

DEPARTMENT OF ENERGY
FY 2002 CONGRESSIONAL BUDGET REQUEST
FOSSIL ENERGY RESEARCH AND DEVELOPMENT

PROPOSED APPROPRIATION LANGUAGE

[(Including Transfer of Funds)]

For necessary expenses in carrying out fossil energy research and development activities, under the authority of the Department of Energy Organization Act (Public Law 95-91), including the acquisition of interest, including defeasible or equitable interests in any real property or any facility or for plant or facility acquisition or expansion, and for conducting inquiries, technological investigations and research concerning the extraction, processing, use, and disposal of mineral substances without objectionable social and environmental costs (30 U.S.C. 3, 1602, AND 1603), [performed under the minerals and materials science programs at the Albany Research Center in Oregon \$540,653,000] ~~\$449,000,000~~, to remain available until expended, [of which \$12,000,000 for oil technology research shall be derived by transfer from funds appropriated in prior years under the heading "Strategic Petroleum Reserve, SPR Petroleum Account" and of which \$95,000,000 shall be derived by transfer from funds appropriated in prior years under the heading "Clean Coal Technology", such funds to be available for a general request for proposals for the commercial scale demonstration of technologies to assure the reliability of the Nation's energy supply from existing and new electric generating facilities for which the Department of Energy upon review may provide financial assistance awards: *Provided*, That the request for proposals shall be issued no later than one hundred and twenty days following enactment of the Act, proposals shall be submitted no later than ninety days after the issuance of the request for proposals, and the Department of Energy shall make project selections no later than one hundred and sixty days after the receipt of proposals: *Provided further*, That no funds are to be obligated for selected proposals prior to September 30, 2001: *Provided further*, That funds provided shall be expended only in accordance with the provisions governing the use of funds contained under the heading under which they were originally appropriated: *Provided further*, That provisions for repayment of government contributions to individual projects shall be identical to those included in the Program Opportunity Notice (Solicitation Number DE-PS01-89FE 61825), issued by the Department of Energy on May 1, 1989, except that repayments from sale or licensing of technologies shall be from both domestic and foreign transactions: *Provided further*, That such repayments shall be deposited in this account to be retained for future projects: *Provided further*, That any project approved under this program shall be considered a Clean Coal Technology Demonstration Project, for the purposes of Chapters 51, 52, and 60 of title 40 of the Code of Federal Regulations: *Provided further*,] of which \$150,000,000 is to be available, after coordination with the private sector, for a request for proposals for a Clean Coal Power Initiative providing for competitively-awarded research, development and demonstration of commercial scale technologies to reduce the

barriers to continued and expanded coal use: *Provided*, That all awards shall be cost-shared with industry participants: *Provided further*, That in order to enhance the return to the taxpayer, provisions for royalties from commercialization of funded technologies shall be included in the program solicitation, including provisions for reasonable royalties from sale or licensing of technologies from both domestic and foreign transactions: *Provided further*, That no part of the sum herein made available shall be used for the field testing of nuclear explosives in the recovery of oil and gas: *Provided further*, That up to 4 percent of program direction funds available to the National Energy Technology Laboratory may be used to support Department of Energy activities not included in this account.

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Program Mission

The U.S. relies on fossil fuels for about 85% of the energy it consumes. Many forecast that high U.S. reliance on these fuels will continue for decades. For example, the Energy Information Administration's 2001 Annual Energy Outlook projects that fossil fuel reliance could approach 90% by 2020. Accordingly, a key goal of the Department's fossil energy activities is to ensure that economic benefits from moderately-priced fossil fuels, and a strong domestic industry that creates export-related jobs, are compatible with the public's expectation for exceptional environmental quality and reduced energy security risks.

In support of this goal, the mission of the Fossil Energy (FE) Research and Development (R&D) program is to enhance U.S. economic and energy security by: (1) managing and performing energy-related research that promotes the reliable, efficient and environmentally sound production and use of fossil fuels; (2) partnering with industry and others to advance clean and efficient fossil energy technologies toward commercialization in the U.S. and international markets, and: (3) supporting the development of information and policy options that benefit the public by ensuring access to adequate supplies of affordable and clean energy.

To ensure that Federally funded and developed technologies and related analysis are relevant to market and public needs, and are transferred into commercial applications, FE participates in joint partnerships with industry utilizing a variety of mechanisms such as cost-shared contracts, targeted outreach activities, and cooperative research and development agreements with the Department's National Energy Technology Laboratory (NETL) and other National Laboratories.

Program Areas

The FY 2002 request for R&D is \$449.0 million. Comparable activities (i.e., R&D plus demonstrations) were funded at \$450.5 million in FY 2001, not including a transfer of \$95 million that does not come available for obligation until September 30, 2001. Including this funding, Fossil R&D was funded at \$545.5 million. In FY 2002 there are significant changes in emphasis within the R&D portfolio. In

FOSSIL ENERGY RESEARCH AND DEVELOPMENT OVERVIEW (Cont'd)

particular, additional funding is requested for activities under a new Clean Coal Power Initiative to demonstrate technology for advanced clean coal powerplants. Turbine R&D is eliminated and R&D funding for natural gas, petroleum, and clean fuels (from coal, oil and natural gas) is significantly reduced.

Clean Coal Power Initiative

The Bush Administration is proposing a new vision in coal research. This Presidential Initiative is a new effort within the Department of Energy's Fossil Energy program that combines investments in research and development with federal matching funds for research and development and first-of-a-kind installations of advanced technologies on coal-fired power plants. As part of this initiative, the administration is requesting \$150 million in FY 2002 for funding advanced research and development and a limited number of joint government-industry-funded demonstrations of new technologies that can enhance the reliability and environmental performance of coal-fired power generators. The nation's power generators, equipment manufacturers, coal producers and others will help identify the most critical barriers to coal's use in the power sector. Industry also will be required to share in the costs of the initiative, with the private participants' share rising to 50 percent or more by the time new technologies are ready for testing at market-entry scales.

Fuels and Power Systems

In FY 2002 Coal and Power Systems has been re-named Fuels and Power Systems. While this area continues to encompass the Department's coal-related R&D, the name change highlights the multi-resource nature (e.g., oil, gas, coal) of fossil energy power and fuel systems. The FY 2002 request for Fuels and Power Systems is \$159.8 million. The FY 2001 appropriation for comparable R&D activities is \$229.2 million. In FY 2001 Fuels and Power Systems also included an additional \$94.8 million for the Power Plant Improvement Initiative.

Fuels and Power Systems addresses demands of the post-2000 domestic market, including the need for reliable, moderate-cost electricity generation that can reduce emissions consistent with evolving environmental requirements while meeting growing electricity demand. These activities will also help U.S. industry develop options for a large and growing export market, while contributing to national energy security. Based on these priorities, the coal program is focused on four goals: (1) develop progressively higher efficiency and cleaner

FOSSIL ENERGY RESEARCH AND DEVELOPMENT OVERVIEW (Cont'd)

power generation systems with 10-20% lower busbar electricity costs, which will ultimately evolve into a "Vision 21" fleet of new power and energy plants with near zero levels of pollutants as well as CO₂. (2) develop super-clean emission control systems for SO₂, NOx, air toxics, and particulate matter that can be applied to existing plants; (3) evaluate economically viable approaches to carbon sequestration to address climate change concerns, and ; (4) develop economically competitive technologies for the production of alternative transportation fuels and chemicals.

The Vision 21 concept integrates program goals to develop the full potential of our abundant fossil fuel resources while addressing climate change concerns. Vision 21 was endorsed in the November 1997 report on Energy R&D by the President's Committee of Advisors on Science and Technology (PCAST), and supported by the National Research Council and other stakeholder groups. Vision 21 plants would comprise a portfolio of fuel-flexible systems and modules capable of producing a varied slate of high-value fossil fuels, (or in combination with opportunity fuels or feed-stocks) commodities and/or electricity tailored to market demands in the 2010-2015 time frame. Distinguishing features of the Vision 21 fleet are (1) capability to produce cheaper electricity at efficiencies over 60 percent when fueled by coal, and 75 percent when fueled with natural gas; (2) near zero pollutants to meet more stringent emissions standards (less than one-tenth of current New Source Performance Standards) at a lower cost; (3) options for no net CO₂ emissions; (4) fuel flexible (coal, natural gas, plus opportunity fuels such as municipal and industrial wastes); and (5) a flexible set of integrated modules configured to meet a range of market applications and capable of producing an array of high-value commodities (such as chemicals, high-quality steam, liquid fuels, and hydrogen) at competitive prices in a free market. Many of the Fuels and Power Systems technologies, after achieving their performance goals, will be integrated into the Vision 21 concept. FY 2002 power systems activities tied to Vision 21 include achieving ultra-high efficiencies by working toward integrating advanced components such as a coal gasifier, fuel cell and turbine.

Significant progress towards achieving these goals will be made in FY 2002 in the Clean Coal Technology (CCT) Demonstration Program as projects involving gasification, advanced fluidized bed combustion, and fuel cell technology progress. Supporting CCT activities, an internet documentation database is now available that will allow stakeholders interested in the progress and implementation of CCTs to retrieve information. The infrastructure provided by the CCT projects is deployed, in certain cases, to advance the R&D program. Similarly, issues addressing systemic improvements in the technology from CCT projects are investigated under the R&D program.

FOSSIL ENERGY RESEARCH AND DEVELOPMENT OVERVIEW (Cont'd)

Fuels and Power Systems includes five elements: (1) Central Systems; (2) Distributed Generation Systems; (3) Sequestration R&D; (4) Fuels, and; (5) Advanced Research. Activities included in the \$61.0 million Central Systems request for FY 2002 are divided into two major areas. The first is Innovations for Existing Plants. A major thrust of this program area is the development of technology to comply with the requirements of the Clean Air Act Amendments (CAAA) of 1990 and new or pending regulations. The FY 2002 budget request emphasizes: development of retrofit NO_x control technologies for compliance with CAAA Title I and Title IV, Phase II regulations, and new PM_{2.5} and ozone National Ambient Air Quality Standards for essentially all existing coal-based power plants; determining PM_{2.5} source-receptor relationships as they relate to coal-fired power plant emissions; and field testing of air toxics control technologies. For mercury, no practical control technology now exists to significantly mitigate emissions from powerplants, so the focus is on both effectiveness and cost. In addition, there may be opportunities for innovative approaches which address two or more of these pollutants simultaneously.

The second area in Central Systems is Advanced Systems, which includes Low Emission Boiler System (LEBS), Indirect Fired Cycle (IFC), Pressurized Fluidized Bed (PFB) combustion, Integrated Gasification Combined Cycle (IGCC), and Advanced Turbines. The target for coal-fueled, advanced central systems is to achieve efficiencies in the 42-48 percent range in the 2000-2005 period that will provide the engineering foundation for system efficiencies in the 55-60 percent range. These latter improvements could reduce CO₂ emissions by over 40 percent compared to current coal-fired systems.

- C The LEBS program is drawing to a close. No further funding is requested in FY 2002.
- C IFC/PFB are being refocused to emphasize hybrid systems. IFC incorporates a new high temperature advanced furnace and pyrolyzer which integrates combustion, heat transfer and emission control processes. In FY 2002, the applicable combustion technology for Vision 21 is folded into the Vision 21 gasification/combustion hybrid concepts under IGCC. For PFB, major emphasis in FY 2002 will shift to provide the key scale-up technology for gasification/fluid bed combustion hybrids for Vision 21 concept options.
- C IGCC offers the potential for significant increases in thermal efficiency as well as significant reductions in capital costs, near-zero emissions of pollutants, and the ability to co-produce electricity and other valuable products. In FY 2002, the program will

FOSSIL ENERGY RESEARCH AND DEVELOPMENT OVERVIEW (Cont'd)

continue its focus on cost and efficiency improvements and performance optimization for power generation and co-production applications.

C The Advanced Gas Turbine Program work on utility-scale turbines will be completed in FY 2001.

The FY 2002 request for Distributed Generation Systems is \$45.1 million. These systems offer the potential to cost-effectively meet peak demand, and in some cases base and intermediate load, without the need for capital intensive central station capacity or costly investments in transmission and distribution. Fuel cell distributed generation systems have the additional advantage of being capable of reducing criteria pollutants well below current New Source Performance Standard levels, reducing non-criteria pollutants such as CO₂ and acid rain precursors, and reducing thermal emissions to the environment. In FY 2002, demonstration of a commercial-scale, 250kW molten carbonate fuel cell (MCFC) power plant system will be completed to verify its applicability for the combined heat and power, and distributed generation markets. A demonstration will also be completed of a 220 kW - 320 kW solid oxide fuel cell (SOFC)/turbine hybrid commercial prototype in support of Vision 21. Successful demonstrations could result in the construction of manufacturing facilities in the U.S. A growing thrust of the program is development of a low cost 5-kilowatt solid state fuel cell for distributed and auxiliary power unit applications. Toward this end, the Solid State Energy Conversion Alliance (SECA) provides a forum to bring entities together which are interested in low-cost, high power-density, solid state fuel cell systems for distributed generation and auxiliary power unit applications. SECA is committed to developing advanced technology that can be readily customized, while still being mass produced to reduce costs, with an initial cost target of \$400/kilowatt for a complete solid state system.

Sequestration R&D explores the potential for greenhouse gas reduction, particularly carbon dioxide. FE's sequestration research, which is part of a larger DOE Sequestration Initiative, is being carried out in collaboration with other parts of the Department, other government agencies, national laboratories, other countries, and industrial firms, and pursues a balanced set of approaches to establish both the environmental acceptability and the required technical and economic performance. The FY 2002 request of \$20.7 million for Sequestration R&D will carry to "proof-of-concept" completion a number of applied R&D options being investigated as part of prior solicitations. For example, integrated research and field demonstrations of CO₂ sequestration in deep, unminable coal seams and depleted oil reservoirs will be conducted and sufficient data developed to determine reservoir integrity and the fate of injected CO₂. The

FOSSIL ENERGY RESEARCH AND DEVELOPMENT OVERVIEW (Cont'd)

long-term program goal is to achieve large-scale carbon sequestration at \$10/ton, which could lead to the reduction of carbon emissions by 145 million tons per year in the U.S. and 270 million tons worldwide by 2030.

The FY 2002 request for Fuels R&D is \$7.0 million and focuses on development of critical components of the fuels technology program. This includes continued development of new ceramic membranes that would separate coal gas, biomass-derived gas, or natural gas into constituents that could be chemically combined to new types of liquid fuels. Also included is advanced technologies to create new industries for the production of premium carbon and industrial products from coal. No funding is requested for the steelmaking process, which is investigating the direct reduction of iron ore. Funding was completed in FY 2001.

The FY 2002 request for Advanced Research is \$26.0 million, which funds two types of activities. The first is a set of crosscutting studies and assessment activities in environmental, technical and economic analyses, coal technology export and international program support. The second includes crosscutting fundamental and applied research programs that focus upon developing the technology base in the enabling science and technology areas that are critical to the successful development of both superclean, very high efficiency coal-based power systems and coal-based fuel systems, with greatly reduced or no net emissions of CO₂. These systems are encompassed in the Vision 21 energyplex. Advanced Research seeks a greater understanding of the physical, chemical, biological and thermodynamic barriers to achieving economic, technologic, and environmental goals and to identify ways to overcome those barriers.

Significant potential benefits can be realized from achieving the Coal and Power Systems goals. For example, combining high efficiency power generation with carbon sequestration technology has the potential to reduce global carbon emissions by more than 500 million tons per year by 2030, and by much more as the existing portfolio of powerplants retires and is replaced by improved technology. Potential savings in cost of electricity is estimated at 0.5 billion per year by 2015, reaching \$2.5 billion per year in 2030, and contributing to power plant sales of \$10 billion per year in 2030.

Natural Gas Technologies

In FY 2002, \$21.0 million is requested for Natural Gas Technologies. This includes activities to help ensure that future domestic gas supplies are adequate and reasonably priced. EIA, in its 2001 Annual Energy Outlook (AEO2000), projects over a 60 percent increase

FOSSIL ENERGY RESEARCH AND DEVELOPMENT OVERVIEW (Cont'd)

in domestic natural gas consumption between 2000 and 2020, with nearly two-thirds used for electric power generation. This requires increasing gas production from parts of the vast domestic resource base that are not currently economical to recover because of the geological setting, quality of the gas, or location relative to infrastructure. The gas program focuses on technical and market needs, and is closely coordinated with industry. Activities seek to ensure long-term availability and reliability of natural gas at reasonable prices and to improve the Nation's ability to store, transport, and distribute gas in an economic, efficient, and environmentally beneficial manner. Major R&D elements include: Exploration and Production; Gas Hydrates; Infrastructure; and Effective Environmental Protection.

The Exploration and Production request for FY 2002 is \$9.4 million, and includes a range of activities, foremost of which are:

- C Advanced Drilling, Completion, and Stimulation projects to develop and demonstrate tools and techniques that will result in minimum formation damage, reduce costs and improve recovery, and minimize the environmental impact of drilling-related operations and waste disposal. FY 2002 cost reduction activities include development of the world's first microwave-processed drill bit and composite drill pipe.
- C Advanced Diagnostics and Imaging Systems to develop and demonstrate advanced imaging and prediction techniques for locating productive areas within low-permeability and fractured reservoirs, and identify and assess the potential productivity of non-conventional gas reservoirs in priority basins to reduce exploration and production risks. These technologies will reduce the number of dry holes; improve production from fractured reservoirs; increase U.S. exploration through greater industry access to and use of geologic and geophysical basin-scale data; and increase the cost effectiveness of field development, infill drilling, and extraction processes.

The \$4.8 million request for Gas Hydrates is a long-term effort seeking to convert the potential gas hydrates resource (estimated at up to 320,000 Tcf) into gas reserves while developing technologies to assure safe petroleum operations in hydrate areas, and define the impact of methane hydrates on the global carbon cycle.

Fossil Energy's \$5.1 million Infrastructure Technology program includes activities to enhance the reliability and deliverability of the Nation's natural gas pipelines and gas storage facilities. These efforts are motivated by increasing concern about the integrity and

FOSSIL ENERGY RESEARCH AND DEVELOPMENT OVERVIEW (Cont'd)

adequacy of the gas delivery and storage infrastructure. This is one of the critical barriers to achieving 30 TCF domestic consumption, projected by 2015, given the age of the existing pipelines, declining industry R&D for enhancing pipeline infrastructure, an uncertain regulatory climate, and long lead times required for new pipeline construction. FY 2002 activities include development of advanced storage technologies for high deliverability facilities and smart automated inside pipeline inspection systems and repair technology.

The Effective Environmental Protection program request is \$1.6 million. The program works to lower the cost of environmental protection through a combination of risk assessment technology development, regulatory streamlining, impact analysis, and facilitating dialogue that attempts to achieve consensus among affected parties on ways to balance the need to develop the Nation's energy resources with the maintenance of our environmental values.

Oil Technology

In FY 2002, \$30.5 million is requested for the Oil Technology program, which seeks to enhance energy security through increased domestic production, as well as helping the U.S. to be a responsible steward of its oil resources. The combined impact of FE R&D could contribute toward preserving the availability of these resources, extending reservoir life, and increasing domestic production.

Objectives of the oil technology program include: stem the decline in domestic oil production; improve the capability of the Nation's petroleum industry to increase the supply of secure, domestic oil; and reduce and resolve environmental issues associated with domestic oil production and processing. These activities are carried out under the areas of Exploration and Production, Reservoir Life Extension and Management, and Effective Environmental Protection.

The FY 2002 request for Exploration and Production is \$20.4 million, which includes work in several areas:

- C Advanced Drilling, Completion, and Stimulation work focuses on developing tools and techniques to drill, complete and stimulate oil wells to reduce costs, improve well productivity, and reduce environmental impacts (smaller surface "footprint" and reduced drilling wastes). FY 2002 activities include demonstrating safe, economic slimhole drilling technology under Arctic conditions.

FOSSIL ENERGY RESEARCH AND DEVELOPMENT OVERVIEW (Cont'd)

- C Advanced Diagnostics and Imaging Systems develops technologies and methodologies that improve the success rates and cost efficiencies for the development of existing fields and the discovery of new fields. A special focus is highly fractured reservoirs and ultra-deep geologic exploration and development environments.
- C Reservoir Efficiency Processes include research to develop and demonstrate tools and methodologies that permit oil operators to recover hydrocarbons from known reservoirs not producible by current technology.
- Arctic Oil and Gas Research will develop advanced technologies for production and use of energy in the Arctic environment.

The Reservoir Life Extension and Management program request is \$4.8 million to provide improved technology and/or more efficient methods to recover more of the 350 billion barrels of discovered but unproduced domestic oil resource, and increase recovery of oil from Federal lands. Evaluation of past advanced field trials in large, promising Class 1, 2, and 3 reservoirs will be completed. Demonstration and testing of technologies specifically targeted for independent operators will be continued.

The Effective Environmental Protection FY 2002 request is \$5.3 million for technologies and practices that reduce the threat to the environment and decrease the cost of effective environmental protection and compliance involved in oil exploration, production, and oil processing. The program will focus on detection and control of air emissions from gas and oil equipment and facilities, treatment and reduction of produced water to meet environmental standards, remediation of soils that have been contaminated with hydrocarbons or produced water, treatment and disposal of wastes containing naturally occurring radioactive materials, underground injection of produced water, and other approaches to manage oil and gas field wastes.

Research currently conducted under Ultra Clean Fuels to develop technology for the refining industry to make low sulfur fuel was determined to be most appropriately funded by the private sector. No funding is requested for this activity in FY 2002.

External Inputs to FE Program Planning

FOSSIL ENERGY RESEARCH AND DEVELOPMENT OVERVIEW (Cont'd)

A number of distinguished expert groups representing industry and academia have provided guidance on FE program priorities. For example:

- C The President's Committee of Advisors on Science and Technology (PCAST), in its November 1997 report "Federal Energy Research and Development for the Challenges of the Twenty-First Century," recommended strong support for: (1) Vision 21, zero-emission energy plants capable of producing combinations of energy, heat, fuels and chemicals from carbonaceous fuels; (2) new approaches for capturing and sequestering carbon; (3) developing a science-based program with industry, Federal Agencies and the Navy to understand the potential of methane hydrates worldwide; (4) technology transfer and cost-effective demonstrations to help maintain production from mature and marginal regions of domestic oil production; and (5) foundation building R&D in universities and National Laboratories to help maintain the energy technology leadership of the United States.
- C The June 1999 PCAST report "Powerful Partnerships – The Federal Role in International Cooperation on Energy Innovation" addresses ways to improve the U.S. program of international cooperation on Energy R&D to best support U.S. priorities and address the key global energy environmental challenges of the next century. The report includes funding recommendations for a variety of initiatives that include approaches such as tax credits, regulatory assistance, training and Federally-supported R&D.
- C Industry groups, particularly formal advisory groups such as the National Coal Council, National Petroleum Council, and the recently-formed Methane Hydrate Advisory Committee, provide periodic guidance. Of particular importance to oil and gas R&D activities is the December 1999 National Petroleum Council report on Natural Gas. Other important reports include survey results from the National Petroleum Council study "Research, Development, and Demonstration Needs of the Oil and Gas Industry," and the Petroleum Technology Transfer Council Needs Assessment. These surveys identified potential high benefit R&D areas, considering the near- and long-term needs of both the supply and utilization sectors, where industry respondents, for a variety of reasons, do not believe the oil and gas industries will make adequate progress on their own.
- C Public input is obtained through workshops on various topics held throughout the year.

Other Program and Crosscutting Areas

FOSSIL ENERGY RESEARCH AND DEVELOPMENT OVERVIEW (Cont'd)

FE is taking steps to ensure that the U.S. benefits directly from cooperative research with foreign governments and multilateral institutions as well as enhanced international regulatory coordination. FE is also working with other Departmental groups, Federal agencies, international organizations and private sector companies to promote the export of domestic fossil fuel technology, including highly efficient processes that can reduce global greenhouse gas emissions.

In the area of Environmental Restoration, FE is working to provide a safe environment at the FE R&D facilities, as well as at off-site locations where R&D projects are sponsored. In addition, FE is responsible for correcting environment, safety and health (ES&H) problems at the Albany Center, a former U.S. Bureau of Mines facility that was transferred to FE in 1997. FY 2002 funding at a level of \$9.5 million is targeted at corrective actions to ensure that the FE R&D facilities are operating in compliance with Federal, state and local ES&H requirements, and that the environmental contamination associated with the on-site operations and off-site locations is remediated. The major share of funding will focus on environmental remediation, indoor air quality and ventilation, industrial safety, emergency preparedness, fire protection, control of toxic and hazardous materials, and protection of water and air quality. A sustained commitment to ES&H is an important factor in retaining public trust in the conduct of FE activities.

The FY 2002 request for Program Direction and Management Support is \$70.0 million. This provides funding for salaries, benefits and overhead expenses for management of the Fossil Energy program at Headquarters and the National Energy Technology Laboratory (NETL), with sites in Morgantown, WV, Pittsburgh, PA and Tulsa, OK.

The FY 2002 request for the Import/Export Authorization Program is \$1.0 million, which promotes the development of interfuel competition and markets for U.S. natural gas and electricity through regulation of natural gas imports and exports, exports of electricity, and the construction and operation of electric transmission lines which cross U.S. international borders.

The Advanced Metallurgical Processes Program at Albany, Oregon, for which \$5.2 million is requested in FY 2002, seeks to determine the factors that limit service life of materials in industrial, structural, or engineering applications and provide solutions to service-life problems through new materials technology, to develop and demonstrate technologies that will reduce waste and pollution, and to use capabilities and expertise to provide focused solutions to high priority national problems. The research at Albany provides information on the performance characteristics of materials being specified for the current generation of fossil-fueled power systems, on the

FOSSIL ENERGY RESEARCH AND DEVELOPMENT OVERVIEW (Cont'd)

development of cost-effective materials for inclusion in Vision 21 systems, and for solving environmental emission problems related to fossil fired energy systems. This program stresses full participation with industry and emphasizes cost sharing to the extent possible.

DEPARTMENT OF ENERGY
 FY 2002 CONGRESSIONAL BUDGET REQUEST

FOSSIL ENERGY RESEARCH AND DEVELOPMENT

PROGRAM FUNDING PROFILE

<u>Sub-program</u>	<u>FY 2000</u> <u>Enacted</u>	<u>FY 2001</u> <u>Enacted</u>	<u>FY 2002</u> <u>Request</u>	<u>Program Change</u> <u>Request vs. FY 2001</u>	
				<u>Dollar</u>	<u>Percent</u>
Clean Coal Power Initiative					
Clean Coal Power Initiative					
Operating Expenses	\$0	\$0	\$150,000	\$150,000	100%
Subtotal Clean Coal Power Initiative	\$0	\$0	\$150,000	\$150,000	100%
Fuels and Power Systems					
Central Systems					
Operating Expenses	\$112,688	\$199,135	\$61,000	\$-138,135	-69%
Distributed Generation Systems					
Operating Expenses	\$43,373	\$52,584	\$45,124	\$-7,460	-14%
Sequestration					
Operating Expenses	\$8,941	\$18,746	\$20,677	\$1,931	10%
Fuels					
Operating Expenses	\$19,844	\$23,423	\$7,000	\$-16,423	-70%
Advanced Research (formerly AR&TD)					
Operating Expenses	\$22,811	\$30,137	\$26,000	\$-4,137	-14%

PROGRAM FUNDING PROFILE - FOSSIL ENERGY RESEARCH AND DEVELOPMENT (Cont'd)

<u>Sub-program</u>	FY 2000 <u>Enacted</u>	FY 2001 <u>Enacted</u>	FY 2002 <u>Request</u>	Program Change <u>Request vs. FY 2001</u>	
				<u>Dollar</u>	<u>Percent</u>
Subtotal Fuels and Power Systems	\$207,657	\$324,025	\$159,801	\$-164,224	-51%
Gas					
Natural Gas Research Operating Expenses	\$30,809	\$45,029	\$21,000	\$-24,029	-53%
Subtotal Gas	\$30,809	\$45,029	\$21,000	\$-24,029	-53%
Petroleum					
Oil Technology Operating Expenses	\$55,748	\$66,874	\$30,499	\$-36,375	-54%
Subtotal Petroleum	\$55,748	\$66,874	\$30,499	\$-36,375	-54%
Program Direction and Management Support Operating Expenses	\$75,479	\$80,086	\$70,000	\$-10,086	-13%
Plant and Capital Equipment Construction	\$2,600	\$3,891	\$2,000	\$-1,891	-49%
Fossil Energy Environmental Restoration Operating Expenses	\$10,000	\$9,978	\$9,500	\$-478	-5%
Cooperative Research and Development Operating Expenses	\$7,193	\$8,071	\$0	\$-8,071	-100%

PROGRAM FUNDING PROFILE - FOSSIL ENERGY RESEARCH AND DEVELOPMENT (Cont'd)

<u>Sub-program</u>	FY 2000 <u>Enacted</u>	FY 2001 <u>Enacted</u>	FY 2002 <u>Request</u>	Program Change Request vs. FY 2001	
				<u>Dollar</u>	<u>Percent</u>
Import/Export Authorization					
Operating Expenses	\$2,173	\$2,295	\$1,000	\$-1,295	-56%
Advanced Metallurgical Processes					
Operating Expenses	\$5,000	\$5,214	\$5,200	\$-14	0%
Prior Year Offsets					
Operating Expenses	\$0	\$-107,000	\$0	\$107,000	-100%
TOTAL FY 2002 Request	<u>\$396,659</u>	<u>\$438,463</u>	<u>\$449,000</u>	<u>\$10,537</u>	<u>2%</u>
Summary					
Operating Expenses	\$394,059	\$434,572	\$447,000	\$12,428	3%
Construction	<u>\$2,600</u>	<u>\$3,891</u>	<u>\$2,000</u>	<u>\$-1,891</u>	<u>-49%</u>
Total Program	<u>\$396,659</u>	<u>\$438,463</u>	<u>\$449,000</u>	<u>\$10,537</u>	<u>2%</u>
Staffing (FTEs)					
Headquarters	115	130	130		
Field	<u>538</u>	<u>575</u>	<u>525</u>		
Total Staffing	<u>653</u>	<u>705</u>	<u>655</u>		

Authorizations:

P.L. 95-91, "Department of Energy Organization Act" (1997)

DEPARTMENT OF ENERGY
 FY 2002 CONGRESSIONAL REVIEW BUDGET REQUEST

FOSSIL ENERGY RESEARCH AND DEVELOPMENT

SUMMARY OF CHANGES

	FY 2002 <u>Request</u>
FY 2001 Enacted	\$438,463
Non-Discretionary	
- Federal Pay Raise and Locality Pay	2,293
- Transit Subsidy	8
- Working Capital Fund	<u>58</u>
FY 2002 Base	\$440,822
 <u>Clean Coal Power Initiative</u>	
- This is a new Presidential initiative that will demonstrate the latest advanced clean coal-based technologies , aimed at sustaining enhanced electricity reliability, generation capacity and clean, affordable power	+150,000
 <u>Central Systems</u>	
- Innovations for Exiting Plants - Funding will support development of fossil fuel combustors with ultra clean NO _x emissions under the Vision 21 program and eliminates a program aimed at optimizing the performance of coal-fired power plants in China and Turkey	-2,102
- Advanced Systems-Low Emission Boiler System (LEBS) - Phase IV activity will continue using prior year funding	0
- Advanced Systems-Indirect Fired Cycle - Funding for the applicable combustion technology for Vision 21 is funded within Advanced Systems-Integrated Gasification Combined Cycle.	-5,997

