DEPARTMENT OF ENERGY
FY 2001 CONGRESSIONAL BUDGET REQUEST
FOSSIL ENERGY RESEARCH AND DEVELOPMENT

PROPOSED APPROPRIATION LANGUAGE

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 and 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 [$419,025,000], *$384,570,000*, to remain available until expended, of which [$24,000,000 shall be derived by transfer from available unobligated balances in the Biomass Energy Development account] *$9,000,000 shall be derived from available prior year balances: Provided*, 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.

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FOSSIL ENERGY RESEARCH AND DEVELOPMENT

Program Mission

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 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.

Program Overview

The U.S. is reliant on fossil fuels for about 85% of the energy it consumes. Many forecast that relatively low fossil fuel prices and high U.S. reliance on these fuels will continue for decades. Accordingly, a key goal of the Department's fossil energy activities is to ensure that economic benefits from market-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.

To be successful, Federally funded and developed technologies and related analysis need to be transferred into commercial applications. This will be accomplished through joint partnerships with industry utilizing a variety of mechanisms including cost-shared contracts and targeted outreach activities, and cooperative research and development agreements with the Department's National Energy Technology Laboratory (NETL) as well as other National Laboratories.

FY2001 Crosscutting Initiatives

Two FY 2001 initiatives crosscut multiple FE programs. The ***Ultra-Clean Transportation Fuels Initiative (UCTFI)*** promotes, in partnership with the refining and transportation industries, the development and deployment of technologies that will produce ultra-clean, high performance transportation fuels for the 21st century from both petroleum and non-petroleum sources. These will enable the introduction of advanced, highly efficient fuel/engine combinations being developed by the Department, such as the Partnership for a

New Generation of Vehicles (PNGV), which offers the promise of lower regional emissions and greater than double the miles per gallon of fuel. In the nearer term, ultra-clean transportation fuels can be produced from improved or new refinery upgrading technology. In the mid-to-longer term, ultra-clean transportation fuels from natural gas, coal and other carbonaceous feedstocks would enjoy a high level of compatibility with the existing infrastructure, and could provide environmental benefits due to their suitability for use in advanced, high-efficiency vehicle engines. The initiative will have two components. The first component will include R&D projects that lead to the production of sufficient quantities of fuel to validate performance and emissions -- testing that will be done in collaboration with DOE's Office of Transportation Technologies. The second component is a supporting research program carried out by National Laboratories and co-sponsored with the fuel industry that is focused on the development of advanced fuel-making process components, materials, and chemistry needed for the manufacture of ultra-clean performing transportation fuels. UCTFI is funded in a new $10 million Ultra Clean Fuels line item under Oil Technology. This initiative is also supported by certain activities in the Fuels area under Coal and Power Systems, and in Natural Gas-to-Liquids under Natural Gas Technologies

The Clean Energy for the 21st Century: International Initiative is a $100 million multi-agency effort to encourage open competitive markets and remove market barriers to clean energy technologies in developing and transition countries and to provide new incentives for clean energy technology innovation and export. This initiative will promote U.S. exports and create high-value jobs, and will assist countries power their economic development while fighting air pollution and climate change. This initiative is an outgrowth of recommendations made in the June 1999 report by the President's Committee of Advisors on Science and Technology (PCAST) on international energy cooperation. This report details a variety of measures, including R&D, that can be used to promote the deployment of advanced energy technologies in other countries, and result in significant economic, environmental and energy security benefits for the U.S. and its trading partners. A total of $13 million is requested in FY2001 for these FE R&D activities, which are divided between Coal and Power Systems and Natural Gas Technologies.

A third FY2001 initiative focusing on energy grid infrastructure issues is discussed under Natural Gas Technologies.

Coal and Power Systems

In FY 2001, changes have been made to the FE budget structure to more clearly show how research activities are linked to various markets. At the top level of the Fossil Energy R&D budget structure, "Coal and Power Systems" replaces "Coal," and picks up activities related to fuel cells and turbines that were formerly under Gas. While advanced turbines and fuel cells will initially be

dominated by power plants that utilize natural gas, the next generation is will also include fuel flexible power generation applications such as coal systems. Furthermore, advanced turbines and fuel cells will be key components in the most advanced, highest-efficiency power plants that could also include fuel-flexible systems and modules capable of producing a variety of high-value products.

The FY 2001 request for Coal and Power Systems is $193.8 million. This program addresses the energy and environmental demands of the post-2000 domestic market, including increasing international pressure to reduce greenhouse gas emissions, and helps U.S. industry meet the needs of a currently large and growing export market, while contributing to national energy security. Based on these priorities, the coal program is focused on four goals. The first is to develop progressively higher efficiency and cleaner 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 (including CO_2) of pollutants. The second is to develop super-clean emission control systems for SO_2, NOx, air toxics, and particulate matter that can be applied to existing plants. The third goal is to develop economically competitive technologies for the production of alternative transportation fuels and chemicals. The fourth goal is to evaluate economically viable approaches to carbon sequestration to address climate change concerns.

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 PCAST report on energy R&D, 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 CO_2 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 Coal and Power Systems technologies, after achieving their performance goals, will be integrated into the Vision 21 concept. FY 2001 power systems activities tied to Vision 21 include achieving ultra-high efficiencies by working toward integrating advanced components such as a gasifier, fuel cell and turbine.

Significant progress towards achieving these goals will be made in FY 2001 through a number of ongoing projects in the Clean Coal Technology (CCT) Demonstration Program. Two advanced integrated gasification combined cycle facilities are scheduled to have completed their operational phase and a third will be under construction to provide clean power with new technology. The design phase will be completed for a second generation pressurized circulating fluidized bed combustion facility in preparation for construction. The data needed to evaluate the comparative merits of eighteen advanced environmental control devices just recently demonstrated will be available. Finally, the first demonstration plant to produce alternative transportation fuels and chemicals at commercial scale by means of the innovative liquid phase methanol process is scheduled to complete its operational phase. 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 CCT projects are investigated under the R&D program.

Coal and Power Systems include five elements: (1) Central Systems; (2) Distributed Generation Systems; (3) Sequestration R&D; (4) Fuels, and; (5) Advanced Research.

Activities included in the $89.4 million Central Systems request are divided into two major areas. The first is Advanced Systems, which includes Low Emission Boiler System (LEBS), Indirect Fired Cycle, Integrated Gasification Combined Cycle (IGCC), Pressurized Fluidized Bed Combustion (PFBC), and Advanced Turbines. The target for coal-fueled, advanced central systems is to achieve efficiencies in the 42-45 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 CO_2 emissions by over 40 percent compared to current coal-fired systems.

The LEBS program is drawing to a close, and no further funding is requested in FY2001. The Indirect Fired Cycle program will continue engineering development at a reduced level focusing on key combustion based technology for Vision 21. The focus for IGCC development will be cost improvement and performance optimization for power generation; gas stream purification and control of hazardous air pollutants for both IGCC and PFBC technologies. Long-term testing will continue on the transport reactor train and hot gas particulate controls for IGCC at the Wilsonville Power Systems Development Facility (PSDF). Operation of a product development unit for desulfurization will continue along with R&D and testing of other novel and advanced sulfur sorbents and systems for IGCC. Also at the Wilsonville facility, operation of an advanced PFB pilot scale module will be initiated. Systems and materials testing and evaluation for performance improvement and cost reductions for PFBC will also continue. In the advanced gas turbine program, DOE will complete full-scale component/subsystem testing and engine manufacturing, begin preparations for full speed

prototype testing, with the second turbine manufacturer of a new class of utility-scale gas turbines, and begin R&D on flexible mid-size gas turbines with unprecedented efficiencies and environmental performance

The other major part of Central Systems is Innovations for Existing Plants, which focuses on environmental control technology. The program continues efforts to develop advanced technologies for controlling fine particulates from power plants in response to the Environmental Protection Agency's revised Particulate Matter ($PM_{2.5}$) ambient standards for airborne particles. It also addresses concerns over mercury and other air toxic emissions by continuing to examine ways to capture these impurities before they escape into the atmosphere. The time frame for implementing these regulations will be between 2005 and 2010, and EPA has indicated that the primary target for control will be existing coal-fired powerplants. As a result, FY 2001 activities include a rapid scaleup of efforts to introduce lower cost technologies which are effective in controlling NOx, SO_2, and mercury, and which are appropriate for retrofit into existing powerplants. In the case of NOx and SO_2, the primary objective of the R&D will be cost reduction. 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. Finally, it should be noted that there are significant overseas markets for lower cost technologies to address NOx and SO_2, particularly in Asia. As part of the PCAST initiative, $4 million will be used to assist in the development of combined heat and power applications in key developing countries that will greatly reduce emissions compared to current practices. This activity would include small-scale technology applications (e.g., fluidized bed combustors, fuel cells) to demonstrate the viability of these approaches in different settings, and to familiarize potential users with the technologies.

Distributed Generation Systems are funded at $42.2 million, and 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. It could be used to provide clean power to remote end users and provide new business opportunities to both utility and non-utility owners. Under this program, fuel cell activities will continue R&D to reduce costs and improve performance for market-ready systems within three years. Testing will begin of a 300kW to 1 MW size market prototype solid oxide fuel cell at a commercial site for distributed power applications. International collaboration will be sought for research related to CO_2 capture and sequestration. It is particularly attractive since the level of international concern associated with climate change is high, the resources to address it are high, and most potential activities are at the pre-competitive stage. The fuel cells program will also focus on R&D to develop hybrid systems for Vision 21 as well as innovative concepts to dramatically reduce fuel cell fabrication costs.

Sequestration R&D is an emerging area of increased focus because the potential for greenhouse gas reduction, particularly carbon dioxide, is so large. Sequestration research will be done in collaboration with other parts of the Department, other government agencies, national laboratories, other countries, and industrial firms, and pursue a balanced set of approaches to establish both the environmental acceptability and the required technical and economic performance. The FY 2001 request of $19.5 million for Sequestration R&D expands the number of possible cost-effective applied R&D options carried to "proof-of-concept" completion under the 1998 "Novel and Advanced Concepts" awards. The long-term program goal is to achieve large-scale carbon sequestration at $10/ton, which would enable the reduction of carbon emissions by 100-500 million tons per year in the 2015-2030 time frame, with an impact on electricity prices to consumers of 0.1-0.2 cents per kilowatt-hour (less than 3%).

