410	92,681	42,932	-49,749
Wind Energy Systems				
Applied Research	13,300	15,000	8,400	-6,600
Turbine Research	12,349	12,428	7,500	-4,928
Cooperative Research & Testing	6,085	12,125	4,600	-7,525
Total, Wind Energy Systems	31,734	39,553	20,500	-19,053
Electric Energy Systems and Storage				
High Temperature Superconducting R&D	31,024	36,819	19,000	-17,819
Energy Storage Systems	3,387	5,987	5,987	0
Transmission Reliability	2,925	8,940	8,940	0
Total, Electric Energy Systems and Storage	37,336	51,746	33,927	-17,819

Program Funding Detail (continued)

(dollars in thousands)

	FY 2000 Comparable Appropriation	FY 2001 Comparable Appropriation	FY 2002 Request	Funding Change
Renewable Support & Implementation				
Departmental Energy Management Program . . .	0	1,984	1,000	-984
International Renewable Energy Program	4,630	4,949	0	-4,949
Renewable Energy Production Incentive Program	1,500	3,991	2,059	-1,932
Renewable Indian Energy Resources	3,864	6,585	0	-6,585
Renewable Program Support.	4,900	3,991	2,059	-1,932
Total, Renewable Support & Implementation	14,894	21,500	5,118	-16,382
National Renewable Energy Laboratory	1,100	3,991	5,000	1,009
Program Direction				
Golden Field Office	2,142	2,779	2,910	131
Idaho Operations Office	95	100	105	5
Headquarters	15,483	15,780	16,185	405
Total, Program Direction	17,720	18,659	19,200	541
Total, Renewable Energy Resources	306,054[1]	373,179[2]	237,477[3]	-135,702

[1]Includes reductions for SBIR program (-$3,216,000), STTR program (-$193,000), FY 2000 Omnibus rescission, contractor savings and general reduction, and Safeguards and Security general reduction.

[2]Includes adjustments for FY 2001 Consolidated Appropriations Act, Spread of General Reduction for Safeguards and Security, and 0.22 percent Omnibus Recission.

[3]The FY 2002 amount will be modified by a budget amendment to be submitted shortly. Renewable Energy Resources will increase by $39,176,000 in the following areas: Biomass/Biofuels Energy Systems, Hydrogen, Hydropower, Electric Energy Systems and Storage, International Renewable Energy Program, and Renewable Energy Production Incentive Program. A reduction in the Energy Conservation account will offset this increase.

Renewable Energy Resources

Program Mission

The Renewable Energy Resources Program leads the national research effort to develop clean, competitive, and reliable renewable energy and power delivery technologies for the 21st century. Within the Office of Energy Efficiency and Renewable Energy (EERE), the program supports research and development of clean, reliable renewable energy technologies and cutting edge power delivery technologies that will enable the reliable delivery of electric services for consumer use in competitive, restructured electric markets. The program also develops clean liquid biofuels for the transportation sector.

The EERE Office of Power Technologies implements most of the program activities, while the EERE Office of Transportation Technologies administers the Biofuels portion of the Biomass/Biofuels Energy Systems Program, and the EERE Office of Federal Energy Management Programs administers the Departmental Energy Management Program.

Program Goals and Objectives

The goal of the Program is to improve the Nation's overall economic strength and competitiveness, energy security, and environmental health through the development of clean, competitive, and reliable power technologies.

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.

About 70 percent of the electric energy generated in the United States is fueled by coal, natural gas, and oil, with the balance provided by nuclear (approximately 20 percent), hydroelectric, and other renewable technologies (approximately 11 percent). Due to the reliance on fossil fuels, power generation is currently a major contributor to pollutant and greenhouse gas emissions in the United States. Finding ways to meet the projected increase in demand for electric power without compromising the Nation's environmental standards is therefore essential if we are to simultaneously sustain the Nation's economic growth and protect human health and the environment.

Many power producers, either in response to public pressure or State and Federal regulatory trends, are seeking to diversify their choices and add renewable energy resources to their fuel mix. Additionally, the combination of environmental concerns, current and potential constraints of large system power transmission and distribution, and technological advances, are all causing distributed and hybrid systems and technologies

such as combined heat and power systems, fuel cells, photovoltaics, wind turbines, geothermal, and biomass systems to gradually augment and sometimes to replace conventional, large-scale generating technologies.

Although regulated utilities traditionally invested in power generation R&D, increased competitive pressures resulting from the ongoing restructuring of the U.S. electric power industry has forced utilities and other companies to reduce or eliminate their R&D budgets. This reality makes Federal investments in renewable energy technologies R&D even more essential. This 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. Areas addressed include materials and component improvement, conversion efficiency, system integration, system control, and evaluation of component lifetime. While such R&D is necessary, it must be complemented with evaluation of field system performance. User acceptance and industry commercialization requires confidence in the day-to-day performance, operating cost, system reliability, and operating lifetime of renewable energy technologies. The program's activities include prototype evaluation and system field tests, where appropriate, to establish a basis for predicting operation and maintenance costs.

A similar objective exists for the energy delivery programs, which include the Electric Energy Systems and Storage research and development programs and the Hydrogen program. The transition to competitive, restructured electric markets -- coupled with growing consumer demand for electricity and constraints in the Nation's transmission and distribution systems -- requires the development of an integrated set of advanced power delivery technologies to enable the reliable delivery of electric services for consumer use. Overcoming regulatory, technical, and institutional barriers to distributed power are addressed to increase emerging efficiency and relieve stress on the Nation's transmission systems. The development of lower cost, high performance power electronic controllers with advanced energy storage systems, provide improved power quality and additional operational capacity within the existing transmission and distribution infrastructure. The development of high temperature superconducting power equipment is addressed to significantly reduce losses in the generation, delivery, and end-use of electricity and to relieve power delivery system constraints, particularly in urban areas. Lower cost and higher performance hydrogen production and storage technologies are addressed that can integrate into any point on the Nation's electric and natural gas delivery systems. Program success depends on industry's ultimate commercialization of the program's technologies under development and partnership with industry is essential. These partnerships include industry co-investment and cost-sharing at increasing levels as technologies near the pre-commercialization stage.

Additionally, the program utilizes the talents found at the National Laboratories and within States, university, and other research organizations across the United States in order to achieve its R&D objectives. This not only helps us to accomplish our R&D mission, but the States are also encouraged to share "lessons learned" through their own peer network activities. Similarly, we also partner with a number of universities across the country to conduct both fundamental and applied R&D.

Specific program objectives include:

- **Contributing to the tripling of installed U.S. electricity generation capacity of non-hydroelectric renewable electricity resources by 2015 (relative to a 1997 level of 8,300 megaWatts of installed capacity, excluding wood waste by-products) and maintaining the viability of hydropower as an important renewable energy resource** - through performance improvements, such as advances in conversion technology, and reductions in capital costs for generation and infrastructure technologies.

- **Overcoming barriers to distributed power to achieve a 20 percent market penetration of new generation capacity by 2012** - by such activities as facilitating the implementation of national standards for interconnecting distributed power with the grid.

- **Maintaining the present high reliability of the Nation's transmission and distribution systems during a period of increased consumer demand for electricity and while enduring numerous constraints on siting and building new transmission and distribution systems** - by providing an integrated approach for the electricity component of the Energy Grid Reliability Initiative. (Electric Energy Systems and Storage R&D Program).

- **Launch a cellulosic ethanol industry** - Based on technology advancements, at least one ethanol production facility using agricultural and/or municipal solid wastes will be operational or under construction by 2004, and another demonstration at a commercial facility be conducted by 2005 using an energy crop or closely related biomass and demonstrate the potential for a tenfold cost reduction for cellulase enzymes for converting cellulosic biomass to ethanol, resulting in enzyme costs of 5 to 10 cents per gallon of ethanol by 2005.

Attainment of these program objectives will contribute to Departmental strategic goals of reducing the vulnerability of the U.S. economy to disruptions in energy supplies; ensuring adequate and affordable energy supplies in a competitive marketplace while improving environmental quality; increasing the efficiency and productivity of energy use; and supporting U.S. energy and economic competitiveness in global markets.

The table below reflects projected aggregated benefits to the Nation resulting from the Renewable Energy Resources program investments in technology advancements. 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: The program benefit ranges are developed through an annual impact analysis process. EERE analyzes the impacts its programs will have on energy savings, cost savings, and carbon reduction if all program goals are met. These estimates are externally reviewed by Arthur D. Little. An integrated analysis model run by an external contractor controls for interaction effects. The integrated analysis model accounts for inter- and intra-sector double counting as well as market trends, including reductions in new electricity generation created by reduced demand.

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.

FY 2002 Performance Measures

At the level of resources proposed in this budget request, good progress is anticipated throughout the next five-year period. Demonstrative FY 2002 indicators of such progress by Renewable Energy Resources program include:

Biomass/Biofuels Energy Systems

- Initiate testing as many as four Small Modular BioPower Systems, with applications domestically and internationally.
- Develop a prototype yeast capable of fermenting multiple biomass-derived sugars to meet cost goals for the ethanol/gasoline blend markets.
- Complete technical feasibility testing of closed-loop, short rotation wood (fast-growing willows) as a dedicated supply source for power generation at two retro-fitted, existing coal power generation facilities.
- Complete technical feasibility demonstration to produce electric power by co-firing coal with switchgrass grown as a dedicated energy crop.

Geothermal Technology Development

- Confirm two new geothermal fields in the U.S.
- Complete construction of a small-scale geothermal power plant for field verification.

Hydrogen Research

- Develop and field validate 5000 psi tanks that will be low weight (7.5 percent weight of hydrogen stored to overall tank weight) and be certified for buses, and vehicles (350 mile range).
- Demonstrate natural gas reforming using catalyzing ceramics within an ion transport membrane (ITM) reactor.

Solar Energy

- Develop a 17 percent energy conversion efficiency for cadmium telluride-based thin film photovoltaic cell at the National Renewable Energy Laboratory.
- Reduce manufacturing cost of PV modules to $2.25 per Watt (equivalent to $0.23 per kWh price of electricity from an installed solar system).

Wind Energy Systems

- Begin experimental operation and testing of a 100 kW cold-weather wind turbine in an Alaskan village.
- Initiate improved resolution national wind atlas by developing resource maps for high priority regions for commercial projects.

Electric Energy Systems and Storage

- **Transmission Reliability** - In cooperation with transmission system operators, develop, test and evaluate prototype models for monitoring and analysis of reactive power, for monitoring of the delivery of ancillary services, and for the application of wide area real time measurements to monitor power flow.
- **Distributed Power** - Support accelerated development of uniform national utility interconnection standards for distributed generation and storage technologies.

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. Adapting to the level of resources proposed in this budget request, several programs will shift resources in FY 2002 in order to more efficiently and effectively meet national energy needs. Indicators of recent progress and shifts by Renewable Energy Resources program include:

Biomass/Biofuels Energy Systems

- In FY 2000, completed operational testing of the Vermont indirect biomass gasifier and produced clean biogas.

- In FY 2000, completed engineering design for Minnesota Gasification Project for a power plant for gasification of alfalfa stems.
- In FY 2000, established partnership with the timber industry, United States Forest Service, and local communities to evaluate environmental effects of forest watershed management when forest thinnings are harvested enhancing the suppression of forest fires and using these thinnings to produce ethanol, electricity, and bio-products.
- In FY 2000, conducted a competitive solicitation and select at least one partner for innovative biofuels production technologies and make awards to qualified research organizations.
- In FY 2000, completed three projects co-firing with biomass on a regular basis.
- In FY 2000, established an Interagency Council and an Advisory Committee on biobased products and bioenergy and developed a Strategic Plan for the development and use of biobased products and bioenergy as required by Executive Order 13134.
- In FY 2000, successfully demonstrated conversion of agricultural wastes to ethanol at a small commercial scale using a genetically engineered fermentative microorganism.
- In FY 2001, in collaboration with the Department of Agriculture, will complete a 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 2001, initiated a feasibility study and conceptual design of a gasifier-based cofiring process.
- 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.

Hydrogen Research

- In FY 2000, demonstrated over 90 percent absorption of CO2 in a sorbent enhanced reformer reactor for hydrogen production.
- In FY 2001, completed a hydrogen refueling station that utilizes both a natural gas reformer, and solar and wind powered electrolysers to produce hydrogen for Sun Line Transit District buses and vehicles and will produce 20 ubic meters per hour of hydrogen via steam reforming of biomass pyrolysis oil 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 primarily focus on high-density storage and small-scale reformer development for distributed power applications and fuel cell vehicles.

Geothermal Technology Development

- In FY 2000, completed two designs of advanced air-cooled condensers for geothermal applications.
- 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 2001, selected industrial partners to build two cost-shared geothermal power plants using Enhanced Geothermal Systems (EGS) technology.

- In FY 2002, the Geothermal Program will close out all field verification projects, the Enhanced Geothermal Systems (EGS) activity, and GeoPowering the West activities in order to permit these programs to be rebaselined.

Hydropower

- In FY 2001, completed conceptual design for advanced "fish friendly" hydroturbine.

Solar Energy

- In FY 2000, facilitated the installation of 20,000 solar energy systems in support of the Million Solar Roofs Initiative, bringing the total number of installed systems to 70,000.
- In FY 2000, developed a 13 percent efficient stable prototype thin-film photo-voltaic module.
- In FY 2000, demonstrate fully autonomous operation of a 10 kW dish engine system for off-grid applications.
- In FY 2000, developed a 14 percent efficient stable prototype thin-film photovoltaic module.
- In FY 2000, evaluated potential for a small (1-10 kW) dish based systems to compete in green distributed markets before 2005.
- In FY 2001, facilitate the installation of 20,000 solar energy systems, bringing the total number of installed systems to 125,000.
- In FY 2002, funding for the Concentrating Solar Power Program will applied to the installation and evaluation of solar dish systems at the University of Nevada. In the last ten years, Concentrating Solar Power technology developed in cooperation with industry has generated over 7,000,000 megaWatt hours of electricity.
- In FY 2002, the Photovoltaic Energy Systems program will achieve multi-megaWatt scale-up and viability of the high throughput ribbon-based (as opposed to ingot based) crystalline silicon technology at Evergreen Solar.
- In FY 2002, the Photovoltaic Energy Systems program is being focused more on core materials and devices R&D with less emphasis on technology validation.

Wind Energy Systems

- In FY 2000, installed and began testing of two proof-of-concept turbines under Next Generation Turbine program leading to commercial availability of technology capable of producing electricity at 2 ½ cents per kWh in 15 mph wind resource by 2003.
- In FY 2000, established Underwriters Laboratories as the first U.S.-based wind turbine certification agent with technical support from the National Wind Technology Center.
- In FY 2001, advanced wind hybrid control system technology developed jointly with USDA Agricultural Research Center were made commercially available.
- In FY 2002, program is shifting away from cooperative research and testing and concentrating on low wind speed turbine technology.

Electric Energy Systems and Storage

In FY 2001, the research and development efforts of the Electric Energy Systems and Storage programs were integrated to provide a coordinated approach for the electricity component of the Energy Grid Reliability Initiative. Collectively, these programs are focused on the development of advanced power system technologies which will enable the reliable delivery of electric services for consumer use in competitive, restructured electric markets.

- **High Temperature Superconducting R&D**

In FY 2000, achieved high temperature superconductor with current carrying capability of 1,000,000 amperes per square centimeter in laboratory tests, over 1,000 times more capacity than copper wire.

In FY 2000, installed first industrial high temperature superconducting electrical transmission cables at Southwire Plant in Carrollton, Georgia and begin testing system reliability.

In FY 2001, Southwire Company documented 6,000 hours (100 load) operation of the first successful high-temperature superconducting power delivery system to power an industrial use.