SUMMARY OF CHANGES - FOSSIL ENERGY RESEARCH AND DEVELOPMENT (Cont'd)

- Advanced Systems-Integrated Gasification Combined Cycle - The funding level supports the continuation of development efforts at the Wilsonville Power Systems Development Facility; co-production feasibility studies; laboratory-scale investigations of Vision 21 activities in air separations; hydrogen separations; gas stream purification and advanced fuel-flexible gasification hybrids -134
- Advanced Systems-Pressurized Fluidized Bed - The decrease will transition the program to combustion hybrid technology development activities at the Wilsonville Power Systems Development Facility, gas stream cleanup development and testing, and continue engineering design concepts in support of Vision 21 -4,175
- Turbines - As work on the utility-scale turbine draws to a close, no additional funding is requested in FY 2002 -30,936
- Power Plant Improvement Initiative (PPII) - Follow-on program activity is being funded in FY 2002 under a new Clean Coal Power Initiative -94,791

Distributed Generation Systems

- Fuel Cells-Advanced Research - The request supports the continuation of generic research on fuel cell systems to lower costs, investigate advanced processes and designs, and to solve fundamental crosscutting materials and design issues -1,794
- Fuel Cells-Fuel Cell Systems - The program will continue to pursue industry cost-shared cost reduction and production improvement research and continues supporting assessments and studies on a market entry system. Activities related to the Solid State Energy Conversion Alliance (SECA) are funded within Fuel Cells-Innovative Systems Concepts -19,432
- Fuel Cells-Vision 21 Hybrids - Research will continue on Vision 21 enabling cost reduction and performance enhancement program on a market entry system -3,467
- Fuel Cells-Innovative Systems Concepts - The increase continues activities leading to development of low cost, solid state fuel cells under SECA +17,233

Sequestration R&D

SUMMARY OF CHANGES - FOSSIL ENERGY RESEARCH AND DEVELOPMENT (Cont'd)

- Sequestration R&D - The increase provides for exploratory research on novel and advanced concepts for greenhouse gas capture, separation, storage and reuse; and increased research facilities and capabilities to expand research in the area of sequestration +1,931

SUMMARY OF CHANGES - FOSSIL ENERGY RESEARCH AND DEVELOPMENT (Cont'd)

Fuels

- Transportation Fuels and Chemicals - The decrease in funding is due to the conclusion of the Early Entrance Coproduction Plant feasibility studies and other coal-based syngas fuels research. The funding also provides for continued research on novel syngas ceramic membrane technology for gas conversion and other novel fuels conversion processes -2,558
- Solid Fuels and Feedstocks - Conclude activity for coal cleaning to produce premium fuels, reduction of air toxic precursors, high efficiency processes development, research on advanced separation technologies, and testing to assist in the successful introduction of U.S. coal utilization into international markets. Also provides for continuing research on methods to produce premium carbon products from coal via industry-led consortia and NETL study -2,291
- Advanced Fuels Research - The program will conclude research on C-1 chemistry novel clean fuels, hydrogen enabling science, molecular modeling for fuels catalyst research, and advanced novel concepts research for ultra-clean fuels and chemicals -4,889
- Steelmaking - The elimination of funding will conclude demonstration of this revolutionary ironmaking process -6,685

Advanced Research

- Coal Utilization Science -The funding provides for continued research toward sensor and control development, the Virtual Demonstration Plant and CO2 mineral sequestration, in support of the Vision 21 concept of a power and fuels complex +14
- Materials - The funding provides for continued program development efforts on high temperature intermetallics, ceramic composites and high temperature filters, membranes, and solid state electrolyte functional materials +15
- Coal Technology Export - The funding provides for continued support for coal and technology export programs and promotion initiatives; assists in trade missions and other activities to promote the export of clean coal technologies; and continues the coordination of all FE international related crosscutting activities -43
- Bioprocessing of Coal - The funding provides for the development of biological processes to sequester CO₂ by natural mitigation strategies and ongoing bioprocessing efforts +3

SUMMARY OF CHANGES - FOSSIL ENERGY RESEARCH AND DEVELOPMENT (Cont'd)

- Environmental Activities - The program continues environmental analyses of air and water quality, solid waste disposal, toxic substance releases, and global climate change -96
- Technical and Economic Analysis - The funding continues studies supporting multi-year planning, FE strategy, and program formulation, provides analytical support for fossil related Energy Policy Act implementation; supports state and regional efforts to develop energy analysis capability +2
- International Program Support - The program continues analysis, studies and technical evaluations of ongoing and planned bilateral and multilateral activities; and continues support for international initiatives that leverage fossil energy resources -48
- Focus Area for Computational Energy Science - The decrease was due to reprogrammed funds added in FY 2001 to construct access to supercomputer and to purchase interface equipment. Continue development of advanced modeling tools and dynamic simulations for Vision 21 -3,993
- University Coal Research - The funding continues support for university research and undergraduate internship programs +7
- HBCUs, Education and Training - The funding continues efforts to accelerate workforce diversity in fossil fuel related technologies +2

Natural Gas Technologies

- Exploration and Production - The budget request does not include funding for field demonstrations of integrated deep drilling systems. In addition, the Multi-National Lab/Industry partnership effort will be eliminated, and no new work in Secondary Gas Recovery will be pursued. Technology transfer work with PTTC will continue at a reduced level -4,871
- Gas Hydrates - The funding allows continuation of a core program of resource characterization of Arctic and marine hydrates with the U.S. Geological Survey, Naval Research Lab and universities. Funding that supports joint industry projects in seafloor stability, resource characterization and feasibility has been reduced. -5,188
- Infrastructure - The request supports reduced funding for research in the storage technology program to further develop

SUMMARY OF CHANGES - FOSSIL ENERGY RESEARCH AND DEVELOPMENT (Cont'd)

existing underground storage facilities; develop cost-effective technologies to determine, prevent or remediate storage well/field deliverability decline; expand peaking storage capability for demand periods; and reduce the investment required to maintain affordable storage service. Also, funding is requested in the infrastructure technology program for research on the environmental impact of pipeline infrastructure and the integrity of distribution systems; underground facility detection; internal inspection; trenchless and horizontal boring technologies; and virtual models for gas system reliability analysis and distribution resource systems	-3,060
- Emerging Processing Technology - No new funding is proposed to continue work for coal mine methane and gas upgrading projects	-9,896
- Effective Environmental Protection - The decrease reflects reductions in the effort to develop and demonstrate technologies to reduce environmental compliance cost and improve environmental performance related to natural gas resource recovery . The program will sustain emphasis on technologies that will improve responsible development of gas resources on public lands	-1,014
<u>Oil Technology</u>	
- Exploration and Production - The program plans to reduce research on oil basin analysis, smart well technology, advanced recovery methods, and fundamental technologies for frontier oil production. In addition, the Multi-National Lab/Industry partnership effort will be eliminated and research benefitting the recovery of petroleum through the use of sonication will be eliminated	-8,494
- Reservoir Life Extension/Management - The request supports the technology research and development with independents program. The decrease reflects completion of work to improve oil recovery and resource management capabilities with Native American tribes	-9,813
- Effective Environmental Protection - The decrease reflects reductions in the effort to develop and demonstrate technologies to reduce environmental compliance costs and improve environmental performance related to upstream and downstream oil industry activities . Focus on upstream technologies that will improve responsible development of gas resources on public lands. The Department has chosen, due to budget constraints, to reduce work with States and other Federal agencies in streamlining regulations and supporting their efforts to make more cost-effective, risk-based regulatory decisions	-5,496

SUMMARY OF CHANGES - FOSSIL ENERGY RESEARCH AND DEVELOPMENT (Cont'd)

- Emerging Processing Technology Applications - No funds for diesel biodesulfurization project for producing low sulfur diesel fuel.	-2,594
- Ultra Clean Fuels - Begin an orderly termination of R&D using prior year funds	-9,978

SUMMARY OF CHANGES - FOSSIL ENERGY RESEARCH AND DEVELOPMENT (Cont'd)

Program Direction and Management Support

- Headquarters Salaries and Benefits - Provides for 80 FTEs at Headquarters. This staff implements and communicates policy to the NETL, sets program objectives, develops program plans and evaluates alternative strategies; develops and defends budget requests; approves procurement plans, and monitors work progress -2,580
- Headquarters Travel - Provides funds for travel in support of the activities stated above. Both domestic and international travel are conducted -38
- Headquarters Contract Services - Provides for contractual services that are generic to the entire FE program. Included are items such as computer services, technical and management support services, E-mail and LAN requirements, computer timesharing/housekeeping, and the working capital fund which provides overhead expenses -265
- Field Salaries and Benefits - Provides funds for 281 FTEs at the National Energy Technology Laboratory (NETL). Activities of the staff include contract and lab monitoring, development and maintenance of project, budget and procurement plans, and other activities related to program and site support -4,917
- Field Travel - Provides funds for travel in support of the above stated activities in the attainment of program goals, both on the domestic front and abroad -140
- Field Contract Services - Provides funds for facility operations, maintenance, finance automated office support service, administrative, management and technical support -4,505

Plant and Capital Equipment

- Construction - The funding provides for general plant projects at the National Energy Technology Laboratory sites and the Albany Research Center -1,891

Cooperative Research and Development

- Cooperative Research and Development - The request eliminates funding for continued research and development at UNDEERC and WRI -8,071

SUMMARY OF CHANGES - FOSSIL ENERGY RESEARCH AND DEVELOPMENT (Cont'd)

Fossil Energy Environmental Restoration

- CERCLA Remedial Actions - Provides funding for the continued cleanup of the Rock Springs and Hoe Creek sites; continuation of the Hannah site revegetation; soil and groundwater cleanup at the FETC-PGH former liquefaction site; and assessment/site investigations of inactive projects -1,707
- RCRA Remedial Actions - Provides for continued on-site remediation activities +137
- Other ES&H Actions - The increase provides for continuing recurring ES&H activities at the FETC sites +1,092

Import/Export Authorization

- Import/Export Authorization - Provides for the salaries and benefits of 7 FTEs who manage the regulatory review of natural gas imports and exports, exports of electricity, the construction of electric transmission lines which cross U.S. international borders, and exercise regulatory oversight of powerplant conversions pursuant to the Powerplant and Industrial Fuel Use Act of 1978 -1,295

Advanced Metallurgical Processes

- Advanced Metallurgical Processes - Continues research on extending the service life on materials while addressing ways to improve environmental impact of hazardous materials paths and processes -14

Use of Prior Year Balances +107,000

FY 2002 Congressional Budget Request \$449,000

DEPARTMENT OF ENERGY
FY 2002 CONGRESSIONAL BUDGET REQUEST

FOSSIL ENERGY RESEARCH AND DEVELOPMENT

CLEAN COAL POWER INITIATIVE

I. **Mission Supporting Goals and Objectives:**

Coal is by far the most abundant U.S. energy resource, with domestic reserves that exceed the energy potential of the world's oil reserves. Americans want reliable and affordable power, and they want clean air too. Meeting the rising electricity demands of our increasingly electronic economy will require the use of coal for the foreseeable future, and we must therefore develop the ability to eliminate the technological barriers to continued coal use.

The Bush Administration is proposing a new vision in coal research. This Presidential Initiative is a new effort within the Department of Energy's Fossil Energy program that combines investments in research and development with federal matching funds for research and development and first-of-a-kind installations of advanced technologies on coal-fired power plants. As part of this initiative, the administration is requesting \$150 million in FY 2002 for funding advanced research and development and a limited number of joint government-industry-funded demonstrations of new technologies that can enhance the reliability and environmental performance of coal-fired power generators.

The Clean Coal Power Initiative will be carried out cooperatively with industry. The nation's power generators, equipment manufacturers, coal producers and others will help identify the most critical barriers to coal's use in the power sector. Industry also will be required to share in the costs of the initiative, with the private participants' share rising to 50 percent or more by the time new technologies are ready for testing at market-entry scales.

To obtain industry's views on the content, coordination and scope of the Clean Coal Power Initiative, the Department of Energy's Office of Fossil Energy will convene a workshop later this year with utilities, equipments manufacturers, fuel suppliers, universities and others.

I. **Mission Supporting Goals and Objectives:** CLEAN COAL POWER INITIATIVE (Cont'd)

Among the discussion topics will be the feasibility of establishing a more formal consortium of private organizations that would help coordinate and guide the initiative.

The CCPI is a follow-on to the Power Plant Improvement Initiative (PPII) and is closely coordinated with R&D activities under Central Systems. All projects would require cost-sharing by participants in the effort, with the industry share increasing as technologies approach commercial states. Commercially successful technologies will contribute royalties back to a program fund to underwrite future research efforts. CCPI will demonstrate the latest technological improvements in efficiency, advanced low-cost emission control technologies, and reliability at new and existing plants.

II. A. **Funding Schedule:**

<u>Activity</u>	<u>FY 2000</u>	<u>FY 2001</u>	<u>FY 2002</u>	<u>\$Change</u>	<u>%Change</u>
Clean Coal Power Initiative	<u>\$0</u>	<u>\$0</u>	<u>\$150,000</u>	<u>\$150,000</u>	<u>100%</u>
Total, Clean Coal Power Initiative	<u>\$0</u>	<u>\$0</u>	<u>\$150,000</u>	<u>\$150,000</u>	<u>100%</u>

II. B. **Laboratory and Facility Funding Schedule:**

<u>Activity</u>	<u>FY 2000</u>	<u>FY 2001</u>	<u>FY 2002</u>	<u>\$Change</u>	<u>%Change</u>
All Other	<u>\$0</u>	<u>\$0</u>	<u>\$150,000</u>	<u>\$150,000</u>	<u>100%</u>
Total, Clean Coal Power Initiative	<u>\$0</u>	<u>\$0</u>	<u>\$150,000</u>	<u>\$150,000</u>	<u>100%</u>

III. **Performance Summary:**

<u>Activity</u>	<u>FY 2000</u>	<u>FY 2001</u>	<u>FY 2002</u>
Clean Coal Power Initiative	No activity. (\$0)	No activity. (\$0)	Initiate a Clean Coal Power Initiative as a follow-on to the

III. **Performance Summary:** CLEAN COAL POWER INITIATIVE (Cont'd)

Activity	FY 2000	FY 2001	FY 2002
Clean Coal Power Initiative (Cont'd)	No activity. (\$0)	No activity. (\$0)	Power Plant Improvement Initiative (PPII) under Central Systems, that will demonstrate the latest advanced clean coal-based technologies beyond PPII , aimed at sustaining enhanced electricity reliability, generation capacity and clean, affordable power. (\$148,500)(TBD) Fund technical and program management support (\$1,500)
Clean Coal Power Initiative, Total	\$0	\$0	\$150,000

DEPARTMENT OF ENERGY
FY 2002 CONGRESSIONAL BUDGET REQUEST

FOSSIL ENERGY RESEARCH AND DEVELOPMENT

CENTRAL SYSTEMS

I. **Mission Supporting Goals and Objectives:**

As the growing national economy relies increasingly on electronically and digitally controlled processes, electricity supply availability becomes a major concern, especially as the electricity generation market is undergoing restructuring. This has resulted in a growing national need for increased electricity and reduced emissions from electric power generation plants to replace and augment an aging power generation infrastructure. Electricity demand from both natural gas and coal is projected to increase significantly through the year 2015 to meet increased energy demand in the U.S. and offset the decline in generation from nuclear power (Annual Energy Outlook, 2001).

Traditionally, electric power generation generally implies large-scale production of electric power in stationary plants that are interconnected by a transmission and distribution system to serve the electric loads in a given area or region. This centralized mode of generation is comprised chiefly of fossil fueled power plants that have rapidly proliferated to meet growing demands. But technology has improved too slowly to keep abreast of societal needs for higher efficiency and reduced environmental impacts.

In response to these needs, the Central Systems Program is focused on improving the existing fleet's performance and to provide innovative technology to support a longer term goal of dramatically improving the efficiency of power systems while reducing emissions of pollutants to near zero levels. In FY 2002, and future years this activity, will be included in the Clean Coal Power Initiative. The near-term focus will continue to develop low-cost technologies. In support of the long term goal, a revolutionary approach called "Vision 21" will continue with the aim of developing technology for high efficiency energy plants with practically zero emissions. Vision 21 is a program that will provide the necessary technology in building blocks along with the integration of these building blocks to attain this goal. A fleet of these Vision 21 plants will be flexible enough to use a variety of fossil resources including coal (our most abundant domestic fuel), natural gas, and other feedstocks. They will produce a slate of energy products including electricity, clean fuels

I. **Mission Supporting Goals and Objectives:** CENTRAL SYSTEMS (Cont'd)

and chemicals, and high grade heat. In some cases, these plants will be able to separate and capture CO₂, a greenhouse gas, for subsequent sequestration.

As part of the current core DOE Fossil Energy RD&D Program, the Central Systems program is addressing the development of cost-effective power systems, based on both coal and natural gas individually and in combination, that are substantially cleaner and more efficient than systems in use today. The Central Systems program includes several advanced power systems based on coal combustion or coal gasification, advanced environmental control technologies, and advanced gas turbine technology. In addition, Central Systems is pursuing a power plant improvement initiative that demonstrates advanced coal-based technologies for improving performance and capacity of new and existing plants. Different kinds of power systems are being developed, each based on a different technology: advanced combustion; gasification combined cycle; pressurized fluidized bed combustion; hybrid combustion systems; advanced turbine systems; and fuel cells in combination with turbines as a hybrid power module. Many of these technologies will evolve into the technology building blocks for Vision 21 while finding applications in related markets along the way, resulting in nearer-term spinoff benefits as well as reducing costs and technical risks for Vision 21 systems.

The program elements for Central Systems include technology developed for existing plants, advanced systems, and Vision 21.

Innovations for Existing Plants - This program element has a near-term focus on developing advanced clean/efficient power systems and highly efficient, cost-effective environmental control technologies for retrofitting to existing powerplants, with applications to new plants as well. Results of this advanced research are used by those who develop, design, manufacture and operate both existing and advanced systems across the entire spectrum of coal utilization technologies not only to improve efficiencies, but also to improve environmental performance. This program's crosscutting efforts address the cost-effective removal of pollutant causing contaminants from fossil fueled systems. It focuses on the development of emissions control technology for SO₂, NO_x, air toxics and particulates to address the energy and environmental demands of the post-2000 timeframe; development of high quality scientific information on emerging environmental issues such as the impact of powerplants on water quality and availability, for decision makers; development of emission controls with saleable byproducts to minimize or eliminate liquid/solid wastes from coal-fired powerplants; and sampling and characterization of advanced power system byproducts. A major thrust of this program area is the development of technology to comply with the requirements of the Clean Air Act Amendments (CAAA) of 1990 and new or pending regulations. The FY 2002 budget request

I. **Mission Supporting Goals and Objectives:** CENTRAL SYSTEMS (Cont'd)

emphasizes development of retrofit NO_x control technologies for compliance with the NO_x SIP Call, TRI acid gas control, 316(b) cooling water intake requirements, and new PM_{2.5} and ozone National Ambient Air Quality Standards for essentially all existing coal-based power plants, determining PM_{2.5} source-receptor relationships as they relate to coal-fired power plant emissions, field testing of air toxics (mercury) control technologies, and characterization of coal-combustion byproducts.

Low-Emission Boiler System (LEBS) - These systems take pulverized coal combustion, the most widely accepted technology for coal-fired generation at the present time, a major step forward by redesigning the process to gain major performance improvements. The LEBS integrates methods of emission control with a super critical steam cycle at the outset of design. This results in powerplants with very low emissions and significantly higher efficiency than a conventional pulverized coal power plant. This program will continue to completion with prior year funds.

Indirect Fired Cycle (IFC) - IFC systems are coal-fired combined cycle systems that produce energy cleanly and efficiently. The IFC program focused on High Performance Power Systems (HIPPS) incorporates a new high temperature advanced furnace and pyrolyzer which integrates combustion, heat transfer and emission control processes. In FY 2002, the applicable combustion technology for Vision 21 is folded into the Vision 21 gasification/combustion hybrid concepts under the Pressurized Fluidized Bed program.

Integrated Gasification Combined Cycle (IGCC) - The IGCC program fosters the development and commercialization of fuel flexible gasification-based processes for converting carbon-based feedstocks to electricity, steam, and a broad range of chemicals and clean fuels. Compared with today's technologies for power generation, IGCC offers the potential for significant increases in thermal efficiency as well as significant reductions in capital costs and near-zero emissions of pollutants. IGCC is an advanced power generation technology that can readily co-produce electricity and other valuable products. In order to achieve the full potential of IGCC, significant advances must be made to reduce the capital and operating and maintenance costs and to improve both the reliability and the overall system availability, while targeting efficiencies of greater than 60% and reducing environmental emissions to near-zero levels. In FY 2002, the program will continue its focus on cost and efficiency improvements and performance optimization for power generation and co-production applications; gas stream purification to meet quality requirements for use with fuel cells and conversion processes; hybrid and advanced gasification concepts for feedstock flexibility and CO₂ capture; and the development and demonstration of technologies for producing hydrogen and reducing greenhouse gas emissions, all of which are key technology building blocks for Vision 21. The IGCC

I. **Mission Supporting Goals and Objectives:** CENTRAL SYSTEMS (Cont'd)

program will be coordinated with other Departmental elements focusing on the production of fuels and chemicals from synthesis gas and the sequestration and utilization of carbon dioxide. The successful accomplishment of these activities will enhance the commercialization prospects of advanced IGCC technologies for the production of electricity for use by utilities, independent power producers, and other industrial stakeholders. It also provides technologies for the coproduction of power and other valuable commodity products that would be characteristic of a Vision 21 plant.

Pressurized Fluidized Bed (PFB) - Although PFB technology has shown technical promise, including high combustion and heat transfer efficiency inherent to fluid beds; sulfur dioxide removal integral to the combustion process through introduction of sorbent into the fluid bed; and low NO_x emissions, alternate technology pathways such as combustion hybrids appear to have even more promise and reduced risks in achieving the efficiency, environmental and cost goals for advanced, flexible combustion power systems. There, the PFB program is in transition in order to provide the necessary technology base for a Vision 21 concept option for a gasification/combustion hybrid. In FY 2002 the major emphasis at the Wilsonville Power System Development Facility will be the development of design concepts applicable to combustion technology for Vision 21. This project provides the key technology for gasification/fluid bed combustion hybrids for Vision 21 concept options.

The **Power Plant Improvement Initiative** (PPII) focuses on demonstrating advanced coal-based power technologies to improve overall plant efficiency, emissions reduction, cost effectiveness and enhanced reliability. The PPII initiated in FY 2001 and implemented in FY 2002 is the initial investment towards this goal. It is a 50% cost-shared program that will demonstrate and deploy these coal-based technologies over the next few years to enhance electricity supply availability and improve environmental and plant performance. It also has a repayment provision that includes repayment in the replication of the technology demonstrated both domestically and internationally. In FY 2002, and future years, continuing demonstration activity will be included in the Clean Coal Power Initiative.

Vision 21 is an extension or continuation of ongoing advanced power systems R&D to lower the cost and improve the environmental performance and efficiency of coal plants. This development effort will lead to the deployment of a family of plants that converts a combination of feedstocks (e.g., coal, natural gas, biomass, and opportunity fuels such as, petroleum coke or heavy oil resid (refinery wastes)) to electricity, heat (e.g., steam), and a suite of high-value products that may include synthesis gas, hydrogen, liquid fuels, chemicals, and by-products (e.g., sulfur and ash or slag). The specific feedstocks and products, and indeed the size and configuration, of

I. **Mission Supporting Goals and Objectives:** CENTRAL SYSTEMS (Cont'd)

each Vision 21 plant will depend on the plant's location, and on the resources, raw materials, and market factors in play at that location. Physically, Vision 21 plants will be a tightly integrated combination of power and fuels processing subsystems or modules that could include advanced combustors and gasifiers; high-temperature heat exchangers; gas separation, reforming, cleanup, and purification systems; turbines; fuel cells; chemical reactors; and advanced control systems. Vision 21 plants will effectively remove environmental constraints as an issue in the use of fossil fuels: emissions of traditional pollutants, including smog and acid rain forming species, will be near zero and the greenhouse gas, carbon dioxide, will be reduced 40-50% by efficiency improvements, and reduced to zero if coupled with sequestration. Vision 21 plants will be affordable: costs will be compatible with sustained economic robustness, enhanced industrial competitiveness, and jobs creation through the availability of low-cost energy. In FY 2002, Vision 21 will continue the development of key enabling technologies, supporting R&D, and systems analyses, simulations and integration through the government/industry/laboratory/university cost-shared partnership based on the Vision 21 technology roadmap.

Central Systems FY 2002 Performance Measures:

Innovations for Existing Plants - Technologies are being developed to enable existing coal-fired powerplants to comply with ozone and PM_{2.5} ambient air quality standards at lower cost.

- Complete Phase I ambient PM_{2.5} characterization report.
- Make selections of research projects under the second round Emission Control Byproducts Consortium solicitation.
- Continue research projects for field testing mercury control technologies.
- Complete evaluations of several advanced NO_x control technologies.

Advanced Systems - Advanced Systems are being developed to significantly reduce emissions by 2015 by: (1) developing market-ready coal power systems with efficiencies over 60 percent and near zero emissions; and (2) integrating advanced turbine and fuel cell technology to achieve market-ready gas-fueled powerplants with efficiencies over 70 percent. Potential benefits from these technologies are potential savings in cost of electricity of \$0.5 billion per year by 2015 reaching \$2.5 billion per year in 2030; generating more than 400,000 jobs per year by 2030; and contributing to powerplant sales of \$10 billion per year in 2030. By 2030, more efficient power

I. **Mission Supporting Goals and Objectives:** CENTRAL SYSTEMS (Cont'd)

plants could reduce greenhouse gas emissions in the U.S. by 35 million tons per year of carbon avoided and 88 million tons of carbon per year avoided worldwide.

- Complete initial tests of the IGCC transport gasifier in an oxygen-blown mode to prepare the way for testing of Vision 21 technologies for concentrating CO₂; prepare a report of results; and evaluate performance to confirm the feasibility of the technology to significantly improve reliability, cost effectiveness, and improved efficiency compared to existing technologies as a long-term goal.
- Complete experimental testing to define the operating parameters of the CO₂ hydrate process and initiate the design of an integrated skid-mounted unit for evaluating the feasibility of effectively separating hydrogen and CO₂ from shifted syngas to meet the long-term goals of providing low-cost hydrogen for high-efficiency fuel cells and for concentrating CO₂ streams for sequestration.
- Complete preliminary design and economic analysis of an air-blown gasification system based on prior experimental data at the Power Systems Development Facility (PSDF) to provide Southern Company the basis for reaching a decision on whether to proceed to a commercial unit.