The request for Fuels R&D is $15.7 million, including support for the Ultra-Clean Transportation Fuels Initiative (UCTFI) discussed earlier. Technology development will continue for the coproduction of clean transportation fuels, chemicals and hydrogen in combination with clean power and heat, including the feasibility and research studies for the Early Entrance Coproduction plant. Also included is development of enabling technology for producing ultra-clean transportation fuels from coal and other feedstocks, and development of premium carbon products, environmentally preferred feedstocks, resource reclamation, and pre-combustion control of air toxics. Activities with longer-term payoffs will be carried out under the Advanced Fuels Research activity and emphasize the scientific underpinning for ultra-clean fuels, novel hydrogen storage and separation technology.

The Advanced Research program, for which $27.0 million is requested, serves as a bridge between fundamental research and engineering development. A major focus is research directed at overcoming crosscutting technical barriers that would prevent advanced power or fuel systems from progressing to commercialization. Sequestration research includes a broad range of physical, chemical and biological options, which will be done in collaboration with other parts of the Department, other government agencies, national laboratories, other countries, and industrial firms. In FY 2001 Fossil Energy will initiate development of biological CO_2 sequestration by conversion into useful products such as liquid fuels. Also included is funding to increase NETL in-house core capabilities to carry out advanced research in areas such as development of materials supporting Vision 21, and pursuit of a "virtual demonstration" capability to reduce the need for expensive hardware testing. Increasing in-house core capabilities will also lead to increased recognition by the global research community of NETL as a center of excellence for research relating to energy plants of the future, thus creating greater opportunities for meaningful international collaboration.

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. Increased economic activity associated with advanced coal and power system technologies could exceed $50 billion per year after 2010 and lead to over one-half million new jobs in the U.S.

Natural Gas Technologies

In FY 2001, $38.8 million is requested for Natural Gas Technologies, which includes activities to help ensure that future domestic gas supplies are adequate and reasonably priced. EIA, in its 2000 Annual Energy Outlook (AEO99), projects a 45 percent increase in domestic natural gas consumption by 2020, with 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 and related research in DOE's Office of Energy Efficiency and Renewable Energy, and Office of Science. 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; Emerging Processing Technology; and Effective Environmental Protection.
The Exploration and Production request for FY 2001 is $12.4 million, and includes a broad range of activities, foremost of which are:

- 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. These technologies are expected to contribute gas reserves of 13 Tcf by 2010.

- Advanced Diagnostics and Imaging Systems technology development to improve seismic and other geophysical acquisition, processing, and interpretation. 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. Advanced diagnostics and imaging systems projects are expected to contribute gas reserves of 7 Tcf by 2010.

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The $2.0 million Gas Hydrates program seeks to convert the potential gas hydrates resource (estimated at up to 320,00 Tcf) into gas reserves while developing technologies to assure safe petroleum operations in hydrate areas, and define the role of methane hydrates in global climate.

A $13.2 million Infrastructure R&D program is under development to enhance energy system reliability and deliverability with the Nation's natural gas pipelines and gas storage facilities. This initiative is motivated by increasing concern about the integrity of the gas delivery and storage infrastructure, which is one of the critical barriers to achieving 30 TCF domestic consumption projected by 2015 given the age of the existing pipelines, declining public benefit "R&D" by industry for enhancing pipeline infrastructure, and uncertain regulatory climate and lead times required for new pipeline construction. Research will focus on ensuring the reliability and optimization of the gas transmission and distribution network and developing advanced storage technologies for high deliverability facilities; advanced materials and enabling technology for longer life, high-strength, non-corrosive pipeline; an obstacle detection systems for horizontal boring applications in distribution pipe; a pipeline leak and intrusion detection system using optical methods; pipeline inspection sensors with internal leak sealing capabilities; and portable methane leak detection systems for real-time visualization of gas pipeline systems. Studies will also be conducted on the overall reliability of the system in its increasing integration with the electric grid.

The Emerging Processing Technologies request is $8.5 million and includes gas-to-liquids test operations and initiation of design to scale-up the ceramic membrane reactor. This industry co-funded project, if successful, will be a breakthrough for converting gas to liquid fuel at competitive economics with oil-based fuels, and could extend the life of the Trans-Alaska oil pipeline and lead to additional Alaska North Slope oil production. This technology will also allow remote and deep-water gas to be converted to transportable liquid fuels and petrochemicals, and provide a source of ultra-clean diesel fuels that have environmental and efficiency benefits over petroleum-derived diesel. These activities are part of the UCTFI discussed earlier. The Emerging Processing Technologies program also includes developing more efficient processes to upgrade the estimated 300 Tcf of domestic natural gas resources that are low-quality and do not meet pipeline standards.

The Effective Environmental Protection program request is $2.6 million, and addresses detection and control of air emissions from gas equipment and facilities, treatment 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, and other approaches to manage 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 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 2001, $52.6 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. Marginally economic wells with high remaining resource potential, but low profitability, are being abandoned at an alarming rate. The cumulative impact is that tens of billions of barrels of oil may never be economically producible. The combined impact of FE R&D could contribute toward preserving the availability of these resources, extending reservoir life, and increasing domestic production by nearly 370 million barrels/year (including gas liquids) by 2010, offsetting equivalent amounts of imports.

Objectives of the oil technology program include: stop 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, Effective Environmental Protection, and Ultra-Clean Fuels.

The FY 2001 request for Exploration and Production is $20.8 million, which includes work in several areas:

- 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.)

- 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.

- Multi-National Lab/Industry Partnership and National Laboratory Supporting R&D is an industry-driven program utilizing a wide range of technologies to effectively recover more of the most difficult oil to recover.

- 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.

The Reservoir Life Extension and Management program request is $11.1 million to coordinate oil technology activities in research, development, and demonstration of advanced technologies for extraction of hydrocarbons from known (discovered) oil reservoirs. Activities include: improving technology and/or methods to recover more of the 350 billion barrels of discovered but unproduced domestic oil resource; and funding for laboratory research and evaluation of past advanced field trials directed to incremental recovery potentials in large, promising Class 1, 2, and 3 reservoirs. In FY 2001, $2.0 million has been included in the reservoir life extension and management area for a preferred "Petroleum Upstream Management Practices (PUMP) Program" aimed at stopping the decline in domestic oil production by 2005, which is a key strategy in the April 1998 Comprehensive National Energy Strategy. PUMP is designed to provide a short-term supplement to mid- and long-term R&D and will focus on three technology areas: advanced oil recovery; data management; and effective environmental compliance. PUMP will use known technology transfer mechanisms, regional approaches, and integrated solutions to technology, regulatory, and data constraints.

The Effective Environmental Protection request is $10.7 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. In FY 2001, the program will focus on detection and control of air emissions from gas and oil equipment and facilities, treatment 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. Activities also include identification of pollutants present in petroleum and development of technologies to prevent their formation and to reduce emissions from petroleum fuels. Also, the program will implement, together with states and industry, on-line expert systems for environmental permitting and reporting that can save both producers and state regulators time and money.

Funding of $10.0 million is requested to initiate an Ultra-Clean Fuels program, which is under the UCTFI described earlier. Manufacturing costs, impurity removal limitations, molecular chemistry, conversion catalysts, feedstock variables in impurity content, and vehicle engine performance are just six of many of the factors that must be addressed in the making of fuels far cleaner in

performance than present-day gasoline and diesel fuels. Industry-government projects, based on a solicitation will be initiated to demonstrate, advanced fuel-making processes at pre-commercial scale, generating sufficient advanced fuel to enable engine/fuel verification testing.

External Inputs to FE Program Planning

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

- 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.

- The June 1999 PCAST report "Powerful Partnership – 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.

- Industry groups, particularly formal advisory groups such as the National Coal Council and National Petroleum Council, 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.

- The National Research Council in 1995 provided a strategic assessment of the U.S. Department of Energy's coal programs.
- Public input is obtained through workshops on various topics held throughout the year.

Other Program and Crosscutting Areas

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 2001 funding at a level of $9.0 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 2001 request for Program Direction and Management Support is $75.1 million. The FY 2001 request recognizes the important role of the National Energy Technology Laboratory in the FE program and the need to fund the sites at a level consistent with program goals. FE also promotes the development of interfuel competition and markets for U.S. natural gas and electricity through regulation of natural gas imports and exports and electricity exports by the $2.3 million Fuels Program.

Consistent with the R&D goals of the Department, the Advanced Metallurgical Processes Program at Albany, Oregon, which was formerly associated with the U.S. Bureau of Mines, is being directed at research to provide life-cycle information for materials produced from minerals. The FY 2001 request for this program is $5.2 million. The program will be coordinated with not only Fossil

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Energy materials R&D but also the materials research at DOE's Office of Energy Efficiency and Renewables and Office of Science. With this coordination, the Department will avoid a duplication of effort and also take full advantage of the unique expertise at the Albany Center which has focused on the full life cycle of materials. The program at Albany will stress full participation with industry and emphasize cost sharing to the extent possible.