In FY 2001, install first superconducting electrical transmission cables to replace existing delivery to an urban substation in Detroit, Michigan and begin testing operation and reliability.

In FY 2001, testing on a 1,000 horsepower superconducting motor with half the losses of a comparable motor today will be completed. (In the United States, two-thirds of today's electricity is consumed by operating motors.)

In FY 2001, complete first year testing of Detroit superconducting transmission cable and document operational costs and reliability.

- **Electric Energy Storage**

In FY 2001, tests of advanced battery storage systems requiring a projected 20 percent less square footage and with a 20 percent longer life than today's systems were conducted (System space requirements are a critical factor in many customer evaluations, and system lifetime is a major factor in life cycle cost.) Achieved one-year payback in transportable 1MW energy storage system deployed at an industrial site for power quality control.

- **Transmission Reliability**

Using the initial assessments and evaluations conducted under this program, there will be a significant shift to the development of advanced technologies which will enable real-time systems control of electric transmission and distribution systems. These advanced technologies will provide real-time

information and control for additional delivery system capacity, security and reliability under competitive markets. They will also provide the flexibility to successfully integrate and reliably operate delivery systems with large amounts of distributed power. The program will also assist in developing advanced transmission congestion relief technologies, and their integration into the power grid.

Funding Profile

(dollars in thousands)

	FY 2000 Comparable Appropriation	FY 2001 Original Appropriation	FY 2001 Adjustments	FY 2001 Comparable Appropriation	FY 2002 Request
Renewable Energy Resources					
Biomass/Biofuels Energy Systems	69,379	86,160	108	86,268	80,500
Geothermal Technology Development	23,333	27,000	-89	26,911	13,900
Hydrogen Research	24,287	27,000	-119	26,881	13,900
Hydropower	4,861	5,000	-11	4,989	2,500
Solar Energy	81,410	93,525	-844	92,681	42,932
Wind Energy Systems	31,734	40,000	-447	39,553	20,500
Electric Energy Systems & Storage	37,336	52,000	-254	51,746	33,927
Renewable Support and Implementation	14,894	21,600	-100	21,500	5,118
National Renewable Energy Laboratory	1,100	4,000	-9	3,991	5,000
Program Direction	17,720	18,700	-41	18,659	19,200
Total, Renewable Energy Resources	306,054 [1]	374,985	-1,806 [2]	373,179	237,477 [3]

[1]Includes reductions for SBIR program (-$3,216,000), STTR program (-$193,000), FY 2000 Omnibus rescission, contractor savings and general reduction, and Safeguards and Security general reduction.

[2]Includes adjustments for FY 2001 Consolidated Appropriations Act, Spread of General Reduction for Safeguards and Security, and 0.22 percent Omnibus Recission.

[3]The FY 2002 amount will be modified by a budget amendment to be submitted shortly. Renewable Energy Resources will increase by $39,176,000 in the following areas: Biomass/Biofuels Energy Systems, Hydrogen, Hydropower, Electric Energy Systems and Storage, International Renewable Energy Program, and Renewable Energy Production Incentive Program. A reduction in the Energy Conservation account will offset this increase.

Public Law Authorization:

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. 106-224, "Biomass Research and Development Act of 2000"

Funding by Site

(dollars in thousands)

	FY 2000	FY 2001	FY 2002	$ Change	% Change
Albuquerque Operations Office					
Los Alamos National Laboratory	6,028	8,250	4,737	-3,513	-42.6%
National Renewable Energy Laboratory	130,334	151,803	105,580	-46,223	-30.4%
Sandia National Laboratory	33,027	35,010	17,549	-17,461	-49.9%
Golden Field Office	42,639	56,045	38,424	-17,621	-31.4%
Atlanta Regional Office	762	972	555	-417	-42.9%
Boston Regional Office	635	2,410	1,845	-565	-23.4%
Chicago Regional Office	843	736	471	-265	-36.0%
Denver Regional Office	1,116	1,328	745	-583	-43.9%
Philadelphia Regional Office	103	346	0	-346	-100.0%
Seattle Support Office	1,758	1,435	866	-569	-39.7%
Albuquerque Operations Office	2,518	4,925	2,286	-2,639	-53.6%
Total, Albuquerque Operations Office	219,763	263,260	173,058	-90,202	-34.3%
Chicago Operations Office					
Argonne National Laboratory	4,705	4,225	2,424	-1,801	-42.6%
Brookhaven National Laboratory	1,650	1,870	650	-1,220	-65.2%
Chicago Operations Office	826	1,023	110	-913	-89.2%
Total, Chicago Operations Office	7,181	7,118	3,184	-3,934	-55.3%
Idaho Operations Office					
Idaho National Engineering and Environmental Laboratory	3,143	3,750	2,275	-1,475	-39.3%
Idaho Operations Office	16,058	18,397	3,605	-14,792	-80.4%
Total, Idaho Operations Office	19,201	22,147	5,880	-16,267	-73.5%
Nevada Operations Office					
Nevada Operations Office	1,970	2,480	800	-1,680	-67.7%
Nevada Test Site	75	25	125	100	400.0%
Total, Nevada Operations Office	2,045	2,505	925	-1,580	-63.1%

(dollars in thousands)

	FY 2000	FY 2001	FY 2002	$ Change	% Change
Oak Ridge Operations Office					
Office of Scientific and Technology Information	101	114	45	-69	-60.5%
Oak Ridge National Laboratory	20,568	22,875	15,758	-7,117	-31.1%
Oak Ridge Operations Office	501	460	0	-460	-100.0%
Total, Oak Ridge Operations Office	21,170	23,449	15,803	-7,646	-32.6%
Richland Operations Office					
Pacific Northwest National Laboratory	1,150	1,200	800	-400	-33.3%
Oakland Operations Office					
Lawrence Berkeley National Laboratory	2,520	3,312	2,805	-507	-15.3%
Lawrence Livermore National Laboratory	3,270	2,970	1,780	-1,190	-40.1%
Oakland Operations Office	5,318	5,547	2,250	-3,297	-59.4%
Total, Oakland Operations Office	11,108	11,829	6,835	-4,994	-42.2%
National Energy Technology Laboratory.	7,910	11,681	10,850	-831	-7.1%
Savannah River Operations Office					
Savannah Operations Office	0	800	150	-650	-81.3%
Total, Savannah Operations Office	0	800	150	-650	-81.3%
Headquarters	16,526	29,190	19,992	-9,198	-31.5%
Total, Renewable Energy Resources	306,054	373,179	237,477	-135,702	-36.4%

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 the 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 Dependent's cost shared Wind Turbine Research partnerships with industry.

NREL provides assistance to 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 will work 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.

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, and 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 available 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 over all 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.

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 provided responsibility for providing technical assistance to developing and transition countries in the use of 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, the Hydropower Programs, and for the Geothermal Program.

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 forests 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 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 counties 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 National Laboratory is the lead laboratory 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 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 projects in the field.

Capital Operating Expenses & Construction Summary

Capital Operating Expenses

(dollars in thousands)

	FY 2000	FY 2001	FY 2002	$ Change	% Change
General Plant Projects	650	1,781	2,100	319	17.9%
General Purpose Equipment	450	2,210	2,100	-110	-5.0%
Project Engineering and Design (PED)	0	0	800	800	100.0%
Total, Operating Expenses	1,100	3,991	5,000	1,009	25.3%

Biomass/Biofuels Energy Systems

Mission Supporting Goals and Objectives

The Biomass Program (also referred to as the Biopower Energy Systems Program) and the Biofuels Energy Systems Program are major elements that support the Biomass R&D Act of 2000 by providing baseload renewable electricity and transportation fuel options which offer substantial environmental benefits to the Nation. The programs result in technologies which work toward integrated feedstock and conversion systems that will make biomass energy competitive with conventional fossil-based options.

Biopower Energy Systems

The Biopower Systems Program supports research and development of biopower technologies that can become significant contributors to the U.S. energy market by 2010. DOE's research is conducted in collaboration with the private sector and other Federal agencies, and includes field validation of technologies for producing power using a variety of fuels in various setting, including utility and distributed applications. Biomass systems promise to help meet our national energy needs, while simultaneously strengthening conventional energy independence, protecting our environment, and improving our rural economy. To meet these objectives, biopower R&D involves a combination of near-, mid-, and long-term activities. The Program's integrated R&D agenda encourages the commercialization of the most economic near-term options for new biomass power generation while laying the groundwork for advanced technologies.

By 2010, the technology advances resulting from the Biopower Program will have engaged in research and development activities will significantly increase the viability of clean, efficient, biomass technologies for a variety of markets. This achievement will be signaled by the addition of 3,000 MW of new biomass power capacity in the United States.

The program will benefit American consumers by helping to revitalize rural economies; creating jobs associated with biopower production and co-products, such as fuel, fiber, and feed; removing and utilizing residues from their waste streams; and improving the environment through reduction in greenhouse gas emissions.

Biofuels Energy Systems

The Biofuels Program funds research, development, and demonstration of technology to enable and support the expansion of an indigenous, integrated biomass-based industry that will reduce reliance on imported fuels; promote rural economic development; and provide for productive utilization of agricultural residues and municipal solid wastes.

The Biofuels Program has identified ethanol as the most promising near-term/mid-term liquid transportation fuels option. In the next several years, industry will most likely deploy ethanol
by adding product value to underutilized agricultural components (e.g., corn fiber and stover), because they are

readily available as low-cost feedstock materials. Energy crops are being developed for the long-term, as demand increases and as scientific and engineering advances make the growing, collection, and conversion of these feedstocks more affordable. Based on university and industry research and recent industry workshops, it has been determined that many of the advances in reducing ethanol production costs depend on the development of cost-effective enzyme technology to break down cellulose to simple sugars. These sugars can be converted to ethanol and/or to other chemicals (lactic acid and levulinic acid, among others), leading to an integrated biorefinery of the future. Strategic partnerships have been formed with industry, universities, and national laboratories to meet the 2005 goal identified below.

Continued support is also provided for the Regional Biomass Energy Program, a strategic alliance to overcome barriers to deploying biofuels technologies at the State and local levels. Additionally, renewable diesel alternatives provide clean fuels to complement Compression Ignition Direct Injection engine development supported by the Department of Energy Office of Transportation Technologies programs funded by the Interior and Related Agencies Appropriations Congressional Subcommittees.

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 stover.

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

By 2010, domestic ethanol production will increase to 4.4 billion gallons, with cellulosic ethanol accounting for 2 billion gallons per year.

By 2010, technologies will be developed which can produce ethanol at a U.S. average production cost of $1.07 per gallon at the ethanol plant gate, excluding distribution, retail markup, and incentives.

Funding Schedule

(dollars in thousands)

	FY 2000	FY 2001	FY 2002	$ Change	% Change
Biopower Energy Systems					
Thermochemical Conversion	1,700	3,400	4,000	600	17.6%
Systems Development	22,480	25,707	25,900	193	0.8%
Feedstock Production	3,100	3,300	3,500	200	6.1%
Regional Biomass Energy Program	1,000	1,335	1,184	-151	-11.3%
Bioenergy	3,000	6,000	2,500	-3,500	-58.3%
Subtotal, Biomass Power Systems	31,280	39,742	37,084	-2,658	-6.7%
Biofuels Energy Systems					
Ethanol Production	29,349	33,614	34,666	1,052	3.1%
Renewable Diesel Alternatives	750	750	750	0	0.0%
Feedstock Production	3,000	3,600	3,500	-100	-2.8%
Regional Biomass Energy Program	2,000	2,212	2,000	-212	-9.6%
Integrated Bioenergy Research	3,000	6,350	2,500	-3,850	-60.6%
Subtotal, Biofuels Systems	38,099	46,526	43,416	-3,110	-6.7%
Total, Biomass/Biofuels Energy Systems	69,379	86,268	80,500	-5,768	-6.7%

Detailed Program Justification

(dollars in thousands)

	FY 2000	FY 2001	FY 2002
BIOPOWER ENERGY SYSTEMS:			
Thermochemical Conversion	**1,700**	**3,400**	**4,000**

This effort conducts basic and applied research, testing, and feasibility studies in the areas of biomass combustion and biomass gasification to provide the foundation for advanced and improved technology. Experimental research is conducted in the areas of biomass combustion and cofiring as well as on the coupling of biomass conversion devices to power generation equipment, including engines, gas turbines and fuel cells. Analytical studies are also conducted on the cost, performance, economic potential, and life-cycle emissions of existing, novel, and competing power generation technologies.

Systems Development	**22,480**	**25,707**	**25,900**
■ **Cofiring with Coal**	11,580	11,912	9,500

Continue developing co-firing by exploring advanced technologies that enhance system reliability, performance, and efficiencies including work with municipalities and rural electric cooperatives. Performance is monitored and verified by analyzing initial cofiring and feedstock production trials and establishing operation and maintenance protocols. The following projects were directed by Congress to be included in this program: The Mount Wachsett College; Biomass Conversion Massachusetts project (FY 2000 $0, FY 2001 $1,000,000, FY 2002 $0); Vermont Agriculture Methane project (FY 2000 $0, FY 2001 $395,000, FY 2002 $0); and Methane Energy and Agriculture Department (MEAD), Tallamook Bay, Oregon (FY 2000 $0, FY 2001 $1,000,000, FY 2002 $0).

■ **Biomass Power for Rural Development**	4,100	4,350	5,800

This Initiative includes the New York Willow project that will produce 30-40 MW of capacity through cofired applications, and the Iowa Switchgrass project that will utilize up to 50,000 acres of switchgrass dedicated to co-firing operations. Performance will be measured by completing two Biomass Power for Rural Development projects with more than 50 MW of new biomass power generating capacity. 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: the Michigan Biotechnology Institute project to be equally derived from power and transportation systems (FY 2000 $1,500,000, FY 2001 $1,000,000, FY 2002 $0) and the Michigan State University project (FY 2000 $0, FY 2001 $500,000, FY2002 $0).

(dollars in thousands)

	FY 2000	FY 2001	FY 2002
■ **Small Modular Biopower**	1,500	3,950	5,000

This program continues 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. This effort will be expanded to include other feedstocks, to increase the flexibility, applicability and reliability of these systems.

■ **Gasification R&D and VT Gasifier Project**	5,300	5,495	5,600

The Vermont Gasifier R&D project has been completed and the technology is being commercialized by the contractor (FERCO). Efforts will now transition R&D to technologies that produce product gas from a broad range of biomass feedstocks. 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.

Feedstock Production	**3,100**	**3,300**	**3,500**

Conduct research to improve yields and reduce handling costs of herbaceous and woody crops produced on farms. Assess the effects of variability in soil type and climate on feedstock characteristics relevant to combustion and gasification systems and on soil carbon sequestration processes, as well as yield variability. Continue efforts to create tools for evaluating viability of multiple bioenergy technologies, with an emphasis on Biopower, and their impact on feedstock demand. Performance will be measured by developing 3 high-yield willow clones which increase yields by at least 20 percent. This increase is primarily to fund an assessment of the effects of variability in soil type and climate on feedstock characteristics relevant to combustion and gasification systems and on soil carbon sequestration processes, as well as yield variability.

(dollars in thousands)

	FY 2000	FY 2001	FY 2002
Regional Biomass Energy Program	**1,000**	**1,335**	**1,184**

Sponsor grants to State Energy Offices that enable technology transfer and industry support of activities to expand the near-term use of biomass conversion technologies and provide reliable information to potential biomass users. This funding continuation will sponsor grants to State Energy Offices and local industries for biomass power projects as well as to complete the integration of biomass resource assessments.

Bioenergy	**3,000**	**6,000**	**2,500**

Provide highly leveraged funds in crosscutting Bioenergy/Biorefinery 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 and bioenergy. These efforts include outreach and analysis activities. The thermo-depolymerization technology site adjacent to the Nevada Test Site was directed by Congress to be included in this program (FY 2000 $0, FY 2001 $4,000,000, FY 2002 $0).