II. A. **Funding Schedule:**

<u>Activity</u>	<u>FY 2000</u>	<u>FY 2001</u>	<u>FY 2002</u>	<u>\$Change</u>	<u>%Change</u>
Innovations for Existing Plants	\$14,393	\$20,102	\$18,000	\$-2,102	-10%
Advanced Systems					
Low-Emission Boiler System (LEBS)	1,955	0	0	0	0%
Indirect Fired Cycle	6,869	5,997	0	-5,997	100%
Integrated Gasification Combined Cycle	34,415	35,134	35,000	-134	0%
Pressurized Fluidized Bed	11,971	12,175	8,000	-4,175	-34%
Turbines	<u>43,085</u>	<u>30,936</u>	<u>0</u>	<u>-30,936</u>	<u>-100%</u>
Subtotal, Advanced Systems	98,295	84,242	43,000	-41,242	-49%
Power Plant Improvement Initiative	<u>0</u>	<u>94,791</u>	<u>0</u>	<u>-94,791</u>	-100%

I. **Mission Supporting Goals and Objectives:** CENTRAL SYSTEMS (Cont'd)

<u>Activity</u>	<u>FY 2000</u>	<u>FY 2001</u>	<u>FY 2002</u>	<u>\$Change</u>	<u>%Change</u>
Total, Central Systems	<u>\$112,688</u>	<u>\$199,135</u>	<u>\$61,000</u>	<u>\$-138,135</u>	<u>-69%</u>

II. B. **Laboratory and Facility Funding Schedule:** CENTRAL SYSTEMS (Cont'd)

	<u>FY 2000</u>	<u>FY 2001</u>	<u>FY 2002</u>	<u>\$Change</u>	<u>%Change</u>
Oak Ridge National Lab	\$1,804	\$670	\$400	\$-270	-40%
Idaho Ntn'l Engineering & Environmental Lab	0	90	0	-90	-100%
Argonne National Lab (East)	981	1180	600	-580	-49%
Lawrence Berkeley National Lab	250	200	0	-200	-100%
Lawrence Livermore National Laboratory	0	2000	0	-2,000	-100%
Los Alamos National Lab	850	973	1,000	27	3%
National Energy Technology Laboratory	14,705	13,469	7,400	-6,069	-45%
All Other	<u>94,098</u>	<u>180,553</u>	<u>51,600</u>	<u>-128,953</u>	<u>-71%</u>
Total, Central Systems	<u>\$112,688</u>	<u>\$199,135</u>	<u>\$61,000</u>	<u>\$-138,135</u>	<u>-69%</u>

III. **Performance Summary:**

<u>Activity</u>	<u>FY 2000</u>	<u>FY 2001</u>	<u>FY 2002</u>
Innovations for Existing Plants	Super Clean Systems: Determine cost and performance of retrofittable NO _x control for superclean systems technologies to meet all Clean Air Act Amendment I and IV requirements. (\$2,458) (TBD)	Super Clean Systems: Continue development of cost effective retrofittable NO _x control for superclean systems technologies to meet all Clean Air Act Amendment I and IV requirements. (\$1,995) (TBD)	Super Clean Systems: Continue development of cost effective retrofittable NO _x control for superclean systems technologies to meet all Clean Air Act Amendment I and IV requirements. (\$1,500) (Also Power, B&W)
	Fine Particulate Control/Air Toxics: Improve measurement	Fine Particulate Control/Air Toxics: Determine and model	Fine Particulate Control/Air Toxics: Determine and model

III. **Performance Summary:** CENTRAL SYSTEMS (Cont'd)

<u>Activity</u>	<u>FY 2000</u>	<u>FY 2001</u>	<u>FY 2002</u>
Innovations for Existing Plants (Cont'd)	<p>characterization techniques for toxic emissions and PM_{2.5} from powerplants and other sites to optimize cost and efficiency of control technologies. Develop and field test lower-cost retrofit technology for control of precursor emissions which cause fine particulates. (\$7,026) (TBD)</p>	<p>ambient PM_{2.5} concentrations as they relate to sources and receptors of PM_{2.5} from coal-fired power plants, obtain field test data for toxic emissions from powerplants and other sites to optimize cost and efficiency of control technologies. Develop and field test lower-cost retrofit technology for control of precursor emissions which cause fine particulates. (\$7,124) (ATS, TBD)</p>	<p>ambient PM_{2.5} concentrations as they relate to sources and receptors of PM_{2.5} from coal-fired power plants, in order to optimize cost and efficiency of control technologies. Develop and field test lower-cost retrofit technology for control of fine particulates, acid gases, and also for controlling mercury and other air toxics. (\$11,100) (ATS, ADA, B&W)</p>
	<p>In-House: Conduct supporting research in by-product characterization in areas such as emissions control, air toxics and fine particulate control, and CO₂ control and provide for customer service and business activities. (\$3,244) (NETL, BRSC)</p>	<p>In-House: Conduct supporting research in areas such as super clean emissions control, air toxics and fine particulate control, by-product characterization, and provide for customer service and business activities. (\$3,292) (NETL, TBD)</p>	<p>In-House: Conduct supporting research in areas such as air toxics and fine particulate control, by-product characterization, and provide for customer service and business activities. (\$3,300) (NETL, TBD)</p>
	<p>Conduct joint industry/government R&D activities to maximize use of coal utilization combustion byproducts; develop</p>	<p>Conduct joint industry/government R&D activities to maximize use of coal utilization combustion byproducts; develop</p>	<p>Conduct joint industry/government R&D activities to maximize use of coal utilization combustion byproducts; develop</p>

III. **Performance Summary:** CENTRAL SYSTEMS (Cont'd)

Activity	FY 2000	FY 2001	FY 2002
Innovations for Existing Plants (Cont'd)	<p>novel approaches to utilize waste from flue gas desulfurization; conduct evaluations of low NO_x burner and multi-fuel combustion byproducts for market specifications; facilitate technology transfer. (\$1,519) (TBD)</p> <p>No activity. (\$0)</p> <p>No activity. (\$0)</p>	<p>novel approaches to utilize waste from flue gas desulfurization; conduct evaluations of low NO_x burner and multi-fuel combustion byproducts for market specifications; facilitate technology transfer. (\$1,547) (TBD)</p> <p>Vision 21: Develop advanced materials for enhancing power plant efficiency including supercritical cycles applicable to Vision 21. (\$1,991) (TBD)</p> <p>International Clean Energy Initiative: Transfer best practice of optimizing the performance of coal-fired power plants for mitigation of climate change gases. Further develop technology collaboration and business opportunities between China, Turkey, other countries and U.S. organizations. Develop improvements in plant performance, availability, and</p>	<p>novel approaches to utilize waste from flue gas desulfurization; conduct evaluations of low NO_x burner and multi-fuel combustion byproducts for market specifications; facilitate technology transfer. (\$1,500) (TBD)</p> <p>Vision 21: Develop advanced materials for enhancing power plant efficiency including supercritical cycles applicable to Vision 21. (\$420) (TBD)</p> <p>No activity. (\$0)</p>

III. **Performance Summary:** CENTRAL SYSTEMS (Cont'd)

Activity	FY 2000	FY 2001	FY 2002
Innovations for Existing Plants (Cont'd)		maintenance. Disseminate results from U.S. R&D program via publications, workshops and seminars. (\$988) (TBD)	
	No activity. (\$0)	Fund technical evaluations of options for an improved U.S. Capital Power Plant. (\$988) (TBD)	No activity. (\$0)
	No activity. (\$0)	Funding testing of Electrocatalytic Oxidation Technology. (\$1,976) (TBD)	No activity. (\$0)
	Fund technical and program management support. (\$146)	Fund technical and program management support. (\$201)	Fund technical and program management support (\$180)
	\$14,393	\$20,102	\$18,000
Advanced Systems-Low-Emission Boiler System (LEBS)	Continue Phase IV which includes the construction and operation of a proof-of-concept facility. Goal is 42% plant efficiency, SO2 and NOx emission less than 1/6 of NSPS and minimal solid waste. Cost sharing of 50% required in Phase IV. (\$1,935) (DB Riley, TBD)	Continue Phase IV, with prior year funds, which includes the construction and operation of a proof-of-concept facility. Goal is 42% plant efficiency, SO2 and NOx emission less than 1/6 of NSPS and minimal solid waste. Cost sharing of 50% required in Phase IV. (\$0) (DB Riley)	Continue Phase IV, with prior year funds, which includes the construction and operation of a proof-of-concept facility. Goal is 42% plant efficiency, SO2 and NOx emission less than 1/6 of NSPS and minimal solid waste. Cost sharing of 50% required in Phase IV. (\$0) (Babcok Borsig

III. **Performance Summary:** CENTRAL SYSTEMS (Cont'd)

Activity	FY 2000	FY 2001	FY 2002 (formerly DB Riley)
	Fund technical and program management support. (\$20)	Fund technical and program management support. (\$0)	No activity. (\$0)
	\$1,955	\$0	\$0
Advanced Systems- Indirect Fired Cycle	Continue HIPPS development on those components and subsystems that are part of the Vision 21 plant. Near-term activities include transition technology to high efficiency concepts with superior levels of environmental performance, high temperature heat exchanger, and novel cycle optimization studies. (\$5,799) (Foster-Wheeler, UTRC, NETL, TBD)	Activity included below.	No activity. (\$0)
	Conduct Vision 21 critical combustion and high temperature furnace modules development and systems design. (\$1,000) (Foster-Wheeler, UTRC, TBD)	Vision 21: Continue HIPPS development on those components and subsystems that are part of the Vision 21 plant. Mid-term activities include coproduction concepts, hybrid cycles, and advanced system integration. (\$5,937)	No activity. (\$0)

III. **Performance Summary:** CENTRAL SYSTEMS (Cont'd)

<u>Activity</u>	<u>FY 2000</u>	<u>FY 2001</u>	<u>FY 2002</u>
		(Foster-Wheeler, UTRC, NETL, TBD)	

III. **Performance Summary:** CENTRAL SYSTEMS (Cont'd)

Activity	FY 2000	FY 2001	FY 2002
	Fund technical and program management support. (\$70) \$6,869	Fund technical and program management support. (\$60) \$5,997	No activity. (\$0) \$0
Advanced Systems-Integrated Gasification Combined Cycle	Gasification Systems Technology: Gasification - Continue development of the transport gasifier and associated particulate control devices. Expand transport reactor data base to co-feeding coal and other low-cost feedstocks. Continue development of improved refractory and high temperature measurement instrumentation. Gas Cleaning/Conditioning - Extend sorbent development for near-zero discharge of SO _x and NO _x . Develop baseline performance of the fluid-bed/transport desulfurizer Process Development Unit (PDU) and evaluate candidate sorbents. Begin design for a desulfurization unit at PSDF. Continue R&D on	Gasification Systems Technology: Gasification - Continue development of the transport gasifier and associated particulate control devices and demonstrate long-term performance of both in air-blown operations. Transition the transport gasifier to oxygen-blown operations. Develop and verify computational fluid dynamics (CFD) model for the transport gasifier. Extend Power Systems Development Facility (PSDF) feedstock database using low-cost alternative feedstocks in combination with coal. Conduct coupon testing of advanced refractories at clean coal technology sites. Continue investigation of alternative	Gasification Systems Technology: Gasification - Continue development of the transport gasifier and associated particulate control devices and demonstrate long-term performance of both under enriched air conditions. Initiate shake down of facilities for oxygen-blown operations at the Power Systems Development Facility (PSDF) and continue evaluation of alternative feedstocks in combination with coal. Modify the transport gasifier computational fluid dynamics (CFD) model for oxygen and enriched air operations and verify performance with data from the PSDF and Transport Reactor Development Unit (TRDU). Continue coupon testing

III. **Performance Summary:** CENTRAL SYSTEMS (Cont'd)

Activity	FY 2000	FY 2001	FY 2002
Advanced Systems- Integrated Gasification Combined Cycle (Cont'd)	<p>NO_x control and HAPS/PM_{2.5} emissions. Product/By-product Utilization - Complete testing of the direct sulfur recovery process as PSDF. Continue investigation on improving slag/ash quality and marketability from co-feed operations. (\$18,054) (SCS, UNDEERC, NETL, ANL, RTI, Praxis, TBD)</p>	<p>temperature measurement instrumentation for high temperature gasifier and conduct development and testing at clean coal technology sites. Gas Cleaning/Conditioning - Continue development of high temperature sorbents for fluid bed and transport desulfurization reactors. Develop kinetic data and CFD models for the transport desulfurizer. Perform comparative analysis of fluid bed and transport desulfurization reactors using the Gas Processing Development Unit to provide data for the design of a facility for PSDF. Conduct desulfurization unit design for PSDF. Extend particulate filter development activities to high temperatures, i.e., > 1000° F. Complete baseline environmental monitoring of CCT sites and begin monitoring during hazardous waste processing. Product/By-Product Utilization - Continue testing of</p>	<p>of advanced refractories at suitable gasification sites. Complete initial R&D of advanced temperature instrumentation for high temperature gasifiers and select concepts for scale-up to prototype units for actual gasifier testing. Gas Cleaning/Conditioning - Continue development of high temperature sorbents for fluid bed and transport desulfurization reactors with focus on producing ultra-clean gas and removing contaminants from using alternative feedstocks. Continue development of kinetic data and CFD models for the transport desulfurizer and begin development of a CFD model for a fluid bed desulfurizer. Perform comparative analysis of fluid bed and transport desulfurization reactors using the Gas Processing Development Unit to provide data for CFD model verification and for the design of a facility for PSDF.</p>

III. **Performance Summary:** CENTRAL SYSTEMS (Cont'd)

Activity	FY 2000	FY 2001	FY 2002
Advanced Systems- Integrated Gasification Combined Cycle (Cont'd)	<p data-bbox="478 1130 806 1203">Systems Analysis/Product Integration:</p> <p data-bbox="478 1247 905 1399">Complete IGCC and co-production design optimization. Continue co-production pioneer plant feasibility studies. Complete development of</p>	<p data-bbox="953 391 1379 938">the direct sulfur recovery process at PSDF and extend testing to include single-step sulfur recovery process. Continue investigation to enhance the quality of gasification ash/slag from co-feed operations and explore new market applications. Explore concepts for converting SO₂ to marketable products. (\$18,229) (SCS, NETL, UNDEERC, Fluent, CMU, RTI, KBR, Albany, TECO, Dynegy, Weyerhauser, Texaco, ANL, SRI, Praxis, VPI, IET, FluoreScience)</p> <p data-bbox="953 1130 1285 1203">Systems Analysis/Product Integration:</p> <p data-bbox="953 1247 1379 1399">Extend design optimization study to include CO₂ capture and fuel cell technologies. Continue engineering analysis and risk</p>	<p data-bbox="1428 391 1854 1101">Continue development of novel sorbent and catalytic techniques for removing sulfur. Product/By-Product Utilization - Complete testing of the direct sulfur recovery skid-mounted process unit at PSDF and continue testing of the single-step sulfur recovery process. Expand efforts on ash/slag characterization and marketability, with particular focus on products from gasification of coal with alternative feedstocks. (\$18,238) (SCS, NETL, UNDEERC, Fluent, CMU, RTI, KBR, Albany, TECO, Global, Weyerhauser, Texaco, ANL, SRI, Praxis, VPI, IET, FluoreScience)</p> <p data-bbox="1428 1130 1759 1203">Systems Analysis/Product Integration:</p> <p data-bbox="1428 1247 1854 1399">Complete one Early Entrance Coproduction Plant study and continue the engineering analyses and risk reduction work associated</p>

III. **Performance Summary:** CENTRAL SYSTEMS (Cont'd)

<u>Activity</u>	<u>FY 2000</u>	<u>FY 2001</u>	<u>FY 2002</u>
Advanced Systems-Integrated Gasification Combined Cycle (Cont'd)	<p>IGCC market strategy. Evaluate process configurations and establish target performance. Conduct product workshops. Facilitate the formation of partnerships and consortia, identify technology needs and requirements, and interact with customers and stakeholders (\$3,528) (NETL, Mitretek, TBD)</p>	<p>reduction activities associated with the Early Entrance Coproduction Plant. Continue market and system analyses for R&D guidance. Provide funding for product outreach and other program related activities. (\$3,981) (NETL, Bechtel, CTC, E2S, Mitretek, Consol, Parsons, Texaco, Dynegy, WMPI, GE, KBR, APCI, Praxair, Dow Corning, Dow Chemical, Siemens-Westinghouse, Methanex, Rentech, SASOL)</p>	<p>with the remaining two projects. Complete gasification design optimization studies incorporating fuel cells and CO₂ capture. Complete U.S. gasification market study for power generation. Continue systems analyses for research guidance and product outreach activities. Conduct industry interviews and develop a long term strategy/roadmap for gasification technology development. (\$3,672) (NETL, Bechtel, CTC, E2S, Mitretek, Consol, Parsons, Texaco, Dynegy, WMPI, GE, KBR, APCI, Praxair, Dow Corning, Dow Chemical, Siemens-Westinghouse)</p>
	<p>Vision 21: Develop gasification and combustion high efficiency energy complexes with near-zero emissions and CO₂ management options. Develop advanced air</p>	<p>Vision 21: Develop gasification and combustion high efficiency energy complexes with near-zero emissions and CO₂ management options. Continue development of</p>	<p>Vision 21: Continue development of hybrid gasification/combustion concepts, focusing on high efficiency, near-zero emissions, and alternative fuels processing. Explore advanced</p>

III. **Performance Summary:** CENTRAL SYSTEMS (Cont'd)

<u>Activity</u>	<u>FY 2000</u>	<u>FY 2001</u>	<u>FY 2002</u>
Advanced Systems- Integrated Gasification Combined Cycle (Cont'd)	<p>separation technology and integration with advanced gas turbines. Develop high temperature hydrogen membrane separation technologies for integrated IGCC/fuel cell applications. Develop advanced gas cleanup technologies for ultra-clean synthesis gas for fuel cell and coproduction applications. Conduct experimental investigations on coal/biomass/waste gasification. Perform system analyses for integration of gasification/combustion/fuel cell/advanced turbines/coproduction applications for achieving Vision 21 goals. Develop advanced fuel cell systems for Vision 21 gasification/combustion applications in conjunction with gas-based fuel cells system development. (\$12,481) (APCI, Texaco, ANL, TECO, RTI, TBD)</p>	<p>advanced membrane-based air separation technologies and begin first level of scaleup. Continue development of high temperature membranes for hydrogen separation and CO₂ concentration. Continue development of low temperature technology for hydrogen/CO₂ separation and begin design of skid-mounted test module. Continue development of feed system technologies for co-feeding coal/alternative feedstocks to high pressure gasifiers. Begin shakedown and testing of municipal solid waste processing technology. Continue development of advanced synthesis gas cleaning technologies to achieve high purity gas for fuel cell and synthesis gas conversion applications. (\$12,573) (APCI, Praxair, ANL, NREC, Enertech, Bechtel, LANL, RTI, IGT, Siemens-Westinghouse, NETL, Foster Wheeler, TBD)</p>	<p>gas cleaning technologies required for near-zero emission hybrid facilities. Investigate feasibility of novel gasification concept for producing hydrogen and sequestration-ready CO₂. Continue with scale-up activities for production and testing of the advanced membrane-based air separation technologies. Continue development of improved materials and module design of high temperature membranes for hydrogen/CO₂ separation and explore fabrication methodologies. Develop high temperature barrier filters that are compatible with hydrogen membrane operations. Continue development of low-temperature technology for hydrogen/CO₂ separation, complete construction of a skid-mounted test module, and begin shakedown testing. Begin construction and testing of novel concepts for co-feeding</p>

III. **Performance Summary:** CENTRAL SYSTEMS (Cont'd)

Activity	FY 2000	FY 2001	FY 2002
Advanced Systems- Integrated Gasification Combined Cycle (Cont'd)			coal/alternative feedstocks to high pressure gasifiers. Complete shakedown and initiate testing of municipal solid waste processing technology. Complete exploratory investigation of novel advanced gas cleaning technologies and begin bench-scale engineering development to achieve high purity synthesis gas for fuel cell and conversion applications. Expand gas cleaning program to include multi-contaminant control concepts and other novel approaches applicable for multi-feed gasification systems. Continue collaborative efforts to develop models and software for process concepts. (\$12,740) (APCI, Praxair, ANL, NREC, Ceramatec, Texaco, PSU, Penn, Enertech, Bechtel, LANL, RTI, IGT, Siemens-Westinghouse, NETL, REI, FW, TEKES, NFCRC, GEEERC, Princeton, INT, Eltron, Chevron, Coors, INEEL, UC,

III. **Performance Summary:** CENTRAL SYSTEMS (Cont'd)

<u>Activity</u>	<u>FY 2000</u>	<u>FY 2001</u>	<u>FY 2002</u>
			ORNL, McDermott, Foster Wheeler, TBD)

III. **Performance Summary:** CENTRAL SYSTEMS (Cont'd)

<u>Activity</u>	<u>FY 2000</u>	<u>FY 2001</u>	<u>FY 2002</u>
	Fund technical and program management support. (\$352) \$34,415	Fund technical and program management support. (\$351) \$35,134	Fund technical and program management support. (\$350) \$35,000
Advanced Systems- Pressurized Fluidized Bed	Continue evaluation of hot gas cleanup filter materials, and systems to refine and validate designs. Evaluate FBC sorbents that reduce consumption with subsequent reduction of CO ₂ . Goal is to significantly enhance performance and reduce cost. Perform supporting research such as system dynamics, combustion characterization, and cofiring with carbon neutral fuels. (\$3,920) (NETL, TBD) Evaluate advanced systems users by performing site specific repowering studies that promote repowering of an actual electricity producer's site. (\$150) (TBD)	Continue evaluation of hot gas cleanup filter materials, and systems to refine and validate designs. Evaluate FBC sorbents that reduce consumption with subsequent reduction of CO ₂ . Goal is to significantly enhance performance and reduce cost. Perform supporting research such as system dynamics, combustion characterization, and cofiring with carbon neutral fuels. (\$2,970) (NETL, TBD) Evaluate previously selected advanced systems users by performing site specific enhancements that lead to reduced cost and efficiency improvements for the repowering studies that promote repowering of an actual electricity producer's site. (\$550)	Continue evaluation of hot gas cleanup filter materials to refine and validate designs and reduce consumption with subsequent reduction of CO ₂ . Goal is to enhanced performance, reduce costs, and support hybrid systems for Vision 21 (\$700). Continue gas stream cleanup testing at PSDF, Wilsonville (\$3,500). (Total \$4,200) (NETL, Southern Co. Services) No activity. (\$0)

III. **Performance Summary:** CENTRAL SYSTEMS (Cont'd)

Activity	FY 2000	FY 2001	FY 2002
Advanced Systems- Pressurized Fluidized Bed (Cont'd)	Continue to improve environmental performance and efficiency with emphasis on HAPS control strategies and gas turbine integration. Cycle improvements through the introduction of other technologies like Fuel Cells and super critical steam cycles will be pursued to achieve Vision 21 goals. (\$390) (NETL)	(TBD) Complete studies of environmental performance and efficiency with emphasis on HAPS control strategies and gas turbine integration. Continue cycle improvements through the introduction of other technologies like Fuel Cells and super critical steam cycles will be pursued to achieve Vision 21 goals. (\$979) (NETL)	No activity. (\$0)
	Continue operation of the APFBC pilot scale project at Wilsonville. (\$7,189) (Southern Co. Services, TBD)	Continue operation of the APFBC pilot scale project at Wilsonville. (\$7,354) (Southern Co. Services, TBD)	Discontinue operation of the APFBC pilot scale module at Wilsonville. (\$0) (Southern Co. Services)
	No activity. (\$0)	No activity. (\$0)	Support the development of design concepts applicable for gasification/fluid bed hybrids for Vision 21. (\$3,200) (Southern Co. Services)
	Explore power systems designs to optimize CO ₂ recycle and	Complete power systems designs to optimize CO ₂ recycle and	Evaluate gas conditioning subsystems and concepts for

III. **Performance Summary:** CENTRAL SYSTEMS (Cont'd)

Activity	FY 2000	FY 2001	FY 2002
Advanced Systems- Pressurized Fluidized Bed (Cont'd)	enrichment for CO ₂ capture or reduction. (\$200) (TBD) Fund technical and program management support (\$122).	enrichment for CO ₂ capture and reduction. Evaluate fluidized-bed combustion sorbents that reduce consumption with subsequent reduction of CO ₂ while reducing cost, increasing temperature and maintaining sulfur capture. (\$200) (NETL, TBD) Fund technical and program management support (\$122).	Vision 21 systems. (\$520) (NETL, TBD) Fund technical and program management support. (\$80)
	\$11,971	\$12,175	\$8,000
Advanced Systems- Turbines	Vision 21: Investigate flexible midsize turbine configurations for Vision 21 powerplex applications including coproduction. (\$710) (General Electric, Pratt and Whitney, Rolls Royce, Siemens-Westinghouse)	Vision 21: Develop enabling technologies for advanced heat engine and turbine cycles including high temperature materials and zero emissions combustion. R&D program for critical technology development, advanced computing, and engine/turbine development. Develop technology for fuel cell/engine hybrid systems, and integration of the ATS into advance coal-fueled power systems. (\$4,963) (Rolls-Royce, Honeywell, General Electric,	No activity. (\$0)

III. **Performance Summary:** CENTRAL SYSTEMS (Cont'd)

<u>Activity</u>	<u>FY 2000</u>	<u>FY 2001</u>	<u>FY 2002</u>
Advanced Systems-Turbines (Cont'd)	Next Generation Turbines: Conduct advanced cycle studies (\$2,500) (Ramgen Power Systems)	Clean Energy Systems, FuelCell Energy, LLNL, NETL, Reaction Engineering, NFCRC, TBD) Next Generation Turbines: Continue Next Generation Turbine Systems technology base crosscutting R&D including: Univ./industry Consortium, national laboratory and in-house research, advanced concept development and systems analysis, low emissions combustion, diagnostics and monitoring technologies, sensors/ controls, materials and manufacturing technologies and advanced computing (\$8,534). Conduct R&D and design studies for the next generation turbine systems (\$5,000) (Total \$13,534) (Ramgen Power Systems, Siemens-Westinghouse, CFD Research Corp., Rolls Royce, Pratt and Whitney, General Electric, TBD)	No activity. (\$0)
	Supporting Technologies:	Supporting Technologies:	No activity. (\$0)

III. **Performance Summary:** CENTRAL SYSTEMS (Cont'd)

Activity	FY 2000	FY 2001	FY 2002
Advanced Systems-Turbines (Cont'd)	Continue supporting technology for high performance, ultra-low emission, reliable, flexible gas turbine systems. Continue technology base development including: Univ. Consortium, in-house research, manufacturing technologies, address fuel flexibility application. Conduct advanced cycle studies. (\$7,509) (SCIES, NETL, Clean Energy Systems, CFD Research Corp., ORNL)	Conduct supporting technology for high performance, ultra-low emission, reliable, flexible gas turbine systems. (\$3,320) (SCIES, NETL, ORNL, TBD)	
	ATS: Complete full-scale component/sub-system testing and engine manufacturing. Initiate site erection and preparation for full speed test. Conduct full-speed no-load engine tests and ATS system integration. (\$31,924) (GE, Siemens-Westinghouse)	ATS: Complete full speed engine tests, ATS system integration, and component testing. Initiate technical, economic, and environmental performance system studies. (\$8,829) (General Electric, Siemens-Westinghouse)	No activity. (\$0)
	Provide technical and program support. (\$442)	Provide technical and program support. (\$290)	No activity. (\$0)
	\$43,085	\$30,936	\$0

III. **Performance Summary:** CENTRAL SYSTEMS (Cont'd)

<u>Activity</u>	<u>FY 2000</u>	<u>FY 2001</u>	<u>FY 2002</u>
Subtotal, Advanced Systems	\$98,295	\$84,242	\$43,000

III. **Performance Summary:** CENTRAL SYSTEMS (Cont'd)

<u>Activity</u>	<u>FY 2000</u>	<u>FY 2001</u>	<u>FY 2002</u>
Power Plant Improvement Initiative	No activity. (\$0)	The Power Plant Improvement Initiative will engage in solicitation and pre-award activities for the program in anticipation of release of funds for obligation on Sept. 30, 2001. (\$93,843) (TBD)	Continue PPII project activities with funds not available until Sept. 30, 2001. The (PPII) will fund projects that will demonstrate advanced coal-based technologies applicable to existing and new power plants including co-production plants. These demonstrations will focus on technology that can be commercialized to address electricity reliability through improved capacity, efficiency and environmental performance. (\$0)
	No activity. (\$0)	Fund technical and program management support. (\$948)	No activity. (\$0)
Subtotal, Power Plant Improvement Initiative	\$0	\$94,791	\$0
Central Systems, Total	\$112,688	\$199,135	\$61,000

DEPARTMENT OF ENERGY
FY 2002 CONGRESSIONAL BUDGET REQUEST

FOSSIL ENERGY RESEARCH AND DEVELOPMENT

DISTRIBUTED GENERATION SYSTEMS

I. **Mission Supporting Goals and Objectives:**

Fuel cells are being developed in the near-term for distributed generation applications. In contrast to central systems, distributed systems generally imply smaller-scale production of electric power in stationary plants at or near the end user. Fuel cells as small modular resources may be used on a stand-alone basis, or integrated with other units, and even connected to a central system grid. These systems may be owned and/or operated by utilities, utility customers, and third parties.

The deregulation and restructuring of the utility industry has accelerated the adoption of distributed power generation in new markets which have higher cost margins than centralized generation. Distributed generation systems like fuel cells potentially offer opportunities for cost-effectively meeting peak demand without the need for capital intensive central station capacity or costly investments in transmission and distribution; they could be used to provide clean power to remote end users; and they could provide new business opportunities to both utility and non-utility owners.

By 2010, distributed generation could emerge as an important segment of the world power-generation market, meeting requirements for higher efficiency and environmental protection and also serving as building blocks to ensure sustainable development. The Fuel Cells Program is leveraging technical innovation to develop advanced power systems for distributed generation that will improve power quality, boost system reliability, reduce energy costs, and help delay/defray capital investments. The program goal is to develop low-cost, high efficiency modular power systems with lower cost, high quality electricity, significantly lower carbon emissions, and near-zero levels of pollutants.

The objectives of the Fuel Cell activity are: (1) to support technology base development of fuel cell systems to provide highly efficient, environmentally superior technology for the generation of electrical and thermal energy for electric utility, industrial, and

commercial/residential markets; and (2) strengthen the national economy by providing technologies that

I. **Mission Supporting Goals and Objectives:** DISTRIBUTED GENERATION SYSTEMS (Cont'd)

improve U.S. international competitiveness in this new manufacturing industry and by generating export sales for technology/ products.

Strategies to develop clean high efficiency fossil fueled powerplants for the 21st Century include: Immediate near-term (to year 2003) - develop and demonstrate high efficiency, environmentally clean, gas-fueled, multi-kilowatt, fuel cell powerplants, and to commercially introduce these powerplants; Near-term (to year 2003-2005) - develop and proof-of-concept test through the Solid State Energy Conversion Alliance (SECA) a potentially low cost 5-kilowatt solid state fuel cell for distributed and auxiliary power unit applications; Mid-term (to year 2010) - develop and demonstrate the advancements in solid state fuel cell technology under SECA and combined cycle fuel cell heat engine technology (fuel cell/turbine hybrids) which will enable industry to significantly penetrate broad markets for high efficiency gas-based systems and commercially introduce coal-fueled, multi-megawatt powerplants at competitive costs; Long-term (2010 to year 2030) - develop and demonstrate the critical high risk technology advancements which will permit U.S. industry to establish commercial availability of advanced, low-cost, ultra-high efficiency, integrated SECA-developed solid state fuel cell/turbine hybrids systems. Fuel cell systems have specifically identified goals which coincide with Vision 21 concepts in the 2010 to 2015 time frame.

The distributed generation systems program supports the Strategic Center for Natural Gas. Natural gas is and will continue to be the primary fuel used for distributed power applications. The advanced systems developed under this program will provide clean, cost effective distributed power options for the emerging converged gas industry.

Fuel Cell Distributed Generation Systems are capable of reducing criteria pollutants well below current New Source Performance Standard levels, reducing non-criteria pollutants such as CO₂ and acid rain precursors, and reducing thermal emissions to the environment. These reductions are achieved through the inherently low emissions and ultra-high efficiency of fuel cell systems. First generation phosphoric acid systems have reached commercial status and are finding applications in premium power markets and locations that require pristine power generation. Higher system efficiencies and lower costs are forecast for advanced molten carbonate and solid oxide fuel cell systems, the second generation systems which will be introduced using natural gas in the near term distributed generation market and later operated on gas and coal in multiple end-use sectors.

Fuel Cell/Turbine Hybrids under Vision 21 provide a more rapid way to commercialize the fuel cell technology. Integration of the fuel

I. **Mission Supporting Goals and Objectives:** DISTRIBUTED GENERATION SYSTEMS (Cont'd)

cell and turbine into a single system lowers system cost and raises system efficiency. Hybrid efforts include dynamic and detailed modeling, small scale system testing, continued system studies and exploration of integration and market issues. Hybrid power modules are expected to be a key enabling technology for long-term Vision 21 systems.

Innovative Concepts include lower-temperature, multi-layer ceramic technology for fuel cells which is an important aspect of lowering fuel cell costs. This effort will be integrated into SECA. SECA is a new paradigm for fuel cells development which will lead to a great advance in fuel cell cost reduction. Work under the Alliance will enable the commercialization of low-cost, solid state fuel cells operating at mid to high temperatures. Work under SECA includes, gas processing (reforming and cleanup), power electronics, controls and diagnostics, heat recovery, modeling and simulation, and material and manufacturing/fabrication research at National Laboratories.

The objective of the SECA is to drastically reduce fuel cell costs to make them a more broadly applicable and more widespread commodity in the competitive, mature distributed generation and auxiliary power markets. SECA provides a means to bring entities together that are seeking low-cost, high power-density, solid state fuel cell systems for those distributed generation and auxiliary power unit applications. The Alliance is committed to the concept of “mass customization” as the route to reducing costs. The initial cost target is \$400/kilowatt for a complete solid state system. The SECA program develops an integrated strategy to address the technical barriers of solid-state fuel cell systems. SECA also focuses research performers on the breakthrough technologies needed to achieve the program goals.

The Advanced Research subactivity supports the program objectives by studying critical enabling science and technology topics related to research on fuel cells to identify new highly innovative fuel cell concepts and to solve fundamental crosscutting materials and design issues.

FY 2002 Performance Measures in furtherance of the above goals include:

- Complete demonstration of a commercial-scale, 250 kW Molten Carbonate Fuel Cell (MCFC) power plant system. This test will verify the commercial design for the MCFC technology for the Combined Heat & Power (CHP) or Distributed Generation (DG) market and, if successful will justify the construction of a MCFC manufacturing facility in the U.S.
- Complete the demonstration of a 220-kW -320 kW Solid Oxide Cell (SOFC)/turbine hybrid commercial prototype in support of

Vision 21. This test will verify the commercial design for the SWPC SOFC technology for the DG or CHP and, if successful will justify the construction of a SOFC manufacturing facility in the U.S.