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PROGRAM FUNDING PROFILE

Activity	FY 1999 Enacted	FY 2000 Enacted	FY 2001 Base	FY 2001 Request	Program Change Request vs. Base Dollar	Program Change Request vs. Base Percent
Coal and Power Systems						
Central Systems						
Operating Expenses	$121,812	$115,257	$115,257	$89,364	$-25,893	-22%
Distributed Generation Systems						
Operating Expenses	$43,069	$44,499	$44,499	$42,200	$-2,299	-5%
Sequestration						
Operating Expenses	$5,825	$9,217	$9,217	$19,500	$10,283	112%
Fuels						
Operating Expenses	$16,710	$20,275	$20,275	$15,700	$-4,575	-23%
Advanced Research (formerly AR&TD)						
Operating Expenses	$19,630	$23,195	$23,195	$27,021	$3,826	16%
Subtotal Coal and Power Systems	$207,046	$212,443	$212,443	$193,785	$-18,658	-9%
Gas						
Natural Gas Research						
Operating Expenses	$25,948	$31,597	$31,597	$38,750	$7,153	23%
Subtotal Gas	$25,948	$31,597	$31,597	$38,750	$7,153	23%

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

Activity	FY 1999 Enacted	FY 2000 Enacted	FY 2001 Base	FY 2001 Request	Program Change Request vs. Base Dollar	Program Change Request vs. Base Percent
Petroleum						
Oil Technology						
Operating Expenses	$47,344	$57,252	$57,252	$52,569	$-4,683	-8%
Subtotal Petroleum	$47,344	$57,252	$57,252	$52,569	$-4,683	-8%
Program Direction and Management Support						
Operating Expenses	$69,481	$75,479	$75,479	$75,064	$-415	-1%
Plant and Capital Equipment						
Construction	$2,600	$2,600	$2,600	$2,000	$-600	-23%
Fossil Energy Environmental Restoration						
Operating Expenses	$11,000	$10,000	$10,000	$9,041	$-959	-10%
Cooperative Research and Development						
Operating Expenses	$6,657	$7,389	$7,389	$5,836	$-1,553	-21%
Fuels Program						
Operating Expenses	$2,173	$2,173	$2,173	$2,300	$127	6%
Advanced Metallurgical Processes						
Operating Expenses	$5,000	$5,000	$5,000	$5,225	$225	5%
Transfer from Biomass						
Operating Expenses (non-add)	$0	($-24,000)	($-24,000)	$0	($-24,000)	-100%

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

Activity	FY 1999 Enacted	FY 2000 Enacted	FY 2001 Base	FY 2001 Request	Program Change Request vs. Base Dollar	Program Change Request vs. Base Percent
Prior Year Offsets						
Operating Expenses	$-740	$0	$0	$-9,000	$-9,000	0%
TOTAL FY 2001 Request at Target	$376,509	$403,933	$403,933	$375,570	$-28,363	-7%
Summary						
Operating Expenses	$373,909	$401,333	$401,333	$373,570	$-27,763	-7%
Construction	$2,600	$2,600	$2,600	$2,000	$-600	-23%
Total Program	$376,509	$403,933	$403,933	$375,570	$-28,363	-7%
Staffing (FTEs)						
Headquarters	115	125	125	130		
Field	541	560	560	575		
Total Staffing	656	685	685	705		

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

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SUMMARY OF CHANGES

	FY 2001 Request
FY 2000 Appropriated	$403,933
- Non-Discretionary	0
FY 2001 Base	$403,933
Central Systems	
- Innovations for Exiting Plants (Formerly AR&ET) - The increase will support development of fossil fuel combustors with ultra clean NO_x emissions under the Vision 21 program and initiate a program aimed at optimizing the performance of coal-fired power plants in China and Turkey	+3,554
- Advanced Systems-Low Emission Boiler System (LEBS) - The decrease completes funding for Phase IV which will conclude with the construction and operation of proof-of-concept (POC) facility using prior year funds	-2,000
- Advanced Systems-Indirect Fired Cycle - The decrease provides for development of concepts to serve as a combustion technology for Vision 21	-5,010
- Advanced Systems-Integrated Gasification Combined Cycle - The decrease will continue operations at the Wilsonville PSDF and development of the transport gasifier; continue development of the CO_2 Hydrate Process for CO_2 sequestration and development of MSW processing techniques	-3,232
- Advanced Systems-Pressurized Fluidized Bed - The decrease will continue research to fully integrate operation of the Advanced Pressurized Fluidized Bed pilot scale project at the Wilsonville Power System Development Facility and continue engineering of design concepts to serve as a combustion technology for Vision 21	-1,017

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

- Turbines - The decrease continues the ultra high efficiency gas turbine technology program; full speed no load testing and development of high efficiency gas turbines for electric power generations; devellpment of flexible mid-size turbines; and development of technologies for fuel cell/engine hybrid systems in the Vision 21 program -18,188

Distributed Generation Systems

- Fuel Cells-Advanced Research - The increase continues research on molten carbonate and solid oxide systems to lower costs, investigate advanced processes and designs, and to solve fundamental crosscutting materials and design issues +1,600

- Fuel Cells-Fuel Cell Systems - The decrease continues system/stack improvement efforts on one full molten carbonate fuel cell system; continues supporting assessments and studies; and continues industry cost-shared cost reduction and product improvement research -15,263

- Fuel Cells-Vision 21 Hybrids - The increase provides for a Vision 21 enabling cost reduction and performance enhancement program including fuel cell/heat engine systems +9,864

- Fuel Cells-Innovative Systems Concepts - The increase continues activities leading to development of innovative low cost, 21st Century fuel cells +1,500

Sequestration R&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 +10,283

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

Fuels

- Transportation Fuels and Chemicals - The increase continues bench scale research on advanced liquefaction and waste/coliquefaction studies; oxygenate catalyst and reactor studies; and syngas polishing and integrated studies +1,925

- Solid Fuels and Feedstocks (Formerly Coal Preparation) - The increase provides for continuing research on methods for coal cleaning to product premium fuels, reduction of air toxic precursors, high efficiency processes development, conduct research on advanced separation technologies, and conduct testing to assist in the successful introduction of U.S. coal utilization into international markets +200

- Steelmaking - Funding for this program is not requested in FY 2001 -6,700

- Advanced Fuels Research (Formerly AR&ET) - The funding continues research on coprocessing of coal with waste material, improved methods for characterizing coal-derived liquids and advanced catalytic approaches to coal liquefaction, developing concepts for producing and studying carbon materials, laboratory scale research on producing liquid transportation fuels and chemicals 0

Advanced Research (Formerly AR&TD)

- Coal Utilization Science -The decrease provides for continued research toward the Grand Challenges of the Virtual Demonstration Plant and CO2 capture, sequestration, and offset, in support of the Vision 21 concept of a power and fuels complex -1,000

- Materials - The increase provides for continued program development efforts on high temperature intermetallics, ceramic composites and high temperature filters, membranes, and solid state electrolyte functional materials. +350

- 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 +505

- Bioprocessing of Coal - The funding provides for the development of biological processes to sequester CO_2 by natural mitigation strategies and ongoing bioprocessing efforts 0

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

- Environmental Activities - The funding continues environmental analyses of air and water quality, solid waste disposal, toxic substance releases, and global climate change 0

- Technical and Economic Analysis - The decrease 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 -29

- International Program Support - The funding 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 0

- International Capacity Building - The increase will develop and implement policy, programs and technology transfer aimed at improving the efficiency of coal-fired power systems to address the emerging electrification needs of developing nations +1,000

- Center for Excellence - The increase will enhance the capability to model and conduct dynamic stimulations of advanced energy plants +3,000

- University Coal Research - The funding continues support for university research and undergraduate internship programs 0

- HBCUs, Education and Training - The funding continues efforts to accelerate workforce diversity in fossil fuel related technologies 0

Natural Gas Technologies

- Exploration and Production - The funding continues a cooperative drilling program with industry; research and field demonstrations in low-permeability reservoirs; development of a natural gas data base and atlases; gas technology transfer efforts; continue diagnostics to characterize gas hydrate deposits; and conduct engineering assessments to determine candidate areas for restimulation tests -1,822

- Gas Hydrates - The decrease continues resource characterization and seismic survey activities -960

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

- Infrastructure - The increase expands the storage technology effort, initiates research directed toward enhancing the U.S. gas infrastructure, and initiates efforts to evaluate and enhance international gas infrastructures +12,200

- Emerging Processing Technology - The dencrease continues assessments of gas conversion feasibility; support for an international center or information on natural gas technologies; and research in low-quality gas upgrading -1,668

- Effective Environmental Protection - The decrease continues environmental research including data analysis, risk assessment, application of advanced research, technology development, and continues outreach and technology transfer program on environmental issues related to natural gas -597

Oil Technology

- Exploration and Production Supporting Research - The decrease continues efforts in advanced drilling, completion, and stimulation (ADCS), advanced diagnostics and imaging systems (ADIS), national lab/industry partnership, reservoir efficiency processes, and analysis and planning at a reduced level -7,608

- Reservoir Life Extension/Management - The decrease continues efforts in recovery field demonstration projects including revisit of classes 1-3 and increased production from marginal wells, technology transfer, and the preferred upstream management practices (PUMP) effort at a reduced level -3,628

- Effective Environmental Protection - The decrease reduced efforts in environmental regulatory review, and risk assessment -117

- Emerging Process Technology Applications - No funding is provided for biodesulfurization of diesel fuel -3,330

- Ultra Clean Fuels - The increase initiates research to develop technology to overcome current limitations for making very low sulfur, clean-burning fuels +10,000

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

Program Direction and Management Support

- Headquarters Salaries and Benefits - The increase provides for 110 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 +1,038

- Headquarters Travel - The funding provides for travel in support of the activities stated above. Both domestic and international travel are conducted 0

- Headquarters Contract Services - The decrease 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 -87

- Field Salaries and Benefits - The increase provides funds for 339 FTEs at the National Energy Technology Laboratory (NETL) and the National Petroleum Technology Office (NPTO). 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 +1,933

- Field Travel - The increase provides funds for travel in support of the above stated activities in the attainment of program goals, both on the domestic front and abroad +101

- Field Contract Services - The decrease provides funds for facility operations, maintenance, finance automated office support service, administrative, management and technical support -3,400

Plant and Capital Equipment

- Construction - The decrease provides for general plant projects at the National Energy Technology Laboratory, the National Petroleum Technology Office, and the Albany Research Center -600