Total, Biomass Power Systems	**31,280**	**39,742**	**37,084**

BIOFUELS ENERGY SYSTEMS:

Ethanol Production	**29,349**	**33,614**	**34,666**
■ **Advanced Fermentation Organisms R&D**	3,177	3,000	5,000

Collaborate with industry and academia to develop organism platforms with increased stability, robustness, and ability to ferment mixed sugars from cellulosic wastes, agricultural residues, and energy crops such as switchgrass, to lower the cost of ethanol production from biomass. Increased funding of $2,000,000 will initiate yeast platform by developing advanced genetic engineering tools and begin genetic manipulation of promising yeast strains. Performance will be measured by developing a yeast that can ferment the biomass-derived sugars, glucose, arabinose and xylose to meet cost goals for ethanol low blend markets. This yeast can also be the basis for the production of other high-value chemicals.

(dollars in thousands)

	FY 2000	FY 2001	FY 2002
■ **Advanced Cellulase R&D**	4,422	7,014	12,000

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. Increased funding in FY 2002 of $4,986,000 for industrial partnerships is to develop highly productive enzyme systems which can produce low cost sugars for the production of ethanol and biobased chemicals. Cost effective cellulase systems remain the most significant barrier to the commercialization of ethanol enzymatic hydrolysis technology. Performance will be measured by fifty percent reductions in enzyme costs relative to the industry baseline.

■ **Pretreatment R&D**	3,000	2,100	4,500

Continue to research and develop pretreatment technology. Continue evaluations of novel pretreatment systems. Second, only to cellulase systems, pretreatment methods remains he most challenging unit operation. Past research and development has not led to cost effective solutions. Increased funding in FY 2002 of $2,400,000 will refocus on developing and understanding fundamental principles of biomass depolymerizations, in collaboration with academia and industry, to aid in developing novel pretreatment systems to improve process efficiency and reduce costs.

■ **Integrated Process Development**	11,000	10,000	10,000

Evaluate and optimize ethanol process unit operations. 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 (stalks and fibrous components). Funding provides technical and engineering support for industrial partners.

(dollars in thousands)

	FY 2000	FY 2001	FY 2002
■ **Cellulose to Ethanol Production Facilities**	7,750	11,500	3,166

Continue to develop partnerships to demonstrate cost-effective conversion of corn stalks to ethanol. The use of corn fiber for ethanol production offers an opportunity for integrating cellulosic ethanol into existing commercial facilities. Competitive solicitations will be conducted to support the integration of cellulosic conversion processes with existing commercial facilities. Performance will be measured by demonstrating feasibility of commercial production of ethanol and co-products from corn fiber stream, in partnership with a major ethanol producer. Decreased funding will reduce the number and require higher cost share by industry partners, in order to focus on core R&D (Advanced Organism R&D, Advanced Cellulases R&D, Pretreatment R&D) and integrated process testing.

The following projects were directed by Congress to be included in the Biofuels Program: Continuation of biomass research at the Energy and Environmental Research Center on the integration of biomass with fossil fuels for advanced power systems transportation fuels (FY 2000 $0, FY 2001 $1,000,000 FY 2002 $0); the University of Louisville to work on the design of bioreactors for production of fuels and chemicals for ethanol production (FY 2000, $0, FY 2001, $600,000 FY 2002 $0); design and construction of a demonstration facility for regional biomass ethanol manufacturing in Southeast Alaska (FY 2000, $0, FY 2001, $2,000,000, FY 2002 $0); $2,000,000 funds for the Michigan Biotechnology Institute to be equally derived from power and transportation systems (FY 2000, $1,500,000 FY 2001, $1,000,000 FY 2002 $0). Funds for these projects are accounted for in the Cellulose to Ethanol Production Facilities Activity.

Renewable Diesel Alternatives (formerly Biodiesel Production)	**750**	**750**	**750**

Develop cropping systems to produce low cost biodiesel, and conduct research to determine performance characteristics of alternatives for the diesel fuel pool, e.g., blends, additives, and lubricants.

(dollars in thousands)

	FY 2000	FY 2001	FY 2002
Feedstock Production	**3,000**	**3,600**	**3,500**
■ **Feedstock Development Centers**	2,350	2,700	2,400

Conduct research and development of model energy crops and residues at integrated biomass feedstock development centers in the Southeast and Midwest/Plains States including residue management, breeding, physiology, advanced biotechnology, carbon sequestration and storage. The Environmental Effects of Energy Crop Deployment research, and the Energy Crop Seedling/Planting Stock Selection Research to select promising genotypes, will be integrated into the Feedstock Development Centers. The funding decrease eliminates research and development of model tree crops such as hybrid poplar and willow at the integrated biomass feedstock development centers, consistent with analyses indicating that agricultural residues and perennial grasses have the better potential as a feedstock for ethanol and biobased chemicals production in the near and mid-term.

■ **Switchgrass Variety Testing and Scale-up Research**	250	400	300

Continue to evaluate newly developed switchgrass lines in field trials established at five USDA National Plant Materials Testing Centers. Establish 10-20 acre scale-up plantings of switchgrass to evaluate yield, operational issues, and cost data. The funding decrease will result in fewer evaluations than originally planned.

■ **Feedstock Composition and Multi Product Use**	200	200	200

Develop plants tailored to produce multiple products, using advanced biotechnology. Research will be conducted to develop the genetic tools required to alter plant composition and survivability leading ultimately to improved conversion efficiencies and cost reductions for biobased fuels and chemicals production. Performance will be measured by constructing a chromosome map containing at least 100 markers for future use in the genetic improvement of switchgrass.

■ **Infrastructure Development** (formerly Mechanization Research)	200	300	600

Evaluate and develop harvest, handling, and storage systems for agricultural residues and switchgrass. Increased funding of $300,000 to evaluate handling, storage, and logistics for agricultural wastes will reduce feedstock cost for ethanol and co-products.

Regional Biomass Energy Program	**2,000**	**2,212**	**2,000**
■ **Utilize the Regional Biomass Energy Program** . . .	1,400	1,712	2,000

Utilize unique State and local networks to identify and help to overcome barriers to the development and deployment of biofuels. Additional funds will support bioenergy R&D, cost-shared site studies for biofuels and co-product facilities, outreach, and technology transfer. Performance will be measured by demonstrating the use of ethanol and biodiesel in at least 10 national parks, in collaboration with the National Park Service

■ **Biodiesel Fuel Formulations**	600	500	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.

Integrated Bioenergy Research and Development	**3,000**	**6,350**	**2,500**

Identify gaps in biobased products and bioenergy portfolio. Conduct life cycle analysis on biobased products and bioenergy. Develop research plans based on roadmaps, gap analysis, and life cycle analysis, which will be reviewed by the Technical Advisory Committee that was created by the Biomass R&D Act of 2000. Reduced funding allows for the above scope of work. Funds have been allocated to core Bioenergy R&D activities consistent with the Biomass R&D Act of 2000.

Total, Biofuels Energy Systems	**38,099**	**46,526**	**43,416**
Total, Biomass/Biofuels Energy Systems	**69,379**	**86,268**	**80,500**

Explanation of Funding Changes from FY 2001 to FY 2002

	FY 2002 vs. FY 2001 ($000)
BIOPOWER ENERGY SYSTEMS:	
Thermochemical Conversion	
■ The program will add research efforts that support systems integrated research and modeling efforts of gasification, including gas cleanup and conditioning.	+600
Systems Development	
■ Co-firing with Coal Initiative - To accommodate the reduced budget request, activities within several projects will be delayed by one year.	-2,412
■ Biomass Power for Rural Development - Additional efforts will include work at the Chariton Valley, New York Salix, and SRI's Alabama Switchgrass projects and bring the R&D projects closer to commercial availability.	+1,450
■ Small Modular Biopower - This increase will provide for the additional cost of field validation for these modular system prototypes. This effort will be also be expanded to examine other feedstocks to increase the flexibility, applicability, and reliability of these systems.	+1,050
■ Gasification R&D and Vermont Gasifier Project - The Vermont Gasification project has been completed. R&D efforts will focus on industry-partnered gas conditioning and clean-up.	+105
Total Funding Change, Systems Development	+193
Feedstock Production	
■ This increase will fund an assessment of the effects of variability in soil type and climate on feedstock characteristics relevant to combustion and gasification systems. This data will be applied to R&D to rapidly domesticate new and advanced feedstocks.	+200
Regional Biomass Energy Program	
■ This decrease will continue funding of grants at a reduced level to State Energy Offices and local industries for biomass power projects and begin to define opportunities defined in previous resource assessments.	-151
Bioenergy	

	FY 2002 vs. FY 2001 ($000)
■ This decrease reflects the integration of Bioenergy activities into the base systems development and feedstock programs. Also, no further funding is provided for the thermo-deploymerization technology demonstration adjacent to the Nevada Test Site.	-3,500
Total Funding Change, Biomass Power Systems	-2,658

BIOFUELS ENERGY SYSTEMS PROGRAM:

Ethanol Production

■ Advanced Fermentation Organisms R&D - Biocatalysts that will be used in commercial systems must be productive, robust, cost effective. The increase is necessary for the development of yeasts as platform organisms for the production of bioenergy and biobased products.	+2,000
■ Advanced Cellulase R&D - Low cost simple sugars from cellulosic biomass could provide a base chemical feedstock that can be used to produce biofuels and biobased products, including ethanol, lactic acid, and succinic acid. The increase is necessary to partner with industry to develop highly productive enzyme systems for the conversion of cellulose to simple sugars.	+4,986
■ Pretreatment R&D - Prior to biocatalyst (enzyme) conversion of biomass to simple sugars, biomass is necessarily exposed to physical and chemical treatment, referred to as pre-hydrolysis or pretreatment which facilitates enzyme action. The increased funding is necessary to support the development of novel pretreatment systems by conducting applied research to understand the fundamental principles of these systems.	+2,400
■ Cellulose to Ethanol Production Facilities - Significant funding has been expended by the Program, in partnership with industry, to demonstrate first generation technology (dilute acid hydrolysis) for the production of ethanol from biomass wastes. The Program's commitments to current partners will be completed in FY 2001. The reduced funding reflects the need for resources to be allocated to core R&D efforts, including pretreatment, cellulases, and fermentation organisms development, in order to develop second generation technology (enzymatic hydrolysis).	-8,334
Total Funding Change, Ethanol Production.	+1,052

	FY 2002 vs. FY 2001 ($000)
Feedstock Production	
■ Feedstock Development Centers - The feedstock development centers have been focused on crops such as switchgrass that will be grown for energy and co-products (non food). The most promising near- and mid-term supply will be agricultural residues and other wastes. The decreased funding will result in fewer centers being fully supported while permitting the program to pursue higher priority infrastructure research and development for agricultural residues.	-300
■ Switchgrass Variety Testing and Scale-up Research - The decreased funding is necessary to support higher priority infrastructure development (equipment, logistics) for agricultural residues.	-100
■ Infrastructure Development (formerly Mechanization Research) - Increased funding is required to evaluate and improve methods for removal, logistics, storage of agricultural waste and switchgrass to lower cost.	+300
Total, Funding Change, Feedstock Production.	-100
Regional Biomass Energy Program	
■ Utilize the Regional Biomass Energy Program - With its existing unique state and local network, the Program is positioned to disseminate bioenergy information and conduct outreach and technology transfer. Additional funding will support outreach and technology transfer activities.	+288
■ Biodiesel Fuel Formulations - Eliminates this office's collaborative program effort with the Office of Heavy Duty Vehicles in the Office of Transportation Technologies.	-500
Total, Funding Change, Regional Biomass Energy Program	-212
Integrated Bioenergy Research and Development	
■ Integrated Bioenergy Research and Development - Major program shifts to increase core technology R&D to support the Biomass R&D Act of 2000 (fuels and bioproducts) results in fewer resources needed for this activity.	-3,850
Total Funding Change, Biofuels Energy Systems	-3,110
Total Funding Change, Biomass/Biofuels Energy Systems	-5,768

Geothermal Technology Development

Mission Supporting Goals and Objectives

The Geothermal Technology Development 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 large portion of the Nation's heat and power needs. The Program sponsors research and development that will help the United States realize substantial economic, environmental, and energy security benefits. Technology improvements will reduce the levelized cost of generating geothermal power to 3 to 5 cents/kWh by 2010, as compared to 5 to 8 cents/kWh in 2000. By so doing, geothermal energy will supply the electrical power or heat energy needs of five million homes and businesses in the United States by 2015. This compares with about 1.5 million homes that used geothermal energy in 2000.

In helping to meet the priority needs of industry, the Program will focus primarily on exploration and drilling research. Better understanding of geothermal processes and improved analytical methods of exploration will enable industry to locate and characterize new geothermal fields at greatly reduced risk. Advanced technology for drilling wells will provide access to deeper resources while lowering costs, thereby expanding the economic resource base. Program goals will be achieved with a balanced strategy of technology improvements in partnership with industry on cost-shared, competitively-selected projects.

Funding Schedule

(dollars in thousands)

	FY 2000	FY 2001	FY 2002	$ Change	% Change
Geoscience and Supporting Technologies	10,071	7,300	3,500	-3,800	-52.1%
Exploration and Drilling Research	6,975	8,200	6,900	-1,300	-15.9%
Energy Systems Research and Testing	6,287	11,411	3,500	-7,911	-69.3%
Total, Geothermal Technology Development	23,333	26,911	13,900	-13,011	-48.3%

Detailed Program Justification

	(dollars in thousands)		
	FY 2000	FY 2001	FY 2002
Geoscience and Supporting Technologies	**10,071**	**7,300**	**3,500**
P **Core Research**	3,514	3,000	3,000

Understand complex natural geothermal processes and develop technology to facilitate producing geothermal resources 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 in reservoir management that promise to give industry reliable tools for reservoir analysis and production.

P **Enhanced Geothermal Systems (EGS)**	3,049	1,700	0

Complete preliminary designs for projects employing EGS technology. The results will be documented and distributed to stakeholders, and projects will be closed out.

P **University Research**	3,508	2,600	500

Conduct competitively-selected research projects in earth science at universities to expand the geothermal knowledge base. Knowledge gained from this work will result in new and improved technology that will help meet cost goals. The decrease in funding reflects the completion, or termination, of multi-year grant awards and a realignment of project activities to complement core research.

P **Seismic Exploration**	0	0	0

In FY 2002, this subactivity has been incorporated into Detection and Mapping, to reflect the role of seismic technology as an important tool in geothermal resource exploration.

P **Detection and Mapping**	0	0	0

In FY 2002, this subactivity has been placed under a new key activity, Exploration and Drilling Research, due to the programmatic similarity and administrative overlap between the resource exploration and drilling components of the Program.

	(dollars in thousands)		
	FY 2000	FY 2001	FY 2002
Exploration and Drilling Research	**6,975**	**8,200**	**6,900**
P **Detection and Mapping**	1,475	2,700	3,000

Continue cost-shared exploration projects initiated with industry in FY 2000 to find and confirm new geothermal resources within the United States. Continue to conduct geophysical, geological, and geochemical exploration research. The budget increase will allow some acceleration of cost-shared projects to bring new geothermal fields into production. This subactivity has been moved from Geoscience and Supporting Technologies because of its close programmatic relationship to Drilling. The work contributes directly to the program goal to serve five million homes by 2015. Performance will be measured by confirming at least two new geothermal reservoirs in the United States during FY 2002.