II. A. **Funding Schedule**: DISTRIBUTED GENERATION SYSTEMS (Cont'd)

<u>Activity</u>	<u>FY 2000</u>	<u>FY 2001</u>	<u>FY 2002</u>	<u>\$Change</u>	<u>%Change</u>
Fuel Cells					
Advanced Research	\$1,169	\$2,794	\$1,000	\$-1,794	-64%
Fuel Cell Systems	35,347	30,932	11,500	-19,432	-63%
Vision 21 Hybrids	5,007	14,967	11,500	-3,467	-23%
Innovative Systems Concepts	<u>1,850</u>	<u>3,891</u>	<u>21,124</u>	<u>17,233</u>	<u>443%</u>
Subtotal, Fuel Cells	<u>43,373</u>	<u>52,584</u>	<u>45,124</u>	<u>-7,460</u>	<u>-14%</u>
Total, Distributed Generation Systems	<u>\$43,373</u>	<u>\$52,584</u>	<u>\$45,124</u>	<u>\$-7,460</u>	<u>-14%</u>

II. B. **Laboratory and Facility Funding Schedule**:

	<u>FY 2000</u>	<u>FY 2001</u>	<u>FY 2002</u>	<u>\$Change</u>	<u>%Change</u>
Argonne National Lab (East)	\$800	\$800	\$800	\$0	0%
Oak Ridge National Lab	205	0	0	0	0%
Pacific Northwest Lab	1,500	2,147	2,000	-147	-7%
National Energy Technology Laboratory	200	1,390	1,655	265	19%
All Other	<u>40,668</u>	<u>48,247</u>	<u>40,669</u>	<u>-7,578</u>	<u>-16%</u>
Total, Distributed Generation Systems	<u>\$43,373</u>	<u>\$52,584</u>	<u>\$45,124</u>	<u>\$-7,460</u>	<u>-14%</u>

III. **Performance Summary:** DISTRIBUTED GENERATION SYSTEMS (Cont'd)

Activity	FY 2000	FY 2001	FY 2002
Fuel Cells- Advanced Research	<p>This program conducts generic research to capitalize on the intrinsic high efficiency and environmentally benign characteristics of advanced fuel cells. Research will be conducted to lower fuel cell costs, to investigate advanced, lower cost and high performance ceramic fuel cell processes and designs, to solve fundamental crosscutting materials and design issues, and to pursue thin film advanced cell processing techniques. (Total \$1,157) (ANL, PNL, TBD)</p> <p>Fund technical and program management support. (\$12)</p>	<p>This program conducts generic research to capitalize on the intrinsic high efficiency and environmentally benign characteristics of advanced fuel cells. Research will be conducted to lower fuel cell costs, to investigate advanced, lower cost and high performance, mid to high temperature solid state fuel cells, to solve fundamental crosscutting materials and design issues, and to pursue thin film advanced cell processing techniques. (Total \$2,766) (ANL, PNL, TBD)</p> <p>Fund technical and program management support. (\$28)</p>	<p>This program conducts generic research to capitalize on the intrinsic high efficiency and environmentally benign characteristics of advanced fuel cells. Research will be conducted to identify new highly innovative fuel cell concepts and to solve fundamental crosscutting materials and design issues. (\$990) (ANL, PNL, TBD)</p> <p>Fund technical and program management support. (\$10)</p>
	\$1,169	\$2,794	\$1,000

III. **Performance Summary:** DISTRIBUTED GENERATION SYSTEMS (Cont'd)

Activity	FY 2000	FY 2001	FY 2002
Fuel Cells- Fuel Cell Systems	Continue cost-shared cost reduction and performance improvement on a stretched out basis on two molten carbonate systems and one tubular SOFC system for market entry by the private sector. (\$31,484) (MC Power, ERC, Westinghouse, ORNL)	Continue cost-shared cost reduction and performance improvement on one full molten carbonate system for market entry by the private sector. (\$13,500) (TBD)	Continue cost-shared cost reduction and performance improvement on one full molten carbonate system for market entry by the private sector; continue supportive distributed generation infrastructure, economic and market study assessments and system assessments and evaluations. (\$11,385) (FCE)
	Continue economic and market study assessments, system assessments and evaluations, materials studies, electrode and electrode process development, and low cost component development. (\$3,500) (ADL, NETL, ANL, TBD)	SECA -Continue distributed generation infrastructure, economic and market study assessments; system assessments and evaluations, materials studies; conduct mid to high temperature Vision 21 fuel cell component and process development, and low cost component development. (\$17,123) (ADL, NL, NETL, TBD)	SECA -related activity will be continued under the Innovative Systems Concepts area.
	Continue technical and program management support. (\$363)	Continue technical and program management support. (\$309)	Continue technical and program management support. (\$115)
	\$35,347	\$30,932	\$11,500

III. **Performance Summary:** DISTRIBUTED GENERATION SYSTEMS (Cont'd)

Activity	FY 2000	FY 2001	FY 2002
Fuel Cells - Vision 21 Hybrids	Conduct a Vision 21 enabling cost reduction and performance enhancement program with fuel cell/turbine technologies, such as the tubular SOFC hybrid; investigate advanced ceramic processes and designs; conduct system studies and explore integration issues. (\$4,956) (TBD)	Conduct a Vision 21 enabling cost reduction and performance enhancement program with Vision 21 fuel cell/turbine hybrid technologies, such as the tubular SOFC hybrid; conduct hybrid follow-on solicitation; conduct system studies and explore integration issues as permitted. (\$14,817) (SWPC, NETL, TBD)	Conduct a Vision 21 enabling cost reduction and performance enhancement program with Vision 21 fuel cell/turbine hybrid technologies, such as the tubular SOFC hybrid; conduct hybrid follow-on solicitation; conduct system studies and explore integration issues as permitted. (\$11,385) (SWPC, NETL, TBD)
	Continue technical and program management support. (\$51)	Continue technical and program management support. (\$150)	Continue technical and program management support. (\$115)
	\$5,007	\$14,967	\$11,500
Innovative Systems Concepts	Continue Vision 21 multi-layer ceramic technology for fuel cells leading to low-cost 21 st Century fuel cell manufacture. (\$1,831) (McDermott, TBD)	SECA - Conduct activities leading to development of low-cost fuel cells. Continue Vision 21 multi-layer ceramic technology for fuel cells leading to low-cost SECA fuel cell manufacture. (\$3,852) (NETL, NL, TBD)	SECA - Conduct mid- to high-temperature SECA-related low-cost solid state fuel cell component and process development; integrate multi-layer ceramic technology for fuel cells leading to low-cost solid state fuel cell manufacture into the SECA activity. (\$20,914) (McDermott, ADL, NL, NETL, TBD)

III. **Performance Summary**: DISTRIBUTED GENERATION SYSTEMS (Cont'd)

<u>Activity</u>	<u>FY 2000</u>	<u>FY 2001</u>	<u>FY 2002</u>
	Fund technical and program management support. (\$19)	Fund technical and program management support. (\$39)	Fund technical and program management support. (\$210)
	\$1,850	\$3,891	\$21,124
Distributed Generation Systems, Total	\$43,373	\$52,584	\$45,124

DEPARTMENT OF ENERGY
FY 2002 CONGRESSIONAL BUDGET REQUEST

FOSSIL ENERGY RESEARCH AND DEVELOPMENT

SEQUESTRATION R&D

I. **Mission Supporting Goals and Objectives:**

Currently, over half of the electricity generated in the U.S. is produced in coal-fired power plants. Including electricity generated by oil and natural gas-fired power plants, this fraction increases to 70%. The U.S. power generation industry needs to maintain a diversified fuel mix to ensure adequate energy supplies at a reasonable price. The continued use of fossil energy, especially coal, will be severely limited unless satisfactory solutions can be found for numerous environmental issues, especially global climate change. Ultimately, to maintain stable concentrations of greenhouse gases in the atmosphere while permitting world-wide economic growth, it will be necessary to sequester carbon from fossil fuels.

The principal thrust of this activity is to develop the applied science and new technologies for addressing the cost-effective management/sequestration of carbon emissions from the production and use of fossil fuels. This research program compliments the advanced power systems research being pursued in FE, which reduces carbon emissions via higher efficiency energy conversion. Sequestration is focused on cost-effective novel concepts for capturing, reusing or storing, or otherwise mitigating carbon and other greenhouse gas (GHG) emissions. Included in the mix of “direct” control options is the direct capture of CO₂ at the power plant before it enters the atmosphere and storage in geologic structures such as oil and gas reservoirs, unmineable coal seams, and deep saline reservoirs. It also includes research on technologies for integrating fossil fuel production and use with “indirect” sequestration by enhancing natural sinks. Included in this area are means to achieve integration with terrestrial sequestration and enhanced ocean storage of carbon. The goal of this research is to create technologies capable of offsetting all growth in U.S. GHG after the year 2015. Research activities are geared toward developing strategies that will reduce the cost of sequestration to \$5 to \$10/ton of carbon. In addition to being cost-effective, these approaches must be environmentally safe and integrate with both existing and new (such as Vision 21) fossil energy conversion systems. The major thrust in FY 2002 will center around exploratory research on novel and innovative concepts for GHG mitigation, advanced CO₂ separation and capture concepts, geological carbon sequestration, and reducing the cost and

I. **Mission Supporting Goals and Objectives:** SEQUESTRATION R&D (Cont'd)

environmental uncertainties of large-scale carbon sequestration. Innovative industry/university and government R&D partnerships will also be pursued along with international collaborative R&D. Funding will also provide support for the in-house R&D Focus Area at the National Energy Technology Laboratory (NETL) with particular emphasis on capture and concentration of CO₂, CO₂ hydrate formation and stability and transport in geologic reservoirs. Close collaboration with the Carbon Management Science Centers on Ocean and Terrestrial Science, and other carbon management basic science activities in the Office of Science will be maintained, providing an integrated approach to advancing the science and technology of carbon sequestration.

The development of carbon dioxide sequestration options is expected to reduce U.S. carbon emissions by 145 million tonnes per year and 270 million tonnes per year worldwide, by 2030.

FY 2002 Performance Measures in furtherance of the above goals include:

- Improve the R&D capability of the Sequestration Focus Area in the areas of geologic and deep ocean CO₂ sequestration.
- Select the most promising projects for greenhouse gas control from solicitations conducted in prior years for continuation.
- Identify suitable saline reservoirs in mid-western U.S.
- Complete evaluation of results of an international collaborative research project with Canada and other countries on carbon dioxide injection into deep unmineable coal seams for sequestration. Coal seams offer long-term carbon dioxide storage locations in close proximity to coal-fired power plants. The results will guide future research options in this very promising area.
- Issue an industry-reviewed carbon sequestration technology development roadmap.

II. A. **Funding Schedule:**

<u>Activity</u>	<u>FY 2000</u>	<u>FY 2001</u>	<u>FY 2002</u>	<u>\$Change</u>	<u>%Change</u>
Sequestration R&D	<u>\$8,941</u>	<u>\$18,746</u>	<u>\$20,677</u>	<u>\$1,931</u>	<u>10%</u>
Total, Sequestration R&D	<u>\$8,941</u>	<u>\$18,746</u>	<u>\$20,677</u>	<u>\$1,931</u>	<u>10%</u>

II. B. **Laboratory and Facility Funding Schedule:** SEQUESTRATION R&D (Cont'd)

	<u>FY 2000</u>	<u>FY 2001</u>	<u>FY 2002</u>	<u>\$Change</u>	<u>%Change</u>
Argonne National Lab	\$65	\$120	\$120	\$0	0%
Idaho Ntn'l Engineering & Environmental Lab	575	862	862	0	0%
Los Alamos National Lab	370	1,545	1,545	0	0%
Lawrence Berkeley National Lab	385	450	450	0	0%
Lawrence Livermore National Lab	175	355	355	0	0%
National Energy Technology Lab	917	1,171	1,700	529	45%
Oak Ridge National Lab	85	508	508	0	0%
Pacific Northwest National Lab	225	170	170	0	0%
Sandia National Lab	335	450	450	0	0%
All Other	<u>5,809</u>	<u>13,115</u>	<u>14,517</u>	<u>1,402</u>	<u>11%</u>
Total, Sequestration R&D	<u>\$8,941</u>	<u>\$18,746</u>	<u>\$20,677</u>	<u>\$1,931</u>	<u>10%</u>

III. **Performance Summary:**

<u>Activity</u>	<u>FY 2000</u>	<u>FY 2001</u>	<u>FY 2002</u>
Sequestration R&D	Greenhouse Gas Control: Continue efforts consisting of exploratory research on advanced and innovative concepts, and/or technology improvements to recover, reuse, and/or store greenhouse gas emissions from coal-based energy systems. Initiate pilot program to obtain data necessary to confirm technical and environmental performance in geologic sequestration. Examine the technical, economic and	Greenhouse Gas Control: Continue efforts consisting of exploratory research, investigations, and/or technology improvements to recover, reuse, and/or store greenhouse gas emissions from fossil fuel-based energy systems. Conduct collaborative R&D with industry and international partners to significantly reduce the costs of CO ₂ separation and capture, demonstrate the technical feasibility of geological	Greenhouse Gas Control: Continue efforts consisting of exploratory research, investigations, and/or technology improvements to recover, reuse, and/or store greenhouse gas emissions from fossil fuel-based energy systems. This effort will continue to focus on partnerships with industry and international entities for research on innovative and advanced concepts to significantly reduce the costs of CO ₂ separation and

III. **Performance Summary:** SEQUESTRATION R&D (Cont'd)

Activity	FY 2000	FY 2001	FY 2002
Sequestration R&D (Cont'd)	environmental impacts of various CO ₂ , CH ₄ and N ₂ O sequestration alternatives. (\$8,849) (IEA, TBD)	sequestration, and significantly reduce the uncertainties (cost and environmental) of large-scale carbon sequestration. Examine the technical, economic and environmental impacts of various CO ₂ , CH ₄ and N ₂ O sequestration alternatives. (\$15,588) (TBD)	capture, demonstrate the technical feasibility of geological sequestration, and significantly reduce the uncertainties (cost and environmental) of large-scale carbon sequestration. Examine the technical, economic and environmental impacts of various CO ₂ , CH ₄ and N ₂ O sequestration alternatives. (\$16,970) (NETL, LANL, INEL, SNL, LLNL, LBNL, ANL, ORNL, Batelle, IEM, TDA, McDermott, RTI, UTA, TBD)
	No activity. (\$0)	Carbon Sequestration Focus Area: Increase research facilities and capabilities to expand research activities on CO ₂ stability and transport in geological reservoirs; augment research on the stability of CO ₂ injected in deep ocean including hydrate formation. (\$2,970) (NETL)	Carbon Sequestration Focus Area: Fully implement research capabilities in the areas of geologic and deep ocean CO ₂ sequestration. (\$3,500) (NETL, TBD)
	Fund technical and program management support. (\$92)	Fund technical and program management support. (\$188)	Fund technical and program management support. (\$207)
Total, Sequestration R&D	\$8,941	\$18,746	\$20,677

III. **Performance Summary:** SEQUESTRATION R&D (Cont'd)

<u>Activity</u>	<u>FY 2000</u>	<u>FY 2001</u>	<u>FY 2002</u>
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DEPARTMENT OF ENERGY
FY 2002 CONGRESSIONAL BUDGET REQUEST

FOSSIL ENERGY RESEARCH AND DEVELOPMENT

FUELS

I. **Mission Supporting Goals and Objectives:**

Title XIII, Subtitle A, Sections 1305 and 1312 of the Energy Policy Act (EPACT) of 1992 authorizes separate programs for research, development, demonstration and commercial application of improved technologies to refine coal to a variety of fuel and non-fuel products and to convert coal into oil substitutes. In compliance with these provisions of EPACT and consistent with these goals, the Fuels Program consists of four related activities: Transportation Fuels and Chemicals, Solids Fuels and Feedstocks, Advanced Fuels Research, and Steelmaking.

Transportation Fuels and Chemicals - The need for liquid fuels is projected to be a critical element of this nation's energy future in the 21st century. The objective of the program is to develop environmentally superior processes in partnership with industry and other government organizations to help industry develop and provide the ultra-clean transportation fuels needed for the 21st century. These fuels will meet the proposed stringent EPA Tier II transportation vehicle standards to be implemented starting in 2004 and other more stringent environmental standards which could follow to reduce environmental pollution from the transportation sector. This is part of a comprehensive, unified Office of Fossil Energy (Office of Oil & Gas, Office of Coal & Power Systems) fuels program to provide options for ultra-clean fuels for the near-, intermediate-, and long-term to meet our Nation's transportation fuel needs and environmental imperatives. The gas conversion research efforts include research and development of ceramic membrane reactors to separate air and partial oxidation of gas to produce less costly synthesis gas, innovative processes to chemically convert gas to readily transportable, competitively priced liquid transportation fuels as well as blending agents able to improve the environmental acceptability of petroleum-based fuels. In the coal research area in the intermediate-term, these fuels will be products from coproduction facilities which will use multiple feedstocks to produce transportation fuels, chemicals and electricity, and in the longer term, these fuels will be produced from stand-alone plants which will integrate advanced sequestration technologies facilitating the closing of the carbon cycle.

I. Mission Supporting Goals and Objectives: FUELS (Cont'd)

The Department's efforts currently are focused on generation and production of synthesis gases (i.e. a mixture of carbon monoxide and hydrogen) and the subsequent catalytic conversion of the synthesis gas to liquid fuels and other products. The Transportation Fuels and Chemicals program is cosponsoring the development of Early Entry Coproduction Plant (EECP) technologies with the Integrated Gasification Combined Cycle (IGCC) program. These gasification-based plants would coproduce some combination of power, fuels and chemicals with high efficiency and reduced capital cost, thus facilitating early commercial entry of both IGCC power and coal-derived fuels and chemicals. Concurrent with the EECP effort, the development of ultra-clean fuels for the 21st century will be implemented through a partnership with the Natural Gas Processing and the Petroleum Processing programs. The Ultra-Clean Fuels Program is included as a separate budget line in the FY 2002 budget. The goal is to work with industry to develop technologies that will enable them to utilize more effectively, the global fossil resources to produce these fuels that can meet increasingly stringent vehicle emissions requirements. The activities sponsored by the Transportation Fuels and Chemicals program are also being coordinated with the Office of Transportation Technologies (EE). A current focus is on working the EE's Office of Heavy Vehicle Technology to develop premium fuels for advanced diesel engines for use in sports/utility vehicles, light trucks and to develop fuels suitable for use in the vehicles resulting from the Partnership for a New Generation of Vehicles (PNGV) program. These surface transportation systems will achieve significantly greater efficiency with substantially lower emissions.

Solid Fuels and Feedstocks - The program's funding is directed toward the development of advanced technologies to: (1) improve the overall efficiency, economics, and environmental performance of energy utilization systems, (2) reduce environmental impacts associated with the generation of greenhouse gases and hazardous air pollutants from utilization of coal, (3) permit greater carbon recovery efficiencies yielding more useful energy from the coal that is mined, (4) recover previously discarded carbon raw materials from waste culm piles and settling ponds, (5) support the evolution of significant new industry through the development of technology and processes for the production of premium carbon and industrial products, and (6) create a data base, through comprehensive testing and evaluation of coals of international economic importance, that is essential to the transfer and utilization of U.S. technology in international markets. The program will conduct international collaborative R&D activities with key foreign laboratories, universities and industry research entities on hydrogen, high volume oxygen separation and other key activities aimed at accelerating/broadening Vision 21 technologies and their use abroad. These technologies will significantly increase the efficiency with which energy from coal is produced, recovered and utilized, create new markets for innovative new products needed to satisfy a more sophisticated consumer demand, and improve the environment through the reduction and/or elimination of waste from energy utilization processes and eliminate past environmental insults

I. **Mission Supporting Goals and Objectives:** FUELS (Cont'd)

by cleaning up the residues of previous activities, and finally reduce the emissions of some of the more toxic air-borne emissions by removing them before they enter the energy utilization process.

Advanced Fuels Research - The activities supported by this effort are responsive to the concept of “Grand Challenges” as being those technology barriers that either have the ability to limit the use of coal as a national energy resource on a sustainable basis or, if developed will insure the role of coal as a viable source of energy during the next century. The concepts that mark the work undertaken in this effort are considered to be “technology breakthroughs”. The research and development work includes examining the potential of these breakthrough concepts to produce transportation fuels, chemicals and carbon products at exceptionally high efficiencies, and with significant economic gains, and minimum environmental impact as well as to make major strides in efforts to close the carbon cycle.

Steelmaking - The overall goal of the Steelmaking Program is to accelerate the development of advanced processes for the environmentally acceptable production of iron. The activity supported by this effort is the development of a simple, low-cost method for production of iron from coal and ore concentrate through “direct reduction”. This revolutionary process is designed to use the lowest cost feedstocks and facilitate integration into existing facilities at any scale, due to its modular design. Successful development will provide iron at costs below any existing or planned process and help make up the expected 10 million ton per year shortfall in iron.

FY 2002 performance measures in furtherance of the above goals include:

- Continue the development of improved ceramic membranes for synthesis gas production from gas.
- Continue the development of advanced technologies to create new industries for the production of premium carbon and industrial products from coal.

II. A. **Funding Schedule:** FUELS (Cont'd)

<u>Activity</u>	<u>FY 2000</u>	<u>FY 2001</u>	<u>FY 2002</u>	<u>\$Change</u>	<u>%Change</u>
Transportation Fuels and Chemicals	\$6,928	\$7,558	\$5,000	\$-2,558	-34%
Solid Fuels and Feedstocks	4,232	4,291	2,000	-2,291	-53%
Advanced Fuels Research	2,160	4,889	0	-4,889	-100%
Steelmaking	<u>6,524</u>	<u>6,685</u>	<u>0</u>	<u>-6,685</u>	<u>-100%</u>
Total, Fuels	<u>\$19,844</u>	<u>\$23,423</u>	<u>\$7,000</u>	<u>\$-16,423</u>	<u>-70%</u>

II. B. **Laboratory and Facility Funding Schedule:**

	<u>FY 2000</u>	<u>FY 2001</u>	<u>FY 2002</u>	<u>\$Change</u>	<u>%Change</u>
National Energy Technology Laboratory	\$3,683	\$3,555	\$2,000	\$-1,555	-44%
Argonne National Laboratory	35	0	0	0	0%
Sandia National Laboratories	350	600	0	-600	-100%
All Other	<u>15,776</u>	<u>19,268</u>	<u>5,000</u>	<u>-14,268</u>	<u>-74%</u>
Total, Fuels	<u>\$19,844</u>	<u>\$23,423</u>	<u>\$7,000</u>	<u>\$-16,423</u>	<u>-70%</u>

III. **Performance Summary:**

<u>Activity</u>	<u>FY 2000</u>	<u>FY 2001</u>	<u>FY 2002</u>
Transportation Fuels and Chemicals (Cont'd)	Feedstock Conversion: Study of novel concepts for achieving improved lower severity conversion and specification products. (\$35). Conduct LaPorte alternative fuels facility operation	Feedstock Conversion: Study of novel concepts for improved conversion efficiency and product quality. (\$800) (NETL)	Feedstock Conversion: Conclude all activity in an orderly manner with prior year funds. (\$0)

III. **Performance Summary:** FUELS (Cont'd)

Activity	FY 2000	FY 2001	FY 2002
Transportation Fuels and Chemicals (Cont'd)	<p>for production of Fischer-Tropsch diesel for engine testing in cooperation with the Office of Energy Efficiency and the Fossil Energy Office of Oil and Gas (\$395). (Total \$430) (ANL, APCI)</p> <p>Reactor/Process Development: Continue bench scale DME research; develop ultra-clean transportation fuels and chemicals for the 21st Century (\$1,480). Continue NETL in-house research on Fischer-Tropsch (F-T) chemistry. Continue bench scale F-T iron catalyst development for coproduction of electricity, fuels and chemicals (\$1,087). Conduct slurry F-T design data base; conduct feasibility studies, R&D and design for the Early Entrance Coproduction Plant with industrial consortium, and perform research on advanced hydrogen/synthesis gas production processes (\$2,499) (Total \$5,066) (Air Products, NETL, CAER, WMPI, Dynergy,</p>	<p>Reactor/Process Development: Continue bench scale DME at APCI; continue the development of ultra-clean transportation fuels and chemicals for the 21st Century (\$2,259). Continue bench scale F-T iron catalyst development for the production of premium transportation fuels and chemicals (\$260). International Clean Energy Initiative: Develop and test the feasibility of technical options for hydrogen to make high-value transportation fuels and other products for the international deployment of the technologies (\$500). Conduct slurry F-T reactor design data base; continue feasibility study, R&D, and design of the Early Entrance Coproduct-</p>	<p>Reactor/Process Development: Conclude all activity in an orderly manner with prior year funds. (\$0)</p>

III. **Performance Summary:** FUELS (Cont'd)

Activity	FY 2000	FY 2001	FY 2002
	Texaco, TBD)	ion Plant with industry consortium. (\$2,900). (Total \$5,919) (Air Products, NETL, CAER, WMPI, Dynergy, Texaco, TBD)	
Transportation Fuels and Chemicals (Cont'd)	Product Upgrading: Continue research on DME/diesel blends; characterize coal-derived transportation fuels. (\$682) (PSU, NETL)	Product Upgrading: Continue research on DME/diesel blends, characterize coal-derived transportation fuels. (\$260) (PSU, NETL)	Product Upgrading: Conclude all activity in an orderly manner with prior year funds. (\$0)
	Systems Engineering: Continue research guidance study and engineering support. NETL technical and engineering analyses. (\$679) (Mitretek, NETL, TBD)	Systems Engineering: Continue technical, economic and environmental analyses; engineering support and technical guidance. (\$503) (Mitretek, NETL, TBD)	Systems Engineering: Conclude all activity in an orderly manner with prior year funds. (\$0)
	No activity. (\$0)	No activity. (\$0)	Continue exploratory research activities of novel conversion concepts of promising chemical and small-scale physical conversion technology innovations. Continue research and development of a novel syngas ceramic membrane technology to enhance Fischer-Tropsch (F-T) gas conversion for

III. **Performance Summary:** FUELS (Cont'd)

Activity	FY 2000	FY 2001	FY 2002
	<p>Fund technical and program management support. (\$71)</p> <p>\$6,928</p>	<p>Fund technical and program management support. (\$76)</p> <p>\$7,558</p>	<p>environmentally superior liquid fuels and hydrogen (\$3,950). Conduct fundamental supporting fuels research at NETL (\$1,000). (Total \$4,950) (APCI, NETL, TBD)</p> <p>Fund technical and program management support. (\$50)</p> <p>\$5,000</p>
<p>Solid Fuels and Feedstocks</p>	<p>Environmental Solid Fuels: Continue research on advanced technologies for the reduction of greenhouse gas emissions via the preparation of biomass feeds for cofiring applications and the development of composite coal/biomass/waste fuels; the pre-combustion removal of air toxic precursors at significantly lower cost than achievable with current technologies; and remediation of coal fines disposal problems via improved fine coal recovery, dewatering, and handling. (\$2,162)</p>	<p>Environmental Technologies: Continue support of the development of a national coal quality data base on trace elements (\$30). Tailored Fuels: Conduct research on technologies for enhanced carbon recovery from coal and coal waste products, improved coal fines processing, and the preparation of coal/biomass/waste for gasification and co-firing applications to lower emissions of greenhouse gases (\$2,491). (Total \$2,521) (NETL, TBD)</p>	<p>Environmental Technologies: Conclude all activity in an orderly manner with prior year funds. (\$0)</p>

III. **Performance Summary:** FUELS (Cont'd)

Activity	FY 2000	FY 2001	FY 2002
Solid Fuels and Feedstocks (Cont'd)	(NETL, TBD) Tailored Carbon Feedstocks: Continue research for advanced technologies for the development of premium carbon products from coal and the preparation of tailored feedstocks for the production of advanced transportation fuels and chemicals from coal/biomass/waste feeds. (\$2,027) (NETL, TBD)	Premium Carbon Products: Conduct technical/economic assessments and laboratory and bench scale research on technologies for the manufacture of carbon products. Conduct research at outside facilities for advanced technologies for the premium carbon products from coal via an industry-led and cost-shared consortium (\$1,427). Advanced Separations: Conduct research in the areas of advanced technologies for solid-solid and solid-liquid separations directed toward fuels production and use (\$300). (Total \$1,727) (NETL, Penn State, TBD)	Premium Carbon Products: Conduct technical/economic assessments and laboratory and bench scale research on technologies for the manufacture of carbon products. Conduct research at outside facilities for advanced technologies for the premium carbon products from coal via an industry-led and cost-shared consortium (\$1,980). Advanced Separations: Conclude research in the areas of advanced technologies for solid-solid and solid-liquid separation with prior year funds (\$0). (Total \$1,980) (NETL, Penn State, TBD)
	Fund technical and program management support. (\$43)	Fund technical and program management support. (\$43)	Fund technical and program management support. (\$20)
	\$4,232	\$4,291	\$2,000
Advanced Fuels Research	Conduct research to identify liquid fuels that are suitable as chemical storage agents for hydrogen and	C-1 Chemistry: Cosponsor investigation of the chemistry of monocarbon compounds for the	C-1 Chemistry: Conclude all activity in an orderly manner with prior year funds. (\$0)

III. **Performance Summary:** FUELS (Cont'd)

Activity	FY 2000	FY 2001	FY 2002
Advanced Fuels Research (Cont'd)	<p>that may be easily reformed on board fuel cell powered vehicles. Conduct research on fuel and chemical production aspects of Vision 21 technologies, and continue exploratory research and laboratory activities for the production of high value products from coal. Conduct molecular modeling for simulating the growth of carbon structures, investigating molecular interactions, and designing catalysts. (\$1,278) (NETL, Univ. of KY, WVU, CFFLS, TBD)</p> <p>Conduct research on new and improved methods for producing liquid transportation fuels and chemicals which will be highly efficient, achieve improved environmental performance with</p>	<p>production of hydrogen, syngas, strategic chemicals and transportation fuels with the EE Office of Advanced Automotive Technologies. Investigate advanced clean diesel and diesel additive production technologies and the production of high value chemicals within the Vision 21 concept (\$789). Hydrogen Economy Enabling Science: Conduct research on enabling science for the hydrogen economy including production of hydrogen from fossil resources and the study of novel media for physical and chemical hydrogen storage. (\$839). (Total \$1,628) (NETL, CFFLS, TBD)</p> <p>Molecular Modeling and Catalyst Development: Conduct studies on molecular modeling for the hydrocracking of F-T wax to diesel. Devise technology for application of combinatorial</p>	<p>Molecular Modeling and Catalyst Development: Conclude all activity in an orderly manner with prior year funds. (\$0)</p>

III. **Performance Summary:** FUELS (Cont'd)

Activity	FY 2000	FY 2001	FY 2002
	reduced CO ₂ byproduct. (\$810) (TBD)	chemistry techniques at high temperatures and pressures. (\$250) (SNL)	
	Study options for incorporation of fuel and chemical modules in Vision 21 plants. (\$50) (NETL)	Advanced Concepts: Investigate advanced concepts underlying the production of ultra-clean fuels and chemicals that would provide the scientific basis for new technology. (\$2,962) (TBD)	Advanced Concepts: Conclude all activity in an orderly manner with prior year funds. (\$0)

III. **Performance Summary:** FUELS (Cont'd)

Activity	FY 2000	FY 2001	FY 2002
Advanced Fuels Research (Cont'd)	Fund technical and program management support. (\$22) \$2,160	Fund technical and program management support. (\$49) \$4,889	No activity. (\$0) \$0
Steelmaking	Steelmaking: Conduct industry cost-shared demonstration of a revolutionary coke making process that produces metallurgical grade coke at lower cost and with virtually zero emissions. (\$6,457) (TBD) Fund technical and program management support. (\$67) \$6,524	Steelmaking: Conduct industry cost-shared demonstration of a revolutionary process that produces direct-reduced iron at lower cost and with virtually zero emissions. (\$6,618) (TBD) Fund technical and program management support. (\$67) \$6,685	No activity. (\$0) No activity. (\$0) \$0
Fuels, Total	\$19,844	\$23,423	\$7,000

DEPARTMENT OF ENERGY
FY 2002 CONGRESSIONAL BUDGET REQUEST

FOSSIL ENERGY RESEARCH AND DEVELOPMENT

ADVANCED RESEARCH

I. **Mission Supporting Goals and Objectives:**

The Advanced Research Program (formerly Advanced Research and Technology Development) funds two types of activities. The first is a set of crosscutting studies and assessment activities in environmental, technical and economic analyses, coal technology export and international program support. The second is a set of crosscutting fundamental and applied research programs which include coal utilization science, materials and components, bioprocessing of coal and university-based coal research. The second set of programs includes an activity focused upon Historically Black Colleges and Universities (HBCU) and other minority institutions and addresses the full spectrum of fossil utilization research and development, technology transfer, outreach, and private sector partnerships.