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

Cooperative Research and Development	
- Cooperative Research and Development - The funding provides for continued research and UNDEERC and WRI	-1,553
Fossil Energy Environmental Restoration	
- CERCLA Remedial Actions - The increase 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 NETL-PGH former liquefaction site; and assessment/site investigations of inactive projects	+578
- RCRA Remedial Actions - The decrease provides for continued on-site remediation activities	-357
- Other ES&H Actions - The decrease provides for continuing recurring ES&H activities at the NETL sites	-1,180
Import/Export Authorization	
- Import/Export Authorization - The increase provides for the salaries and benefits of 20 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	+127
Advanced Metallurgical Processes	
- Advanced Metallurgical Processes - The increase continues research on extending the service life on materials while addressing ways to improve environmental impact of hazardous materials paths and processes	+225
Use of Prior Year Balances	-9,000
FY 2001 Congressional Budget Request	$375,570

DEPARTMENT OF ENERGY
FY 2001 CONGRESSIONAL BUDGET REQUEST

FOSSIL ENERGY RESEARCH AND DEVELOPMENT

CENTRAL SYSTEMS

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

Traditionally, electric power generation generally implies large-scale production of electric power in stationary plants that are normally 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. Although the impending deregulation and restructuring of the utility industry will accelerate the adoption of distributed power generation, centralized power systems will continue to be needed as the value of electricity's capabilities continue to grow. The Central Systems program is using technical innovation to develop advanced power systems, utilizing coal--our most abundant domestic fuel--with the capability of creating centralized power systems that can meet current requirements for higher efficiency and environmental protection and serve as building blocks to ensure sustainable development in the 21st century. In addition, as part of Central Systems, development of utility-size high efficiency gas turbines along with advanced medium-size turbine development will enable the efficient, clean use of natural gas as well as providing the key power modules for both coal and gas power systems for the 21st Century.

There is a growing national need for increased electricity and reduced emissions from electric power generation plants. 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, 2000).

As part of the current core DOE Fossil Energy R&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. Different kinds of power systems are being developed, each based on a different technology: advanced pulverized coal combustion; gasification combined cycle; pressurized fluidized bed combustion; indirect fired cycles; advanced turbine systems; and fuel cells in combination with turbines as a

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

hybrid power module. Each technology development effort has its own set of objectives and time schedules for development and deployment.

To achieve radical improvements in the performance of fossil fuel-based power systems and to virtually eliminate environmental issues as a barrier to fossil fuel use will require a new paradigm for the continuing development of both technology and systems that incorporate the technology. Any of the technologies under development cannot individually achieve the efficiency, environmental, and cost goals that will be needed in the early decades of the 21st century. Rather, we need a new approach that allows us to integrate power and fuel system "modules" into systems that achieve the performance and cost goals needed to address the coming challenges. The new approach that we propose is called "Vision 21".

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

Innovations for Existing Plants - This subprogram involves supporting crosscutting activities that are essential to the development of 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. Environmental Technology crosscutting efforts address the cost-effective removal of pollutant causing contaminants from fossil fueled systems. It focuses on the development of super clean emissions control technology (greater than 95% reduction) for SO_2, 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 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 2001 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.

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

There is a growing concern worldwide over climate change emissions and the role they play in global warming. The International Power Plant Efficiency project would identify and execute a range of measures that could optimize the performance of exiting coal-fired power plants in China and Turkey. Forecasts in these countries indicate a substantial increase in coal use over the next decade and beyond. Much of this increase will be for electricity generation. Increasing power plant efficiency at existing power stations offers considerable promise of reducing CO_2 emissions. Substantial experience and know-how in the U.S. about optimization of power plant performance can be transferred. In addition, where opportunities exist, performance optimization will center on combined heat and power (CHP) applications, to dramatically increase overall utilization efficiency to fulfill the total energy needs.

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. Advanced Pulverized Coal-Fired systems should achieve early market entry enhancing the export potential for these technologies. Target performances are system efficiencies of 42% and SO_2 and NO_x emissions less than 1/6 the Environmental Protection Agency's New Source Performance Standards (NSPS). The LEBS technologies that include low NO_x slagging combustion, an advanced sorbent process for simultaneous SO_2 and NO_x removal, and high temperature materials development will become the base technologies for Vision 21.

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 pyrolzer which integrates combustion, heat transfer and emission control processes. The first generation HIPPS will have system efficiencies around 47% and emission levels less than 1/10 NSPS. More advanced systems will be capable of achieving system efficiencies greater than 47%, and will dramatically reduce carbon dioxide emissions levels and help mitigate global climate change. The very low pollutant emissions will enable the utility sector to better respond to projected growth in electricity demand while complying with the SO_2 emissions cap set by the Clean Air Act Amendments of 1990. In FY 2001, the major thrust will be a continuation of Phase II engineering development of concepts selected in FY 1995, and to serve as a combustion technology for Vision 21. The High Temperature Advanced Furnace (HITAF) is an important component supporting Vision 21. It is needed to achieve the high efficiency performance goal in Vision 21.

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

Integrated Gasification Combined Cycle - The objective of the IGCC program is to foster the development and commercialization of fuel flexible gasification-based processes for converting carbon-based feedstocks to electricity, steam, fuels, chemicals, or hydrogen. Compared with today's technologies, IGCC offers the potential for significant increases in thermal efficiency as well as significant reductions in capital costs and emissions of hazardous air pollutants. In addition, IGCC is an advanced power generation technology capable of co-producing 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 of these advanced gasification systems and to improve both the reliability and the overall system availability, while targeting efficiencies of at least 52% and reducing environmental emissions well below 1/10 NSPS. In FY 2001, the program will continue its focus on cost improvement techniques and performance optimization of IGCC for power generation and co-production applications; gas stream purification and the monitoring and control of hazardous air pollutants; and the development and demonstration of technologies for reducing greenhouse gas emissions. The IGCC 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, as well as provide technologies for the coproduction of power and other valuable commodity products.

Pressurized Fluidized Bed (PFB) - PFB systems have several advantages 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 as a consequence of low combustion temperatures. Combustion efficiency and SO_2 /NO_x control are all enhanced by application of pressure. The PFB program is directed toward developing systems with efficiencies approaching 45% with SO_2 and NO_x levels of 1/5 NSPS and conducting research to further improve the efficiency of the PFB systems over 52% with SO_2 and NO_x levels of 1/10 NSPS. The thrust of the research is in hot gas particulate filtration, critical to advanced PFBC systems, and improvements in the subsystems and the interfaces thereof to enhance system efficiency and reduce cost and pollutant emissions necessary for market entry. These activities are basic components, that along with the identified Vision 21 funding, support the Advanced Research and Sequestration Centers of Excellence. In FY 2001, major emphasis will be on fully integrated operation of the Advanced Pressurized Fluidized Bed pilot scale project at the Wilsonville Power System Development Facility and continuation engineering of design concepts to serve as a combustion technology for Vision 21. This project also directly supports PFB technology for commercial scale-up.

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

Advanced Turbine Systems (ATS) - Manufacturers' projections suggest that greater than 70 percent of all new power generation equipment installed in the U.S. after the year 2000 will be derived from the ATS program. This represents a domestic market as large as $5 billion per year after the year 2000. ATS will be among the lowest cost producers of electricity which could result in an estimated $7.0 billion in electric consumer savings by the year 2015.

- **Growing Environmental Concerns:** There is a growing concern worldwide over climate change emissions and the role they play in global warming. ATS provides the cleanest fossil fueled central power generation option which will be commercially available by the year 2002. With emissions of 0.2 lb/MW-hr of nitrogen oxides and 750 lb/MW-hr of carbon dioxide emissions, ATS will save billions of dollars in environmental compliance while significantly reducing greenhouse gases.

- **Enhancing the U.S. Industrial Competitiveness:** Currently U.S. turbine manufacturers annually export more than $3 billion worth of power generation systems. Maintaining the U.S. technological lead in gas turbines will provide for increased exports and enhance our industrial competitiveness.

Two vendors are developing the utility ATS, General Electric Company (GE) and Siemens-Westinghouse Electric Corporation (SWEC). The GE and Siemens-Westinghouse Advanced Turbine Systems Combined Cycle promises improved economics of electric power generation with outstanding environmental performance for natural gas and coal-fired applications, achieving 60% efficiency, single digit Nitrogen Oxide (NOx) levels, and a 10 percent reduction in the cost of electricity compared to current systems. The ATS is expected to be commercialized by the year 2002. This advanced combined-cycle turbine system is also the foundation for power modules of the Vision 21 energy plants. Although the introductory fuel is natural gas, the ATS will be adaptable to coal and biomass firing.

Under the ATS program, technology base research and development is being conducted to support development of the ATS and maintain U.S. leadership in the gas turbine industry. Under this program, the following activities are ongoing: an industry/university program to support university student internships and collaborative projects and workshops on combustion, materials and heat transfer; U.S. DOE - National Energy Technology Laboratory combustion R&D; development of advanced processes for ATS component manufacturing; and evaluation of humid air turbine applications. Also, studies which will define the next generation turbine system will be completed during FY 2000-2001. DOE is initiating R&D studies to evaluate potential Flexible Gas Turbine System concepts,

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

market applications, public benefits, technical risk, and development needs in order to identify the priority R&D areas that will be undertaken in FY 2001.

Many of the advanced, coal-fired power generation technologies currently being developed or demonstrated incorporate gas turbines. These include integrated gasification combined cycles, advanced pressurized fluidized bed combustion, and indirectly fired systems. Systems where injected moisture can boost both power and efficiency include the Integrated Gasification Humid Air Turbine. The Coal and Biomass Application element of the program will address the transfer of technology developed under the ATS program to advanced coal and biomass based systems. Systems studies are being performed by the major turbine manufacturers to evaluate the adaptability of the systems for coal and biomass systems.

Vision 21 is an extension or continuation of ongoing R&D to lower the cost and improve the environmental performance and efficiency of coal plants that 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), 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 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 included 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.

The requested funding would be used to perform system studies that would define R&D needs for high performance and low cost integration of hybrid sub-systems such as gasification, fuel cells and advanced turbines in Vision 21 configurations.