P **Innovative Drilling Subsystems**	5,100	4,800	3,800

Continue development of major components, such as the Diagnostics-While-Drilling (DWD) subsystem, for integration into an Advanced Drilling System that will reduce the cost of drilling geothermal wells by up to 50 percent, from $300 per foot in 2000 to $150 per foot by 2008. In FY 2002, DWD research, listed below as a separate subactivity in FY 2001, is included under the Innovative Drilling Subsystems subactivity. The change in funding is the result of channeling the majority of subsystem research into DWD development while de-emphasizing work on subsystems of lesser priority, such as drill bits.

P **Near-Term Technology Development**	400	700	100

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

P **Diagnostics While Drilling**	0	0	0

In FY 2002, this subactivity, which is essential to the development of an Advanced Drilling System, has been incorporated above into Innovative Drilling Subsystems.

Energy Systems Research and Testing	**6,287**	**11,411**	**3,500**
P **Advanced Heat and Power Systems**	3,405	3,000	2,500

Improve technology in heat conversion and power systems for application to a broad range of geothermal resources and environmental conditions. The subactivity involves laboratory research on innovative systems, including heat exchangers, air-cooled condensers, and other components, for both low and high temperature applications. The reduction in funding stems from the completion of work on advanced heat cycles and some condenser studies.

(dollars in thousands)

	FY 2000	FY 2001	FY 2002
P **Systems Field Verification**	0	1,745	0

Conclude work on the development of small-scale electric power plants and direct use projects and close out contracts with industry partners. Project documentation of engineering designs will be provided for all projects, enabling industry to conduct comparative analyses of designs for future power plant developments. In FY 2001, this subactivity was designated as Small-Scale Field Verification.

P **Industry Support**	2,882	5,066	1,000

Provide technical, economic, and institutional analysis and support, including outreach and communication, for both low and high temperature applications. Funding in FY 2002 is decreased to reflect completion of the Lake County Basin 2000 Geothermal Project, which was directed by Congress (FY 2000 $0, FY 2001 $2,000, FY 2002 $0), and to support high priority work in other program areas.

P **GeoPowering the West**	0	1,600	0

Conclude outreach activities for addressing regional and state geothermal development opportunities and barriers. The results of those activities will be shared with stakeholders from the public and private sectors.

Total, Geothermal Technology Development	**23,333**	**26,911**	**13,900**

Explanation of Funding Changes from FY 2001 to FY 2002

	FY 2002 vs. FY 2001 ($000)
Geoscience and Supporting Activities	
# Enhanced Geothermal Systems - The decrease represents close out of financial assistance awards to industry partners.	-1,700
# University Research - University grants have been reduced as a result of concluding several multi-year awards and changing scientific and technical studies to complement work in Core Research.	-2,100
Total, Geoscience and Supporting Activities	-3,800

	FY 2002 vs. FY 2001 ($000)
Exploration and Drilling Research	
# Detection and Mapping - Geothermal resource detection and mapping activities will allow greater emphasis by the Program on finding the large, hidden resources believed to exist throughout the western states. The increase in funding over the FY 2001 budget for work in this area will support drilling costs in Phase 2 of the Geothermal Resource Exploration and Definition Project.	+300
# Innovative Drilling Subsystems - This subactivity will focus primarily on the Diagnostics-While Drilling (DWD) subsystem, the key component of the Advanced Drilling System. The reduction in FY 2002 funding results from placing emphasis on DWD research while scaling back development of other subsystems.	-1,000
# Near-Term Technology Development - The decrease in funding reflects completion of conventional drilling equipment and practices projects. Additional new work in this area is not planned.	-600
Total, Exploration and Drilling Research	-1,300
Energy Systems Research and Testing	
# Advanced Heat and Power Systems - The decrease reflects the completion of work in selected technical areas.	-500
# System Field Verification - The decrease in funding results from ending cost-shared field activities to develop small-scale electric power plants and direct use projects.	-1,745
# Industry Support -. Funding in FY 2002 is decreased due to completion of the Lake County Basin 2000 Geothermal Project and diversion of resources to other program areas.	-4,066
# GeoPowering the West - Work in this area ends and the results transferred to regional and state stakeholder partners.	-1,600
Total, Energy Systems Research and Testing	-7,911
Total Funding Change, Geothermal Technology Development	-13,011

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 energy 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 produced 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.

The Hydrogen Program will coordinate with the Department of Transportation and EERE's Office of Transportation Technologies 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. By 2020, an integrated process development unit will be operational which 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 by-product is water. Hydrogen can be produced from either fossil or renewable resources and as a transportable fuel, it has greater flexibility than electricity for transportation vehicle and remote area use, so many scientists see it as the basis for the total sustainable, clean energy economy of the future.

Funding Schedule

(dollars in thousands)

	FY 2000	FY 2001	FY 2002	$ Change	% Change
Core Research and Development	13,050	14,725	7,900	-6,825	-46.4%
Technology Validation	8,757	9,009	4,900	-4,109	-45.6%
Analysis and Outreach	2,480	3,147	1,100	-2,047	-65.0%
Total, Hydrogen Research and Development	24,287	26,881	13,900	-12,981	-48.3%

Detailed Program Justification

(dollars in thousands)

	FY 2000	FY 2001	FY 2002
Core Research and Development	**13,050**	**14,725**	**7,900**
P **Thermal Processes**	5,300	5,500	2,840

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. The levels of 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 $0) and the Gasification of Iowa Switch project (FY 2000 $0, FY 2001 $250,000, FY 2002 $0). Performance will be measured by demonstrating the Ion Transport Membrane (ITM) process in a laboratory setting at an equivalent of 24,000 standard cubic feet per day. Decreased funding of $2,660,000 will delay the achievement of the ITM milestone by four years (until 2005) and result in the termination of eight industry and university programs on biomass and natural gas reforming technologies.

(dollars in thousands)

	FY 2000	FY 2001	FY 2002
P **Photolytic Processes**	2,565	2,884	1,660

Support research into biological systems and advanced semi-conductors which will directly split water to hydrogen and oxygen. Fabricate a modular photoelectrochemical (PEC) production cell, perform characterization testing of a strain of algae producing large volumes of hydrogen from water, and develop higher efficiency multi-junction amorphous silicon semi-conductors. Decreased funding of $1,224,000 will delay the completion of the milestone by two years (2004), reduce the budget on three laboratory research projects developing photobiological processes to produce hydrogen from water by half and result in the termination of four other university projects developing semiconductors to split water into hydrogen and oxygen. Performance will be measured by designing a process development unit for photoelectrical production of hydrogen.

P **Storage**	3,247	3,284	1,800

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. Decrease in funding will delay the milestone by one year, until 2003, and result in the termination of three university, three industry and two national laboratory projects, developing advanced adsorbents for on board vehicle storage. Performance will be measured by fabrication of a hydride storage tank that can achieve 5.5 percent by weight hydrogen with a desorption temperature of 100 EC.

P **Utilization**	1,938	3,057	1,600

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. 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. The funding reduction of $1,457,000 will delay the completion of the solid oxide electrolyzer milestone from 2002 until 2006, and result in the termination of four industry and two university projects developing sensors for leak detection in a fuel cell vehicle and the stretch out of co-funded projects with the Office of Fossil Energy that produce hydrogen, sequester the carbon dioxide and produce high value carbon products.

(dollars in thousands)

	FY 2000	FY 2001	FY 2002
Technology Validation	**8,757**	**9,009**	**4,900**
P **Renewable Energy Systems**	1,568	1,986	1,080

Install and operate biomass to hydrogen and one wind/reversible hydrogen generation and storage fuel cell system and validate the economic viability of these systems for remote and on-grid utility applications. The $906,000 decrease will allow Phase 2 completion of a reversible fuel cell project, and install and operate an electrolyzer system at a renewable system site. Reductions in electrolyzer costs to achieve a factor of two reductions by 2002 will be delayed for 2.5 years. Advanced pyrolysis projects to convert switchgrass and sugar cane to hydrogen will be deferred.

P **Distributed/Remote Power**	2,389	1,153	450

Install and validate at a user site a residential, power park and off-grid power system. Decreased funding of $703,000 will eliminate all diesel fuel cell activities for Alaska and defer the power park validation efforts more than two years.

P **Hydrogen Infrastructure**	4,800	5,870	3,370

Validate technologies for hydrogen infrastructure for fueling of hydrogen vehicles. Complete safety tests on high pressure hydrogen storage tanks and cryogas tanks. Install these tanks on vehicle test beds for operational testing. The following project was directed by Congress to be included in this program: Multi-year demonstration of Underground Mining Locomotive and an Earth Loader Powered by Hydrogen at existing facilities within Nevada (FY 2000 $0, FY2001 $2,000,000 FY 2002 $0). The decreased funding request of $2,500,000 reflects completion of the installation of a natural gas to hydrogen refueling station, lower funding to several industry storage and refueling projects identified in our collaboration with the Office of Transportation Technologies solicitation, and elimination of the hydrogen locomotive and front-end loader projects.

(dollars in thousands)

	FY 2000	FY 2001	FY 2002
Analysis and Outreach	**2,480**	**3,147**	**1,100**

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. Decreased funding of $2,047,000 reflects elimination of educational related activities and a funds shift from lower priority analysis work to higher priority analysis work. The Montana Trade Port Authority, Billings, Montana Project was directed by Congress to be included in this program (FY 2000 $350,000, FY 2001 $350,000, FY 2002 $0).

Total, Hydrogen Research	**24,287**	**26,881**	**13,900**

Explanation of Funding Changes from FY 2001 to FY 2002

		FY 2002 vs. FY 2001 ($000)
Core Research and Development		
#	Thermal Processes -The reduction eliminates all higher risk processes that require a major technological breakthrough. These include processes that decompose hydrogen sulfide, use solar energy to reform natural gas, and produce hydrogen from waste materials.	-2,660
#	Photolytic Processes -The reduction will eliminate projects producing hydrogen from biological systems and stretch out those projects which use semi-conductors to split water into hydrogen and oxygen.	-1,224
#	Storage -The decrease is due to the elimination of a number of new approaches for carbon storage, and to stretch out the development of a hydride storage system.	-1,484
#	Utilization - The decrease is due to the elimination of a number of sensor projects, reduction in the solid oxide electrolyzer research and the stretch out of a number of projects that utilize hydrogen with the Office of Fossil Energy.	-1,457
Total, Core Research and Development		-6,825
Technology Validation		

		FY 2002 vs. FY 2001 ($000)
#	Renewable Energy Systems - The decrease is due to the stretch out of the advanced pyrolysis projects to produce hydrogen from biomass feedstocks and the elimination of one electrolyzer projects with industry.	-906
#	Distributed/Remote Power - The decrease will eliminate funding for all diesel reforming work to produce hydrogen for fuel cells in remote areas of Alaska and defer the power park integration efforts.	-703
#	Hydrogen Infrastructure - The decrease will eliminate funding for all activities not required to support the Office of Transportation Technologies joint solicitation.	-2,500
Total, Technology Validation		-4,109
Analysis and Outreach		
#	The decreased funding will eliminate all funded activities for education, outreach and information exchange with middle schools, high schools and colleges. Eliminate all analysis projects that do not involve technical assessments of funded research activities.	-2,047
Total Funding Change, Hydrogen Research		-12,981

Hydropower

Mission Supporting Goals and Objectives

The Hydropower Program improves the technical, economic, and environmental performance of the Nation's abundant, in-place hydropower resources through collaborative research and development with industry and other Federal agencies.

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. Current hydropower technology, while essentially emission-free, can have undesirable environmental effects, such as fish injury and mortality from passage through turbines, as well as detrimental changes in the quality of dissolved gases in downstream water. Advanced hydropower turbine technology could minimize these adverse effects yet preserve the ability to generate electricity from an important renewable resource.

The efforts of the Hydropower program will facilitate the development of a commercially viable turbine technology capable of reducing the rate of fish mortality to 2 percent or lower by 2015 (compared with turbine-passage mortalities of 5 to 10 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 substitute to fossil fuels.

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.

Funding Schedule

(dollars in thousands)

	FY 2000	FY 2001	FY 2002	$ Change	% Change
Advanced Turbine Research and Development	4,861	4,989	2,500	-2,489	-50.0%
Total, Hydropower	4,861	4,989	2,500	-2,489	-50.0%

Detailed Program Justification

		(dollars in thousands)		
		FY 2000	FY 2001	FY 2002
Advanced Turbine Research and Development		**4,861**	**4,989**	**2,500**
P	**Large Turbine Testing**	0	2,300	0
	Funding is eliminated for cost-shared testing and support of competitively selected environmentally-friendly large turbine (greater than 1 MW) designs developed by industry.			
P	**Low-Head/Low-Power Testing**	0	500	0
	Funding is eliminated for cost-shared testing and support of competitively selected environmentally-friendly low head/low power turbine designs developed by industry.			
P	**Biologically-Based Criteria Development**	1,041	1,409	1,000
	Develop biological experiments and instrumentation development to establish biologically-based performance criteria. The decrease in funding of $409,000 is redirected for the Advanced Turbine Pilot-Scale Testing and the Mini-Hydro Research and Development efforts.			
P	**Advanced Turbine Pilot-Scale Testing**	3,800	700	800
	Perform pilot-scale proof-of-concept testing of the Alden Research Laboratory advanced turbine conceptual design to verify predicted biological performance. $100,000 in increased funding will allow completion of the planned biological and hydraulic testing program. Performance will be measured by successful completion of proof-of-concept testing activities.			
P	**Mini-Hydro Research and Development**	20	80	700
	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. The $620,000 increase will provide for the continuation of the on-going resource assessment activities as well as the investigation of promising turbine designs.			
Total, Hydropower		**4,861**	**4,989**	**2,500**

Explanation of Funding Changes from FY 2001 to FY 2002

		FY 2002 vs. FY 2001 ($000)
Advanced Turbine Research and Development		
Large Turbine Testing		
#	Funding eliminated for large turbine testing to maintain funding for completing higher priority pilot-scale testing, supporting biological studies and continuation of low head/low power/mini-hydro R&D.	-2,300
Low-Head/Low-Power Turbine Testing		
#	Funding eliminated for low-head/low-power testing to maintain funding for completing higher priority pilot-scale testing, supporting biological studies, and continuation of low head/low power/mini-hydro R&D.	-500
Biological-Based Criteria Development		
#	Decreased funding for biological criteria development to maintain full funding of pilot-scale turbine testing and low head/low power/mini-hydro R&D.	-409
Advanced Turbine Pilot-Scale Testing		
#	Increased funding to complete proof-of-concept testing of the Alden Research Laboratory advanced turbine design to determine biological and hydraulic performance.	+100
Mini-Hydro Research and Development		
#	Increased funding to begin significant low head/low power and mini-hydro R&D effort including continued resource assessment activities and additional test and verification activities.	+620
Total Funding Change, Hydropower		-2,489

Solar Energy

Mission Supporting Goals and Objectives

The Office of Solar Energy Technologies sponsors research and development (R&D) that improves the performance and reliability while reducing the cost of solar technologies that can harness the sun's energy. With their inherent flexibility and scalability, the solar programs support a tremendous range of applications including large-scale power production, on-site electricity generation, and thermal energy for space heating and hot water. Solar technologies have a number of unique benefits. For example, small-scale distributed solar systems are able to provide energy at the point of use which can significantly shave utility peak loads and eliminate transmission and distribution losses, while increasing energy service reliability. Solar systems also increase customer choice, reduce price volatility, emit virtually no harmful emissions, and reduce dependence on foreign fuel supplies. The goals of the solar programs are given below:

- Concentrating Solar Power (CSP) R&D Program – Complete testing of the 25 kW dish system at the University of Nevada and terminate all activities with the least disruption to industry, university, and National Laboratory partners.