In the crosscutting studies and assessments subprograms, the thrusts of international program support, environmental activities, coal technology export, and technical and economic analysis are to complement and enhance all Fossil Energy endeavors by providing both financial and technological leverage. International involvement is limited to those selected areas where it has been determined that the U.S. will benefit at least to the extent it contributes. FE, through these activities, always attempts to encourage the leveraging of research and development funds while promoting U.S. industrial interests and to use them as opportunities to achieve responsible international consensus and opinion on technical business assessment and policy issues.

The crosscutting fundamental and applied research programs focus upon developing the technology base in the enabling science and technology areas that are critical to the successful development of both superclean, very high efficiency coal-based power systems and coal-based fuel systems with greatly reduced or no net emissions of CO₂. These systems are encompassed in the Vision 21 energyplex. Advanced Research seeks a greater understanding of the physical, chemical, biological and thermodynamic barriers to achieving economic, technologic, and environmental goals and to identify ways to overcome those barriers. The program is unique in that it is directed to specific underlying fundamental scientific and engineering problems closely connected to short-term, mid-term and

I. **Mission Supporting Goals and Objectives:** ADVANCED RESEARCH (Cont'd)

long-range Fossil Energy objectives.

In order to achieve these goals, an Advanced Research focus area on Computational Energy Sciences was established at the National Energy Technology Laboratory (NETL). This focus area will conduct simulations and modeling activities to produce a “technology base” from which the energy plants of the future will be designed, built and operated.

The Coal Utilization Science subprogram focuses on research pertinent to all coal utilization systems, with specific attention paid to increasing our knowledge of the principal mechanisms that control coal combustion processes. It will address issues affecting the utilization of coal, and its primary thrust is in support of the development of the Vision 21 concept. It will involve novel concepts for CO₂ capture and sequestration, such as mineral carbonation, and virtual simulations and modeling of components and subsystems. It will also include research on instrumentation and diagnostics to support the need for advanced controls and sensors. High performance advanced materials and equipment are essential to advanced coal technologies. Thus, the thrust of the advanced materials subprogram is to develop advanced gas separation and particulate removal technology, as well as to develop solutions to materials performance barriers unique to very high temperature, highly corrosive coal combustion and gasification environments. Exploratory research and innovation to maximize the use of coal in environmentally preferable ways is typified by the bioprocessing of coal subprogram. The focus of the biotechnology program is to conduct biological research to produce clean fuels and to reduce greenhouse gas emissions (NO_x, SO_x, and CO₂) from existing and new powerplants. The thrust of the university coal research and HBCU education and training subprograms is to support competitively awarded research grants to U.S. universities to address Fossil Energy's highest priority research needs.

The major goal of the Advanced Research Program focus is to develop, by 2015, a series of advanced materials, subsystem technologies, and breakthrough process concepts that are essential to the success of Vision 21.

FY 2002 Performance Measures in furtherance of the above goals include:

- Develop solid oxide fuel cell electrolyte materials that operate at lower temperatures (650-800°C), thereby reducing fuel cell operating costs and decreasing corrosion of component parts.
- Provide between 15 and 20 grants to teams of university students and professors to perform research ranging from fundamental

I. **Mission Supporting Goals and Objectives:** ADVANCED RESEARCH (Cont'd)

studies in coal science and utilization, to long range exploratory research that could lead to future breakthroughs.

- Provide between 5 and 7 grants to teams of students and professors at minority institutions.
- Implement computational study of device-level experimental investigation of a critical Vision 21 component.
- Prepare detailed engineering assessments to design pounds/hour CO₂ mineral sequestration unit.
- Complete research efforts to determine alternate sources and processes for Mg and Ca as potential feedstock for CO₂ sequestration via mineral carbonation.
- Demonstrate that biohydrogen generation using extremophiles can be conducted on a production scale.

II. A. **Funding Schedule:**

<u>Activity</u>	<u>FY 2000</u>	<u>FY 2001</u>	<u>FY 2002</u>	<u>\$Change</u>	<u>%Change</u>
Coal Utilization Science	\$6,150	\$6,236	\$6,250	\$14	0%
Materials	6,821	6,985	7,000	15	0%
Technology Crosscut					
Coal Technology Export	845	843	800	-43	-5%
Bioprocessing of Coal	1,350	1,347	1,350	3	0%
Environmental Activities	2,000	1,996	1,900	-96	-5%
Technical & Economic Analyses	750	748	750	2	0%
International Program Support	1,000	998	950	-48	-5%
Focus Area for Computational Energy Science	<u>0</u>	<u>6,993</u>	<u>3,000</u>	<u>-3,993</u>	<u>-57%</u>
Subtotal, Technology Crosscut Research	5,945	12,925	8,750	-4,175	-32%
University Coal Research	2,921	2,993	3,000	7	0%
HBCUs, Education and Training	<u>974</u>	<u>998</u>	<u>1,000</u>	<u>2</u>	<u>0%</u>
Total, Advanced Research	<u>\$22,811</u>	<u>\$30,137</u>	<u>\$26,000</u>	<u>\$-4,137</u>	<u>-14%</u>

II. B. **Laboratory and Facility Funding Schedule:** ADVANCED RESEARCH (Cont'd)

	<u>FY 2000</u>	<u>FY 2001</u>	<u>FY 2002</u>	<u>\$Change</u>	<u>%Change</u>
Argonne National Lab (East)	\$982	\$978	\$988	\$10	1%
Idaho Ntn'l Engineering & Environmental Lab	570	570	570	0	0%
National Energy Technology Laboratory	2,600	9,563	5,720	-3,843	-40%
Los Alamos National Lab	600	600	600	0	0%
Oak Ridge National Lab	3,923	4,044	4,435	391	10%
Pacific Northwest Lab	840	840	770	-70	-8%
Sandia National Laboratories	550	550	550	0	0%
Ames National Laboratory	140	140	230	90	64%
All Other	<u>12,606</u>	<u>12,852</u>	<u>12,137</u>	<u>-715</u>	<u>-6%</u>
Total, Advanced Research	<u>\$22,811</u>	<u>\$30,137</u>	<u>\$26,000</u>	<u>\$-4,137</u>	<u>-14%</u>

III. **Performance Summary:**

<u>Activity</u>	<u>FY 2000</u>	<u>FY 2001</u>	<u>FY 2002</u>
Coal Utilization Science	Conduct research to enable reduction or elimination of environmental impacts of coal use; focus on greenhouse gases that may affect global climate change. Continue research toward the Virtual Demonstration Plant. Conduct systems analysis of Vision 21 concepts to identify critical research areas. Implement projects to develop critical enabling	Conduct research to enable reduction or elimination of environmental impacts of coal use; focus on greenhouse gases that may affect global climate change. Continue research toward the Virtual Demonstration Plant in support of the Vision 21 power and fuels complex. Continue development of instrumentation, diagnostics and controls for	Conduct research to enable reduction or elimination of environmental impacts of coal use; focus on greenhouse gases that may affect global climate change. Continue research for and conduct preliminary model testing and research for Virtual Demonstration Plant. Continue development of instrumentation, diagnostics and controls for advanced power

III. **Performance Summary**: ADVANCED RESEARCH (Cont'd)

<u>Activity</u>	<u>FY 2000</u>	<u>FY 2001</u>	<u>FY 2002</u>
Coal Utilization Science (Cont'd)	<p>technologies for advanced power and fuel systems in support of Vision 21 and incorporate the results into the Virtual Demonstration. Continue research in basic combustion, contaminant evolution, fundamental carbon studies, and predictive models. Continue research on mineral sequestration of CO₂. (\$6,087) (NETL, SNL, MIT, TBD)</p>	<p>advanced power systems. Conduct systems analysis of Vision 21 concepts to identify critical research areas. Continue projects to develop critical enabling technologies for advanced power and fuel systems and in support of Vision 21; and incorporate the results into the Virtual Demonstration. Continue research in basic combustion, contaminant evolution, fundamental carbon studies, and predictive models. Continue research on mineral sequestration of CO₂ at large scale (1 kg). (\$5,924) (NETL, SNL, LANL, TBD)</p>	<p>systems. Continue stochastic modeling and systems analysis of Vision 21 concepts. Continue with six projects selected under the Vision 21 solicitation and issue new solicitations to develop critical enabling technologies for advanced power and fuel systems and in support of Vision 21. Continue research in basic combustion, contaminant evolution, fundamental carbon studies, and predictive models. Continue research on mineral sequestration of CO₂ at large scale (1 kg) utilizing a full scale flow loop. (\$5,937) (NETL, SNL, LANL, Natl. Fuel Cell Res., Fluent, Reaction Engineering, TBD)</p>
	No activity. (\$0)	Initiate collaborative efforts with Basic Energy Science on the Strategic Simulation Initiative to develop a new generation of combustion simulation	Continue collaborative efforts with Basic Energy Science on the Strategic Simulation Initiative to develop a new generation of combustion simulation

III. **Performance Summary:** ADVANCED RESEARCH (Cont'd)

Activity	FY 2000	FY 2001	FY 2002
Coal Utilization Science (Cont'd)	Fund technical and program management support. (\$63) \$6,150	computational models. (\$250) (TBD) Fund technical and program management support. (\$62) \$6,236	computational models. (\$250) (TBD) Fund technical and program management support. (\$63) \$6,250
Materials	Continue those essential activities of the high temperature structural ceramic composites, alloys, and functional materials developments that are enabling elements for the development of economical, high efficiency, and environmentally clean fossil energy power systems. These include resistant coatings; fabrication processes; filters; ceramic membranes; solid state electrolytes; carbon fibers; ceramic heat exchangers; and non-destructive evaluation techniques. (\$5,516) (ANL, INEEL, ORNL, PNNL)	Continue those essential activities of the high temperature structural ceramic composites, alloys, and functional materials developments that are enabling elements for the development of economical, high efficiency, and environmentally clean fossil energy power systems. These include resistant coatings; fabrication processes; filters; ceramic membranes; solid state electrolytes; carbon fibers; ceramic heat exchangers; and non-destructive evaluation techniques, high- and very-high temperature intermetallics, and oxide-dispersion-strengthened alloys. (\$5,474) (ANL, INEEL, ORNL,	Continue those essential activities of the high temperature structural ceramic composites, alloys, and functional materials developments that are enabling elements for the development of economical, high efficiency, and environmentally clean fossil energy power systems. These include resistant coatings; fabrication processes; filters; ceramic membranes; solid state electrolytes; carbon fibers; ceramic heat exchangers; non-destructive evaluation techniques, high- and very-high temperature intermetallics, and oxide-dispersion-strengthened alloys. (\$5,015) (ANL, INEEL, ORNL,

III. **Performance Summary**: ADVANCED RESEARCH (Cont'd)

<u>Activity</u>	<u>FY 2000</u>	<u>FY 2001</u>	<u>FY 2002</u>
		PNNL)	Eltron, Ames, Huntington Alloys, NETL)

III. **Performance Summary:** ADVANCED RESEARCH (Cont'd)

Activity	FY 2000	FY 2001	FY 2002
Materials (Cont'd)	<p>Continue breakthrough concepts to develop materials for achieving very low cost hydrogen and oxygen separation from mixed gas streams and for stabilizing greenhouse gases. These are critical enabling technologies to deploy Vision 21 energy plants. (\$1,235) (TBD)</p>	<p>Increase support to breakthrough concepts to develop materials for achieving very low cost hydrogen and oxygen separation from mixed gas streams and for stabilizing greenhouse gases. These are critical enabling technologies to deploy Vision 21 energy plants. (\$1,441) (AMES, NETL, SNL, TBD)</p>	<p>Support development of alloys for supercritical systems. Increase support to breakthrough concepts to develop materials for achieving very low cost hydrogen and oxygen separation from mixed gas streams and for stabilizing greenhouse gases. These are critical enabling technologies to deploy Vision 21 energy plants. (\$1,915) (LANL, SNL, ORNL, PNNL, ARC, TBD)</p>
	<p>Fund technical and program management support. (\$70)</p>	<p>Fund technical and program management support. (\$70)</p>	<p>Fund technical and program management support. (\$70)</p>
	\$6,821	\$6,985	\$7,000
Technology Crosscut - Coal Technology Export	<p>Sustain continued support to deploy cleaner coal and power generation systems internationally. Continue pursuit of opportunities identified by the World Energy Council Working Group on the Strategic Value of Cleaner Fossil Fuel Systems for the international</p>	<p>Sustain continued support to deploy cleaner coal and power generation systems internationally. Pursue opportunities identified by the World Energy Council Committee on Cleaner Fossil Fuel Systems and the Southern States Energy Board for the international</p>	<p>Sustain continued support to deploy cleaner coal and power generation systems internationally. Intensify the pursuit of opportunities identified by the World Energy Council Committee on Cleaner Fossil Fuel Systems and the Southern States Energy</p>

III. **Performance Summary:** ADVANCED RESEARCH (Cont'd)

Activity	FY 2000	FY 2001	FY 2002
Technology Crosscut - Coal Technology Export (Cont'd)	sale of U.S. clean coal technologies and advanced power systems; and maintain efforts to develop collaborative environmental partnerships among major developing nations, U.S. states and local governments, NGO's and industry to support regional efforts to promote the increased use of cleaner power systems. Preserve the efforts in the Pacific Rim including sharing best practice information with utilities. (\$845) (TBD)	sale of clean technologies and advanced power systems. Promote deployment of cleaner energy systems through training, conferences, and information and technical exchanges on cleaner power systems. (\$843) (TBD)	Board for the international sale of U.S. clean coal technologies and advanced power systems. Expand the establishment of effective partnerships to advance U.S. interests in environmental protection by promoting deployment of cleaner energy systems through training, conferences, site visits and information and technical exchanges on clean power systems, best practices, privatization with targeted utilities and governments and advising countries on identification and elimination of barriers for deployment of cleaner coal and power systems. (\$800) (TBD)
	\$845	\$843	\$800
Technology Crosscut - Bioprocessing of Coal	Develop biological processes to reduce CO ₂ production and to sequester CO ₂ . Complete evaluation of electro-chemically	Develop biological processes for fuels that have a significantly lower unit content of greenhouse gas than currently available fuel to reduce	Develop biological processes for fuels that have a significantly lower unit content of greenhouse gas than currently available fuel to reduce

III. **Performance Summary:** ADVANCED RESEARCH (Cont'd)

Activity	FY 2000	FY 2001	FY 2002
Technology Crosscut - Bioprocessing of Coal (Cont'd)	<p>supplied electron carriers in synthesis gas fermentations. Develop biofiltration for removal of NO_x from combustion gases. Completed lab-scale testing of specific microorganisms to control zebra mussels. Develop biological CO₂ sequestration by conversion into useful products such as liquid fuels and investigate global, natural CO₂ mitigation strategies such as whittings and ocean scale algae sequestration. (\$1,336) (ORNL, INEEL, TBD)</p> <p>Fund technical and program management support. (\$14)</p> <p style="text-align: center;">\$1,350</p>	<p>the impact on global climate change. Continue development of biofiltration for removal of NO_x from combustion gases. Initiate larger scale batch testing of toxins from microorganisms to control zebra mussels. Develop new biomineralization techniques for carbon sequestration. Continue to develop biological CO₂ sequestration by conversion into useful products such as liquid fuels and investigate global, natural CO₂ mitigation strategies such as whittings and ocean scale algae sequestration. (\$1,333) (ORNL, INEEL, TBD)</p> <p>Fund technical and program management support. (\$14)</p> <p style="text-align: center;">\$1,347</p>	<p>the impact on global climate change. Complete development of biofiltration for removal of NO_x from combustion gases. Conduct field tests to develop toxin to safely control zebra mussels. Continue to develop biological CO₂ sequestration by conversion into useful products such as liquid fuels and investigate global, natural CO₂ mitigation strategies such as whittings and ocean scale algae sequestration. (\$1,336) (ORNL, INEEL, U. State of NY, Cal. State U., TBD)</p> <p>Fund technical and program management support. (\$14)</p> <p style="text-align: center;">\$1,350</p>
Technology Crosscut - Environmental	Continue analyses of issues associated with air and water quality, solid waste disposal, and	Continue analyses of issues associated with air and water quality, solid waste disposal, and	Continue analyses of issues associated with air and water quality, solid waste disposal, and

III. **Performance Summary:** ADVANCED RESEARCH (Cont'd)

Activity	FY 2000	FY 2001	FY 2002
Activities Technology Crosscut - Environmental Activities (Cont'd)	toxic substances, and global climate change. Continue emission trends and forecast studies. (\$1,800) (ANL, ICF, Resource Dynamics, TMS, PNNL, TBD) Provide environmental, safety and health, safeguards and security and National Environmental Policy Act (NEPA) assistance and assessment support to field offices. (\$200) (TMS)	toxic substances, and global climate change. Continue emission trends and forecast studies. (\$1,796) (ANL, ICF, Resource Dynamics, TMS, PNNL, TBD) Provide environmental, safety and health, safeguards and security and National Environmental Policy Act (NEPA) assistance and assessment support to field offices. (\$200) (TMS)	toxic substances, and global climate change. Continue emission trends and forecast studies. (\$1,710) (ANL, ICF, Resource Dynamics, TMS, PNNL, TBD) Provide environmental, safety and health, safeguards and security and National Environmental Policy Act (NEPA) assistance and assessment support to field offices. (\$190) (TMS)
	\$2,000	\$1,996	\$1,900
Technology Crosscut - Technical and Economic Analysis	Continue studies supporting multi-year planning, FE strategy and program formulation; conduct contract studies on issues that crosscut FE programs including strategic benefits of and new markets for fossil fuel technology. Conduct critical studies to identify major challenges, "leapfrog"	Continue studies supporting multi-year planning, FE strategy and program formulation; conduct contract studies on issues that crosscut FE programs including strategic benefits of and new markets for fossil fuel technology. Conduct critical studies to identify major challenges, "leapfrog"	Continue studies supporting multi-year planning, FE strategy and program formulation; conduct contract studies on issues that crosscut FE programs including strategic benefits of and new markets for fossil fuel technology. Conduct critical studies to identify major challenges, "leapfrog"

III. **Performance Summary:** ADVANCED RESEARCH (Cont'd)

Activity	FY 2000	FY 2001	FY 2002
Technology Crosscut - Technical and Economic Analysis (Cont'd)	technologies, and advanced concepts that are applicable to fossil energy systems, and have the potential to improve their efficiency, cost, and/or environmental performance. (\$750) (ANL, ICF, EIA, Resource Dynamics, TMS, TBD)	technologies, and advanced concepts that are applicable to fossil energy systems, and have the potential to improve their efficiency, cost, and/or environmental performance. (\$748) (ANL, ICF, EIA, Resource Dynamics, TMS, TBD)	technologies, and advanced concepts that are applicable to fossil energy systems, and have the potential to improve their efficiency, cost, and/or environmental performance. (\$750) (ANL, ICF, EIA, Resource Dynamics, TMS, TBD)
	\$750	\$748	\$750
Technology Crosscut - International Program Support	Support Fossil Energy's commitment to the International Energy Agency (IEA) program effort. Preserve active relationships with international organizations such as the World Energy Council (WEC) and United States Energy Association (USEA). Implement Environmental Corps activities in conjunction with the U.S., China Energy and Environmental Center function. Initiate cleaner energy technology activities in Russia, Newly Independent States	Continue support of Fossil Energy's commitment to the International Energy Agency (IEA) program effort. Provide leadership, direction, cooperation and coordination of office activities with other Federal agencies, state and local governments, energy trade associations, and the energy industry. Preserve and enhance active relationships with national and international organizations such as the World Energy Council (WEC), United States Energy Association (USEA), Southern	Continue support of Fossil Energy's commitment to the International Energy Agency (IEA) program effort. Provide leadership, direction, cooperation and coordination of office activities with other Federal agencies, state and local governments, energy trade associations, and the energy industry. Preserve and enhance active relationships with national and international organizations such as the World Energy Council (WEC), United States Energy Association (USEA), Southern

III. **Performance Summary:** ADVANCED RESEARCH (Cont'd)

Activity	FY 2000	FY 2001	FY 2002
Technology Crosscut - International Program Support (Cont'd)	formerly of the Soviet Union and Southern and Western regional African countries. Assessment and assistance of near and middle east, other regions and U.S. Industry-International Outreach. Determine opportunities for power systems in targeted countries. (\$1,000) (TBD)	States Energy Board (SSEB) and the National Association of State Energy Officials (NASEO). Implement Environmental Corps activities in China and activities of the U.S.-China Energy and Environmental Center. Focus on expanding cleaner energy technology power systems activities in Southern and Western regional African countries, Eastern Europe, the Pacific Rim, Russia and Newly Independent States, South Asia/Near East, Western Europe, and the Western Hemisphere. Determine opportunities for power systems in targeted countries. (\$998) (TBD)	States Energy Board (SSEB) and the National Association of State Energy Officials (NASEO). Focus on expanding cleaner energy technology power systems activities in Southern and Western regional African countries, Eastern Europe, the Pacific Rim, Russia and Newly Independent States, South Asia/Near East, Western Europe, and the Western Hemisphere. Determine opportunities for power systems and clean fuels from coal in targeted countries. (\$950) (TBD)
	\$1,000	\$998	\$950
Technology Crosscut - Focus Area for Computational Energy Science	No activity. (\$0)	Enhance NETL capabilities to model and conduct dynamic simulations of advanced energy plants. Establish a consortium with industry, national labs and regional	Continue developing NETL's capabilities to model and conduct dynamic simulations of advanced energy plants. Complete advanced modeling tools for sub-elements in

III. **Performance Summary:** ADVANCED RESEARCH (Cont'd)

Activity	FY 2000	FY 2001	FY 2002
Technology Crosscut - Focus Area for Computational Energy Science (Cont'd)	No activity. (\$0)	universities and collaborate with other DOE programs for simulation, materials, fabrication/manufacturing research. Expand scientific simulation and computational capability at NETL through installation of a high speed computer data line located at the Supercomputing Center. Complete the conversion of basic and applied science models into a supercomputing environment and conduct runs of simulations to verify codes.(\$6,923) (NETL)	turbines and fuel cells. Continue advanced development of combustion dynamics, pollution formation and separations computational tools. (\$2,970)
	\$0	Fund technical and program management support. (\$70)	Fund technical and program management support. (\$30)
	\$0	\$6,993	\$3,000
Technology Crosscut, Subtotal	\$5,945	\$12,925	\$8,750
University Coal Research	Support grants at U.S. universities which emphasize longer-term research that will accelerate technology development and	Support grants at U.S. universities which emphasize longer-term research that will accelerate technology development and	Support grants at U.S. universities which emphasize longer-term research that will accelerate technology development and

III. **Performance Summary**: ADVANCED RESEARCH (Cont'd)

Activity	FY 2000	FY 2001	FY 2002
University Coal Research (Cont'd)	<p>identify breakthrough technologies for the next century; focus on scientific and technological issues that are key to achieving FE's strategic objectives; and increase the number of critical key research areas to include global climate change. Collaboration through joint proposals involving university and industry teams will continue. Continue to explore novel approaches and innovative concepts developed in other scientific and technological areas that will assist in developing breakthrough technologies for coal utilization. (\$2,851) (TBD)</p>	<p>identify breakthrough technologies for the next century; focus on scientific and technological issues that are key to achieving FE's strategic objectives; and increase the number of critical key research areas to include global climate change. Collaboration through joint proposals involving university and industry teams will continue. Continue to explore novel approaches and innovative concepts developed in other scientific and technological areas that will assist in developing breakthrough technologies for coal utilization. (\$2,923) (TBD)</p>	<p>identify breakthrough technologies for the next century; focus on scientific and technological issues that are key to achieving FE's strategic objectives; continue to support critical key research areas to include Vision 21, global climate change, materials, sensors and controls, and by-products from coal. Continue collaboration through joint proposals involving university and industry teams, and teams with three or more universities. Continue to explore novel approaches and innovative concepts developed in other scientific and technological areas that will assist in developing breakthrough technologies for coal utilization. Award Phase 2 grants to last year's most meritorious innovative concept grantees. (\$2,930) (TBD)</p>
	Support the undergraduate	Support the undergraduate	Support the undergraduate

III. **Performance Summary:** ADVANCED RESEARCH (Cont'd)

Activity	FY 2000	FY 2001	FY 2002
University Coal Research (Cont'd)	internship program to allow those junior-level science and engineering majors to experience fundamental research in the areas of environmental science and engineering, and energy, where no graduate course or degrees are offered in their major field of study. (\$40) (TBD)	internship program to allow those junior-level science and engineering majors to experience fundamental research in the areas of environmental science and engineering, and energy, where no graduate course or degrees are offered in their major field of study. (\$40) (TBD)	internship program to allow students having science and engineering majors to perform fundamental research in the areas of environmental science and fossil energy, where no graduate course or degrees are offered in their major field of study at their institutions. (\$40) (TBD)
	Fund technical and program management support. (\$30)	Fund technical and program management support. (\$30)	Fund technical and program management support. (\$30)
	\$2,921	\$2,993	\$3,000
HBCUs, Education and Training	Conduct research activities with HBCU and other minority institutions and support an HBCU annual technology transfer symposium. (\$964) (TBD)	Conduct research activities with HBCU and other minority institutions and support an HBCU annual technology transfer symposium. (\$988) (TBD)	Conduct research activities with HBCU and other minority institutions and support an HBCU annual technology transfer symposium. (\$990) (TBD)
	Fund technical and program management support. (\$10)	Fund technical and program management support. (\$10)	Fund technical and program management support. (\$10)
	\$974	\$998	\$1,000
Advanced			

III. **Performance Summary**: ADVANCED RESEARCH (Cont'd)

<u>Activity</u>	<u>FY 2000</u>	<u>FY 2001</u>	<u>FY 2002</u>
Research, Total	\$22,811	\$30,137	\$26,000

DEPARTMENT OF ENERGY
FY 2002 CONGRESSIONAL BUDGET REQUEST

FOSSIL ENERGY RESEARCH AND DEVELOPMENT

NATURAL GAS TECHNOLOGIES

I. **Mission Supporting Goals and Objectives:**

Natural gas consumption in the United States is projected by several leading research organizations to reach or exceed 33 Tcf per year by 2020, increasing from 22 Tcf in 1997 (projections of EIA, GRI, Enron). Reduced emissions targets for greenhouse gases could lead to a 40 Tcf gas market by 2010. Gas will play a key role in the 21st century transition to a post-oil economy for transportation fuels. Most of the domestic gas resource base is not yet fully known and is located in such areas as: deep formations, low-permeability sandstones, below basalt formations, hydrates, deep water, and remote areas -- Gulf of Mexico and Alaska.

Federal Roles and Responsibilities: Federal roles and responsibilities in natural gas supply research are to: (1) provide strategic guidance for national energy policy; (2) support efficient and sustainable use of domestic energy resources; (3) protect the environment and public safety; (4) enhance the value of Federal lands (38% of gas production is on Federal lands); (5) enhance global market opportunities for U.S. energy technologies; (6) contribute to U.S. science and technology leadership; (7) apply a unique national perspective to technology development that is independent of company specific and State-specific interests; and (8) ensure the integrity and viability of the Nation's energy infrastructures.

DOE's Role In Gas RD&D: Support national goals to: (1) enhance the efficiency and environmental quality of domestic gas exploration, recovery, and processing operations; (2) focus on high-risk technology that private companies alone won't undertake; (3) provide scientific and technological information and analysis to assist policymakers in their decision making; and (4) contribute to science based improvements in regulations to reduce uncertainties and costs while achieving optimal environmental protection.

The overall goal of the Natural Gas Technologies Program is to improve the Nation's ability to supply, store, transport, distribute, and utilize gas in an economic, efficient, and environmentally beneficial manner. In support of DOE's mission, the program funds activities

I. **Mission Supporting Goals and Objectives:** NATURAL GAS TECHNOLOGIES (Cont'd)

that contribute toward: lowering costs for finding and producing gas; improving the confidence in continued availability of a long-term gas supply, and increasing the efficiency of recovery from existing reservoirs (Exploration and Production); enabling characterization and study of gas hydrates (Gas Hydrates); assuring gas infrastructure reliability, flexibility, and emergency response capability (Infrastructure); improving the quality and utility of natural gas for the consuming public (Emerging Processing Technology); and, developing and ensuring availability of low cost environmental compliance technology, and reducing regulatory barriers to economic and efficient market operations by promoting coordinated and innovative Federal and State regulations (Effective Environmental Protection). Each program area has its own unique mission that contributes to the goals and mission of the overall Natural Gas Technologies Program. The total program will increase the value of the natural gas resource base for gas consumers, for Federal, State, and local governments and for the gas industry. The DOE National Energy Technology Laboratory (NETL) located in Morgantown, West Virginia, Pittsburgh, Pennsylvania, and Tulsa, Oklahoma manages the gas technology program implementation activities.

Exploration and Production: The Office of Fossil Energy will continue to fund basic and applied RD&D. Specifically, in the Advanced Drilling Completion, and Stimulation product line funding is requested to: develop and demonstrate a set of tools and techniques that will: (a) result in minimum damage during the drilling, completion, and fracturing stages to particular formations; (b) develop new concepts in drilling; and (c) minimize overall environmental impact of drilling-related operations and waste disposal. In the Advanced Diagnostics & Imaging Systems Program funding is requested to develop and demonstrate advanced imaging and prediction techniques for locating productive areas within low-permeability and fractured reservoirs. In addition, the product line will continue to identify and assess the potential productivity of non-conventional gas reservoirs in priority basins to reduce exploration and production risks. A stripper gas well enhancement sub-program is attempting to extend the productive life of active low rate wells (currently contributing 5% of the domestic gas supply) by continuing an industry-driven consortium to investigate multiple technologies to improve stripper well production. Finally, technology transfer activities will be continued, addressing independent producers via internet, newsletters and workshops.

Gas Hydrates: Efforts are underway to ensure safe extraction of conventional oil and gas resources located near hydrate deposits, enable safe and economic production of gas from hydrates and assess their impact on the global carbon cycle.