The Central Systems Program supports the Office of Fossil Energy Integrated Natural Gas Center for Excellence and the Advanced Research Center of Excellence. Gas fueled turbine systems will play a major role in providing clean, affordable new and replacement

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

capacity in the U.S. over the next twenty years. Vision 21 systems developed will contribute to the long term R&D needed to achieve zero emissions, ultra high efficiency coal power plants for the post year 2015 timeframe in the U.S.

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.

FY 2001 Performance Measures in furtherance of the above goals include:

- Complete testing and prepare a report of results evaluating the performance of Selective Non-Catalytic Reduction NOx technology on the Cardinal powerplant. This technology is one of a suite of options which FE, in partnership with industry, has developed to facilitate lower-cost compliance with EPA regulations requiring reductions in NOx emissions to the atmosphere from existing coal-fired powerplants by 2003.
- Deliver to EPA a high quality report on the ambient $PM_{2.5}$ levels in the upper Ohio River Valley, including areas from Ohio, Pennsylvania, and West Virginia. This activity helps DOE focus control technology R&D on the most critical pollutants.
- Provide a tailor-made sorbent capable of controlling all forms of mercury present in coal combustion flue gases for pilot-scale testing. By December 2000, EPA is required to determine if mercury emissions from electric steam generating units should be regulated, and if so, to adopt regulations by December 2003. Mercury control concepts that can remove both elemental and oxidized forms of mercury from utility flue gases will be required if regulations are promulgated.

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

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

FY 2001 Performance Measures in furtherance of the above goals include:

- Complete initial tests of the IGCC transport gasifier in an air-blown mode; prepare a report of results; and evaluate performance to confirm the feasibility of the technology to significantly improve the long-term goals of greater reliability, cost effectiveness, and improved efficiency compared to existing technologies. Conduct tests of the unit in an oxygen-blown mode to demonstrate further improvements in performance and to allow for the concentration of CO_2 to achieve the goals of Vision 21.
- Demonstrate the feasibility of effectively separating hydrogen and CO_2 from syngas using both high-temperature hydrogen separation membranes and low temperature CO_2 hydrate technology to meet the long-term goals of providing low-cost hydrogen for high-efficiency fuel cells and for providing concentrated CO_2 streams for sequestration.
- Complete full speed no load testing of GE's 7H-ATS turbine and deliver 7H turbine to Sithe site. Deliver final report to the DOE on ATS program accomplishments and demonstration site testing. Complete production nozzle low cycle fatigue tests. (Note: DOE is not paying for construction/and demonstration which would be initiated at the Sithe Heritage Demonstration site for 7H ATS in FY 2001)
- Continue engine design, manufacturing tooling, and engine process development of the Siemens-Westinghouse turbine. Complete manufacturing of ATS turbine vanes and initiate field test for the 501 GS, the 59% efficient (LHV) combined cycle power plant. The 501GS is the Siemens-Westinghouse pre-product leading to the development and testing of the 501 ATS, targeted for FY 2002.

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

Activity	FY 1999	FY 2000	FY 2001	$Change	%Change
Innovations for Existing Plants (Formerly AR&ET)	$12,923	$14,646	$18,200	$3,554	24%
Advanced Systems					
Low-Emission Boiler System (LEBS)	14,608	2,000	0	-2,000	-100%
Indirect Fired Cycle	6,359	7,010	2,000	-5,010	-71%
Integrated Gasification Combined Cycle	30,168	35,211	31,979	-3,232	-9%
Pressurized Fluidized Bed	14,356	12,202	11,185	-1,017	-8%
Turbines	43,398	44,188	26,000	-18,188	-41%
Subtotal, Advanced Systems	108,889	100,611	71,164	-29,447	-29%
Total, Central Systems	$121,812	$115,257	$89,364	$-25,893	-22%

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

	FY 1999	FY 2000	FY 2001	$Change	%Change
Oak Ridge National Lab	$1,700	$2,181	$1,700	$-481	0%
Argonne National Lab (East)	1,581	731	700	-31	-4%
Los Alamos National Lab	0	850	973	123	14%
National Energy Technology Laboratory	15,879	14,707	12,911	-1,796	-12%
All Other	102,652	96,788	73,080	-23,708	-24%
Total, Central Systems	$121,812	$115,257	$89,364	$-26,016	-23%

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

Activity	FY 1999	FY 2000	FY 2001
Innovations for Existing Plants (Formerly Advanced Research and Environmental Technology)	Super Clean Systems: Continue ongoing NO_x control projects. ($1,440) (TBD)	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. ($2,500) (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. ($2,000) (TBD)
	Fine Particulate Control/Air Toxics: Continue, at a reduced level, to improve measurement characterization techniques for toxic emissions from powerplant sites; and ongoing projects to optimize mercury control technologies for both cost-effectiveness and efficiency; develop lower-cost retrofit fine particulate control technology to meet pending new standards. ($6,545) (TBD)	Fine Particulate Control/Air Toxics: Improve measurement 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. ($7,150) (TBD)	Fine Particulate Control/Air Toxics: Determine and model 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. ($6,218) (ATS, TBD)

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

Activity	FY 1999	FY 2000	FY 2001
Innovations for Existing Plants (Formerly Advanced Research and Environmental Technology) (Cont'd)	In-House: Continue in-house research and support in the areas of super clean emissions control, air toxics and fine particulate control, and CO_2 control. Provide for customer service and business activities. ($3,076) (NETL, BRSC)	In-House: Conduct supporting research in by-product characterization in areas such as emissions control, air toxics and fine particulate control, and CO_2 control and provide for customer service and business activities. ($3,300) (NETL, BRSC)	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. ($3,300) (NETL, TBD)
	Waste Management:		
	Continue environmental monitoring of completed projects involving advanced power generation technology byproducts at disposal and acid mine drainage abatement sites. ($102) (TBD)	This activity is included in the overall in-house effort above. ($0)	This activity is included in the overall in-house effort above. ($0)
	Continue in-house characterization of coal utilization byproducts and maintenance of related data bases. ($108) (NETL)	This activity is included in the overall in-house effort above. ($0)	This activity is included in the overall in-house effort above. ($0)

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

Activity	FY 1999	FY 2000	FY 2001
Innovations for Existing Plants (Formerly Advanced Research and Environmental Technology) (Cont'd)	Conduct joint industry/ government R&D activities to maximize use of coal utilization combustion byproducts; develop 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. ($1,520) (TBD)	Conduct joint industry/ government R&D activities to maximize use of coal utilization combustion byproducts; develop 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. ($1,550) (TBD)	Conduct joint industry/ government R&D activities to maximize use of coal utilization combustion byproducts; develop 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. ($1,550) (TBD)
	No activity. ($0)	No activity. ($0)	Vision 21: Develop advanced fossil fuel combustors with ultra-low NO_x emissions characteristics. ($990) (TBD)

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

Activity	FY 1999	FY 2000	FY 2001
Innovations for Existing Plants (Formerly Advanced Research and Environmental Technology) (Cont'd)	No activity. ($0)	No activity. ($0)	**International Clean Energy Initiative**: Transfer best practice of optimizing the performance of coal-fired power plants for mitigation of climate change gases, and where opportunities exist to configure these systems for combined heat and power applications to dramatically increase the overall utilization efficiencies. Further develop technology collaboration and business opportunities between Chinese, Turkish and U.S. organizations. Develop improvements in performance by

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

Activity	FY 1999	FY 2000	FY 2001
Innovations for Existing Plants (Formerly Advanced Research and Environmental Technology) (Cont'd)			better plant control as opposed to additional investment of any significant kind. Develop measures to improve the study of plant efficiency covering the boiler and ancillary plant (coal quality, mills, steam turbines, condensing plants, etc.) Study availability issues including review of operational and maintenance procedures. Identify measures to reduce SO_x and NO_x. Disseminate results from U.S. R&D program throughout China and Turkey, including utilities, and organizations concerned with environmental protection via publications, workshops and seminars. ($3,960) (TBD)
	Fund technical and program management support. ($132)	Fund technical and program management support. ($146)	Fund technical and program management support. ($182)
	$12,923	$14,646	$18,200

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

Activity	FY 1999	FY 2000	FY 2001
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. Provide NEPA requirements. Implement customer service activities. ($14,458) (DB Riley, ORNL, TBD)	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. ($1,980) (DB Riley, TBD)	Continue Phase IV, with prior year funds, which includes the construction and operation of a proof-of-concept facility. Continue development of the copper oxide process by testing a 10 MWe module. 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)
	Fund technical and program management support. ($150)	Fund technical and program management support. ($20)	Fund technical and program management support. ($0)
	$14,608	$2,000	$0

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

Activity	FY 1999	FY 2000	FY 2001
Advanced Systems-Indirect Fired Cycle	Refocus HIPPS development on those components and subsystems that are part of the Vision 21 plant. ($4,768) (Foster-Wheeler, UTRC)	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. ($5,940) (Foster-Wheeler, UTRC, NETL, TBD)	Activity included below.
	Continue NETL in-house research on combustion mechanisms and pollutant formation/suppression/ removal in highly turbulent flows for application to HIPPS technology ($1,100). Project management ($376). Customer service ($50). (Total $1,526) (NETL, TBD)	In-house support included above.	In-house support included below.

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

Activity	FY 1999	FY 2000	FY 2001
Advanced Systems-Indirect Fired Cycle (Cont'd)	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. ($1.980) (Foster-Wheeler, UTRC, NETL, TBD)
	Fund technical and program management support. ($65)	Fund technical and program management support. ($70)	Fund technical and program management support. ($20)
	$6,359	$7,010	$2,000
Advanced Systems-Integrated Gasification Combined Cycle	Continue development of the transport-bed gasifier and associated hot gas particulate control devices at the Wilsonville Power Systems Development Facility (PSDF). Begin design activities for the construction of a fluid-bed desulfurization reactor (20% cost share). ($9,610) (SCS)	Activity included under Gasification Systems Technology.	Activity included under Gasification Systems Technology.