- National Photovoltaic R&D Program – By 2005, increase the efficiency of thin film modules from the current 7 percent to 11 percent in multi-megaWatt production; reduce the direct manufacturing cost of photovoltaic modules by 30 percent from the current average cost of $2.50/Watt to $1.75/Watt; establish greater than 20-year lifetime for PV systems by improving the reliability and lifetime of balance-of-systems components and reducing recurring costs by 40 percent; and partner with the U.S. PV industry to help achieve their Industry Roadmap goals, to attain a near term goal of 1 gigaWatt cumulative U.S. sales (export and domestic) by 2005 and 30 gigawatts by 2020.

- Solar Buildings Technology Research – Complete R&D on new polymers and manufacturing processes to reduce the cost of solar water heating from today's 8¢/kWh to 4¢/kWh by 2004. The integration of solar technology and energy efficient buildings will result in an annual energy bill of less than $600 for an average size home by 2004 and zero by 2010.

Although the cost of solar technology has been reduced by over 60 percent in the last 15 years, more technical advances are needed to compete with lower priced fossil fuels in major energy markets. Toward this end, the solar technology program supports the research of world-class scientists and engineers in industry, universities, and the national laboratories. This research is positioning solar technology to provide economic, environmentally clean energy for the 21st century and beyond. A key strategy in putting solar technology at the point of use is making it an integral part of residential or commercial buildings (e.g., solar shingles that generate electricity and roof-integrated solar water heaters) or adapting it for a community's distributed power needs (e.g., small solar dish systems). DOE's efforts to reduce building energy consumption through energy efficiency and provide on site renewable energy production could lead to zero-net-energy buildings where all of their energy needs are economically met by renewable energy sources.

Funding Schedule

(dollars in thousands)

	FY 2000	FY 2001	FY 2002	$ Change	% Change
Concentrating Solar Power					
Distributed Power System Development	3,849	5,950	1,932	-4,018	-67.5%
Dispatchable Power System Development	5,638	4,630	0	-4,630	-100.0%
Advanced Component Research	5,437	3,130	0	-3,130	-100.0%
Subtotal, Concentrating Solar Power	14,924	13,710	1,932	-11,778	-85.9%
Photovoltaic Energy Systems					
Fundamental Research	11,571	18,360	9,400	-8,960	-48.8%
Advanced Materials and Devices	25,000	26,000	20,100	-5,900	-22.7%
Technology Development	28,000	30,700	9,500	-21,200	-69.1%
Subtotal, Photovoltaic Energy Systems	64,571	75,060	39,000	-36,060	-48.0%
Solar Building Technology Research					
Space Conditioning and Water Heating	1,915	3,911	2,000	-1,911	-48.9%
Subtotal, Solar Building Technology Research	1,915	3,911	2,000	-1,911	-48.9%
Total, Solar Energy	81,410	92,681	42,932	-49,749	-53.7%

Detailed Program Justification

(dollars in thousands)

	FY 2000	FY 2001	FY 2002
CONCENTRATING SOLAR POWER:			
# **Distributed Power System Development**	**3,849**	**5,950**	**1,932**
• **Grid Reliability Systems**	2,657	4,310	1,932
After the installation and checkout of the 25 kW dish system at the University of Nevada has been completed, all activities will be terminated. The following project was directed by Congress to be included in this program: University of Nevada - Las Vegas, 1.0 MW dish engine field validation power (FY 2000 $0, FY 2001 $1,000, FY 2002 $0).			
• **Remote Power Systems**	1,192	1,640	0
Upon completion of the installation of a 10 kW dish system on Native American lands, all activities will be terminated. This system will be operated and maintained by DOE-trained Native American personnel.			
# **Dispatchable Power System Development**	**5,638**	**4,630**	**0**
• **Low Cost System Designs**	3,020	2,550	0
Terminate all activities and direct funding to higher priority work within Solar Energy.			
• **Storage and Tech Support**	2,618	2,080	0
Terminate all activities and direct funding to higher priority work within Solar Energy.			
# **Advanced Component Research**	**5,437**	**3,130**	**0**
High Efficiency System Designs	2,586	710	0
Terminate all activities and direct funding to higher priority work within Solar Energy.			
• **Analysis and Field Operations**	1,756	1,490	0
Terminate all activities and direct funding to higher priority work within Solar Energy.			
• **Innovative Power Converters**	1,095	930	0
Terminate all activities and direct funding to higher priority work within Solar Energy.			
Total, Concentrating Solar Power	**14,924**	**13,710**	**1,932**

(dollars in thousands)

FY 2000	FY 2001	FY 2002

PHOTOVOLTAIC ENERGY SYSTEMS:

		FY 2000	FY 2001	FY 2002
#	**Fundamental Research**	**11,571**	**18,360**	**9,400**
	• **Measurement and Characterization**	5,471	5,960	3,500

Continue research to identify efficiency-limiting defects and advance the fundamental understanding of both PV materials and devices using state-of-the-art characterization techniques. Only most critical research in support of industry will be conducted in FY 2002. Transfer findings to the PV community.

	• **Basic Research/University Programs**	5,000	6,700	3,900

Continue only highest priority university and industrial research in response to competitive solicitation issued in FY 2000 for basic R&D on breakthrough, non-conventional PV technologies (Beyond the Horizon). Conduct only the highest priority research and analysis that improves the understanding of fundamental properties and performance of crystalline silicon, thin film materials and novel materials and cell devices.

	• **High Performance Advanced Research**	1,100	5,700	2,000

Reduce High Performance Initiative to focus only on contracts that can lead to higher efficiency thin film technologies. Postpone contracts and research on 33 percent concentrator systems. Performance will be measured by identifying key issues and pathways to achieving a 25 percent multi-junction thin film cell.

#	**Advanced Materials and Devices**	**25,000**	**26,000**	**20,100**
	• **Thin Film Partnership Program**	17,000	18,500	8,000

Re-compete the Thin Film Partnership Program in FY 2002 and fund only the most promising industry cost shared contracts that address near term advancements. Performance will be measured by demonstrating a 19 percent-efficient thin film cell.

	• **Crystalline Silicon/High Efficiency Devices and Reliability**	8,000	7,500	2,600

Support only the most innovative research on high efficiency devices and silicon crystal growth methods with improved throughput, conversion efficiency, and lower energy and materials cost as compared to current methods. Support only the highest priority module reliability research.

(dollars in thousands)

	FY 2000	FY 2001	FY 2002
• **Advanced Manufacturing R&D**	0	0	9,500

Fully fund the most promising 3-year cost shared contracts for a new competitive solicitation to develop in-situ process diagnostics and intelligent processing needed for integrated module manufacturing scale-up. All contracts will have 50 percent 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 the previous Technology Development activity called PVMaT (+$9,500). Performance will be measured by achieving module manufacturing processes capable of $1.75/Watt direct manufacturing cost with 50-megawatt production capacity.

#	**Technology Development**	**28,000**	**30,700**	**9,500**
•	**PVMat**	10,000	11,000	0

All manufacturing R&D and PVMaT activities under Technology Development will be completed in FY2001. These highly successful cost-shared contracts achieved manufacturing cost reductions of 50 percent from 1996 levels. More advanced R&D activities are being funded in Advanced Materials and Devices.

•	**Systems Engineering & Reliability**	12,500	13,700	9,000

The systems and reliability activity will refocus its efforts on the critical need to improve reliability of the entire PV system, including balance-of-system components such as inverters. This effort also supports development of standards and codes, and procedures for certifying performance of commercial systems.

•	**PV Building Integrated R&D**	1,700	2,000	0

All PV-BONUS Two contracts will be completed in FY 2001. All R&D efforts on building integrated product development will be transferred to industry.

•	**Partnerships for Technology Introduction** . .	2,300	1,000	500

This activity centers on testing and verification activities for grid-connected applications. In FY2002, only most critical activities will be conducted.

(dollars in thousands)

	FY 2000	FY 2001	FY 2002
• **Million Solar Roofs (MSR) Initiative**	1,500	3,000	0
This activity facilitates the deployment of solar systems throughout the U.S. through energy training, technical assistance and outreach programs with state and local partnerships. Commitments for installation of nearly a million "roofs" have already been received. This activity will be transferred to industry in FY 2002.			
Total, Photovoltaic Energy Systems	**64,571**	**75,060**	**39,000**
SOLAR BUILDING TECHNOLOGY RESEARCH:			
• **Space Conditioning and Water Heating**	**1,915**	**3,911**	**2,000**
• **Research and Development**	1,915	3,111	1,500
Build and field test prototypes of a low-cost solar water heater, utilizing newly-developed polymers, in collaboration with industrial partners. Performance will be measured by building and testing low cost solar water heaters that have the potential for reducing the cost of energy from 8¢/kWh in 1998 to 4¢/kWh by 2004.			
• **Zero Energy Building Design**	0	800	500
Builder teams will finalize design concepts for zero energy homes. The analysis of the optimum mix of technologies needed for zero energy homes will be completed and the results communicated to the builder teams.			
Total, Solar Energy	**81,410**	**92,681**	**42,932**

Explanation of Funding Changes from FY 2001 to FY 2002

		FY 2002 vs. FY 2001 ($000)
CONCENTRATING SOLAR POWER:		
Distributed Power Systems Development		
#	**Grid Reliability Systems** - All activities will be terminated after the 25 kW system at the University of Nevada has been installed and is operating satisfactorily.	-2,378
#	**Remote Power Systems-** All activities will be terminated.	-1,640
Dispatchable Power Systems Development		
#	**Low Cost System Designs** - All activities will be terminated.	-2,550
#	**Storage and Tech Support** - All activities will be terminated.	-2,080
Advanced Component Research		
#	**High Efficiency System Designs** - All activities will be terminated.	-710
#	**Analysis and Field Operations** - All activities will be terminated and all facilities will be closed down pending further determination.	-1,490
#	**Innovative Power Converters** - All activities will be terminated.	-930
Total, Concentrating Solar Power		-11,778
PHOTOVOLTAIC ENERGY SYSTEMS:		
Fundamental Research		
#	**Measurement & Characterization** - Reduction in research to focus on only most critical needs.	-2,460
#	**Basic Research/University Research** - Reduction in research to focus on only most critical needs.	-2,800
#	**High Performance Research** - Reduction will fund only high-efficiency thin film multi-junction contracts.	-3,700
Advanced Materials and Devices		
#	**Thin Film Partnership** - Reduction to fund only most promising industry contracts	-10,500

		FY 2002 vs. FY 2001 ($000)
#	**Crystalline Silicon/High Efficiency Devices and Reliability** - Reduction to support only highest priority research activities	-4,900
#	**Advanced Manufacturing R&D** - This new activity replaces prior year PVMaT activity conducted under Technology Development.	+9,500
	Technology Development	
#	**PVMat** - All contracts completed in FY 2001. This effort will focus on more advanced R&D needs within Advanced Materials and Devices.	-11,000
#	**Systems Engineering and Reliability** - Reduction to focus only on most critical system and component reliability needs.	-4,700
#	**PV Building Integrated R&D** - This activity will be transferred to industry in FY 2002.	-2,000
#	**Partnerships for Technology Introduction** - Reduction will allow work to focus on only most critical activities industry.	-500
#	**Million Solar Roofs** - This activity will be transferred to industry.	-3,000
Total, Photovoltaic Energy Systems		-36,060
	SOLAR BUILDING TECHNOLOGY RESEARCH:	
	Space Conditioning and Water Heating	
#	**Research and Development** - Development of the low cost solar water heater will be curtailed to fund other higher priority work. This delays completion of the activity by one or two years to encourage industry partners to step in and maintain activities.	-1,611
#	**Zero Energy Building Design** - Activities will be limited to completing the design and analysis of zero energy building concepts proposed by builder teams selected during FY 2001 and then provided to teams for utilization.	-300
Total, Solar Building Technology Research		-1,911
Total Funding Change, Solar Energy		-49,749

Wind Energy Systems

Mission Supporting Goals and Objectives

The Wind Energy Systems Program helps the United States attain the substantial economic, environmental, and energy security benefits of expanding the domestic and worldwide use of wind energy, and of fostering a world-class, domestic wind energy industry. The Program focuses on completing the research, testing, and field verification needed by U.S. industry to fully develop advanced wind energy technologies, and on coordinating with partners and stakeholders to overcome barriers to wind energy use.

Wind energy diversifies the Nation's energy supply, takes advantage of a domestic resource, and helps the Nation curb emissions of pollutants and greenhouse gases. Wind energy can provide electricity at some of the lowest costs available, while providing a hedge against future fuel price fluctuations. Economic benefits of wind energy stem from energy cost savings, its heavy equipment and service industry infrastructure, and the revenue it brings to rural areas. Domestic manufacturing of wind turbine systems creates jobs and income, and provides a hedge against changes in the value of the dollar that could inflate the cost of imported hardware.

Over the last decade, wind has shown high promise for becoming a major supply of low cost, clean energy in the United States. However, wind is still contributing only a small fraction of its potential and faces many challenges to becoming a substantial contributor to U.S. energy supply, particularly in dynamic restructured markets for electric power. There is a clear need to support continued improvement of the technology and to provide national leadership and coordination in addressing institutional, technical, and market barriers to the use of wind energy.

The Wind Energy Systems Program has established several goals to focus efforts to advance the use of wind energy in the United States while maximizing domestic economic benefit from this development. The Next Generation Turbine project is targeted to achieve a cost of wind energy of three cents per kilowatt-hour at Class 6 (15 mph annual average) wind sites by 2004. To greatly expand viable areas for wind energy, a goal of achieving 4 cents per kilowatt-hour in Class 4 (13 mph annual average) wind resources by 2015 has been established. This goal would lead to at least a twenty-fold increase in viable locations for installing large wind energy systems without Federal subsidy, a critical advancement for ensuring that wind energy will fulfill its promise as a major source of low cost, clean electricity for the Nation. Achieving these cost of energy targets will enable wind energy to be a major contributor for meeting the Department's goal of tripling U.S. renewable energy capacity by 2015.

Funding Schedule

(dollars in thousands)

	FY 2000	FY 2001	FY 2002	$ Change	% Change
Applied Research	13,300	15,000	8,400	-6,600	-44.0%
Turbine Research	12,349	12,428	7,500	-4,928	-39.7%
Cooperative Research and Testing	6,085	12,125	4,600	-7,525	-62.1%
Total, Wind Energy Systems	31,734	39,553	20,500	-19,053	-48.2%

Detailed Program Justification

(dollars in thousands)

	FY 2000	FY 2001	FY 2002
Applied Research	**13,300**	**15,000**	**8,400**
P **Core Research**	8,640	8,670	6,800

Continue highest priority 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 efforts will focus on the primary program thrust to develop low wind speed turbine technology essential for increasing resource areas for wind development in the United States by a factor of twenty or more. Performance measures in FY 2002 will include completion of one year of data collection under the Long-Term Inflow and Structures Test and completion of design code validation using wind tunnel test data obtained in FY 2000.

P **Wind Partnerships for Advanced Component Technologies (WindPACT)**	2,450	3,970	1,000

Conclude wind turbine system scaling analyses and prepare final reports. Prototype testing for a sub-scale advanced drive train system and proof of concept blade fabrication processes will commence in FY 2002 and other, less critical components, will be deferred.

P **University Research**	950	870	500

Competitively select two new projects for advanced wind turbine and systems research, and complete funding for several ongoing wind energy research activities with universities.

(dollars in thousands)

		FY 2000	FY 2001	FY 2002
P	**Wind Hybrid Systems**	960	1,060	0

Conclude design studies, testing, and analysis of wind hybrid systems conducted in FY 2001 based on industry success with system installation and performance in Alaska and other remote locations and transfer results to industry.

P	**Avian Research**	300	430	100

Terminate field studies of avian interactions with large wind turbine projects, and develop final reports of findings and strategies for mitigating avian concerns based on existing information. Maintain staff expertise for helping industry implement mitigation measures.