I. **Mission Supporting Goals and Objectives:** NATURAL GAS TECHNOLOGIES (Cont'd)

Infrastructure: Efforts are being directed to enhance energy system reliability with the Nation's natural gas pipelines and gas storage facilities. Advanced technology research projects are directed to ensure the reliability and integrity of transmission and utility distribution pipeline systems, to increase the accuracy of the gas volume and energy content measurement of gas in storage, and to provide science and engineering solutions for the development of gas storage facilities in regions without conventional storage options. Efforts are focused to develop cost-effective technologies and engineering techniques that expand peaking storage capacity to meet gas requirements during high demand periods, to develop real-time storage measurement technologies to reduce uncertainties in storage inventories attributable to storage metering biases, to reduce stress corrosion and cracking on gas transmission and distribution lines, to develop systems capable of detecting third-party damage and external force damage to pipelines, to develop technology to improve the efficiency and environmental controls for reciprocating and turbo compressors, and to undertake research to develop advanced technology capable of determining pipeline wall integrity.

Effective Environmental Protection: Funding for environmental research activities will bring credible scientific information and advanced technologies to address the environmental issues that have been identified by industry, and state and federal regulators as highest priority. In FY 2002, the program will focus on detection and control of air emissions from gas equipment and facilities, treatment of produced water to meet environmental standards, remediation of hydrocarbon or produced water contaminated soils, treatment and disposal of wastes containing naturally occurring radioactive materials, and other approaches to manage oil and gas field wastes. The program works to lower the cost of effective environmental protection in these environmental issue areas through a combination of risk assessment, technology development, regulatory streamlining, impact analysis, and facilitating dialogue among the affected parties on ways to balance the need to develop the nation's energy resources with the maintenance of our environmental values.

Performance Measures:

- Develop and demonstrate technologies, with near-term commercial potential to double average per-well productivity, that can detect and quantify areas of high fracture density in currently uneconomic low permeability gas reservoirs
- Complete laboratory testing and begin field demonstrations of improved remedial technologies for storage wells that could reduce the cost of deliverability enhancement by 10% per year for the gas storage industry by 2007.
- Develop the world's first microwave-processed drill bit and commercialize composite drill pipe.

II. A. **Funding Schedule:** NATURAL GAS TECHNOLOGIES (Cont'd)

<u>Activity</u>	<u>FY 2000</u>	<u>FY 2001</u>	<u>FY 2002</u>	<u>\$Change</u>	<u>%Change</u>
Exploration and Production	\$13,893	\$14,221	\$9,350	\$-4,871	-34%
Gas Hydrates	2,887	9,938	4,750	-5,188	-52%
Infrastructure	977	8,110	5,050	-3,060	-38%
Emerging Processing Technology	9,919	10,146	250	-9,896	-98%
Effective Environmental Protection	<u>3,133</u>	<u>2,614</u>	<u>1,600</u>	<u>-1,014</u>	<u>-39%</u>
Total, Natural Gas Technologies	<u>\$30,809</u>	<u>\$45,029</u>	<u>\$21,000</u>	<u>\$-24,029</u>	<u>-53%</u>

II. B. **Laboratory and Facility Funding Schedule:**

	<u>FY 2000</u>	<u>FY 2001</u>	<u>FY 2002</u>	<u>\$Change</u>	<u>%Change</u>
Argonne National Lab (East)	\$195	\$75	\$0	\$-75	-100%
Brookhaven National Lab	75	0	0	0	0%
Idaho National Engineering Lab	568	50	0	-50	-100%
Lawrence Berkeley Lab	665	1,355	800	-555	-41%
Lawrence Livermore National Laboratory	434	0	0	0	0%
Los Alamos National Laboratory	715	650	0	-650	-100%
National Energy Technology Laboratory	1,257	1,695	540	-1,155	-68%
Oak Ridge National Lab	135	0	0	0	0%
Pacific Northwest Laboratory	575	850	825	-25	-3%
Sandia National Laboratories	300	589	175	-414	-70%
All Other	<u>25,890</u>	<u>39,765</u>	<u>18,660</u>	<u>-21,105</u>	<u>-53%</u>
Total, Natural Gas Technologies	<u>\$30,809</u>	<u>\$45,029</u>	<u>\$21,000</u>	<u>\$-24,029</u>	<u>-53%</u>

III. **Performance Summary:** NATURAL GAS TECHNOLOGIES (Cont'd)

Activity	FY 2000	FY 2001	FY 2002
Exploration and Production	<p>Advanced Drilling, Completion, and Stimulation (DCS): Continue development and field testing of high rate-of-penetration, slimhole, directional, and underbalanced drilling products; and of advanced completion technologies. Continue testing, deployment, and technology transfer of underbalanced drilling technology and minimum formation damage drilling and fracturing. Continue fluid fracture research with the GRI at Oklahoma University. Continue development of a revolutionary drilling system. (\$5,680) (NETL, Oklahoma Univ., Sperry Sun, Drilling Eng'g Assoc., Novatek, Mauer, Tempress, Tech Int., TBD)</p> <p>Advanced Diagnostics and Imaging Systems: Continue research in low-permeability</p>	<p>Advanced Drilling, Completion, and Stimulation (DCS): Continue development and field testing of high rate-of-penetration, slimhole, directional, and underbalanced drilling products; and of advanced completion technologies. Continue testing, deployment, and technology transfer of underbalanced drilling technology and minimum formation damage drilling and fracturing. Continue fluid fracture research with the GRI at Oklahoma University. Continue development of a revolutionary drilling system. (\$5,319) (NETL, Novatek, Mauer, Tempress, ACPT, Tech Int., TBD)</p> <p>Advanced Diagnostics and Imaging Systems: Continue research in low-permeability</p>	<p>Advanced Drilling, Completion, and Stimulation (DCS): Complete development of world's first microwave-processed drill bit as a new drilling concept. Commercialize composite drill pipe in onshore and offshore applications. Conclude field testing of advanced directional mud hammer and commercialization of associated high speed data communications system. Continue development of advanced and underbalanced drilling concepts to reduce cost and footprint and increase capability of drilling industry. Initiate research to integrate deep drilling technologies for field demonstrations in the Rocky Mts. (\$5,309) (NETL, PSU, Novatek, Mauer, Tempress, ACPT, Tech Int., TBD)</p> <p>Advanced Diagnostics and Imaging Systems: Complete testing and validation of natural fracture</p>

III. **Performance Summary**: NATURAL GAS TECHNOLOGIES (Cont'd)

Activity	FY 2000	FY 2001	FY 2002
Exploration and Production (Cont'd)	<p>reservoir field deployment with industry in the Greater Green River and other priority basins. Continue development of diagnostics for imaging and predicting gas in natural fractured reservoirs, conducting advanced geoscience measurements including seismic processing and interpretation, and use of advanced National Laboratory capabilities. Continue analysis of deep gas potential in priority basins. (\$4,896) (NETL, LBL, SNL, ICF, USGS, Marine Board, TBD)</p> <p>Multi NL/Industry Partnership: Support R&D in exploration and production technologies in projects identified by industry partners. (\$685) (National Labs)</p> <p>Secondary Gas Recovery: Continue tests of methodologies in</p>	<p>reservoir field development with industry in priority basins. Continue development of diagnostics for imaging and predicting gas in naturally fractured reservoirs, conducting advanced geoscience measurements including seismic processing and interpretation, and use of advanced National Laboratory capabilities. Continue analysis of deep gas potential in priority basins. (\$5,616) (NETL, LBL, SNL, USGS, Marine Board, ARI, N. Mex. Tech., TBD)</p> <p>Multi NL/Industry Partnership: Support R&D in exploration and production technologies in projects identified by industry partners. (\$998) (National Labs)</p> <p>Secondary Gas Recovery: Continue tests of methodologies in</p>	<p>detection technologies in five major U.S. tight gas basins. Several projects for development and validation of the next generation of fracture detection technologies to reduce dry hole rates will be terminated. Complete a second infill drilling optimization study. Improved recovery solicitation issued in FY 2001 will be scaled back, but not eliminated. Conduct a long-term sustainability of gas supply study in Rocky Mt. basins. (\$2,900) (NETL, GeoSpectrum, ARI, Stanford, LBL, SUNY, SNL, USGS, N. Mex. Tech.)</p> <p>Multi NL/Industry Partnership: No activity. (\$0)</p> <p>Secondary Gas Recovery: Last phase of project will be terminated.</p>

III. **Performance Summary:** NATURAL GAS TECHNOLOGIES (Cont'd)

Activity	FY 2000	FY 2001	FY 2002
	the Appalachian Basin and the offshore Gulf Coast. (\$900) (BEG, WV Consortium)	the Appalachian Basin and the offshore Gulf Coast. (\$798) (BEG, WV Consortium)	(\$0)
Exploration and Production (Cont'd)	<p>Stripper Wells Revitalization: Conduct engineering assessment of wells to determine candidate areas for restimulation tests; test and evaluate via field tests the effect of revitalization efforts to extend the productive life of the well. (\$642) (TBD)</p> <p>Technology Transfer: Support industry led efforts in technology transfer. (\$947) (PTTC)</p> <p>No activity. (\$0)</p>	<p>Stripper Wells Revitalization: Continue engineering assessments of wells to determine candidate areas for restimulation; test and evaluate impact of revitalization techniques on the productive life of wells. (\$748) (TBD)</p> <p>Technology Transfer: Support industry led efforts in technology transfer. (\$599) (PTTC)</p> <p>Arctic Research: Establish an Arctic Research program for peer reviewed research; coordinate research conducted through Fossil Energy and Energy Efficiency; conduct outreach and serve as a liaison between the State and DOE. (\$250 provided from Energy Efficiency appropriation.) (TBD)</p>	<p>Stripper Wells Revitalization: National, industry-driven consortium to investigate multiple technologies to improve stripper well production. (\$500) (PSU)</p> <p>Technology Transfer: Support industry led efforts in technology transfer (\$300) (PTTC)</p> <p>Arctic Research: Continue Arctic Research program for peer reviewed research; coordinate research conducted through Fossil Energy and Energy Efficiency; conduct outreach and serve as a liaison between the State and DOE. (\$247) (TBD)</p>

III. **Performance Summary:** NATURAL GAS TECHNOLOGIES (Cont'd)

Activity	FY 2000	FY 2001	FY 2002
	Provide technical and program management support. (\$143) \$13,893	Provide technical and program management support. (\$143) \$14,221	Provide technical and program management support. (\$94) \$9,350
Gas Hydrates	Expand resource characterization and seismic survey activities in the onshore and offshore areas. (\$2,857) (TBD) Provide technical and program management support. (\$30) \$2,887	Continue resource characterization and seismic survey activities in onshore and offshore areas. Work will concentrate on hydrate issues in the Gulf of Mexico and the Alaskan North Slope including safe drilling, seafloor stability, characterization and production. (\$9,838) (U. WY, CMRET, Clarkson, CGS, USGS, NRL, TBD) Provide technical and program management support. (\$100) \$9,938	Continue characterization of Arctic and offshore hydrate resources. Research in areas that are currently important to the Nation– safety and seafloor stability and hydrates role in global climate change. (\$4,702) (U. of Wyo., CMRET, Clarkson, CGS, USGS, NRL, TBD) Provide technical and program management support. (\$48) \$4,750
Infrastructure	Storage Technology: Continue support to industry for deliverability enhancement, gas measurement and advanced storage concepts. (\$967) (ARI, PNL,	Storage Technology: Continue support to industry for deliverability enhancement, reservoir management, gas metering and measurement, and	Storage Technology: Complete ongoing activities in deliverability enhancement and reservoir management. Continue support to industry for metering and

III. **Performance Summary:** NATURAL GAS TECHNOLOGIES (Cont'd)

Activity	FY 2000	FY 2001	FY 2002
Infrastructure (Cont'd)	LLNL, TBD)	advanced storage concepts engineering studies. Initiate proof-of-concept research on large storage capacity alternatives in non reservoir rock for regions of the U.S. without conventional storage options. Accelerate development of short-term, high deliverability storage systems to serve future distributed gas power systems. Develop high deliverability gas storage system model to serve the power generation marketplace. (\$3,134) (ARI, TBD)	measurement, and advanced storage concepts. These activities include development of a direct energy meter for storage applications, and support of large capacity, high deliverability storage in granitic rock. (\$1,500) (ARI, Schlumberger-Holditch, Furness-Newburge, NYSEG, TBD)
	No activity. (\$0)	Infrastructure Technology: Initiate research directed to ensure the reliability of the gas transmission and distribution network and increase the efficiency of the pipeline system, advance development of longer life, high-strength, non-corrosive pipeline materials, develop smart automated inside pipeline inspection sensor systems and repair technology,	Infrastructure Technology: Continue research directed to ensure the reliability and integrity of the gas transmission and distribution network, develop smart automated inside pipeline inspection sensor systems, conduct research on obstacle detection systems for horizontal boring applications for laying distribution pipelines, develop systems capable

III. **Performance Summary:** NATURAL GAS TECHNOLOGIES (Cont'd)

Activity	FY 2000	FY 2001	FY 2002
Infrastructure (Cont'd)	Provide technical and program management support. (\$10)	Provide technical and program management support. (\$81)	Provide technical and program management support. (\$50)
	\$977	\$8,110	\$5,050
Emerging Processing Technology	Gas-to-Liquids: Monitor and evaluate gas-to-liquids feasibility factors for remote gas in Alaska, Gulf of Mexico and other domestic locations as stand-alone operations and/or with other power or energy conversion technology. Continue basic exploratory research activities	Gas-to-Liquids: Continue process and economic evaluation of GTL conversion options and feasibility studies for remote gas in Alaska, Gulf of Mexico and other domestic locations. Continue exploratory research activities of novel conversion concepts, and support	No Activity. (\$0)

III. **Performance Summary**: NATURAL GAS TECHNOLOGIES (Cont'd)

Activity	FY 2000	FY 2001	FY 2002
Emerging Processing Technology (Cont'd)	<p>of novel conversion concepts. Continue cost-shared development of innovative hydrogen plasma pyrolysis and other chemical conversion, and continue scaleup and field testing of small-scale physical conversion technologies for the production of transportable liquids from natural gas. Complete material, seal and reactor development, and preliminary reactor design of novel ceramic membrane technology for enhancing Fischer-Tropsch gas conversion process to produce environmentally superior liquid fuels and hydrogen. Liquids include low emission, high performance motor vehicle fuel blends at competitive costs and suitable for existing as well as advanced engines under development with DOE/EE program support. (\$6,104) (U. of AK-Fairbanks, INEL, LANL-</p>	<p>cost-shared development and field testing of promising chemical and small-scale physical conversion technology innovations. Build and begin test operations of a laboratory-scale, novel ITM-Syngas ceramic membrane reactor to enhance Fischer-Tropsch (FT) gas conversion for environmentally superior liquid fuels and hydrogen. Initiate design and component manufacture for first stage scale-up of ITM syngas ceramic reactor incorporating initial laboratory test results. Continue development and validation of GTL catalysts, reactor and process designs. Accelerate process delineation and development for ultra clean, high performance, gas-derived liquid motor fuel products for the 21st Century suitable for deployment in Alaska, the Gulf of Mexico, and other remote sites. (\$6,239) (U.of AK-Fairbanks, LANL-Cryenco,</p>	

III. **Performance Summary**: NATURAL GAS TECHNOLOGIES (Cont'd)

<u>Activity</u>	<u>FY 2000</u>	<u>FY 2001</u>	<u>FY 2002</u>
	Cryenco, LBNL, Air Products, PNL, PSU, CAER, NETL, TBD)	LBL, Air products, PNNL, PSU, CAER, NETL, TBD)	

III. **Performance Summary**: NATURAL GAS TECHNOLOGIES (Cont'd)

Activity	FY 2000	FY 2001	FY 2002
Emerging Processing Technology (Cont'd)	Gas Tech Information: Continue support of an international center for information on natural gas technologies. (\$311) (GTI)	Gas Tech Information: Continue support of an international center for information on natural gas technologies. (\$317) (GTI)	Gas Tech Information: Continue support of an international center for information on natural gas technologies. (\$247) (GTI)
	Gas Upgrading: Continue research in low-quality gas upgrading, including development of improved sulfur and CO ₂ removal processes and development of advanced concepts of readying high nitrogen unmarketable gas for use. Continue development of advanced hybrid gas separation and dehydration technologies for onshore and offshore applications. Continue multi-strata upgrading and utilization. (\$1,577) (NETL, SNL, MTR, SRI, Texas A&M, Radian, Bend, TBD)	Gas Upgrading: Continue research in low-quality gas upgrading, including development of improved sulfur, CO ₂ , water, and nitrogen removal technologies. Continue development of advanced hybrid gas separation and dehydration technologies for onshore and offshore applications. Continue multi-strata upgrading and utilization. (\$1,612) (SNL, NETL, Texas A&M, TBD)	Gas Upgrading: Terminate low-quality gas upgrading activities. (\$0)
	Initiate Phase III of coal mine methane project. (\$1,825) (TBD)	Continue Phase III of coal mine methane projects. (\$1,876) (TBD)	No activity. (\$0)
	Provide technical and program management support. (\$102)	Provide technical and program management support. (\$102)	Provide technical and program management support. (\$3)

III. **Performance Summary:** NATURAL GAS TECHNOLOGIES (Cont'd)

Activity	FY 2000	FY 2001	FY 2002
	\$9,919	\$10,146	\$250
Effective Environmental Protection	<p>Program Planning Data Analysis: Continue data collection and the development of analytical tools for program planning, for outreach and technology transfer, including the capability to quantify environmental costs and assess constraints to gas resource recovery, collection and distribution. Continue to perform legislative and regulatory impact analysis related to both upstream and downstream gas environmental issues. (\$425) (ANL, EPA)</p>	<p>Program Planning Data Analysis: Continue data collection and the development of analytical tools for program planning, for outreach and technology transfer, including the capability to quantify environmental costs and assess constraints to gas resource recovery, collection and distribution. Continue to perform legislative and regulatory impact analysis related to both upstream and downstream gas environmental issues. (\$424) (TBD)</p>	<p>Program Planning Data Analysis: Continue data collection and the development of analytical tools for program planning, for outreach and technology transfer, including the capability to quantify environmental costs and assess constraints to gas resource recovery, collection and distribution. Continue to perform legislative and regulatory impact analysis related to both upstream and downstream gas environmental issues. (\$300) (TBD)</p>
	<p>Technology Development: Continue efforts to develop and demonstrate technologies and methods for improving the economics and environmental performance of all facets of gas supply including methods that enable operators to define options</p>	<p>Technology Development: Continue to develop and demonstrate technologies and methods for improving the economics and environmental performance of all facets of gas supply including defining options and costs of alternative</p>	<p>Technology Development: Continue efforts to develop and demonstrate technologies and methods for improving the economics and environmental performance of all facets of gas supply. This includes defining options and costs of alternative</p>

III. **Performance Summary**: NATURAL GAS TECHNOLOGIES (Cont'd)

Activity	FY 2000	FY 2001	FY 2002
Effective Environmental Protection (Cont'd)	<p>and costs of alterative environmental compliance strategies, application of advanced research and new methods of detecting and controlling air emissions (including particulate matter from gas equipment and facilities). Continue development of treatment and disposal technologies for NORM and other wastes. Continue cooperative efforts to establish scientifically based regulations. (\$1,729) (Greenhill, Natl. Labs, State of Miss., TBD)</p> <p>Outreach and Technology Transfer: Continue outreach and technology transfer efforts on environmental issues affecting natural gas supply, including compliance efforts with industry, states, and others to identify and</p>	<p>environmental compliance strategies, application of advanced research and new methods of detecting and controlling air emissions from gas equipment and facilities. Continue development of treatment and disposal technologies for gas exploration and wastes. Continue cooperative efforts to establish scientifically based regulations. (\$1,725) (Natl. Labs, Waterloo, TBD)</p> <p>Outreach and Technology Transfer: Continue outreach and technology transfer efforts on environmental issues affecting natural gas supply, including compliance efforts with industry, states, and others to identify and</p>	<p>environmental compliance strategies, application of advanced research and new methods of detecting and controlling air emissions from gas equipment and facilities. Emphasize technologies that will improve responsible development of gas resources on public lands, consistent with current multiple-use policies of Federal Land management agencies. Continue development of treatment and disposal technologies for gas exploration and wastes. Continue cooperative efforts to establish scientifically based regulations. (\$984) (Natl. Labs, SNL, WU, TBD)</p> <p>Outreach and Technology Transfer: Continue outreach and technology transfer efforts on environmental issues affecting natural gas supply, including compliance efforts with industry, states, and others to identify and</p>

III. **Performance Summary**: NATURAL GAS TECHNOLOGIES (Cont'd)

<u>Activity</u>	<u>FY 2000</u>	<u>FY 2001</u>	<u>FY 2002</u>
	address environmental challenges to expanded natural gas production. (\$947) (IOGCC, TBD)	address environmental challenges to expanded natural gas production. (\$439) (TBD)	address environmental challenges to expanded natural gas production. (\$300) (TBD)

III. **Performance Summary**: NATURAL GAS TECHNOLOGIES (Cont'd)

<u>Activity</u>	<u>FY 2000</u>	<u>FY 2001</u>	<u>FY 2002</u>
Effective Environmental Protection (Cont'd)	Provide technical and program management support. (\$32)	Provide technical and program management support. (\$26)	Provide technical and program management support. (\$16)
	\$3,133	\$2,614	\$1,600
Natural Gas Technologies, Total	\$30,809	\$45,029	\$21,000

DEPARTMENT OF ENERGY
FY 2002 CONGRESSIONAL BUDGET REQUEST

FOSSIL ENERGY RESEARCH AND DEVELOPMENT

OIL TECHNOLOGY

I. **Mission Supporting Goals and Objectives:**

The oil research program, in partnership with industry and its stakeholders, will develop cutting edge technologies to better find and produce petroleum and convert it into transportation products while minimizing waste production and environmental damage. This program will demonstrate the effectiveness of these technologies to support the Nation's energy security and science and technology leadership goals through studies in the areas of extraction technologies, fundamental chemistry, processing, and reservoir characterization. This leadership is also supplemented by teacher training programs, student and faculty internships, as well as a broad program of university research. Minority participation in science is addressed through the Minority Education Initiative.

Federal Roles and Responsibilities in Oil Technology Research are to: (1) provide strategic guidance for national energy policy; (2) support efficient use of domestic energy resources; (3) protect the environment and public safety; (4) enhance the value of Federal lands and future supply and more complex environmentally sensitive areas (27% of oil production is on Federal lands); (4) enhance global market opportunities for U.S. energy technologies; (5) contribute to U.S. science and technology leadership; (6) apply a unique national perspective to technology development that is independent of company-specific or State-specific interests; and (7) foster the use of new technology through a nationwide technology transfer network.

The key sections of this program are: (1) Exploration and Production; (2) Reservoir Life Extension and Management; and (3) Effective Environmental Protection. Program planning and support and technology transfer are integral components of each of the key areas. The DOE National Petroleum Technology Office (NPTO), an arm of the National Energy Technology Laboratory (NETL), located in Tulsa, Oklahoma, manages all oil technology program implementation activities.

Because reliable domestic energy supplies are vital to the Nation's economy, this program conducts projects designed to enhance the efficiency and environmental quality of domestic oil operations. These R&D programs are conducted in partnership with industry,

I. **Mission Supporting Goals and Objectives:** OIL TECHNOLOGY (Cont'd)

universities, National Laboratories, State and local governments, and other organizations. Private sector participation is emphasized through industry cost-sharing with individual companies and consortia to ensure market relevance and to facilitate the transfer of technology to the private sector while leveraging Federal R&D investment. Near-term efforts are focused on transferring state of the art technologies to independents and long-term research and development of novel or revolutionary technology advances.

Exploration and Production research consists of Advanced Drilling, Completion, and Stimulation systems (ADCS), Advanced Diagnostics and Imaging Systems (ADIS), Reservoir Efficiency Processes, and Planning and Analysis efforts. The ADCS work focuses on developing enabling technologies to drill, complete and stimulate oil wells, as well as improving the efficiency of surface operations. This provides a balanced portfolio of technologies to match the diverse geologic formations, approach technologically challenging environments, increase exploration success, improve producibility of wells, minimize formation damage, reduce operating costs, improve flowability and minimize potential environmental damage.

The ADIS work focuses on the development of technologies and methodologies that more clearly define petroleum reservoirs and associated reservoir rock, fluid distributions and rock-fluid interactions that impact producibility. The development and application of advanced diagnostic and imaging systems improves the success rates and cost efficiencies for new field discoveries and the development of existing fields. The program conducts research to develop technologies to better define oil reservoirs in increasingly geologically complex environments which often occur in deeper and higher temperature and pressure regions such as the sub-salt and ultra deep regions of the Gulf of Mexico.

The Multi-National Lab/Industry partnership line item has been eliminated due to funding constraints. National Lab research and development will be pursued within technology line items. Future mechanisms for work with National Labs will be determined based on funding levels and type of research needed.

Reservoir Efficiency Processes includes research to develop and demonstrate tools and methodologies that permit oil operators to recover hydrocarbons from known reservoirs not producible by current technology. It also supports university research in extraction technologies and recovery-process modeling to ensure a supply of well-trained workers. The program is directed toward oil, unrecoverable with current technology, through advanced methods while at the same time helping the smaller producer with day-to-day

I. **Mission Supporting Goals and Objectives:** OIL TECHNOLOGY (Cont'd)

problems. The main areas of research are chemical methods, gas flooding methods, microbial methods, heavy oil methods, novel methods and reservoir simulation.

The Planning and Analysis area supports the program by providing accurate data on the oil resource, supply and utilization trends, industry activities and R&D needs, assuring that legislative, regulatory and policy initiatives in oil supply, environmental and processing are based on the best available information to support program goals. This area also supplies analytical systems used to prioritize RD&D efforts and evaluate oil recovery and utilization over a wide range of technological and economical conditions.

Reservoir Life Extension/Management work focuses on advanced technologies for extraction of hydrocarbons from known, or discovered, oil reservoirs. These activities provide improved technology and/or more efficient methods to recover more of the discovered but unproduced domestic oil resource, and increase recovery of oil from Federal lands. Laboratory research and evaluation of past advanced field trials in large, promising Class 1, 2, and 3 reservoirs will be completed. Demonstration and testing of technologies specifically targeted for independent operators will be continued.

The technologies are conveyed to industry users through an aggressive technology transfer program implemented at the National Petroleum Technology Office (NPTO) through widespread distribution of project results to industry, universities, other government agencies, and the general public; support for tutorial workshops on the application of oil technologies; and development of software for improved reservoir management, exploration and development activities. NPTO also strongly supports the extensive and highly successful technology transfer work being accomplished through the Petroleum Technology Transfer Council with its 10 regional centers.

The preferred Petroleum Upstream Management Practices (PUMP) program is designed to provide a short-term supplement to long-term R&D. PUMP will delineate preferred management practices in three technology areas: advanced oil recovery; data management; and effective environmental compliance. The program will focus on projects that promote an expedited application of technologies or approaches that will develop best practices databases, and use existing technology transfer mechanisms to address a regional need or issue. These projects are designed to provide integrated solutions to technological, regulatory, environmental and data constraints and must have quick implementation and rapid results in order to increase the near-term oil supply.

I. **Mission Supporting Goals and Objectives:** OIL TECHNOLOGY (Cont'd)

Effective Environmental Protection research activities focus on technologies and practices that reduce the threat to the environment and decrease the cost of effective environmental protection and compliance involved in oil exploration, production, and processing. The activities are distributed into four program elements: risk assessment, regulatory streamlining, technology development, and program planning and analysis. Program goals are to maximize industry recovery, processing, and utilization of U.S. oil resources by reducing the cost of effective environmental protection. The program works to reduce the cost of environmental compliance through a combination of risk assessment, technology development, regulatory streamlining, impact analysis, and facilitating dialogue that attempts to achieve consensus among the affected parties on ways to balance the need to develop the Nation's energy resources while maintaining our environmental values. This program fills critical data gaps allowing the introduction of new refining processes needed to meet future transportation fuels through reduction of environmental risks and cleanup as well as improved permitting systems.

Performance Measures:

- Continue to develop methods to reduce the amount of produced water by improving conformance control methods
- Continue improvements in geophysical data acquisition, processing and interpretation technologies to increase resolution and accuracy of complex (including naturally fractured reservoirs) .
- Complete air tracer sampling using a small, remotely controlled blimp to determine the actual impact of oil and gas activities on regional pollution problems in the San Joaquin Valley.
- Continue analysis and risk-based protocols for fine particulates for effective promulgation of proposed regulations.
- Complete bench-scale development of a down-hole oil-water separator that meets industry needs for volume, water-cut, and solids production.
- Demonstrate safe economic slimhole drilling technology in actual use under Arctic conditions.