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

Activity	FY 1999	FY 2000	FY 2001
Advanced Systems-Integrated Gasification Combined Cycle	Continue PDU operation of NETL's novel fluid-bed/transport reactor to evaluate desulfurization process concepts and sorbents. ($3,100) (NETL, TBD)	Activity included under Gasification Systems Technology	Activity included under Gasification Systems Technology
	Continue R&D and testing to develop high capacity, regenerable, attrition-resistant sorbents for use in fluid-bed/transport desulfurization reactors. Initiate project to test the direct sulfur recovery process at the Wilsonville PSDF on coal-derived synthesis gas. Continue development of novel single-step processes for removal of sulfur and ammonia. ($2,000) (NETL, RTI, GE, TBD)	Activity included under Gasification Systems Technology.	Activity included under Gasification Systems Technology.

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

Activity	FY 1999	FY 2000	FY 2001
Advanced Systems-Integrated Gasification Combined Cycle (Cont'd)	Conduct IGCC design optimization study to obtain firm cost, schedule, and performance data. Continue R&D on the control of alkali and HAPS/trace species. Investigate CO2 recovery and utilization technologies. Implement customer service activities. ($2,036) (UNDEERC, NETL, TBD)	Optimization study and customer service activities included under Systems Analysis/Product Integration. R&D on alkali control, HAPS and CO_2 included under Gasification Systems Technology.	Optimization study and customer service activities included under Systems Analysis/Product Integration. R&D on alkali control, HAPS and CO_2 included under Gasification Systems Technology.

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

Activity	FY 1999	FY 2000	FY 2001
Advanced Systems-Integrated Gasification Combined Cycle (Cont'd)	Conduct innovative approaches for improving plant efficiencies for power and fuels production, thereby reducing greenhouse gas emissions. Conduct work on the development and integration of advanced air separation technologies with gasification and advanced gas turbines ($4,175)	Included under Vision 21.	Included under Vision 21.
	Accelerate the development of high temperature hydrogen membrane separation technologies for integrated IGCC/fuel cell applications ($1,500). Develop advanced gas cleanup technologies for meeting more stringent gas quality requirements for fuel cell integration ($2,024). Conduct experimental investigations on biomass gasification and perform	Hydrogen membrane separation; advanced gas cleanup; experimental investigations on biomass gasification and experimental testing of co-firing biomass and municipal wastes included under Gasification Systems Technology.	Hydrogen membrane separation; advanced gas cleanup; experimental investigations on biomass gasification and experimental testing of co-firing biomass and municipal wastes included under Gasification Systems Technology.
	system analyses for integration of IGCC/fuel cell/advanced turbines/ co-production applications in the pulp and paper industry ($3,500). Perform experimental testing of cofiring of biomass and municipal wastes and perform relevant	Systems analyses for integration of IGCC/fuel cell/advanced turbines and feasibility studies for co-firing/co-production applications included under Systems Analysis/ Product Integration.	Systems analyses for integration of IGCC/fuel cell/advanced turbines and feasibility studies for co-firing/co-production applications included under Systems Analysis/ Product Integration.

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

Activity	FY 1999	FY 2000	FY 2001
Advanced Systems-Integrated Gasification Combined Cycle (Cont'd)	system integration studies. Conduct feasibility studies for cofiring/coproduction applications ($2,000). (Total $13,199) (TBD, ANL)		
	Included in activities above.	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 PDU and evaluate candidate sorbents. Begin design for a desulfurization unit at PSDF.	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 CFD model for the transport gasifier. Extend 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 temperature measurement

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

Activity	FY 1999	FY 2000	FY 2001
Advanced Systems- Integrated Gasification Combined Cycle (Cont'd)		Continue R&D on 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. ($18,525) (SCS, UNDEERC, NETL, ANL, RTI, Praxis, TBD)	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^{o} F. Complete baseline environmental monitoring of CCT sites and begin monitoring during hazardous waste processing. **Product/By-Product Utilization** - Continue testing of the direct sulfur recovery process at PSDF

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

Activity	FY 1999	FY 2000	FY 2001
Advanced Systems-Integrated Gasification Combined Cycle (Cont'd)			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 SO_2 to marketable products. ($15,622) (SCS, NETL, UNDEERC, Fluent, CMU, RTI, KBR, Albany, TECO, Dynegy, Weyerhauser, Texaco, ANL, SRI, Praxis, VPI, IET, FluoreScience)

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

Activity	FY 1999	FY 2000	FY 2001
Advanced Systems-Integrated Gasification Combined Cycle (Cont'd)	Included in activities above.	Systems Analysis/Product Integration: Complete IGCC and co-production design optimization. Continue co-production pioneer plant feasibility studies. Complete development of 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)	Systems Analysis/Product Integration: Extend design optimization study to include CO_2 capture and fuel cell technologies. Continue engineering analysis and risk 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. ($3,747) (NETL, Bechtel, CTC, E2S, Mitretek, Consol, Parsons, Texaco, Dynegy, WMPI, GE, KBR, APCI, Praxair, Dow Corning, Dow Chemical, Siemens-Westinghouse, Methanex, Rentech, SASOL)
	No activity. ($0)	Vision 21: Develop gasification and combustion high efficiency energy complexes with near-zero	Vision 21: Develop gasification and combustion high efficiency energy complexes with near-zero

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

Activity	FY 1999	FY 2000	FY 2001
Advanced Systems-Integrated Gasification Combined Cycle (Cont'd)		emissions and CO_2 management options. Develop advanced air 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/co-production 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	emissions and CO_2 management options. Continue development of advanced membrane-based air separation technologies and begin first level of scaleup. Continue development of high temperature membranes for hydrogen separation and CO_2 concentration. Continue development of low temperature technology for hydrogen/CO_2 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 mining 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. **International Clean Energy Initiative:** Develop

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

Activity	FY 1999	FY 2000	FY 2001
Advanced Systems-Integrated Gasification Combined Cycle (Cont'd)		development. ($12,806) (APCI, Texaco, ANL, TECO, RTI, TBD)	international collaborative efforts to advance pre-competitive R&D and accelerate Vision 21 development options including hydrogen and oxygen separation, reformer, and catalytic technologies. ($990) (Total Vision 21 $12,290) (APCI, Praxair, ANL, NREC, Enertech, Bechtel, LANL, RTI, IGT, Siemens-Westinghouse, NETL, TBD)
	Fund technical and program management support. ($223)	Fund technical and program management support. ($352)	Fund technical and program management support. ($320)
	$30,168	$35,211	$31,979

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

Activity	FY 1999	FY 2000	FY 2001
Advanced Systems- Pressurized Fluidized Bed	Continue evaluation of previously selected and developed HGCU barrier filter materials, devices and systems toward refining and validating designs. Continue to focus on development and testing newly selected materials for applicability to HGCU barrier filtration and evaluation of new filter configurations and system designs for PFBC applications with potential to significantly enhance performance and reduce cost relative to first and second generation systems. ($2,675) (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. ($4,000) (NETL, 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)

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

Activity	FY 1999	FY 2000	FY 2001
Advanced Systems- Pressurized Fluidized Bed (Cont'd)	Continue R&D at NETL on PFB dynamics, advanced concepts, combustion characterization and fundamental research to reduce the out year risks associated with commercialization of this technology. NETL's emphasis in the near term will focus primarily in the HGCU and GT technology areas followed by efforts to attain the year 2010 goals. ($2,746) (NETL)	Included in activity above.	Included in activity above.
	Continue customer education activities, via future site specific repowering studies. Long term efforts would be to promote repowering of an actual electricity producer's site at minimum cost to the government. ($154) (TBD)	Evaluate advanced systems users by performing site specific repowering studies that promote repowering of an actual electricity producer's site. ($150) (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. ($150) (TBD)

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

Activity	FY 1999	FY 2000	FY 2001
Advanced Systems- Pressurized Fluidized Bed (Cont'd)	Continue effort aimed at improvements in environmental performance and efficiency with emphasis on assessing emissions with focus on HAPS, control strategies and GT development. Near term spotlight is on HGCU, GT, and coal/feed systems development to meet the year 2005 goals. Cycle improvements through the introduction of other technologies like the Kalina Cycle and super critical steam cycles will be pursued to achieve the year 2010 goals. ($700) (NETL)	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. ($400) (NETL)	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. ($400) (NETL)
	Continue operation of the APFBC pilot scale project at Wilsonville. ($7,935). (Southern Co. Services, TBD)	Continue operation of the APFBC pilot scale project at Wilsonville. ($7,330). (Southern Co. Services, TBD)	Continue operation of the APFBC pilot scale project at Wilsonville. ($7,354). (Southern Co. Services, TBD)

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

Activity	FY 1999	FY 2000	FY 2001
Advanced Systems- Pressurized Fluidized Bed (Cont'd)	No activity. ($0)	Explore power systems designs to optimize CO_2 recycle and enrichment for CO_2 capture or reduction. ($200) (TBD)	Complete power systems designs to optimize CO_2 recycle and 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 ($146).	Fund technical and program management support ($122).	Fund technical and program management support ($111).
	$14,356	$12,202	$11,185
Advanced Systems- Turbines	Continue the advanced turbine systems ultra high efficiency gas turbine technology program. Continue technology base development including: Univ. Consortium, in-house research, manufacturing technologies, address fuel flexibility application. ($8,725) (SCERDC, NETL, Pratt/Whitney, ORNL)	Continue the advanced turbine systems ultra high efficiency gas turbine technology program. Continue technology base development including: Univ. Consortium, in-house research, manufacturing technologies, address fuel flexibility application. Conduct advanced cycle studies. ($10,381) (SCIES, RAMGEN, NETL, Pratt/Whitney, ORNL, TBD)	Continue the advanced turbine systems ultra high efficiency gas turbine technology program. Continue technology base development including: Univ. Consortium, in-house research, manufacturing technologies, and advanced computing. ($8,910) (SCIES, NETL, ORNL, TBD)