	Turbine Research	**12,349**	**12,428**	**7,500**
P	**Next Generation Turbine**	5,560	5,115	3,800

Complete design and delay fabrication of final prototype turbines; continue testing of engineering and manufacturing development turbines. Funding is decreased as industry partners focus on lower risk technology path, and begin assuming a higher share of project costs for hardware purchases and installation of prototypes. Performance will be measured by achievement of established subcontract milestones for prototype turbine design and fabrication, and by achievement of intermediate progress toward demonstrating capability for achieving 3 cent per kilowatt-hour cost target at Class 6 wind sites by 2004.

P	**Low Wind Speed Turbine**	0	200	1,100

The Low Wind Speed Turbine activity is the follow on from the FY 2001 Advanced Turbine Concepts activity. In coordination with the outcome of the WindPACT project, complete Advanced Turbine Concepts studies initiated in FY 2001 to identify promising technology path(s) leading to cost-effective wind turbines for sites with annual average wind speeds of 13 miles per hour. Achieving this goal will require aggressive improvements to each major turbine subsystem. Innovations such as aeroelastic tailoring, lightweight, flexible rotors, simplified direct drive or low-speed drive trains, and sophisticated control systems are promising avenues for achieving the 30 - 40 percent improvement needed over today's state-of-the-art. Two industry partners will be competitively selected to continue WindPACT component technology research efforts and to commence a multi-year effort to develop cost-effective low wind speed turbines.

P	**Near Term Research and Testing**	1,100	0	0

Project completed with FY 2000 funding.

(dollars in thousands)

	FY 2000	FY 2001	FY 2002
P **Small Wind Turbine**	500	1,000	500

Continue support for industry efforts to fabricate final prototypes of advanced small wind turbines ranging from 5 to 50 kilowatts, and commence field testing to confirm performance and reliability. Begin preparation of final project reports. Funding level decrease follows from completion of intensive hardware development stage of project in FY 2001.

P **Cold Weather Turbine**	810	200	100

Support performance and reliability field testing of prototype turbines at the National Wind Technology Center, including confirmation of standalone power system operation in the Hybrid Power Test Bed, and in actual remote community, extreme environment service in Alaska.

P **Supporting Research and Testing**	4,379	5,913	2,000

Perform highest priority research, design review, analysis and testing to ensure that industry wind turbine research efforts take full advantage of wind program technology developments and capabilities.

Cooperative Research and Testing	**6,085**	**12,125**	**4,600**
P **Wind Powering America**	0	3,315	0

Terminate activities for addressing wind power development opportunities and barriers. Provide documented results to stakeholder partners.

P **Industry Support**	2,085	2,390	1,600

Focus on high priority industry efforts in resolving near-term technical and institutional issues and develop targeted products for wind energy communications and outreach.

P **Regional Field Verification**	0	2,100	400

Complete development activities and commence field operation of projects selected in FY 2001, and provide technical, data collection, analysis, and reporting support to cost-sharing project hosts. Project development reports will be completed by the end of FY 2002. The following projects were directed by Congress to be included in this program: Kotzebue Wind Project (FY 2000 $0, FY 2001 $1,000, FY 2002 $0) and Turtle Mountain Community College in North Dakota (FY 2000 $0, FY 2001 $100, FY 2002 $0).

		(dollars in thousands)		
		FY 2000	FY 2001	FY 2002
P	**Certification**	800	700	500
	Support laboratory testing and design review services in support of U.S. wind turbine certification agent. Funding level reflects transition from certification program startup to stable level for routine operations in support of Underwriters Laboratories wind turbine certification program.			
P	**Utility Analysis**	2,000	2,450	1,300
	Reduce scope and focus on high priority 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.			
P	**National Wind Technology Center Operations**	1,200	1,170	800
	Operate the National Wind Technology Center facilities at the National Renewable Energy Laboratory, and provide testing support to industry at a modestly reduced scope.			
	Total, Wind Energy Systems	**31,734**	**39,553**	**20,500**

Explanation of Funding Changes from FY 2001 to FY 2002

		FY 2002 vs. FY 2001 ($000)
	Applied Research	
#	Decrease in Core Research reflects completion of several wind turbine design code aerodynamic and structural validation efforts, and focus on highest priority research	-1,870
#	WindPACT funding decreased as initial system scaling studies are completed or are deferred and industry partners assume lead for completing advanced drive train and rotor blade research, development, and commercialization.	-2,970
#	University Research decreased as fewer design code supporting research projects will be required to complement Core Research activities.	-370

		FY 2002 vs. FY 2001 ($000)
#	Wind Hybrid Systems research concluded upon completion of industry partnership effort to develop advanced hybrid control system technology, and ability of industry to complete further research for further technology improvements.	-1,060
#	Avian Research decreased as subcontracts for field data collection and analysis efforts are terminated, and industry assumes responsibility for implementing mitigation measures.	-330
Total, Applied Research		-6,600
Turbine Research		
#	Next Generation Turbine project funding decreased as schedule of prototypes is slowed to allow industry partners to focus on lower risk technology path and begin assuming higher share of project costs for final prototype development and testing stages.	-1,315
#	Small Wind Turbine project decreased as majority of hardware design and fabrication activities will be completed in FY 2001, and industry partners begin assuming higher share of final project costs.	-500
#	Low Wind Speed Turbine (formerly Advanced Turbine Concepts in FY 2001) project funding increased to allow expanding and completing studies commenced in FY 2001, and launching a competitive solicitation for developing wind turbine technology essential for enabling wind energy to be a cost-effective source of bulk power in much broader areas of the Nation with lower wind speeds.	+900
#	Cold Weather Turbine project funding decrease reflects transition from completion of turbine research and development to laboratory and Alaskan field testing and certification support.	-100
#	Funding for Supporting Research and Testing corresponds to a shift to higher priority projects and reduced focus on need for design support and component qualification testing activities, compared with less costly remaining needs for supporting field testing activities.	-3,913
Total, Turbine Research		-4,928

		FY 2002 vs. FY 2001 ($000)
Cooperative Research and Testing		
#	Termination of Wind Powering America funding reflects transition of activities, for addressing opportunities for and barriers to expanded wind energy use, to regional and state stakeholder partners.	-3,315
#	Decreased funding for Industry Support reflects completion of several financial assistance awards for wind energy analysis and outreach projects in FY 2001 and shift to higher priority projects.	-790
#	Regional Field Verification funding decreased following completion of cost sharing for project development activities with FY 2001 funding, in comparison with less costly support for data collection, operations assistance, and reporting and completion of Congressionally directed projects.	-1,700
#	Certification funding decreased as laboratory capability development completed and activities transition to routine testing and design review support for Underwriters Laboratories wind turbine certification program.	-200
#	Utility Analysis funding decrease reflects a reduced scope to allow work on higher priorities and an increased commitment of U.S. wind energy industry, utilities, and stakeholders in supporting technical studies to address grid integration issues and opportunities.	-1,150
#	National Wind Technology Center Operations decreased consistent with level of ongoing high priority research, analysis, and testing activities retained within the program for FY 2002.	-370
Total, Cooperative Research and Testing		-7,525
Total Funding Change, Wind Energy Systems		-19,053

Electric Energy Systems and Storage

Mission Supporting Goals and Objectives

The Electric Energy Systems and Storage programs conduct research and development of advanced technologies to enhance the reliability of electric power transmission and distribution and to significantly improve efficiency, reliability, capacity, and power quality of electric generation, delivery, and end-use in the United States. Energy Storage and Transmission Reliability program goals are to develop energy storage facilities with an energy density greater than 5kWh per square foot at a cost below $700/kWh; and improving the reliability of electric power generation and distribution system through the integration and interconnection of distributed energy resources (at least 20 percent of new installed capacity by 2012) and integrating real time measurement and control networks throughout the grid.

The successful, industry-led, Superconductivity Partnership Initiative supported aggressive projects to design advanced electrical applications such as generators, transformers, motors, transmission cables, current controllers, flywheel energy systems, and magnetic separation systems. The industry-led Second Generation Wire Development exploits breakthroughs at national laboratories that promise unprecedented current-carrying capacity in high-temperature superconducting wires. Several industry teams are now working with the national laboratories to scale-up the new discoveries. The strategic research component, led by the national laboratories, provides the underlying knowledge base needed for the success of these superconductivity projects. The goal of high-temperature superconductivity is to reduce energy losses by half and provide equipment half the size of current systems by 2010 through the use of high temperature superconducting wires to create super efficient generators, transformers, and transmission cables.

DOE's Energy Storage and Transmission Reliability as part of the Distributed Energy Resources Program work together to implement DER technology deployment strategies that address standards making, infrastructure, energy delivery, technical, institutional, and regulatory needs. Transmission Reliability research develops real-time measurement and control networks, and electric system models and tools. This research ensures reliable and efficient grid operations and markets while integrating distributed energy in the competitive marketplace. It also removes technical, regulatory and institutional barriers and develops interconnection standards for deployment of DER near the potential users. Energy Storage Systems funds the design of integrated systems, research on advanced storage components, and development of economic and performance models. The Department partners with 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.

Funding Schedule

(dollars in thousands)

	FY 2000	FY 2001	FY 2002	$ Change	% Change
High Temperature Superconducting R&D	31,024	36,819	19,000	-17,819	(48.4)%
Energy Storage Systems	3,387	5,987	5,987	0	0.0%
Transmission Reliability	2,925	8,940	8,940	0	0.0%
Total, Electric Energy Systems and Storage	37,336	51,746	33,927	-17,819	(34.4)%

Detailed Program Justification

(dollars in thousands)

	FY 2000	FY 2001	FY 2002
High Temperature Superconducting R&D	**31,024**	**36,819**	**19,000**

The High Temperature Superconductivity (HTS) R&D program investigates the properties of crystalline materials that become free of electrical resistance at temperatures below the boiling point of liquid nitrogen. The lack of electrical resistance makes possible electrical power systems, super- efficient 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 will carry 100 times the amount of electricity compared to the same diameter conventional copper wires. Buried transmission cables made of superconductive materials will eliminate the environmental and reliability problems of overhead electrical transmission lines that are subject to lightning strikes, ice storms, high winds, and falling tree limbs.

		FY 2000	FY 2001	FY 2002
#	**Superconductivity Partnership Initiative**	14,000	14,000	5,000

Complete previously selected multi-year projects with industry to develop first-of-a-kind high temperature superconducting electrical transmission cables, HTS generators, and HTS transformers demonstrating great improvements in efficiency and capacity for application to the U.S. electric grid. The current solicitation for the next stage of developing these innovative electrical systems will be cancelled.

(dollars in thousands)

	FY 2000	FY 2001	FY 2002
# **Second Generation Wire Initiative**	8,000	12,100	8,000

Industrial consortia will work with national laboratories to develop high-performance, low-cost, second-generation, high temperature superconducting wire. Performance is measured by achieving industry production of the first 100-meter lengths of second-generation high temperature superconducting wire. The installation and monitoring the world's first utility application of a high temperature superconducting power cables and industrial high temperature superconducting transformer in the United States provide additional performance measures. The decrease in funding reprioritizes the joint efforts to be conducted among DOE laboratories, American industry, and universities to continue the development, commercialization, and application of high temperature superconductors.

# **Strategic Research**	9,024	10,719	6,000

Maintain cost-shared core research to support new discoveries and innovations for the Second Generation Wire Development. These efforts leverage research of complementary work funded by the DOE Office of Basic Energy Science. This includes work on planning and analysis as well as communication and outreach to gather information on future requirements for the HTS technologies and to maintain contact with stakeholders.

Energy Storage Systems	**3,387**	**5,987**	**5,987**

Energy Storage, together with other distributed energy resources, provides the high nines of reliability required by the digital economy, telecommunication, and high tech manufacturing. While today's grid can at best give 3 nines of reliability, energy storage provides seamless power during micro outages, voltage sags, and frequency disturbances. 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. The program funds the design of systems with integrated power electronics, contributes to research on advanced storage components, and performs strategic research analysis by developing economic and performance models. Performance will be measured by installation and testing of a 10 kWh flywheel energy storage device and an advanced Li-ion battery storage system, and development of a 1 MW semiconductor power electronics switch.

(dollars in thousands)

	FY 2000	FY 2001	FY 2002
# **Storage System Integration**	1,600	2,600	2,600

Reduce inefficiencies of unique systems and late-stage integration energy storage systems; apply results of Intermediate-State-of-Charge battery management testing to fielded system; initiate the deployment of a multi-megawatt storage system with a utility partner; field test and evaluate a 100 kW remote hybrid system for the Alaskan village mini-grid and a hybrid, renewable community theater. Investigate multi-megawatt storage technologies with a Nevada utility industry partner for energy management application.

# **Component R&D**	1,000	2,400	2,400

Develop individual storage devices, power electronics, and control systems for all sizes of storage systems; begin testing of an advanced flywheel storage device in collaboration with the Superconducting Projects Initiative and Southern California Edison; begin laboratory testing and demonstration project planning with Virginia Power for an advanced lithium-ion battery system to be deployed at an e-commerce site; complete prototype production and initiate testing of an advanced semiconductor power electronic switch capable of megaWatt-level operation.

# **Strategic Research**	787	987	987

Advance performance, economic models, and benefits analysis of storage systems to include distributed energy system applications; continue addressing grid reliability through the Transmission Power Quality Reliability Project; study potential strengths, weaknesses and applications of new technologies and help organize an International Conference on Energy Storage and other communication tools.

(dollars in thousands)

	FY 2000	FY 2001	FY 2002
Transmission Reliability	**2,925**	**8,940**	**8,940**

Transmission Reliability will be implemented through National laboratory/electricity industry/ university partnerships to conduct research on the reliability of the Nation's electricity infrastructure. Power System Reliability will develop advanced transmission technologies that promote competitive markets, ensure system reliability, increase network capacity for large scale, long distance power transfers, and promote the large scale integration of distributed energy resources into power system operations and competitive electricity markets. Distributed Power supports the development of advanced distribution technologies and interconnect standards, and removal of barriers to enable the seamless integration of distributed generation (e.g., photovoltaics, wind, fuel cells, microturbines), energy storage, and direct load control into the electricity system. The program includes development and support for the application of reliability tools to four additional transmission systems, accelerated support to remove technical, regulatory and institutional barriers to transmission system expansion and upgrades, and evaluation of "microgrid" test bed demonstrations that incorporate distributed energy resources with utility partners.

#	**Power System Reliability**	2,425	4,965	4,470

Power System Reliability (PSR) with develops information management, wide area measurement, and disturbance recognition systems to enable reliable system operation and efficient markets. The program 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 technologies into the grid, including advanced composite conductors. The program participates in model development and test bed demonstrations to identify and remove technical barriers to the large scale deployment of distributed energy resources. PSR 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 by partnerships initiated to evaluate load as a reliability. PSR supports communications and analysis for collaboration with electric industry stakeholders to facilitate real-time alignment of advanced reliability technologies. The decrease of $495,000 will slow down efforts to identify transmission congestion issues, and formulate solutions for transmission system upgrade/expansion.

(dollars in thousands)

	FY 2000	FY 2001	FY 2002
# **Distributed Power**	500	3,975	4,470

Provides for completion, field validation and implementation of a national interconnection standard for DER; system integration R&D on 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 power for high-tech industries, evaluation of innovative concepts for distributed power applications including advanced electric space conditioning and hybrid technologies; development of plug-and-play interface and control technologies for next-generation intelligent autonomous grid-connected and grid-independent local energy systems. It will also champion the removal of regulatory and institutional barriers to DER and communication tools and market analysis. The increase of $495,000 supports field validation of the interconnection standard and system integration R&D for high reliability and power quality applications for high-tech industries. Performance is measured by establishing an approved national standard for interconnection of DER with electric power systems and establishing a certification process for the interconnection equipment.