II. A. **Funding Schedule:**

<u>Activity</u>	<u>FY 2000</u>	<u>FY 2001</u>	<u>FY 2002</u>	<u>\$Change</u>	<u>%Change</u>
Exploration and Production	\$27,666	\$28,844	\$20,350	\$-8,494	-29%
Reservoir Life Extension/Management	14,305	14,662	4,849	-9,813	-67%

<u>Activity</u>	<u>FY 2000</u>	<u>FY 2001</u>	<u>FY 2002</u>	<u>\$Change</u>	<u>%Change</u>
Effective Environmental Protection	10,534	10,796	5,300	-5,496	-51%
Emerging Processing Technology Applications	3,243	2,594	0	-2,594	-100%
Ultra Clean Fuels	<u>0</u>	<u>9,978</u>	<u>0</u>	<u>-9,978</u>	<u>0%</u>
Total Oil Technology	<u>\$55,748</u>	<u>\$66,874</u>	<u>\$30,499</u>	<u>\$-36,375</u>	<u>-54%</u>

II. B. **Laboratory and Facility Funding Schedule:** OIL TECHNOLOGY (Cont'd)

	<u>FY 2000</u>	<u>FY 2001</u>	<u>FY 2002</u>	<u>\$Change</u>	<u>%Change</u>
Argonne National Lab (East)	\$450	\$250	\$0	\$-250	-100%
Brookhaven National Lab	0	200	0	-200	-100%
Idaho Natl. Engineering & Environmental Lab	925	807	0	-807	-100%
Lawrence Berkeley Lab	1,405	1,115	0	-1,115	-100%
Lawrence Livermore National Lab	600	600	0	-600	-100%
Los Alamos National Laboratory	550	176	0	-176	-100%
National Energy Technology Lab	0	500	200	-300	-60%
Oak Ridge National Laboratory	1,385	1,777	100	-1,677	-94%
Pacific Northwest National Lab	0	200	0	-200	-100%
Sandia National Laboratories	450	300	0	-300	-100%
All Other	<u>49,983</u>	<u>60,949</u>	<u>30,199</u>	<u>-30,750</u>	<u>-50%</u>
Total, Oil Technology	<u>\$55,748</u>	<u>\$66,874</u>	<u>\$30,499</u>	<u>\$-36,375</u>	<u>-54%</u>

III. **Performance Summary:**

<u>Activity</u>	<u>FY 2000</u>	<u>FY 2001</u>	<u>FY 2002</u>
Exploration and Production	Advanced Drilling, Completion, Stimulation: Continue capability upgrades that allow the advanced research and high temperature/	Advanced Drilling, Completion, Stimulation: Continue capability upgrades in Phase 4 of the unique Advanced Cuttings Transport	Advanced Drilling, Completion, Stimulation and Operations: Continue capability upgrades in Phase 5 of the unique Advanced

Exploration and
Production (Cont'd)

high pressure experimentation for prediction of the rheology of and cuttings transport in energized fluids (air, mist, gas assisted, foam, etc.) in horizontal and inclined wellbores using the DOE HP/HT Flow Loop. Continue research on the development of three-phase separation technology that provides for lower costs, improved efficiency, and a reduced footprint on a onshore production pad or offshore platform. Continue to upgrade and expand the current DOE suite of risk based decision-making tools used most by industry. Continue development of advanced downhole sensor technology using fiber optics. Continue research in efficiency of well stimulation. Complete project to optimize horizontal well completions. Continue development research on a downhole positive displacement motor for coiled tubing drilling. (\$2,508) (Univ. of Tulsa, WU, LANL, INEEL, Va. Polytech, Univ. Houston, PRRC, AWU, TBD)

Facility that allow research on high temperature/high pressure experimentation for prediction of the rheology of and cuttings transport in energized fluids (air, mist, gas assisted, foam, etc.) in horizontal and inclined wellbores using the DOE HP/HT Flow Loop. Complete development and field testing of advanced downhole sensor technology using fiber optics. Initiate new projects in Stimulation. Add to the current suite of risk-based decision-making tools. (\$2,502) (PRRC, Univ of Tulsa, Va Polytech, WU, LANL, Univ of Houston, TBD)

Cuttings Transport Facility that allow research on HT/HP experimentation on energized fluids (air, mist, gas assisted, foam, etc.) and synthetic drill fluids in horizontal and inclined wellbores onshore and offshore. Complete the risk based decision-making software. Continue research efforts in Completion and Stimulation with the national labs. Support specific consortia and joint industry collaborations that enhance the Program goals. (\$2,500) (PRRC, Univ of Tulsa, Natl. Labs, TBD)

III. **Performance Summary:** OIL TECHNOLOGY (Cont'd)

Activity	FY 2000	FY 2001	FY 2002
Exploration and Production (Cont'd)	<p>Advanced Diagnostics and Imaging Systems: Continue advanced reservoir diagnostic and imaging systems work including, advanced microseismic mapping, geomechanical influences on reservoir during depletion/repressurization, and EM process sensing with industry for large producing reservoirs to optimize oil recovery while minimizing environmental risks. Study relationships between seismic and acoustic measurements and reservoir properties; apply results to improved management of oil recovery. Continue development of advanced imaging technologies and algorithms, NMRI and Cat-Scan for quantitative analysis of reservoir rock architecture and fluid distribution. Develop technologies for accurate measurement of multiphase relative permeabilities in steady and unsteady-state conditions under broad temperature and pressure conditions, and investigate</p>	<p>Advanced Diagnostics and Imaging Systems: Continue advanced reservoir diagnostics and imaging systems work including; relationships between seismic measurements and reservoir properties; and EM process sensing to optimize oil recovery. Technology development including NMRI and Cat-Scan for quantitative analysis of reservoir rock architecture and fluids distribution to quantify understanding of how wettability, imbibition, in-situ relative permeability, as well as other engineering parameters are controlled by rock-fluid interactions and impact oil production. Continue developing integrated geological, geophysical and engineering data and methods for upscaling these varied databases, to predict areal and vertical distributions of the reservoir architecture and fluid flow patterns for more accurate geologic and engineering modeling</p>	<p>Advanced Diagnostics and Imaging Systems: Continue development of advanced reservoir diagnostics and imaging systems work to optimize oil discovery and recovery. Develop quantitative engineering parameters that control rock-fluid interactions which impact oil production. Develop larger scale remote sensing techniques and the integration of multiple geological, geophysical and engineering data, at the field-to basin-scales for the development of more accurate geologic and engineering models needed in exploration and in simulation of production/EOR/ IOR activities. Continue fundamental geoscience efforts focusing on geoscience/engineering reservoir characterization on naturally fractured reservoirs. Continue development of hydrocarbon predictive tools for exploration, sedimentary modeling, development of lithostratigraphic models and fluid transport models in selected U.S. basins. (\$6,904)</p>

III. **Performance Summary:** OIL TECHNOLOGY (Cont'd)

Activity	FY 2000	FY 2001	FY 2002
Exploration and Production (Cont'd)	<p>influences of rock-fluid interactions on these critical parameters. Develop integrated geological, geophysical and investigate influences of rock-fluid interactions on these critical parameters. Develop integrated geological, geophysical and engineering data and methods for predicting areal and vertical distribution of reservoir architecture and mobile oil flow patterns, using methodologies for upscaling to the interwell scale for infill drilling and EOR/IOR, thus minimizing numbers of infill wells, surface footprints and associated environmental effects. Continue fundamental geoscience involving geoscience/engineering reservoir characterization for a variety of reservoir types and depositional environments to optimize field development and management while minimizing environmental exposure. Study the framework and controls of hydrocarbon generation in the South-Central</p>	<p>and simulation to optimize development, production, and EOR/IOR activities. Continue Fundamental Geoscience procurement involving the geoscience/ engineering reservoir characterization of fractured reservoirs to optimize oil recovery. Continue development and testing of a hydrocarbon prediction tool for exploration; sedimentary modeling programs using advanced algorithms, expert theory, and importing climatic models to complete detailed lithostratigraphic models; and a model for hydrodynamic fluids transport in the Uinta and Paradox Basins. (\$7,029) (LLNL, LBNL, ORNL, ANL, INEEL, RERI, Stanford, Cal Tech, 8 MegaPRDA contracts, PRDA-TBD)</p>	<p>(FE-PS contracts, CalTech, PRIME, National Laboratories, TBD)</p>

III. **Performance Summary:** OIL TECHNOLOGY (Cont'd)

Activity	FY 2000	FY 2001	FY 2002
Exploration and Production (Cont'd)	<p>Appalachians. Investigate reservoir pressure/gas saturations, wettability and matrix block size on spontaneous imbibition in fractured reservoirs for improved oil recovery. Continue development of sedimentary modeling programs using advanced algorithms, including the continued development of comprehensive detailed lithostratigraphic/climatic models including the continued development of comprehensive detailed lithostratigraphic/climatic models integrated sedimentary basin modeling. Continue Basin Analysis and research on the Onshore Gulf of Mexico in Alabama and Mississippi. (\$6,984) (LLNL, SNL, ORNL, LBNL, Stanford, RERI, ANL, , Univ. of Alabama, NRC, Cal Tech, 9 Program Solicitation awards, 7 PRDA mortgages)</p> <p>Multi National Lab/Industry Partnership: Continue to adapt and transfer technologies that advance understanding of the characteristics</p>	<p>Multi National Lab/Industry Partnership: Continue to adapt and transfer technologies that advance understanding of the characteristics</p>	<p>No activity. (\$0)</p>

III. **Performance Summary:** OIL TECHNOLOGY (Cont'd)

Activity	FY 2000	FY 2001	FY 2002
Exploration and Production (Cont'd)	<p>and producibility from oil reservoirs, optimize the performance of production tools and processes, reduce environmental footprint and waste emissions and improve reservoir management resulting in higher oil recovery through leveraging of industrial, oil program and other public funds. Continue to integrate high performance National Lab computational capabilities to address difficult problems such as subsalt imaging, testing of advanced exploration concepts and multiphase flow in subsea pipelines. (\$7,416) (9 National Labs)</p> <p>Reservoir Efficiency Processes: Continue the development of state-of-the-art reservoir simulation models and the development scaled down reservoir simulation models for desktop computers. Continue to advance thermal methods for heavy oil extraction and screen potential heavy oil recovery processes. Continue work to</p>	<p>and producibility from oil reservoirs, optimize the performance of production tools and processes, reduce environmental footprint and waste emissions and improve reservoir management resulting in higher oil recovery through leveraging of industrial, oil program and other public funds. Continue to integrate high performance National Lab computational capabilities to address difficult problems such as subsalt imaging, testing of advanced exploration concepts and multiphase flow in subsea pipelines. (\$7,400) (NL-TBD)</p> <p>Reservoir Efficiency Processes: Issue a solicitation to develop recovery processes for mature reservoirs. Continue development of improved sweep techniques, and state-of-the-art reservoir simulation models. Continue to develop microbial methods. Continue mechanistic studies to reduce surfactant adsorption and advance</p>	<p>Reservoir Efficiency Processes: Continue to develop recovery processes for mature reservoirs. Continue to support a Novel Surfactant Industry/University consortium for development of novel surfactants. Continue development of improved sweep techniques, and state-of-the-art reservoir simulation models.</p>

III. **Performance Summary:** OIL TECHNOLOGY (Cont'd)

Activity	FY 2000	FY 2001	FY 2002
Exploration and Production (Cont'd)	<p>improve reservoir sweep for gas flooding, especially for carbon dioxide flooding, by using foams and direct thickeners. Continue the development of microbial flooding techniques by developing genetically modified microbes. Continue to develop microbial methods to develop surfactant and other oil recovery agents from waste products which helps lower environmental damage from the disposal of these wastes. Continue mechanistic studies to reduce surfactant adsorption. Continue to advance the state-of-the-art in development of new polymers for oil recovery. Continue low cost oil recovery methods using wettability alternations and alkaline-surfactant-polymer(ASP). Continue work with Native American Tribes through targeted research work and training to increase oil recovery efficiency from Tribal lands in an environmentally and culturally sound manner. Continue work with the Tribes in the Black Mesa</p>	<p>the state-of-the-art in development of new polymers and gels. Continue to advance thermal methods for heavy oil extraction and novel processes which will aid oil recovery from naturally fractured reservoirs. (\$6,840) (Univ of Kansas, Columbia Univ, Univ of Pittsburgh, Univ of Texas, Univ of Utah, Geo-Microbial, Univ of Southern California, Univ of Oklahoma, Stanford Univ, LBNL, INEEL, Univ of Kansas, Columbia Univ, Univ of Pittsburgh, Univ of Texas, Univ of Utah, Geo-Microbial, Univ of Southern California, Univ of Oklahoma, Stanford Univ, TBD)</p>	<p>Continue to develop microbial methods. Continue to advance the state-of-the-art in reservoir simulation. Continue mechanistic studies to reduce surfactant adsorption and advance the state-of-the-art in development of new polymers and gels. Continue to advance thermal methods for heavy oil extraction and screen potential heavy oil recovery processes. Continue to advance thermal methods for heavy oil extraction and novel processes which will aid oil recovery from naturally fractured reservoirs. (\$6,800) (National Labs, FE-PS contracts, TBD)</p>

III. **Performance Summary:** OIL TECHNOLOGY (Cont'd)

<u>Activity</u>	<u>FY 2000</u>	<u>FY 2001</u>	<u>FY 2002</u>
	Basin (\$6,794) (, INEEL, LBNL, NMIMT, TRW, Univ of Kansas, Columbia Univ, Univ of Pittsburgh, Univ of Texas, Univ of Utah, Geo-Microbial, Univ of Southern California, Univ of Oklahoma, Stanford Univ, 9 Program Solicitation awards)		

III. **Performance Summary:** OIL TECHNOLOGY (Cont'd)

Activity	FY 2000	FY 2001	FY 2002
Exploration and Production (Cont'd)	<p>Analysis and Planning: Continue technical planning and analysis support for implementing and evaluating effective and efficient oil research programs. Conduct producibility assessment of major reservoirs, maintain and update the oil resource information base, enhance and maintain metrics capabilities for the Oil Program, enhance and maintain statistical data, models, and supporting systems for effective planning and continue technical and analytical support tasks. Continue project impact/oversight/analysis efforts. Support the contractor review workshop for program evaluation. (\$3,680) (RMC, TRW, Univ. of Tulsa, EIA, TBD)</p> <p>No activity. (\$0)</p>	<p>Analysis and Planning: Continue technical planning and analysis support for implementing and evaluating effective and efficient oil research programs. Conduct producibility assessment of major reservoirs, maintain and update the oil resource information base, enhance and maintain metrics capabilities for the Oil Program, enhance and maintain statistical data, models, and supporting systems for effective planning and continue technical and analytical support tasks. Continue project impact/oversight/analysis efforts. Support the contractor review workshop for program evaluation. (\$3,792) (RMC, TRW, Univ. of Tulsa, TBD)</p> <p>Sonication: Conduct research benefitting the recovery of petroleum through the use of sonication or ultrasonic technology from other industries. (\$993) (TBD)</p>	<p>Analysis and Planning: Continue technical planning and analysis support for implementing and evaluating effective and efficient oil technology research programs. Enhance and maintain statistical data, models and supporting systems to evaluate petroleum policy options and to enhance metrics capabilities. Conduct efforts to validate the effectiveness of the oil technologies to meet programmatic and agency goals. (\$3,200) (RMS, TRW, IOGCC, TBD)</p> <p>No activity. (\$0)</p>

III. **Performance Summary:** OIL TECHNOLOGY (Cont'd)

Activity	FY 2000	FY 2001	FY 2002
Exploration and Production (Cont'd)	<p>No activity. (\$0)</p> <p>Fund technical and program management support. (\$284)</p> <p>\$27,666</p>	<p>Arctic Research: Establish an Arctic Research program for peer reviewed research; coordinate research conducted through Fossil Energy and Energy Efficiency; conduct outreach and serve as a liaison between the State and DOE. (\$750 provided from Energy Efficiency appropriation.) (TBD)</p> <p>Fund technical and program management support. (\$288)</p> <p>\$28,844</p>	<p>Arctic Research: Continue Arctic Research program for peer reviewed research; coordinate research conducted through Fossil Energy and Energy Efficiency; conduct outreach and serve as a liaison between the State and DOE. (\$742) (TBD)</p> <p>Fund technical and program management support. (\$204)</p> <p>\$20,350</p>
Reservoir Life Extension/ Management	<p>Recovery Field Demonstrations:</p> <p>Class 1-3 Revisit: Extend reservoir life to maximize oil recovery and improve environmental performance from our initial investment by revisiting major reservoir groups to address key production problems identified in previous work. (\$6,472) (Ensign, Binger, Michigan Tech, Luff, U. of KS, TU, Plains-IL, Venoco,</p>	<p>Recovery Field Demonstrations:</p> <p>Class 1-3 Revisit: Extend reservoir life to maximize oil recovery and improve environmental performance from our initial investment by revisiting major reservoir groups to address key production problems identified in previous work. (\$4,344) Identify the successes from previous Independents projects. Identify the</p>	<p>Recovery Field Demonstrations:</p> <p>Advanced Technologies: Evaluate and identify the most promising technologies in the Class, Class Revisit, and Research with Independents programs. Report the results to the public. (\$580) (TBD)</p>

III. **Performance Summary:** OIL TECHNOLOGY (Cont'd)

Activity	FY 2000	FY 2001	FY 2002
Reservoir Life Extension/ Management (Cont'd)	<p>UGS, U. of Alabama)</p> <p>Increase Production from Marginal Wells: Review the promising technologies identified in the Class Program and Class Revisit projects to identify one technology and commence advanced research work on that technology. Focus on the technology transfer of the results. Continue to focus on production problems identified by small operators by conducting cost-shared research with independents improved recovery or for reservoir management techniques on marginal wells at risk of abandonment. Improvement can</p>	<p>most promising technologies identified in the Class Revisit or research with Independents projects and commence advanced research on two or three technologies. (\$2,363) (Total \$6,707) (Binger, Michigan Tech, Luff, U. of KS, TU, Plains-IL, UGS, U. of Alabama, Conoco, TBD)</p> <p>Increase Production from Marginal Wells, Native Americans Lands, and Independent Producers: Expand research and development with independents program to accelerate field testing and use of effective technologies by domestic oil industry. Identify best practices and lessons learned for aggressive technology transfer in the PUMP program. (\$538) Native American Initiatives - Complete the targeted research projects initiated with the tribes in 1999 to benefit Native Americans, and prepare for the second round of projects. Continue</p>	<p>Increase Production from Marginal Wells and Independent Producer Properties: Expand the successful technology research and development with independents program to accelerate field testing and expand the use of effective technologies in areas dominated by the independent producers. Evaluate the success and failure of these projects for dissemination of "lessons learned". (\$1,038) (TBD)</p>

III. **Performance Summary:** OIL TECHNOLOGY (Cont'd)

Activity	FY 2000	FY 2001	FY 2002
Reservoir Life Extension/ Management (Cont'd)	<p>come through decreased operating or environmental costs or improved equipment design. (\$1,040) (Golder, Oil & Gas Consultants, Ft. Peck, 10 Independents awards)</p> <p>Technology Transfer: Continue technology outreach by supporting regional workshops providing complete packages of applicable results from Class Demonstration and other projects to assist oil producers in extending reservoir life in an environmentally acceptable manner; improve efficiency and coverage in electronic and hardcopy dissemination of publications and software; increase participation of Native American and HBCU students in expanded summer intern program of career-enhancing petroleum science research projects, continue teacher training program for elementary/secondary petroleum energy education;</p>	<p>successful training initiative for Native American decision makers. (\$500) (Total \$1,038) (Golder, Oil & Gas Consultants, Ft. Peck, TBD)</p> <p>Technology Transfer: Continue technology outreach by supporting regional workshops providing complete packages of applicable results from Class Demonstration and other projects to assist oil producers in extending reservoir life in an environmentally acceptable manner; improve efficiency and coverage in electronic and hardcopy dissemination of publications and software; continue training initiative for Native Americans; continue teacher training program for elementary/secondary petroleum energy education; expand schedule of exhibits at professional meetings and upgrade display materials and equipment.</p>	<p>Technology Transfer: Support PTTC regional workshops with publications, software and technical expertise; increase dissemination of information on independent operator participation in oil field demonstration program; support Minority Education Initiative through internships; and provide science teacher training in oil technology. These efforts will improve the ability to meet the technological and environmental information needs of domestic producers, support service industry elements, academic researchers, technical associations, and the public sector. (\$2,783) (PTTC, RMC, TBD)</p>

III. **Performance Summary:** OIL TECHNOLOGY (Cont'd)

Activity	FY 2000	FY 2001	FY 2002
Reservoir Life Extension/ Management (Cont'd)	<p>expand schedule of exhibits at professional meetings and upgrade display materials and equipment. These efforts will improve the ability to meet the technological and environmental needs of major and independent producers, support service industry elements, academic researchers, technical associations, and the public sector. (\$3,083) (PTTC, RMC, SPE, TBD)</p>	<p>These efforts will improve the ability to meet the technological and environmental needs of major and independent producers, support service industry elements, academic researchers, technical associations, and the public sector.) (\$3,178) (PTTC, RMC, TBD)</p>	<p>Preferred Petroleum Upstream Management Practices (PUMP): Compile results from the first round PUMP projects in specific producing regions of the Nation for the interactive, Internet-based DOE database of "preferred practices". (\$400) (TBD)</p>
	<p>Preferred Petroleum Upstream Management Practices (PUMP): Supplement the Oil Technology program that will use the best currently available technology and employ a variety of proactive technology transfer mechanisms to get operators to implement them in the field; includes environmental problem solving to address key regional constraints, and data management efforts aimed at reducing costs for industry and government. (\$3,563) (TX RR,</p>	<p>Preferred Petroleum Upstream Management Practices (PUMP): Expand the FY 2000 work to include the creation of a database of "best practices" used successfully in areas such as 3-D and 4-D seismic, well logging, well design, enhanced oil recovery, risk assessment, and other oil recovery areas. Aggressively transfer these practices to industry through a proactive program of direct contact with producers. The environmental problem solving and</p>	

III. **Performance Summary:** OIL TECHNOLOGY (Cont'd)

Activity	FY 2000	FY 2001	FY 2002
Reservoir Life Extension/ Management (Cont'd)	GWPC, TBD) Fund technical and program management support. (\$147) \$14,305	regulatory streamlining activities will be targeted to address key regional constraints in two regions using PUMP advanced oil recovery technology. (\$3,592) (TBD) Fund technical and program management support. (\$147) \$14,662	Fund technical and program management support. (\$48) \$4,849
Effective Environmental Protection	Program Planning and Analysis: Continue analysis of industry environmental trends and available technologies. Maintain performance measure data for program planning and technology transfer. Continue coordination with states, EPA and other Federal agencies to provide energy and economic analyses for longer term regulatory initiatives. Continue to perform legislative and regulatory impact analysis related to oil environmental issues. (\$825)	Program Planning and Analysis: Continue analysis of industry environmental trends and available technologies. Maintain performance measure data for program planning and technology transfer. Continue coordination with states, EPA and other Federal agencies to perform and provide energy and economic analyses for legislative and regulatory initiatives related to oil environmental issues. (\$823) (ANL, ICF, PERF, KWT/Aspen, TBD)	Program Planning and Analysis: Continue analysis of industry environmental trends and available technologies. Maintain performance measure data for program planning and technology transfer. Provide energy and economic analyses for legislative and regulatory initiatives related to oil environmental issues. (\$500) (PERF, Natl. Labs, TBD)

III. **Performance Summary:** OIL TECHNOLOGY (Cont'd)

Activity	FY 2000	FY 2001	FY 2002
Effective Environmental Protection (Cont'd)	<p>(ANL, , DynCorp, EPA, TBD)</p> <p>Streamline State/Tribal/Federal Regulations: Consistent with stakeholder needs, continue and enhance cooperative efforts with the states, tribes, and Federal agencies to streamline environmental regulations and regulatory processes to simplify regulations without compromising environmental protection. Enhance on-line expert environmental reporting and permitting systems to reduce costs to producers and regulators (\$800). Generate independent quality scientific data to help implement national policy in streamlining and improving existing regulations and laws (\$776). (Total \$1,576) (IOGCC, ORNL, LANL, Nat'l Labs, Va Polytech, TBD)</p> <p>Risk Assessment: Continue to provide credible scientific data for regulatory decision making. Continue research to assess and</p>	<p>Streamline State/Tribal/Federal Regulations: Continue and enhance cooperative efforts with the states, tribes, and Federal agencies to streamline environmental regulations and regulatory processes with emphasis on public lands. Enhance on-line expert environmental reporting and permitting systems to reduce costs to producers and regulators (\$883). Generate independent quality scientific data to help implement national policy in streamlining and improving existing regulations and laws (\$632). (Total \$1,515) (ORNL, U. of KY, Nat'l Labs, TBD)</p> <p>Risk Assessment: Provide credible scientific data for regulatory decision making. Continue research to assess and mitigate</p>	<p>Streamline State/Tribal/Federal Regulations: Continue cooperative efforts with the states, tribes, and Federal agencies to streamline environmental regulations and regulatory processes (\$610). Generate scientific data to facilitate policy makers' ability to develop and implement regulations (\$390) (Total \$1,000) (Nat'l. Labs, Univ. of Tulsa)</p> <p>Risk Assessment: Provide credible scientific data for regulatory decision making in exploration and production, including risks posed</p>

III. **Performance Summary:** OIL TECHNOLOGY (Cont'd)

Activity	FY 2000	FY 2001	FY 2002
Effective Environmental Protection (Cont'd)	<p>mitigate environmental risks posed by exploration and production, including risks posed by injection for disposal and enhanced oil recovery, hydrocarbon or produced water spills, air emissions and management of oil field wastes. Continue assistance to States with research, analysis, and improved data management to support risk-based regulatory decisions consistent with stakeholder's objectives of streamlining and improving environmental regulations. Work with industry, states, and EPA to conduct research to help EPA make decisions based on sound science in the area of particulate matter emissions. Serve as a neutral third party between Federal and state regulators and the petroleum industry to develop scientific information on the environmental and health risks of pollutants emitted by the petroleum industry. (\$4,601) (GWPC, Natl. Labs, ,</p>	<p>environmental risks posed by exploration and production, including risks posed by injection, spills, oil emissions, and management of drilling and production wastes. Assist States to support risk-based regulatory decisions consistent with stakeholder's objectives of streamlining and improving environmental regulations (\$3,396). Develop credible scientific environmental and/or health information to assist EPA and States in implementing proposed regulations affecting fuel characteristics and composition end points for remediation of cleanup sites, and analysis of effects of fine particulate from petroleum processing and fuels. (\$591). (Total \$3,987) (GWPC, Natl. Labs, INEEL, ANL, BLM, LBNL, PERF, IGT, DynCorp, ORNL, KW Tunnell, TBD)</p>	<p>by injection, spills, oil emissions, and management of drilling and production wastes (\$1,453). Develop credible scientific environmental analysis of effects of fine particulate from petroleum processing and fuels (\$250). (Total \$1,703) (Natl. Labs, BLM, PERF, GWPC, TBD)</p>

III. **Performance Summary:** OIL TECHNOLOGY (Cont'd)

Activity	FY 2000	FY 2001	FY 2002
<p>Effective Environmental Protection (Cont'd)</p>	<p>INEEL, ANL, ORNL, LLNL, LBNL, PERF, BLM, Univ of KY, IGT, KW Tunnell, MMS)</p> <p>Technology Development: Continue to develop and field test more cost-effective environmental compliance technologies in the areas of produced water treatment, remediation, air emissions control and monitoring, and oil field waste management and disposal (\$1,451). Identify various pollutants present in petroleum and develop technology to prevent their formation. In keeping with PCAST recommendations, perform research to make fuels that have fewer emissions affecting global climate change (\$1,973). (Total \$3,424) (TBD, Natl Labs, ORNL, INEEL, PNL, OERB, ANL, TU, AWMA, LANL)</p> <p>Fund technical and program management support. (\$108)</p> <p style="text-align: center;">\$10,534</p>	<p>Technology Development: Continue to develop and field test more cost-effective environmental compliance technologies in the areas of produced water treatment, remediation, air emissions control and monitoring, and oil field waste management and disposal (\$1,441). In keeping with PCAST recommendations, perform research to make fuels that have fewer pollutants and fewer emissions affecting global climate change (\$2,922). (Total \$4,363) (TBD, Natl Labs, ORNL, INEEL, PNL, OERB, TU, TBD-PS)</p> <p>Fund technical and program management support. (\$108)</p> <p style="text-align: center;">\$10,796</p>	<p>Technology Development: Continue to develop more cost-effective environmental compliance technologies for oil field waste management and disposal (\$516). Perform research to reduce environmental impacts of processing this hemisphere's heavy crude oil to make high-quality fuels (\$1,528). (Total \$2,044) (Natl. Labs, TU, GEER)</p> <p>Fund technical and program management support. (\$53)</p> <p style="text-align: center;">\$5,300</p>

III. **Performance Summary:** OIL TECHNOLOGY (Cont'd)

Activity	FY 2000	FY 2001	FY 2002
Emerging Processing Technology Applications	The R&D activity will provide data to validate viability of biodesulfurization of diesel fuel for application in small refineries. (\$3,210) (PetroStar)	The R&D activity will provide data to validate viability of biodesulfurization of diesel fuel for application in small refineries. Initiate innovative processes research through competitive solicitation. Conduct in-house processing research at NETL. (\$2,568) (PetroStar, NETL, TBD)	No activity. (\$0)
Emerging Processing Technology Applications (Cont'd)	Fund technical and program management support. (\$33)	Fund technical and program management support. (\$26)	No activity. (\$0)
	\$3,243	\$2,594	\$0
Ultra Clean Fuels	No activity (\$0)	Ultra Clean Fuels: Initiate research through both competitive solicitations and the National Laboratory Partnership to develop technology to overcome current limitations for making very low sulfur, clean burning transportation fuels. (\$9,878) (PetroStar, Research Triangle Inst., Phillips Petro, Parxair, ICRC, Envires, Conoco, Ford, 4 national laboratories)	Ultra Clean Fuels: Conduct an orderly termination of R&D using prior year funds. The R&D was implemented in FY 2001 from competitive solicitations and National Laboratory Partnerships to overcome current limitations for making very low sulfur, clean burning transportation fuels. (\$0)

III. **Performance Summary:** OIL TECHNOLOGY (Cont'd)

Activity	FY 2000	FY 2001	FY 2002
	No activity. (\$0)	Fund technical and program management support. (\$100)	No activity. (\$0)
	\$0	\$9,978	\$0
Oil Technology, Total	\$55,748	\$66,874	\$30,499

DEPARTMENT OF ENERGY
 FY 2002 CONGRESSIONAL BUDGET REQUEST

FOSSIL ENERGY RESEARCH AND DEVELOPMENT

PROGRAM DIRECTION AND MANAGEMENT SUPPORT

I. Mission Supporting Goals and Objectives:

This activity provides funding for salaries, benefits and overhead expenses for management of the Fossil Energy program at Headquarters and the National Energy Technology Laboratory (NETL), with sites in Morgantown, WV, Pittsburgh, PA and Tulsa, OK. The Headquarters staff is responsible for overall direction of the programs that includes implementing DOE policy, communicating guidance consistent with that policy to the FE field offices, establishing program objectives, developing program plans and evaluating alternative program strategies, developing and defending budget requests to the Office of Management and Budget and to Congress, reviewing procurement plans, monitoring work progress, and approving revisions in work plans as required to attain program goals. The NETL performs the day-to-day project management functions of assigned programmatic areas that include monitoring Fossil Energy contracts and National Laboratory activities, developing project budgets, implementing procurement plans, and other program and site support activities necessary to achieve program objectives.