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

Activity	FY 1999	FY 2000	FY 2001
Advanced Systems-Turbines (Cont'd)	No activity. ($0)	Vision 21: Investigate flexible midsize turbine configurations for Vision 21 powerplex applications including coproduction. ($800) (TBD)	Vision 21: Conduct R&D and design studies for the flexible gas turbine systems ($5,000). 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. ($2,970) (Total $7,970) (TBD)

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

Activity	FY 1999	FY 2000	FY 2001
	Continue the investment program for Natural Gas through an accelerated advanced turbine system program. Complete full-scale component/sub-system testing and engine manufacturing. Initiate site erection and preparation for full speed test. ($34,228) (GE, Siemens-Westinghouse)	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. ($32,565) (GE, Siemens-Westinghouse)	Complete full speed engine tests, ATS system integration, and component testing. Initiate technical, economic, and environmental performance system studies. ($8,860) (GE, Siemens-Westinghouse)
	Provide technical and program support. ($445)	Provide technical and program support. ($442)	Provide technical and program support. ($260)
	$43,398	$44,188	$26,000
Subtotal, Advanced Systems	$108,889	$100,611	$71,164
Central Systems, Total	$121,812	$115,257	$89,364

DEPARTMENT OF ENERGY
FY 2001 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 in the 21st century. 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 System/Vision 21 subactivity in support of the Energy Policy Act 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

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

providing technologies that 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: 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; Mid-term (to year 2010) - develop and demonstrate the advancements in fuel cell technology and combined cycle fuel cell heat engine technology (fuel cell/turbine hybrids) and 21st Century Fuel Cells operating at mid to high temperatures 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 fuel cell systems. Fuel cell systems offer innovative approaches to distributed generation in support of climate change initiatives and are a major part of the Vision 21 concept for distributed and central station applications in the Advanced Power Systems Technology area. Although fuel cell systems have specifically identified goals, these goals coincide with Vision 21 concepts in the 2010 to 2015 time frame.

These Fuel Cell Systems are capable of reducing criteria pollutants well below current New Source Performance Standard levels, reducing non-criteria pollutants such as CO_2 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 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 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.

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

Innovative Concepts include lower-temperature, multi-layer ceramic technology for fuel cells which is an important aspect of lowering fuel cell costs. It is the beginning of the introduction of a new paradigm to fuel cell manufacturing which will lead to a great advance in fuel cell cost reduction. The research will help lead to commercialization of low-cost, fuel cell/turbine hybrids and 21st century fuel cells operating at mid to high temperatures. 21st Century Fuel Cells are Vision 21-enabling fuel cell technology, such as solid-state fuel cells in networks or multi-staged designs, etc. Innovative concept work which supports Hybrids and 21st Century Fuel Cells includes dynamic modeling, gas processing (reforming and cleanup), virtual design activities and material and manufacturing/ fabrication research at National Laboratories.

The Advanced Research subactivity supports the program objectives by studying critical enabling science and technology topics related to research on fuel cells to lower fuel cell costs, to investigate advanced lower cost and higher performance ceramic fuel cell processes and designs, and to solve fundamental crosscutting materials and design issues, such as seals and structural support. The results of the investigations are used by those who develop, design, manufacture and operate fuel cell systems which include the molten carbonate and solid oxide systems discussed above, as well as for the fuel cell/turbine hybrid system. Advanced research of fuel cell power systems seeks to capitalize on their intrinsic high efficiency and their environmentally benign characteristics, emphasizing research on electrochemistry, catalysis, interconnections, and materials interactions for molten carbonate, solid oxide and advanced devices. The research will continue to support the development of 21st Century Fuel Cells operating at mid to high temperatures.

The distributed generation systems program will support the Office of Fossil Energy Natural Gas Center for Excellence. 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.

The Office of Fossil Energy plans to continue cooperative efforts with the Department of Defense and private industry in activities that accelerate commercialization of fuel cells, and in collaborative RD&D programs that leverage government resources.

The near-term goals of the distributed generation program are to: yield commercial offerings of fuel cell powerplants in the 200-kW to 3-MW range, lower fuel cell powerplant costs to under $1500 per kW by 2003, achieve fuel cell conversion efficiencies of between 50% to 60%, and demonstrate distributed generation technologies in cogeneration applications with efficiency reaching 85%. By being near end-users, these technologies will provide an increase in power quality and reliability subject to network voltage fluctuations and transmission lines. Eliminating the long distance transportation of electricity will also reduce costs for electrical and heating/cooling

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

expansion.

FY 2001 Performance Measures in furtherance of the above goals include:

- Complete construction for demonstration of a commercial-scale, 300kW to 1-MW Molten Carbonate Fuel Cell (MCFC) power plant system. This test will verify the commercial design for the MCFC technology for the CHP or DG market and, if successful will enable the construction of a MCFC manufacturing facility in the U.S.
- Begin testing of a 300-kW to 1-MW Solid Oxide Fuel 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 enable the construction of a SOFC manufacturing facility in the U.S.

II. A. **Funding Schedule**:

Activity	FY 1999	FY 2000	FY 2001	$Change	%Change
Fuel Cells					
Advanced Research	$1,169	$1,200	$2,800	1,600	133%
Fuel Cell Systems	39,952	36,263	21,000	-15,263	-42%
Vision 21 Hybrids	0	5,136	15,000	9,864	192%
Innovative Systems Concepts (formerly Multiple-Layer Ceramic Technology)	1,948	1,900	3,400	1,500	79%
Subtotal, Fuel Cells	43,069	44,499	42,200	-2,299	-5%
Total, Distributed Generation Systems	$43,069	$44,499	$42,200	$-2,299	-5%

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

	FY 1999	FY 2000	FY 2001	$Change	%Change
Argonne National Lab (East)	$900	$800	$800	$0	0%
Oak Ridge National Lab	0	205	400	195	100%
Pacific Northwest Lab	290	300	300	0	0%
National Energy Technology Laboratory	740	200	370	170	85%
All Other	41,139	42,994	40,330	-2,664	-6%
Total, Distributed Generation Systems	$43,069	$44,499	$42,200	$-2,299	-5%

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

Activity	FY 1999	FY 2000	FY 2001
Fuel Cells-Advanced Research	This program conducts generic research to capitalize on the intrinsic high efficiency and environmentally benign characteristics of advanced fuel cells. Research will be continued on molten carbonate and solid oxide electrodes, electrolytes and interconnects; solid oxide advanced concept, material and seals; and thin film advanced cell processing techniques. Funding for a cooperative research and development agreement between a national laboratory and a fuel cell manufacturer will be continued. (Total $1,157) (ANL, PNL, TBD)	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 $1,188) (ANL, PNL, TBD)	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 21st Century solid state fuel cells, to solve fundamental crosscutting materials and design issues, and to pursue thin film advanced cell processing techniques. (Total $2,772) (ANL, PNL, TBD)
	Fund technical and program management support. ($12)	Fund technical and program management support. ($12)	Fund technical and program management support. ($28)
	$1,169	$1,200	$2,800

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

Activity	FY 1999	FY 2000	FY 2001
Fuel Cells- Fuel Cell Systems	Continue cost-shared cost reduction and performance improvement on a stretched out basis on two molten carbonate systems for market entry by the private sector. Continue cost-shared cost reduction and production improvement for tubular SOFC systems for market entry by the private sector. ($36,605) (MC Power, ERC, Westinghouse, ORNL)	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. ($31,705) (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. ($14,000) (TBD)
	Continue at a reduced level economic and market study assessments, system assessments and evaluations, corrosion studies, electrode life verification, and component development. ($2,937) (ADL, NETL, ANL, TBD)	Continue economic and market study assessments, system assessments and evaluations, materials studies, electrode and electrode process development, and low cost component development. ($4,195) (ADL, NETL, ANL, TBD)	Continue distributed generation infrastructure, economic and market study assessments; system assessments and evaluations, materials studies; conduct mid to high temperature Vision 21, 21st Century fuel cell component and process development, and low cost component development. ($6,790) (ADL, NL, NETL, TBD)
	Continue technical and program management support. ($410)	Continue technical and program management support. ($363)	Continue technical and program management support. ($210)
	$39,952	$36,263	$21,000

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

Activity	FY 1999	FY 2000	FY 2001
Fuel Cells - Vision 21 Hybrids	No activity. ($0)	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. ($5,085) (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. ($14,850) (SWPC, NETL, TBD)
	No activity. ($0)	Continue technical and program management support. ($51)	Continue technical and program management support. ($150)
	$0	$5,136	$15,000
Innovative Systems Concepts (formerly Multiple-Layer Ceramic Technology)	Initiate development of multi-layer ceramic technology for fuel cells. ($1,928) (McDermott)	Continue Vision 21 multi-layer ceramic technology for fuel cells leading to low-cost 21st Century fuel cell manufacture. ($1,881) (McDermott, TBD)	Conduct activities leading to development of low-cost, 21st Century fuel cells. Continue Vision 21 multi-layer ceramic technology for fuel cells leading to low-cost 21st Century fuel cell manufacture. ($3,366) (NETL, NL, TBD)
	Fund technical and program management support. ($20)	Fund technical and program management support. ($19)	Fund technical and program management support. ($34)

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

Activity	FY 1999	FY 2000	FY 2001
	$1,948	$1,900	$3,400
Distributed Generation Systems, Total	$43,069	$44,499	$42,200

DEPARTMENT OF ENERGY
FY 2001 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 CO_2 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. 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 2001 will center around expanding exploratory research on novel and innovative concepts for GHG mitigation, advanced CO_2 separation and capture concepts, geological carbon sequestration, and reducing the cost and 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 Center of Excellence with particular emphasis on capture and concentration of CO_2, CO_2 hydrate formation and

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

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 an additional 145 million tonnes per year and 270 million tonnes per year worldwide, by 2030.