Total, Electric Energy Systems and Storage	**37,336**	**51,746**	**33,927**

Explanation of Funding Changes from FY 2001 to FY 2002

	FY 2002 vs. FY 2001 ($000)
High Temperature Superconducting R&D	
# **Superconductivity Partnership Initiative** - The decrease in funding allows for close-out of existing cost-shared, competitively selected, major projects with industry to develop electrical systems demonstrating advances in efficiency and reliability from use of the latest high temperature superconducting wire.	-9,000

		FY 2002 vs. FY 2001 ($000)
#	**Second Generation Wire Development -** The Accelerated Coated Conductor Initiative, begun by Congress in FY 2001, will terminate. The lower funding level allows the program to build on the major investment in national laboratory infrastructure in FY 2001 which provided for new equipment and personnel to facilitate industry and laboratory scientists working jointly on technology development.	-4,100
#	**Strategic Research -** The decrease in cost-shared core research to promote new discoveries and innovations reflects a desired shift to greater funding by industry.	-4,719
	Total, High Temperature Superconducting R&D	-17,819
	Energy Storage Systems	
#	No funding change in Energy Storage Systems.	0
	Transmission Reliability	
#	**Power System Reliability (PSR)** - The decrease will slow down development of advanced tools and models for the transmission and distribution system.	-495
#	**Distributed Power** - The increase of $495,000 supports field testing to validate the Institute of Electrical and Electronics Engineers (IEEE) P1547 interconnection standard and system integration R&D for high reliability and power quality applications in high-tech industries. Field validation of the interconnection standard is essential for implementation of the standard.	+495
	Total, Transmission Reliability	0
	Total Funding Change, Electric Energy Systems and Storage	-17,819

Renewable Support and Implementation

Mission Supporting Goals and Objectives

The Renewable Support and Implementation line item is comprised of several programs submitted in prior year budgets as separate line items. These programs collectively encourage the use of renewable energy technologies by state and local governmental entities, non-profit electric cooperatives, residents in remote areas of the U.S. not served or under-served by the electric grid, and Native Americans both on Tribal lands and at Tribal colleges and universities. Renewable Support also includes activities which promote the use of renewable technologies, improved energy efficiency measures, and better management of utility costs at Department of Energy facilities throughout the country.

The mission, goals, and objectives of each program are as follows:

Departmental Energy Management Program (DEMP)

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 and approving official 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.

DUET assists DOE in demonstrating Federal leadership by improving energy management at DOE facilities, reducing energy costs, leveraging private sector investment, and developing model programs for energy management. DUET works with DOE's Energy Management Steering Committee, comprised of representatives from all of the DOE program offices, to identify, fund, and implement cost-effective energy improvements at DOE sites. DUET promotes the use of energy savings performance contracts to assist DOE in meeting energy management requirements. For all DOE program offices, DUET manages utility rate intervention cases to protect DOE's consumer interests.

Combined, these efforts will accomplish significant savings. By 2005, DOE's cost for energy and utilities will decline by 10 percent, or $30 million annually compared to 1996 and overall DOE will reduce their energy use per square foot by 45 percent as compared to FY 1985.

International Renewable Energy Program

In FY 2002, domestic priorities require these technical assistance, information dissemination, and trade barrier reduction activities pertaining to renewable energy and energy efficient technologies be suspended. Consequently, no funding is being requested for the International Renewable Energy Program (IREP).

In FY 2000 and FY 2001, this program provided regionally focused technical assistance and information dissemination assistance to energy decision makers in the developed and developing world. These efforts promoted the use of U.S. renewable energy technologies and services. The program furthered international discussion and collaboration with regard to emission and environmental issues.

Renewable Energy Production Incentive

The Renewable Energy Production Incentive encourages state and local governmental entities (usually public power electric utilities) and non-profit electric cooperatives to acquire renewable energy generation resources. For these tax-exempt owners of new renewable energy generation systems, the program provides, under the authority of the Energy Policy Act of 1992, financial incentives that are comparable to the value of either production tax incentives or investment tax credits available to the private-sector owners of certain types of new renewable energy generation.

The incentive program directly supports goals stated in the strategic plans of the Department, the Office of Energy Efficiency and Renewable Energy, and the Office of Power Technologies that seeks to triple the installed non-hydroelectric renewable energy generating capacity in the U.S. by 2015. The program supports this goal by helping demonstrate renewables in a key and often innovative sector of the electric utility industry. By 2004, the program expects electricity generation resulting from this program to increase to 1 billion kWh.

Indian Renewable Energy Resources Program

The Indian Renewable Energy Resources Program undertook four projects in Alaska in FY 2000, which included a diesel project in Nome, a diesel backup system in Sitka, the Power Creek Hydroelectric Project in Haida, and the Old Harbor Hydroelectric Project on Kodiak Island.

In FY 2001 the program provided additional funds to the Nome diesel project, the Power Creek Project, the Swan Lake Intertie Project in Ketchikan, and a new turbine upgrade project began at the Indian River Hydroelectric facility. Due to funding limitations, the program was unable to assist Tribal residents residing on reservations in the lower forty-eight states. No funding is being requested for the Indian Renewable Energy Resources Program.

Renewable Program Support

The Renewable Program Support - Competitive Solicitation Program obtains, analyzes, and disseminates essential cost and operational information needed to improve the efficiency and effectiveness of the solicitation of renewable energy projects, as well as reduce perceived risk associated with selecting renewable energy and hybrid renewable energy generation systems for use in the competitive market.

This program competitively selects field validation projects which can reduce the uncertainties regarding the applicability and reliability of renewable energy technologies in these 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 three year period.

The Renewable Program Support - Electricity Restructuring Program provides Federal and State officials unbiased technical assessments of utility restructuring issues relating to energy efficiency and renewable energy. As the only national effort, the mission of the 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.

A key objective is to provide unbiased assessments of the costs and benefits of market based energy efficiency, public benefits funds, consumer information and disclosure provisions, 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 restructured utility markets to State, regional and Federal decisionmakers.

The program's mission, goal, and objectives are accomplished through outreach and assistance to key state energy and environmental officials on policy and restructuring technical issues. 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.

Funding Schedule

(dollars in thousands)

	FY 2000	FY 2001	FY 2002	$ Change	% Change
Departmental Energy Management . . .	0	1,984	1,000	-984	-49.6%
International Renewable Energy Program	4,630	4,949	0	-4,949	-100.0%
Renewable Energy Production Incentive Program	1,500	3,991	2,059	-1,932	-48.4%
Renewable Indian Energy Resources . . .	3,864	6,585	0	-6,585	-100.0%
Renewable Program Support	4,900	3,991	2,059	-1,932	-48.4%
Total, Renewable Support and Implementation	14,894	21,500	5,118	-16,382	-76.2%

Detailed Program Justification

		(dollars in thousands)		
		FY 2000	FY 2001	FY 2002
Departmental Energy Management		**0**	**1,984**	**1,000**
#	**Energy Management Project Support**	0	1,500	750

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 1 to 2 renewable energy projects or other emerging technologies; providing a rate of return of at least 20 percent on the dollars invested; and achieving an annual savings of 10 billion Btus.

#	**Energy Management Model Program Development**	0	484	250

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 two office buildings; and acquiring Leadership in Energy and Environmental Design Building Certification for one new sustainable building design.

International Renewable Energy Program		**4,630**	**4,949**	**0**
#	**U.S. Initiative on Joint Implementation**	4,630	4,449	0

In FY 2001, the U.S. Initiative on Joint Implementation (USIJI) conducted its 14th round of project solicitations and has resulted in 44 private-sector projects in 23 countries and are projected to sequester more than 300 metric tons of carbon dioxide at a cost of $4 per ton. The International Renewable Energy Program (IREP) has provided technical assistance, information dissemination, conducted trade missions and reverse trade missions. No funding is being requested for the International Renewable Energy Program in FY 2002, as resources will be directed to higher priority Renewable Energy Resources programs.

(dollars in thousands)

	FY 2000	FY 2001	FY 2002
# **Office of Arctic Energy**	0	500	0

The following project was directed by Congress to be included in the Renewable Support and Implementation Program and will be partially funded from this program in FY 2001: Office of Arctic Energy (FY 2000 $0, FY 2001 $500,000, FY 2002 $0). No funding is being requested for this program in FY 2002 in order to support higher priorities within Renewable Energy Resources programs.

Renewable Energy Production Incentive Program	**1,500**	**3,991**	**2,059**

Annual Production Incentive Payments will be provided to the owners of approximately 30-50 qualified facilities. Performance will be measured by providing incentive payments for about 727,000 megaWatt-hours of qualified FY 2001 renewable electric generation. Fully fund Tier 1 projects (wind and solar). Tier 2 projects (open-loop biomass, mostly landfill gas) will likely be funded, based on past levels of applications received, at a range of only 1-3 percent of requested amounts.

Renewable Indian Energy Resources	**3,864**	**6,585**	**0**

Provides for grants to build hydroelectric projects in Alaska as directed by Congress to be included in this program: Eyak Native Corporation Power Creek Hydroelectric 6 MW project located near Cordova AK; completion is expected in FY 2001 (FY 2000 $1,642,000, FY 2001 $2,297,000, FY 2002 $0); Nome Diesel Upgrade project contract awarded in September 2000 to install a new diesel with 4.4 MW capacity (FY2000 $1,000,000, FY 2001 $996,000, FY 2002 $0); Swan Lake Intertie scheduled to begin construction in 2001 using funds provided by a previous grant from the Alaska Power Administration for $10 million (FY 2000 $0, FY 2001 $1,996,000, FY 2002 $0); Indian River Hydroelectric Turbine Upgrades (FY 2000 $0, FY 2001 $1,296,000, FY 2002 $0). The Sitka Diesel Backup System 4.5 MW capacity is schedule for completion in FY 2001 (FY 2000 $939,850, FY 2001 $0, FY 2002 $0); and the Old Harbor Hydroelectric Project, Kodiak Island, 500 kW capacity, Federal Energy Regulatory Commission (FERC) license was issued in December 2000 and completion is estimated in 2002 (FY 2001 $282,150, FY 2001 $0, FY 2002 $0). No funding is being requested for any activities in FY 2002 in order to support higher priority activities within Renewable Energy Resources programs.

(dollars in thousands)

	FY 2000	FY 2001	FY 2002
Renewable Program Support	**4,900**	**3,991**	**2,059**
# **Electric Restructuring**	984	998	1,000

Technical Analysis and Assistance – Perform technical analyses in the area of energy efficiency and renewable energy, public benefits funds, consumer information and disclosure provisions, green marketing programs, distributed generation concepts, and other policy and market mechanisms for energy efficiency and renewable energy in restructured utility markets. Particular emphasis this year will be on market-based mechanisms, such as demand management programs, that provide near-term assistance to electricity-short regions of the United States. 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, perform an assessment of the private sector energy efficiency services industry under electric restructuring.

# **Competitive Solicitation**	1,000	1,494	1,059

Competitively select 2-4 projects (including those on Native American lands and with Tribal Colleges and Universities). Performance will be measured by competitively awarding, and initiating development of, 2 to 4 diverse field validation or educational projects. This represents a $935,000 decrease in the program and will result in fewer and less diverse projects being selected.

# **Indoor Air Quality**	0	999	0

The following project was directed by Congress to be included in the Renewable Implementation and Support program: Indoor Air Quality and Energy Conservation Research Planning (FY 2000 $0, FY 2001 $999,000, FY 2002 $0).

# **Distributed Power**	2,916	0	0

Distributed Power is funded through Electric Energy Systems and Storage, Transmission Reliability.

# **Office of Arctic Energy**	0	500	0

The following project was directed by Congress to be included in the Renewable Support and Implementation Program and will be partially funded from this program in FY 2001: Office of Arctic Energy (FY 2000 $0, FY 2001 $500,000, FY 2002 $0). No funding is being requested for this program in FY 2002 in order to support higher priorities within Renewable Energy Resources programs.

Total, Renewable Support and Implementation	**14,894**	**21,500**	**5,118**

Explanation of Funding Changes from FY 2001 to FY 2002

		FY 2002 vs FY 2001 ($000)
Departmental Energy Management		
#	Decrease of energy retrofit and alternatively financed projects and model energy management programs.	-984
International Renewable Energy Program		
#	Program activities will be curtailed in order to direct funding to higher priority work within Renewable Energy Resources programs.	-4,949
Renewable Indian Energy Resources		
#	Program activities will be curtailed in order to direct funding to higher priority work within Renewable Energy Resources programs.	-6,585
Renewable Energy Production Incentive Program		
#	The decrease reflects funding being directed to higher priority programs within Renewable Energy Resources Programs. Funds are expected to be adequate to fully support Tier 1 projects (wind and solar), with Tier 2 projects (open-looped biomass, mostly landfill gas) likely to be essentially sponsored at only 1-3 percent of requested amounts.	-1,932
Renewable Program Support		
#	Reduce selection of 2 to 4 diverse field validation projects.	-1,932
Total Funding Change, Renewable Support and Implementation.		-16,382

National Renewable Energy Laboratory

Mission Supporting Goals and Objectives

The National Renewable Energy Laboratory (NREL) leads 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 photovoltaics, wind energy, biomass-derived fuels and chemicals, energy-efficient buildings, advanced vehicles, solar manufacturing, industrial processes, solar thermal systems, hydrogen fuel cells, superconductivity, geothermal, and waste-to-energy technologies. Many of NREL's research achievements have been ranked among the Nation's most significant technical innovations by R&D Magazine, Discover, and Popular Science.

The funds below support NREL's infrastructure needs including necessary repairs, maintenance, calibration, equipment replacement, new construction, and facility modifications. These expenditures protect the Federal Government's investment and support of the domestic renewable energy industry, and ensure that NREL remains the Nation's preeminent center for researching, developing, and demonstrating renewable energy and energy efficiency technologies. In addition, the FY 2002 budget request includes for the first time, facility project engineering design (PED) funding as directed in the FY 2001 Energy and Water Development conference report.

Background

NREL, located in Golden, CO, is the world leader in developing renewable energy technologies and a primary laboratory for developing energy-efficiency technologies. Originally called the Solar Energy Research Institute, NREL was established by the Solar Energy Research, Development, and Demonstration Act of 1974 as a national center for Federally sponsored solar energy R&D. President George Bush designated the Solar Energy Research Institute a National Laboratory on September 16, 1991, and changed the name to the National Renewable Energy Laboratory.

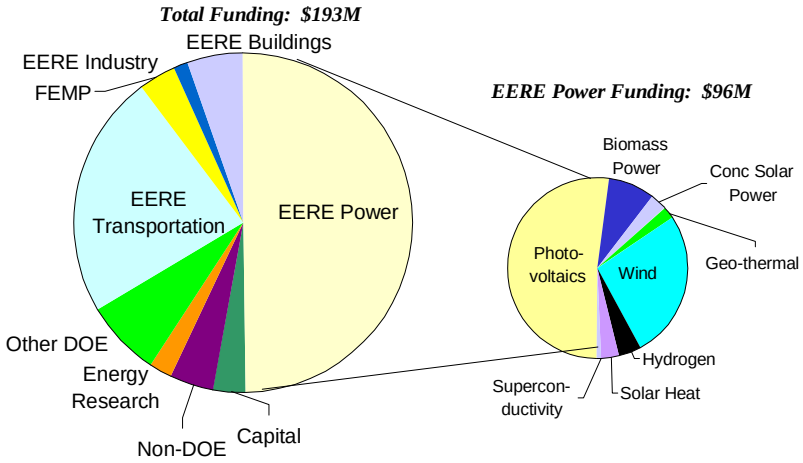
NREL is a Federally Funded Research and Development Center. Its highly skilled technical staff of about 850 scientists, engineers, analysts, and support personnel are internationally known and respected, and represent the world's largest collection of renewable energy and energy efficiency experts. As such, it is a strategic advisor to DOE, as well as a partner, assisting the Department with a full range of activities—from research and development through technology demonstration to facilitating introduction of these technologies into global markets. NREL is responsible for integrating the expertise and viewpoints of industry, academia, and DOE, and collaborates with many different organizations in accomplishing its mission. As a contractor-operated laboratory owned by DOE, NREL is managed by Midwest Research Institute of Kansas City, MO, with Battelle Memorial Laboratory of Columbus, OH, and Bechtel Corporation of San Francisco, CA, as major subcontractors. EERE has the primary responsibility for NREL's activities and stewardship responsibilities for NREL's long-term development. Locally, the laboratory contract is managed by DOE's Golden Field Office.