II. A. Funding Schedule:

<u>Activity</u>	<u>FY 2000</u>	<u>FY 2001</u>	<u>FY 2002</u>	<u>\$Change</u>	<u>%Change</u>
Headquarters Program Direction					
Salaries and Benefits	\$9,662	\$10,677	\$8,750	\$-1,927	-18%
Travel	489	488	450	-38	-8%
Contract Services	<u>5,865</u>	<u>5,765</u>	<u>5,500</u>	<u>-265</u>	<u>-5%</u>
Subtotal, Headquarters Program Direction	16,016	16,930	14,700	-2,230	-13%

II. A. Funding Schedule: PROGRAM DIRECTION AND MANAGEMENT SUPPORT

<u>Activity</u>	<u>FY 2000</u>	<u>FY 2001</u>	<u>FY 2002</u>	<u>\$Change</u>	<u>%Change</u>
Field Program Direction					
Salaries and Benefits	29,152	31,017	27,806	-3,211	-10%
Travel	1,398	1,394	1,254	-140	-10%
Contract Services	<u>28,913</u>	<u>30,745</u>	<u>26,240</u>	<u>-4,505</u>	<u>-15%</u>
Subtotal, Field Program Direction	<u>59,463</u>	<u>63,156</u>	<u>55,300</u>	<u>-7,856</u>	<u>-12%</u>
Total, Program Direction and Management Support	<u>\$75,479</u>	<u>\$80,086</u>	<u>\$70,000</u>	<u>\$-10,086</u>	<u>-13%</u>

II. B. Laboratory and Facility Funding Schedule:

	<u>FY 2000</u>	<u>FY 2001</u>	<u>FY 2002</u>	<u>\$Change</u>	<u>%Change</u>
National Energy Technology Laboratory	59,463	63,156	55,300	-7,856	-12%
All Other	<u>16,016</u>	<u>16,930</u>	<u>14,700</u>	<u>-2,230</u>	<u>-13%</u>
Total, Program Direction and Management Support	<u>\$75,479</u>	<u>\$80,086</u>	<u>\$70,000</u>	<u>\$-10,086</u>	<u>-13%</u>

III. Performance Summary: PROGRAM DIRECTION AND MANAGEMENT SUPPORT

<u>Activity</u>	<u>FY 2000</u>	<u>FY 2001</u>	<u>FY 2002</u>
Headquarters Program Direction - Salaries and Benefits	Provide funds for 105 FTE's at Headquarters. This staff implements and communicates policy to the ETC's, sets program objectives, develops program plans and evaluates alternative strategies;	Provide funds for 110 FTE's at Headquarters. This staff implements and communicates policy to the ETC's, sets program objectives, develops program plans and evaluates alternative strategies;	Provide funds for 80 FTE's at Headquarters. This staff implements and communicates policy to the ETC's, sets program objectives, develops program plans and evaluates alternative strategies;

III. **Performance Summary:** PROGRAM DIRECTION AND MANAGEMENT SUPPORT

Activity	FY 2000	FY 2001	FY 2002
Headquarters Program Direction - Salaries and Benefits (Cont'd)	develops and defends budget requests; approves procurement plans; and monitors work progress. (\$9,662)	develops and defends budget requests; approves procurement plans; and monitors work progress. (\$10,677)	develops and defends budget requests; approves procurement plans; and monitors work progress. (\$8,750)
	\$9,662	\$10,677	\$8,750
Travel	Provide funds for travel in support of the activities stated above. Both domestic and international travel are conducted. (\$489)	Provide funds for travel in support of the activities stated above. Both domestic and international travel are conducted. (\$488)	Provide funds for travel in support of the activities stated above. Both domestic and international travel are conducted. (\$450)
	\$489	\$488	\$450
Headquarters Program Direction - Contract Services	Provide for contractual services that are generic to the entire FE program. Included are items such as computer services, technical and management support services. (\$1,200) (TBD)	Provide for contractual services that are generic to the entire FE program. Included are items such as computer services, technical and management support services. (\$1,425) (TBD)	Provide for contractual services that are generic to the entire FE program. Included are items such as computer services, technical and management support services. (\$1,200) (TBD)
	Fund SBIR in the amount of \$6,917 from prior year and/or various R&D program funds within the Fossil Energy R&D account. (\$0)	Fund SBIR in the amount of \$6,542 from prior year and/or various R&D program funds within the Fossil Energy R&D account. (\$0)	Fund SBIR in the amount of \$6,486 from prior year and/or various R&D program funds within the Fossil Energy R&D account. (\$0)

III. **Performance Summary**: PROGRAM DIRECTION AND MANAGEMENT SUPPORT

<u>Activity</u>	<u>FY 2000</u>	<u>FY 2001</u>	<u>FY 2002</u>
Headquarters Program Direction - Contract Services (Cont'd)	Fund the Small Business Technology Transfer (STTR) in the amount of \$493 from prior year and/or various R&D program funds within the Fossil Energy R&D account. (\$0)	Fund the Small Business Technology Transfer (STTR) in the amount of \$397 from prior year and/or various R&D program funds within the Fossil Energy R&D account. (\$0)	Fund the Small Business Technology Transfer (STTR) in the amount of \$374 from prior year and/or various R&D program funds within the Fossil Energy R&D account. (\$0)
	Provide for the operation, maintenance and upgrading of FE headquarters-wide network and desktop workstation computer systems and televideo units. (\$1,035)	Provide for the operation, maintenance and upgrading of FE headquarters-wide network and desktop workstation computer systems and televideo units. (\$748)	Provide for the operation, maintenance and upgrading of FE headquarters-wide network and desktop workstation computer systems and televideo units. (\$800)
	Provide for printing services. (\$80) (TIC)	Provide for printing services. (\$50) (TIC)	Provide for printing services. (\$0) (TIC)
	Upgrade electronic records management systems. (\$100)	Upgrade electronic records management systems. (\$100)	Upgrade electronic records management systems. (\$0)
	Provide working capital fund. (\$3,450)	Provide working capital fund. (\$3,442)	Provide working capital fund. (\$3,500)
	\$5,865	\$5,765	\$5,500

III. **Performance Summary**: PROGRAM DIRECTION AND MANAGEMENT SUPPORT

<u>Activity</u>	<u>FY 2000</u>	<u>FY 2001</u>	<u>FY 2002</u>
Headquarters Program Direction, Subtotal	\$16,016	\$16,930	\$14,700
Field Program Direction Salaries and Benefits	Provide funds for NETL staff of 324 FTEs. Activities of the staff include project management, product development, contract management, and other service activities related to program and site support. It is anticipated that 9 FTEs of the 324 FTEs will be paid via reimbursable agreements, therefore, salaries and benefits associated with these FTEs are not included in the budget estimate. (\$29,152)	Provide funds for NETL staff of 339 FTEs. Activities of the staff include project management, product development, contract management, and other service activities related to program and site support. It is anticipated that 9 FTEs of the 339 FTEs will be paid via reimbursable agreements, therefore, salaries and benefits associated with these FTEs are not included in the budget estimate. (\$31,017)	Provide funds for NETL staff of 281 FTEs. Activities of the staff include project management, product development, contract management, and other service activities related to program and site support. It is anticipated that 9 FTEs of the 281 FTEs will be paid via reimbursable agreements, therefore, salaries and benefits associated with these FTEs are not included in the budget estimate. (\$27,806)
	\$29,152	\$31,017	\$27,806
Travel	Provide funds for travel in support of the above activities in the attainment of program goals, both on the domestic front and abroad. (\$1,398)	Provide funds for travel in support of the above activities in the attainment of program goals, both on the domestic front and abroad. (\$1,394)	Provide funds for travel in support of the above activities in the attainment of program goals, both on the domestic front and abroad. (\$1,254)
	\$1,398	\$1,394	\$1,254

III. **Performance Summary**: PROGRAM DIRECTION AND MANAGEMENT SUPPORT

<u>Activity</u>	<u>FY 2000</u>	<u>FY 2001</u>	<u>FY 2002</u>
Contract Services	Provide substantial funding of facility operations, maintenance, finance, information automation, administrative, management and technical support. (\$28,913)	Provide substantial funding of facility operations, maintenance, finance, information automation, administrative, management and technical support. (\$30,745)	Provide funding for facility operations, maintenance, finance, information automation, administrative, management and technical support. (\$26,240)
	\$28,913	\$30,745	\$26,240
Field Program Direction, Subtotal	\$59,463	\$63,156	\$55,300
Program Direction and Management Support, Total	\$75,479	\$80,086	\$70,000

DEPARTMENT OF ENERGY
FY 2002 CONGRESSIONAL BUDGET REQUEST

FOSSIL ENERGY RESEARCH AND DEVELOPMENT

PLANT AND CAPITAL EQUIPMENT

I. Mission Supporting Goals and Objectives:

No funding is requested for capital equipment purchases. Any such needs will be funded within project operating costs, subject to Congressional reprogramming guidelines.

Funding for general plant projects at the National Energy Technology Laboratory (NETL) sites and the Albany Research Center (ARC) is requested. General plant projects include repairs, improvements, alterations and additions that are essential to the safe, environmentally acceptable and efficient operations of the NETL sites and ARC.

II. A. Funding Schedule:

<u>Activity</u>	<u>FY 2000</u>	<u>FY 2001</u>	<u>FY 2002</u>	<u>\$Change</u>	<u>%Change</u>
Construction	<u>\$2,600</u>	<u>\$3,891</u>	<u>\$2,000</u>	<u>\$-1,891</u>	<u>-49%</u>
Total, Plant and Capital Equipment	<u>\$2,600</u>	<u>\$3,891</u>	<u>\$2,000</u>	<u>\$-1,891</u>	<u>-49%</u>

II. B. Laboratory and Facility Funding Schedule

	<u>FY 2000</u>	<u>FY 2001</u>	<u>FY 2002</u>	<u>\$Change</u>	<u>%Change</u>
All Other	<u>\$2,600</u>	<u>\$3,891</u>	<u>\$2,000</u>	<u>\$-1,891</u>	<u>-49%</u>
Total, Plant and Capital Equipment	<u>\$2,600</u>	<u>\$3,891</u>	<u>\$2,000</u>	<u>\$-1,891</u>	<u>-49%</u>

III. **Performance Summary:** PLANT AND CAPITAL EQUIPMENT

<u>Activity</u>	<u>FY 1999</u>	<u>FY 2000</u>	<u>FY 2001</u>
Construction	Provide General Plant Projects (GPP) at the NETL and NPTO. (\$2,600)	Provide for General Plant Projects (GPP) at the NETL and NPTO. (\$3,891)	Provide for General Plant Projects (GPP) at the NETL, NPTO, and ARC. (\$2,000)
	\$2,600	\$3,891	\$2,000
Plant and Capital Equipment, Total	\$2,600	\$3,891	\$2,000

DEPARTMENT OF ENERGY
FY 2002 CONGRESSIONAL BUDGET REQUEST

FOSSIL ENERGY RESEARCH AND DEVELOPMENT

FOSSIL ENERGY ENVIRONMENTAL RESTORATION

I. **Mission Supporting Goals and Objectives:**

The objectives of the Fossil Energy (FE) Environmental Restoration activities are to ensure protection of workers, the public, and the environment in performing the mission of the National Energy Technology Laboratory (NETL) at Morgantown (MGN), West Virginia and Pittsburgh (PGH), Pennsylvania sites, and at Tulsa, Oklahoma (the National Petroleum Technology Office (NPTO)), and the Albany Research Center (ARC) in Albany, Oregon. Activities include those necessary to protect workers and the public from exposure to hazardous conditions and materials (e.g., fires, carcinogens, asbestos, lead, etc.), identify and correct safety and health hazards, improve workplace monitoring and industrial safety programs, and achieve compliance with Federal, state and local safety and health requirements, including Department of Energy (DOE) initiatives. Activities also include environmental protection, and cleanup activities on-site, and at several former off-site research and development locations. DOE has received a Notice of Violation from the State of Wyoming requiring cleanup of the Rock Springs and Hoe Creek sites. Groundwater and soil monitoring/remediation is also required at the NETL and ARC sites to ensure compliance with Federal, state and local requirements.

FY 2002 performance measures are listed below that support the overarching goal of making consistent and measurable progress in reducing and eliminating injuries, incidents and environmental releases.

- Complete a series of lead and asbestos abatement actions at NETL according to schedule.
- Complete a series of indoor quality /ventilation fixes for the NETL R&D buildings according to schedule.
- Design and complete Phase II of public address systems at NETL-PGH.
- Upgrade gas alarm systems in five NETL buildings.
- Expand Rock Springs, WY oil shale retort cleanup activities at Site 12.
- Implement environmental management programs and achieve objectives and targets of ISO 14001/CEMP systems.

I. **Mission Supporting Goals and Objectives:** ENVIRONMENTAL RESTORATION (Cont'd)

- Conduct environmental monitoring and surveillance activities (air, water, wastewater) in support of permit maintenance for the NETL sites.
- Implement risk management/maintenance programs at NETL, i.e., hazardous waste management, emergency preparedness, workplace violence, fire protection, occupational medicine, and environmental quality programs.
- Conduct environment, safety and health training, according to the job hazard analyses.
- Implement new activities to meet waste minimization goals.
- Complete a series of lead and asbestos abatement actions and remove hazardous materials at ARC.
- Complete emergency and security programs at ARC.
- Continue with equipment/facility upgrades and infrastructure repairs at the ARC.
- Reduce electrical energy consumption at the ARC.
- Reduce sanitary waste from routine operations at ARC.
- Increase purchases of environmentally preferable products and services at ARC and NETL to 100% where competitively available and performance standards are met.

II. A. **Funding Schedule:**

<u>Activity</u>	<u>FY 2000</u>	<u>FY 2001</u>	<u>FY 2002</u>	<u>\$Change</u>	<u>%Change</u>
CERCLA Remedial Actions	\$2,122	\$3,756	\$2,049	\$-1,707	-45%
RCRA Remedial Actions	2,345	1,988	2,125	137	7%
Other ES&H Actions	<u>5,533</u>	<u>4,234</u>	<u>5,326</u>	<u>1,092</u>	<u>26%</u>
Total, Fossil Energy Environmental Restoration . . .	<u>\$10,000</u>	<u>\$9,978</u>	<u>\$9,500</u>	<u>\$-478</u>	<u>-5%</u>

I. B. **Laboratory and Facility Funding Schedule:**

III. **Performance Summary:** ENVIRONMENTAL RESTORATION (Cont'd)

Activity	FY 2000	FY 2001	FY 2002	\$Change	%Change
<u>Activity</u>	<u>FY 2000</u>	<u>FY 2001</u>	<u>FY 2002</u>	<u>\$Change</u>	<u>%Change</u>
All Other	<u>\$10,000</u>	<u>\$9,978</u>	<u>\$9,500</u>	<u>\$-478</u>	<u>-5%</u>
Total, Fossil Energy Environmental Restoration . . .	<u>\$10,000</u>	<u>\$9,978</u>	<u>\$9,500</u>	<u>\$-478</u>	<u>-5%</u>
CERCLA Remedial Actions	Continue cleanup of Rock Springs sites. (\$952) (Army Corps of Engineers)	Continue cleanup of Rock Springs sites. (\$569) (Army Corps of Engineers)	Continue cleanup of Rock Springs sites. (\$800) (Army Corps of Engineers)		
	Continue cleanup of Hoe Creek site. (\$835) (Army Corps of Engineers)	Continue cleanup of Hoe Creek site. (\$300) (Army Corps of Engineers)	Continue cleanup of Hoe Creek site. (\$300) (Army Corps of Engineers)		
	Continue Hannah Site revegetation. (\$35)	Continue Hannah Site revegetation. (\$50)	Continue Hannah Site revegetation. (\$70)		
	No activity. (\$0)	Implement new CERCLA site investigations and project closeouts. (\$100) (TBD)	Implement new CERCLA site investigations and project closeouts. (\$200) (TBD)		
	No activity. (\$0)	Continue cleanup of soil and groundwater at former NETL liquefaction sites. (\$75) (TBD)	No activity. (\$0)		
	Perform onsite CERCLA-type remediation assessments at NETL. (\$100) (TBD)	Perform onsite CERCLA-type remediation assessments at NETL. (\$60) (TBD)	Perform onsite CERCLA-type remediation assessments at NETL. (\$30) (TBD)		

III. **Performance Summary:** ENVIRONMENTAL RESTORATION (Cont'd)

Activity	FY 2000	FY 2001	FY 2002
	Implement CERCLA PRP Response Activities. (\$200) (TBD) \$2,122	Implement CERCLA PRP Response Activities, e.g., Connecticut coal gasification site. (\$2,602) (TBD) \$3,756	Implement CERCLA PRP Response Activities. (\$649) (TBD) \$2,049
RCRA Remedial Actions	Continue NETL on-site remediation activities such as lead and asbestos abatement; waste minimization and pollution prevention activities; toxic chemical management program upgrades; hazardous material and waste compliance activities; and surface water compliance problems. (\$1,400) (TBD)	Continue NETL on-site remediation activities such as lead and asbestos abatement; waste minimization and pollution prevention activities; toxic chemical management program upgrades; stormwater system design; chemical management software implementation; hazardous material and waste compliance activities; surface water compliance; and site support contractor RCRA related activities. (\$1,310) (TBD)	Continue NETL limited on-site remediation activities such as waste water treatment plant upgrades; toxic chemical management program upgrades; stormwater system design; chemical management software implementation; hazardous material and waste compliance activities; surface water compliance; and site support contractor RCRA related activities. (\$1,355) (TBD)

III. **Performance Summary:** ENVIRONMENTAL RESTORATION (Cont'd)

Activity	FY 2000	FY 2001	FY 2002
	<p>Continue RCRA cleanup actions at Albany Research Center including characterizing and resolving chemical and radioactive storage and labeling; soil and groundwater characterization; fume hood and scrubber upgrades; air emission management; and materials handling and disposal problems. (\$945) (TBD)</p>	<p>Continue RCRA cleanup actions at Albany Research Center including asbestos removal, characterizing and resolving chemical storage and labeling; soil and groundwater monitoring; fume hood and scrubber upgrades; air emission management; and materials handling and disposal activities. (\$678) (TBD)</p>	<p>Continue RCRA cleanup actions at Albany Research Center including lead and asbestos abatement, characterizing and resolving chemical storage and labeling; soil and groundwater monitoring; fume hood and scrubber upgrades; air emission management; and materials handling and disposal activities. (\$770) (TBD)</p>
	\$2,345	\$1,988	\$2,125
<p>Other ES&H Actions</p>	<p>Continue ES&H activities at the NETL sites requiring corrective action and related activities including monitoring and surveillance; indoor air quality fixes; resolution of life safety code deficiencies; fire protection compliance actions; ergonomics; training improvements; structural safety fixes; and emergency preparedness upgrades. (\$4,296) (TBD)</p>	<p>Continue ES&H activities at the NETL sites requiring corrective action and related activities including monitoring and surveillance; indoor air quality fixes; resolution of life safety code deficiencies; fire protection compliance actions; ergonomics; training improvements; structural safety fixes; emergency preparedness activities and site support contractor ES&H related activities. (\$3,408) (TBD)</p>	<p>Maintain regulatory programs (emergency management, safety, and fire protection). (\$4,300) (TBD)</p>

III. **Performance Summary:** ENVIRONMENTAL RESTORATION (Cont'd)

Activity	FY 2000	FY 2001	FY 2002
	Initiate ES&H program activities at NPTO including emergency management and drills, training, etc. (\$20) (TBD)	Continue ES&H program activities at NPTO including inspections, emergency management and drills, training, etc. (\$15) (TBD)	Continue ES&H program activities at NPTO including inspections, emergency management and drills, training, etc. (\$15) (TBD)
	Initiate site-wide safety and health corrective actions at Albany Research Center including structural upgrading; monitoring and surveillance; indoor air quality and ventilation upgrades; fire suppression systems; and training. (\$1,107) (TBD)	Continue site-wide safety and health programs and corrective actions at Albany Research Center including monitoring and surveillance; indoor air quality and ventilation upgrades; medical and industrial hygiene; fire detection and suppression systems; walking surface repairs; personal protective equipment maintenance; and training. (\$711) (TBD)	Continue site-wide safety and health programs and corrective actions at Albany Research Center including monitoring and surveillance; indoor air quality and ventilation upgrades; medical and industrial hygiene; fire detection and suppression systems; walking surface repairs; personal protective equipment maintenance; and training. (\$911) (TBD)
Other ES&H Actions (Cont'd)	Technical and management support. (\$110)	Technical and management support. (\$100)	Technical and management support. (\$100)
	\$5,533	\$4,234	\$5,326
Fossil Energy Environmental Restoration, Total	\$10,000	\$9,978	\$9,500

DEPARTMENT OF ENERGY
 FY 2002 CONGRESSIONAL BUDGET REQUEST

FOSSIL ENERGY RESEARCH AND DEVELOPMENT

COOPERATIVE RESEARCH AND DEVELOPMENT

I. Mission Supporting Goals and Objectives:

The Cooperative Research and Development program supports activities of federal/industry/research institute endeavors and federal/state/industry partnerships. It was originally created in FY 1989 and provided the federal share of support for Jointly Sponsored Research Programs (JSRP) at the Western Research Institute (WRI) and the University of North Dakota Energy and Environmental Research Center (UNDEERC). The research projects under the JSRP at those centers receive at least 50 percent cost sharing from non-federal partners. The Department anticipates that these centers can compete successfully for Fossil Energy funding through the competitive solicitation process.

II. A. Funding Schedule:

<u>Activity</u>	<u>FY 2000</u>	<u>FY 2001</u>	<u>FY 2002</u>	<u>\$Change</u>	<u>%Change</u>
Cooperative Research and Development	<u>\$7,193</u>	<u>\$8,071</u>	<u>\$0</u>	<u>\$-8,071</u>	<u>-100%</u>
Total, Cooperative Research and Development . . .	<u>\$7,193</u>	<u>\$8,071</u>	<u>\$0</u>	<u>\$-8,071</u>	<u>-100%</u>

I. B. Laboratory and Facility Funding Schedule:

<u>Activity</u>	<u>FY 2000</u>	<u>FY 2001</u>	<u>FY 2002</u>	<u>\$Change</u>	<u>%Change</u>
All Other	<u>\$7,193</u>	<u>\$8,071</u>	<u>\$0</u>	<u>\$-8,071</u>	<u>-100%</u>
Total, Cooperative Research and Development . . .	<u>\$7,193</u>	<u>\$8,071</u>	<u>\$0</u>	<u>\$-8,071</u>	<u>-100%</u>

III. **Performance Summary:** COOPERATIVE RESEARCH AND DEVELOPMENT (Cont'd)

Activity	FY 2000	FY 2001	FY 2002
Cooperative Research and Development	Provide support for cooperative research programs at WRI (\$3,576) and UNDEERC (\$3,577) which are 50-50 cost-shared with non-federal clients. (\$7,153) (WRI, UNDEERC)	Provide support for cooperative research programs at WRI (\$4,015) and UNDEERC (\$4,016) which are 50-50 cost-shared with non-federal clients. (\$8,031) (WRI, UNDEERC)	No activity. (\$0)
	Fund technical and program management support. (\$40)	Fund technical and program management support. (\$40)	No activity. (\$0)
Cooperative Research and Development, Total	\$7,193	\$8,071	\$0

DEPARTMENT OF ENERGY
FY 2002 CONGRESSIONAL BUDGET REQUEST

FOSSIL ENERGY RESEARCH AND DEVELOPMENT

IMPORT/EXPORT AUTHORIZATION

I. **Mission Supporting Goals and Objectives:**

The Office of Import/Export Authorization (OIEA) manages the regulatory review of natural gas imports and exports, exports of electricity, and the construction and operation of electric transmission lines which cross U.S. international borders; and exercises regulatory oversight of the conversion of existing oil and gas-fired powerplants, processes exemptions from the statutory provisions of the Powerplant and Industrial Fuel Use Act of 1978 (FUA), as amended, and processes certifications of alternate fuel capability pursuant to the provisions of the amended FUA. These regulatory activities help promote the national energy strategy goal of securing future energy supplies by helping to ensure: the availability of reliable, competitively priced natural gas; that surplus domestic gas supplies can be marketed internationally in a competitive and environmentally sound manner; and that exports of electric energy and the construction of new international electric transmission lines do not adversely impact on the reliability of the U.S. electric power supply system. The program promotes the use of alternate fuels in new baseload electric powerplants; and assumes that international gas and electricity trade occurs in the freest possible marketplace. The OIEA's activities help deregulate energy markets and reduce international trade barriers, and to create an integrated North American energy market. OIEA encourages greater exchange of technical and regulatory information among our trading partners. Through its publications, OIEA increases public awareness of energy issues and the advantages of competition in the marketplace.

II. A. **Funding Schedule:**

<u>Activity</u>	<u>FY 2000</u>	<u>FY 2001</u>	<u>FY 2002</u>	<u>\$Change</u>	<u>%Change</u>
Import/Export Authorization	<u>\$2,173</u>	<u>\$2,295</u>	<u>\$1,000</u>	<u>\$-1,295</u>	<u>-56%</u>
Total, Import/Export Authorization	<u>\$2,173</u>	<u>\$2,295</u>	<u>\$1,000</u>	<u>\$-1,295</u>	<u>-56%</u>

II. B. **Laboratory and Facility Funding Schedule:** IMPORT/EXPORT AUTHORIZATION (Cont'd)

<u>Activity</u>	<u>FY 2000</u>	<u>FY 2001</u>	<u>FY 2002</u>	<u>\$Change</u>	<u>%Change</u>
All Other	<u>\$2,173</u>	<u>\$2,295</u>	<u>\$1,000</u>	<u>\$-1,295</u>	<u>-56%</u>
Total, Import/Export Authorization	<u>\$2,173</u>	<u>\$2,295</u>	<u>\$1,000</u>	<u>\$-1,295</u>	<u>-56%</u>

III. **Performance Summary:**

<u>Activity</u>	<u>FY 2000</u>	<u>FY 2001</u>	<u>FY 2002</u>
Import/Export Authorization	Modify or rescind 3 conversion orders. Process 50 certifications of coal capability and 3 exemptions. (\$50)	Modify or rescind 3 conversion orders. Process 50 certifications of coal capability and 3 exemptions. (\$50)	Modify or rescind 3 conversion orders. Process 50 certifications of coal capability and 3 exemptions. (\$50)

III. **Performance Summary**: IMPORT/EXPORT AUTHORIZATION (Cont'd)

<u>Activity</u>	<u>FY 1999</u>	<u>FY 2000</u>	<u>FY 2001</u>
	<p>Process 200 gas import/export applications. Provide support for consultations with U.S. trading partners. Provide regulatory compliance and industry monitoring. Participate in FERC proceedings and international studies. Provide petroleum policy support for ASFE. NEPA compliance activities. (20 FTEs) (\$1,357)</p>	<p>Process 200 gas import/export applications. Provide support for consultations with U.S. trading partners. Provide regulatory compliance and industry monitoring. Participate in FERC proceedings and international studies. Provide petroleum policy support for ASFE. NEPA compliance activities. (20 FTEs) (\$1,479)</p>	<p>Process 100 gas import/export applications. Provide support for consultations with U.S. trading partners. Provide regulatory compliance and industry monitoring. Participate in FERC proceedings and international studies. Provide petroleum policy support for ASFE. NEPA compliance activities. (7 FTEs) (\$550)</p>
<p>Import/Export Authorization (Cont'd)</p>	<p>Process 100 electricity export applications and 10 construction permits. Monitor and analyze international and domestic electricity trade. Participate in FERC proceedings. Participate in international studies and trade negotiations. NEPA compliance activities. (\$630)</p>	<p>Process 100 electricity export applications and 10 construction permits. Monitor and analyze international and domestic electricity trade. Participate in FERC proceedings. Participate in international studies and trade negotiations. NEPA compliance activities. (\$630)</p>	<p>Process 50 electricity export applications and 5 construction permits. Monitor and analyze international and domestic electricity trade. Participate in FERC proceedings. Participate in international studies and trade negotiations. NEPA compliance activities. (\$300)</p>

III. **Performance Summary:** IMPORT/EXPORT AUTHORIZATION (Cont'd)

<u>Activity</u>	<u>FY 1999</u>	<u>FY 2000</u>	<u>FY 2001</u>
	Provide management and administrative support. (\$136)	Provide management and administrative support. (\$136)	Provide management and administrative support. (\$100)
Import/Export Authorization, Total	\$2,173	\$2,295	\$1,000

DEPARTMENT OF ENERGY
FY 2002 CONGRESSIONAL BUDGET REQUEST

FOSSIL ENERGY RESEARCH AND DEVELOPMENT

ADVANCED METALLURGICAL PROCESSES

I. **Mission Supporting Goals and Objectives:**

The Advanced Metallurgical Processes program conducts inquiries, technological investigations, and research concerning the extraction, processing, use, and disposal of mineral substances under the mineral and materials science program at the Albany Research Center (ARC) in Oregon.

The program's goals are to address the full life cycle of materials production and cost-effective processing of improved materials through to their disposal and recycling. The program seeks to determine the factors that limit service life of materials in industrial, structural, or engineering applications and to provide solutions to service-life problems through new materials technology, to develop and demonstrate technologies that will reduce waste and pollution, and to use capabilities and expertise to provide focused solutions to high priority national problems. The research at ARC directly contributes to Fossil Energy's objectives by providing information on the performance characteristics of materials being specified for the current generation of power systems, on the development of cost-effective materials for inclusion in Vision 21 systems, and for solving environmental emission problems related to fossil fired energy systems. The program at ARC stresses full participation with industry through partnerships and emphasizes cost sharing to the fullest extent possible. All FY 2001 performance measures were met. FY 2002 performance measures include:

- Complete a summary report identifying mechanisms of degradation of coal gasification refractory materials. Initiate investigations on methods that might be used to monitor the corrosion of refractories during slag attack testing and possible use of these techniques in industrial applications.
- Construct and operate a continuous bench scale reactor, 5 lbs. an hour, to demonstrate the mineral carbonation process.

II. A. **Funding Schedule:** ADVANCED METALLURGICAL PROCESSES (Cont'd)

<u>Activity</u>	<u>FY 2000</u>	<u>FY 2001</u>	<u>FY 2002</u>	<u>\$Change</u>	<u>%Change</u>
Advanced Metallurgical Processes	<u>\$5,000</u>	<u>\$5,214</u>	<u>\$5,200</u>	<u>\$-14</u>	<u>0%</u>
Total, Advanced Metallurgical Processes	<u>\$5,000</u>	<u>\$5,214</u>	<u>\$5,200</u>	<u>\$-14</u>	<u>0%</u>

II. B. **Laboratory and Facility Funding Schedule**

	<u>FY 2000</u>	<u>FY 2001</u>	<u>FY 2002</u>	<u>\$Change</u>	<u>%Change</u>
All Other	<u>\$5,000</u>	<u>\$5,214</u>	<u>\$5,200</u>	<u>\$-14</u>	<u>0%</u>
Total, Advanced Metallurgical Processes	<u>\$5,000</u>	<u>\$5,214</u>	<u>\$5,200</u>	<u>\$-14</u>	<u>0%</u>

III. **Performance Summary:**

<u>Activity</u>	<u>FY 2000</u>	<u>FY 2001</u>	<u>FY 2002</u>
Advanced Metallurgical Processes	Continue research identified during FY 1999 to contribute to Fossil Energy's Vision 21 Systems to include reducing greenhouse gas emissions through CO ₂ sequestration, advanced refractory research, and partnerships for implementing improved efficiency technology, energy production system by-product processing and materials development. Continue research efforts in partnership with industry and with State and Federal agencies to build viable domestic	Continue research identified during FY 2000 to contribute to Fossil Energy's Vision 21 Systems to include reducing greenhouse gas emissions through CO ₂ sequestration, and advanced refractory research. Continue research efforts by developing partnerships with industry and with State and Federal agencies to build viable domestic commercial capabilities in waste-free environmentally benign materials production, energy production	Continue research to contribute to Fossil Energy's Vision 21 Systems to include reducing greenhouse gas emissions through CO ₂ sequestration, and advanced refractory research. Continue research efforts by developing partnerships with industry and with State and Federal agencies to build viable domestic commercial capabilities in waste-free environmentally benign materials production, energy production system by-product processing and

III. **Performance Summary:** ADVANCED METALLURGICAL PROCESSES (Cont'd)

Activity	FY 2000	FY 2001	FY 2002
Advanced Metallurgical Processes (Cont'd)	<p>commercial capabilities in waste-free environmentally benign materials production. Continue research efforts to achieve better understanding of wear, corrosion, and fracture, resulting in an improved understanding of component structure and properties for better performance in mining and processing of coal and in Vision 21 System components. Develop a continuous casting process for lightweight titanium for gas and oil industry applications. (\$4,950) (ARC)</p> <p>Fund technical and program management support. (\$50)</p>	<p>system by-product processing and materials development. Continue research efforts to achieve better understanding of wear, corrosion, and fracture, resulting in an improved understanding of component structure and properties for better performance in Vision 21 System components, in powerplant infrastructure, and in mining and minerals processing equipment. (\$5,162) (ARC)</p> <p>Fund technical and program management support. (\$52)</p>	<p>materials development. Continue research efforts to achieve better understanding of wear, corrosion, and fracture, resulting in an improved understanding of component structure and properties for better performance in Vision 21 System components, in powerplant infrastructure, and in mining and minerals processing equipment. (\$5,148) (ARC)</p> <p>Fund technical and program management support. (\$52)</p>
Advanced Metallurgical Processes, Total	\$5,000	\$5,214	\$5,200