NREL's capabilities include a number of laboratories, user facilities, and centers of excellence:

- **National Wind Technology Cente**r. A national center for designing and testing improved wind turbine technology, with user facilities for industry.
- **National Center for Photovoltaic**s. A national center, managed jointly by NREL and Sandia National Laboratories, supporting DOE and the photovoltaic industry by conducting R&D, testing components, and designing modules and systems.
- **Solar Radiation Research Laboratory**. A facility to test, calibrate, and compare radiometers and other solar radiation measuring equipment using world radiation reference standards.
- **High-Flux Solar Furnac**e. A national user facility providing highly concentrated sunlight for material and surface processing; of interest to automotive, aerospace, defense, electronic, and other industries.
- **Alternative Fuels User Facility and Process Development Uni**t. A 1-ton-per-day pilot plant for converting biomass to ethanol, available to industry to pilot processes intended for larger, commercial-scale facilities.
- **Thermochemical User Facilit**y. A process development facility that converts biomass feedstocks and other renewable fuels into a variety of products, such as electricity, high-value chemicals, and transportation fuels.
- **Battery Thermal Test Facilit**y. A user facility available to industry to design and test advanced batteries for electric and hybrid-electric vehicles.

NREL's total funding for FY 2002 is estimated at approximately $130 million, including $4 million in capital and construction. About 92 percent of NREL's funding comes from EERE. In addition, DOE's Office of Science, private firms, other DOE offices, and other government agencies provide the balance of the laboratory's funding. NREL subcontracts 40-60 percent of its funding to industry and universities. Most of the NREL research subcontracts are cost-shared by industry and university partners. In total, NREL has subcontracts or other formal partnership agreements with 100-150 industry partners, 50-75 universities, and 40-50 not-for-profit organizations. NREL has a strong track record for innovation, the laboratory has received 28 prestigious R&D 100 awards since 1982. These awards are given annually by *Research and Development* magazine to honor the year's 100 most significant technological advances. NREL has received many other technology awards as well, including awards from *Popular Scienc*e, *Architecture* magazine, *Discover* magazine, and the Federal Laboratory Consortium for Excellence in Technology Transfer.

NREL FY 1999 Major Funding Sources



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

(Changes from FY 2001 Congressional Budget Request are denoted with a vertical line in the left margin)

Significant Changes

No significant changes from FY 2001 in either scope or funding.

1. Construction Schedule History

Fiscal Quarter				Total Estimated Cost ($000)	Total Project Cost ($000)
A-E Work Initiated	A-E Work Completed	Physical Construction Start	Physical Construction Completed		

N/A – See subproject details

2. Financial Schedule

(dollars in thousands)

Fiscal Year	Appropriations	Obligations	Costs
Design and Construction			
FY 2000	1,100	1,100	655
FY 2001	3,991	3,991	3,300
FY 2002	4,200	4,200	4,000
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

3. Project Description, Justification and Scope

This infrastructure project funds two subprojects:

- Replaces and upgrades NREL general capital equipment.
- Update and expand capabilities of facilities and infrastructure already in use at NREL.

Project Description, Justification and Scope

This section addresses general infrastructure that constitute's NREL's general capital needs (general purpose projects, general purpose equipment). This does not include program-specific capital equipment.

- Projects to correct ES&H deficiencies including fire safety improvements 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 2000	FY 2001	FY 2002	Outyear 2003-2006	Construction Start / Completion Dates
2,100/yr	2,000/yr	450	2,210[a]	2,100	8,400	1Q 2002 - 4Q 2006

[a] Includes an additional $710,000 based on the FY 2001 House EWD markup.

This investment replaces and upgrades NREL's general capital equipment at a regular annual rate. Currently 20 percent of NREL's capital equipment (general purpose and program-specific) currently in use is beyond its useful life. Specific equipment needs are identified at the time of budget submission and reevaluated as funding becomes available. 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 2000	FY 2001	FY 2002	Outyear 2003-2006	Construction Start / Completion Dates
2,100/yr	2,000/yr	650	1,781[a]	2,100	8,400	1Q 2002 - 4Q 2006

[a] Includes an additional $390,000 based on the FY 2001 House EWD markup.

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 (NWTC) sites. Specific projects are identified at the time of budget submission and reevaluated as funding becomes available. These projects include:

- Upgrades to utilities, HVAC systems, and related systems within buildings.
- Energy efficiency improvements within buildings.
- Safety 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 sites.

4. Details of Cost Estimate

N/A

5. Method of Performance

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

(Changes from FY 2001 Congressional Budget Request aredenoted with a vertical line in the left margin)

Significant Changes

- First inclusion of Project Engineering and Design (PED) budget request for the DOE National Renewable Energy Laboratory (NREL). A proposed sum of $800,000 will complete an evaluation of the planned Science and Technology Facility in Golden, CO.

1. Construction Schedule History

	Fiscal Quarter				Total Estimated Cost ($000)
	A-E Work Initiated	A-E Work Completed	Physical Construction Start	Physical Construction Completed	
FY 2002 Budget Request (*A-E and technical design only*)	1Q 2002	4Q2002	N/A	N/A	800

2. Financial Schedule

(dollars in thousands)

Fiscal Year	Appropriations	Obligations	Costs
FY 2002	800	800	800

3. Project Description, Justification and Scope

This is the initial year of a pilot initiative to provide Architect-Engineering (AE) services (Title I and Title II) for an Office of Energy Efficiency and Renewable Energy (EERE) construction project. It allows a planned $30 million NREL-Science and Technology Project to proceed from conceptual into preliminary (Title I) and definitive 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 procurements.

Application of a PED line item enables this NREL project to proceed immediately upon completion of conceptual design into preliminary and final design, thereby accelerating facility construction, ensuring cost savings based on current rates of inflation, as well as producing more mature cost, schedule, and technical baselines for the Science and Technology Facility when its budget is possibly submitted to Congress in FY 2003.

FY 2002 Design Project

Fiscal Quarter				**Total Estimated Cost (Design Only) ($000)**	**Preliminary Full total Estimated Cost Projection ($000)**
A-E Work Initiated	A-E Work Completed	Physical Construction Start	Physical Construction Completed		
1Q 2002	2Q 2004	2Q 2003	TBD	3,000	30,000

Design TEC	Previous	FY 2003	FY 2004	FY 2005	Outyears	Design Completion
3,000	0	2,000	1,000	0	0	2Q 2004

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. A lack of space is limiting participation by visiting professionals, industrial partners, and students at SERF. This overcrowding is also damaging worker productivity and discouraging the retention of high quality staff.

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)	520
Design Management Costs (12.5% of TEC)	100
Project Management Costs (12.5% of TEC)	100
Design Phase Contingency (current estimates include contingency based on risk analysis)	80
Total, Design Costs	800
Construction Phase	
Improvements to Land	0
Buildings	0
Utilities	0
Inspection, Design and Project Liaison, Testing, Checkout and Acceptance	0
Construction Management	0
Project Management	0
Total, Construction Phase	0
Contingency	
Design Phase	0
Construction Phase	0
Total Contingency	0
Total, Line Items (TEC)	800

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)

	Prior years	FY2002	Outyears	Total
Project Cost				
Facility Costs				
Design	0	800	0	800
Construction	0	0	0	0
Total, Line Item (TEC)	0	800	0	800
Total Facility Costs (Federal and Non-Federal)	0	800	0	800
Other Project Costs				
Conceptual design costs . . .	0	0	0	0
Other project-related costs	0	0	0	0
Total, Other Project Costs	0	0	0	0
Total Project Cost (TPC)	0	800	0	800

Renewable Energy Resources Program Direction

Mission Supporting Goals and Objectives

Program Direction provides the Federal staffing resources and associated funding to support the management and oversight of the Renewable Energy programs. This activity includes funding for support service contractors, equipment, travel, crosscutting activities, and Assistant Secretary initiatives.

As technology gains are lead to productivity increases in the performance of the Federal staff, the cost to support each FTE has also increased. Each year the costs for salaries, information technology, office space, office supplies, and office equipment have increased. The FY 2002 budget request makes some provision for escalating costs; however, travel and training costs are only minimally covered in this request.

In the Spring of 2000, the National Academy of Public Administration (NAPA), published the report *A Review of Management in the Office of Energy Efficiency and Renewable Energy*, providing an overview of EERE's management and program practices. The report cited 39 specific recommendations for improving the way EERE does business. Four major areas of concern have emerged from the report: fragmentation of EERE; emphasis on process rather than product; a need for improved communications; and weaknesses in decision making processes. In response to the report, and as part of EERE's ongoing improvement of management practices, EERE developed an Implementation Plan that outlines actions intended to mitigate NAPA's concerns. These actions and intended results are designed to accomplish the following priority objectives:

- Provide clear direction on EERE's goals and objectives and align, adjust, and optimize the EERE portfolio of programs to achieve these goals and objectives;
- Fully implement a comprehensive management framework – the Strategic Management System– for the business management functions of planning, budget formulation, budget execution, and evaluation. Ensure a strong program analysis and evaluation capability to support all phases of the system;
- Strengthen program management by setting high standards for program managers; clearly defining their roles and responsibilities; providing the tools necessary to manage efficiently; and providing the training necessary to use those tools effectively; and
- Hold all levels of EERE management and employees accountable for accomplishing the goals and objectives of the organization, including management reforms and the implementation of this plan.

Funding Schedule

(dollars in thousands, whole FTEs)

	FY 2000	FY 2001	FY 2002	$ Change	% Change
Golden					
Salaries and Benefits	1,590	2,181	2,105	-76	-3.5%
Travel	116	125	130	5	4.0%
Support Services	127	370	390	20	5.4%
Other Related Expenses	309	103	285	182	176.7%
Total, Golden	2,142	2,779	2,910	131	4.7%
Full Time Equivalents	17	22	20	-2	-9.1%
Idaho					
Salaries and Benefits	95	100	105	5	5.0%
Travel	0	0	0	0	0.0%
Support Services	0	0	0	0	0.0%
Other Related Expenses	0	0	0	0	0.0%
Total, Idaho	95	100	105	5	5.0%
Full Time Equivalents	1	1	1	0	0.0%
Headquarters					
Salaries and Benefits	9,340	10,546	10,840	294	2.8%
Travel	334	380	380	0	0.0%
Support Services	4,119	3,079	3,185	106	3.4%
Other Related Expenses	1,690	1,775	1,780	5	0.3%
Total, Headquarters	15,483	15,780	16,185	405	2.6%
Full Time Equivalents	92	98	95	-3	-3.1%
Total Renewable Energy Resources					
Salaries and Benefits	11,025	12,827	13,050	223	1.7%
Travel	450	505	510	5	1.0%
Support Services	4,246	3,449	3,575	126	3.7%
Other Related Expenses	1,999	1,878	2,065	187	10.0%
Total, Program Direction	17,720	18,659	19,200	541	2.9%
Total, Full Time Equivalents	110	121	116	-5	-4.1%

Detailed Program Justification

(dollars in thousands)

	FY 2000	FY 2001	FY 2002
Salaries and Benefits	**11,025**	**12,827**	**13,050**

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 staff 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 the Renewable Energy budgets; and communications with the public and stakeholders regarding policies, budgets, program performance and related issues. Additionally, this Program Direction account supports staff at the Golden Field Office and the Idaho Operations Office. Performance will be measured by the responsiveness to national energy policy goals and objectives; continued improvement in the utilization of Federal staffing, travel, and support service activities; and continued reduction in fiscal year-end uncosted obligations and increases in competitive awards and cost-sharing.

Travel	**450**	**505**	**510**

A nominal increase in travel reflects projected escalation of travel costs and per diem. Travel has been substantially reduced from previous years through the use of teleconferencing facilities for the conduct of oversight activities of some field organizations, and further reductions would preclude EERE's ability to achieve its mission requirements.

Support Services	**4,246**	**3,449**	**3,575**

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 mailroom 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. As a Program Secretarial Office, the capability to develop/implement integrated business management systems and the related information technology infrastructure is required in order to strengthen collaborative efforts between Headquarters and field components.

(dollars in thousands)

	FY 2000	FY 2001	FY 2002
Other Related Expenses	**1,999**	**1,878**	**2,065**

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 2000 through FY 2002 is $1,690,000, $1,775,000 and $1,780,000 respectively. Rent is the largest Working Capital Fund component. (FY 2000 through FY 2002 is $965,000, $985,000, and $990,000 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 split between the Energy and Water Development Appropriation and Interior and Related Agencies Appropriation.

Total, Renewable Energy Resources Program Direction	**17,720**	**18,659**	**19,200**

Explanation of Funding Changes from FY 2001 to FY 2002

	FY 2002 vs. FY 2001 ($000)
Salaries and Benefits	
■ Increase in salaries and benefits supports general pay increases, locality pay adjustments, promotions, and within-grade increases.	+223
Travel	
■ A nominal increase is primarily to support escalating airfare and lodging costs with offsets from alternatives to travel such as videoconferencing.	+5
Support Services	
■ Reflects an increased level of assistance for preparation of program planning materials and support for program briefings and presentations.	+126
Other Related Expenses	
■ Increase supports activities such as additional computer workstations and network infrastructure technology upgrades to improve operational efficiencies, printing and reproduction, and funding for field office rent increase.	+187
Total Funding Change, Renewable Energy Resources Program Direction	+541

Support Services

(dollars in thousands)

	FY 2000	FY 2001	FY 2002	$ Change	% Change
Technical Support Services					
Economic and Environmental Analysis	1,586	959	1,245	286	29.8%
Feasibility of Design Considerations	0	0	0	0	0.0%
Total, Technical Support Services	1,586	959	1,245	286	29.8%
Management Support Services					
Management Studies	0	0	0	0	0.0%
Training and Education	0	0	0	0	0.0%
ADP Support	360	360	200	-160	-44.4%
Administrative Support Services	2,300	2,130	2,130	0	0.0%
Total, Management Support Services	2,660	2,490	2,330	-160	-6.4%
Subtotal Support Services	4,246	3,449	3,575	126	3.7%
Use of Prior-Year Balances	0	0	0	0	0.0%
Total, Support Services	4,246[a]	3,449[a]	3,575[a]	126	3.7%

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

Other Related Expenses

(dollars in thousands)

	FY 2000	FY 2001	FY 2002	$ Change	% Change
Training	5	5	5	0	0.0%
Working Capital Fund	1,690	1,775	1,780	5	0.3%
Printing and Reproduction	0	0	0	0	0.0%
Rental Space	0	0	0	0	0.0%
Software Procurement/Maintenance Activities/Capital Acquisitions	5	5	5	0	0.0%
Other	299	93	275	182	195.7%
Subtotal, Other Related Expenses	1,999	1,878	2,065	187	10.0%
Use of Prior-Year Balances	0	0	0	0	0.0%
Total, Other Related Expenses	1,999	1,878	2,065	187	10.0%