FY 2001 Performance Measures in furtherance of the above goals include:

- Select and award the most promising projects dealing with developing novel and innovative concepts for GHG control from a phased solicitation competed in FY1998. Six projects (out of twelve) were continued to Phase II, detailed engineering and feasibility investigations, in FY1999. Phase III, starting in FY2001, will involve pilot-scale testing of the most promising concepts, which could range from a novel fuel cycle that minimizes carbon dioxide emissions to advanced catalysis and membrane systems that separate and concentrate carbon dioxide.
- Complete evaluation of Phase III 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 of the Phase III evaluation will be used to determine appropriate actions for Phase IV of the project with Canada.
- Conduct field testing, at a meaningful scale, of geologic sequestration concepts in the U.S. Geologic sequestration is an attractive option for U.S. fossil fuel production and utilization industries for long-term storage of carbon dioxide. Model guidelines for geologic sequestration will be developed in collaborative efforts with the oil and gas industry, the U.S. Geological Survey, and other DOE organizations.

II. A. **Funding Schedule**:

Activity	FY 1999	FY 2000	FY 2001	$Change	%Change
Sequestration R&D	$5,825	$9,217	$19,500	$10,283	112%
Total, Sequestration	$5,825	$9,217	$19,500	$10,283	112%

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

	FY 1999	FY 2000	FY 2001	$Change	%Change
All Other	$5,825	$9,217	$19,500	$10,283	112%
Total, Sequestration R&D	$5,825	$9,217	$19,500	$10,283	112%

III. **Performance Summary**:

Activity	FY 1999	FY 2000	FY 2001
Sequestration R&D	Greenhouse Gas Control: Continue efforts to investigate and/or improve the capabilities of technologies to recover, reuse, and/or store greenhouse gas emissions from coal-based energy systems; examine the technical, economic and environmental impacts of various CO_2 sequestration alternatives; continue participation in the IEA Greenhouse Gas R&D program; continue ongoing exploratory research projects initiated in prior years to mitigate greenhouse gas emissions; continue novel and advanced concepts projects to obtain required engineering and environmental data. ($5,766) (IEA, TBD)	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 environmental impacts of various CO_2, CH_4 and N_2O sequestration alternatives. ($9,125) (IEA, TBD)	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 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_2O sequestration alternatives. ($16,335) (TBD)

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

Activity	FY 1999	FY 2000	FY 2001
Sequestration R&D (Cont'd)	No activity. ($0)	No activity. ($0)	Center of Excellence: 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)
	Fund technical and program management support. ($59)	Fund technical and program management support. ($92)	Fund technical and program management support. ($195)
Total, Sequestration R&D	$5,825	$9,217	$19,500

DEPARTMENT OF ENERGY
FY 2001 CONGRESSIONAL BUDGET REQUEST

FOSSIL ENERGY RESEARCH AND DEVELOPMENT

FUELS

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

The Energy Policy Act (EPACT) of 1992 Title XIII, Subtitle A, Section 1301 authorizes programs for research, development, demonstration and commercialization of coal based technologies. Title XIII, Subtitle A, Sections 1305 and 1312 of this act also 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 (formerly Coal Liquefaction), Solids Fuels and Feedstocks (formerly Coal Preparation), Advanced Fuels Research (formerly Advanced Research and Environmental Technology), and Steelmaking.

Transportation Fuels and Chemicals (formerly Coal Liquefaction) - 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. In the coal program 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. Funding for this initiative is requested in the Petroleum Processing budget line. 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. The FY 2001 budget request supports the continued development of coal-derived ultra-clean transportation fuels technologies at the laboratory and bench scale, and does support studies and engineering evaluations needed to guide the research and development efforts in support of the objective of providing affordable, ultra-clean transportation fuels and chemicals by 2015.

Solid Fuels and Feedstocks (formerly Coal Preparation) - 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

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

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 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 (formerly Advanced Research and Environmental Technology) - 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, significant economic gains, 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 coke from a variety of coal feedstocks. The activity supported by this effort is a 50% industry cost-shared demonstration of a revolutionary coke making process that produces metallurgical grade coke at lower cost and with virtually zero emissions, using U.S. coal. The demonstration unit will be constructed at LTV Steel's Cleveland Works.

The development of Ultra-Clean Transportation Fuels will reduce carbon emissions by enabling the use of higher efficiency engines. This is estimated to average 19 million tonnes per year of carbon emissions by 2030.

FY 2001 performance measures in furtherance of the above goals include:

- Negotiate contracts for Ultra-Clean Transportation Fuels for the 21st Century projects to be performed in partnership with industry for the development of technologies that will produce ultra-clean, high performance transportation fuels from both petroleum and non-petroleum sources.
- Complete analysis to determine the economic feasibility of technologies for coproduction of clean, higher value transportation fuels, and/or chemicals and electricity. This information will be used to produce an RD&D plan, to implement technology development, if necessary, leading to preliminary engineering/design packages that will meet future energy demands in a deregulated market.

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

- Initiate proof-of-concept scale testing at industrial facilities of several advanced solid fuels technologies selected from laboratory-scale projects completed in FY 2000 under the first phase of the Solid Fuels and Feedstocks Grand Challenge solicitation.
- Begin investigation of fuels production from fossil resource derived feedstocks, such as Synthesis Gas, using biomimetic catalysts. Biomimetic catalysts are a class of materials that mimic the actions of enzymes to produce desired products under less rigorous conditions.

II. A. **Funding Schedule**:

Activity	FY 1999	FY 2000	FY 2001	$Change	%Change
Transportation Fuels and Chemicals	$9,955	$7,075	$9,000	$1,925	27%
Solid Fuels and Feedstocks (formerly Coal Preparation)	5,006	4,300	4,500	200	5%
Advanced Fuels Research (formerly AR&ET)	1,749	2,200	2,200	0	0%
Steelmaking	0	6,700	0	-6,700	-100%
Total, Fuels	$16,710	$20,275	$15,700	$-4,575	-23%

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

	FY 1999	FY 2000	FY 2001	$Change	%Change
National Energy Technology Laboratory	$3,964	$4,260	$3,440	$-820	-19%
Argonne National Laboratory	72	35	100	65	186%
Sandia National Laboratories	550	350	600	250	71%
All Other	12,124	15,630	11,560	-4,070	-26%
Total, Fuels	$16,710	$20,275	$15,700	$-4,575	-23%

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

Activity	FY 1999	FY 2000	FY 2001
Transportation Fuels and Chemicals	Feedstock Conversion: Continue bench scale research on advanced two stage liquefaction and coprocessing of coal/resid processes including support of the China initiative. Continue waste/coal coprocessing bench scale study ($3,587). Study of novel concepts for achieving improvements in two stage liquefaction to achieve greater efficiency and lower cost ($954). Conduct LaPorte alternative fuels facility operation for production of DME for engine testing in cooperation with the Office of Energy Efficiency and the Fossil Energy Office of Oil and Gas ($300). (Total $4,841) (HTI, NETL, SNL, APCI)	Feedstock Conversion: Study of novel concepts for achieving improved lower severity conversion and specification products ($35). Conduct LaPorte alternative fuels facility operation 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)	Feedstock Conversion: Study of novel concepts for improved conversion efficiency and product quality. ($1,485) (ANL, SNL, NETL)

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

Activity	FY 1999	FY 2000	FY 2001
Transportation Fuels and Chemicals (Cont'd)	Reactor/Process Development: Continue bench scale oxygenate and chemicals catalyst and process development ($1,123). 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 ($1,379). Continue slurry F-T reactor design data base; perform feasibility study for Early Entrance Coproduction Plant with industrial consortium ($1,803) (Total $4,305) (Air Products, RTI, NETL, WMPI, Dynergy, Texaco, TBD)	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 ($2,646) (Total $5,213) (Air Products, NETL, CAER, WMPI, Dynergy, Texaco, TBD)	Reactor/Process Development: Continue bench scale DME at APCI; continue the development of ultra-clean transportation fuels and chemicals for the 21st Century ($1,500). Continue bench scale F-T iron catalyst development for the production of premium transportation fuels and chemicals ($1,100).**International Clean Energy Initiative:** Develop and test the feasibility of low cost options for hydrogen production/separation and coproduction of hydrogen along with other high-value transportation fuels and other products for the international deployment of the technologies ($1,980). Conduct slurry F-T reactor design data base; continue feasibility study, R&D, and design of the Early Entrance Coproduction Plant with industry consortium. ($2,350). (Total $6,930) (Air Products, NETL,

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

Activity	FY 1999	FY 2000	FY 2001
Transportation Fuels and Chemicals (Cont'd)			CAER, WMPI, Dynergy, Texaco, TBD)
	Product Upgrading:	Product Upgrading:	Product Upgrading:
	Perform research on DME/diesel fuel blends, characterize coal-derived transportation fuels. ($200) (WVU, PSU, NETL)	Continue research on DME/diesel blends; characterize coal-derived transportation fuels. ($682) (PSU, NETL)	No activity. ($0)
	Systems Engineering:	Systems Engineering:	Systems Engineering:
	Continue technical, economic and environmental analysis; and engineering support and technical guidance. ($523) (Mitretek, NETL, TBD)	Continue research guidance study and engineering support. NETL technical and engineering analyses. ($679) (Mitretek, NETL, TBD)	Continue technical, economic and environmental analyses; engineering support and technical guidance. ($495) (Mitretek, NETL, TBD)
	Fund technical and program management support. ($86)	Fund technical and program management support. ($71)	Fund technical and program management support. ($90)
	$9,955	$7,075	$9,000
Solid Fuels and Feedstocks (formerly Coal Preparation)	Environmental Solid Fuels: Initiate research for very high removal of air toxic precursors at significantly lower cost than achievable with current	Environmental Solid Fuels: Continue research on advanced technologies for the reduction of greenhouse gas emissions via the preparation of biomass feeds for	Environmental Technologies: Conduct research for low cost precombustion control or air toxic precursors and continue support of the development of a national

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

Activity	FY 1999	FY 2000	FY 2001
Solid Fuels and Feedstocks (formerly Coal Preparation) (Cont'd)	technologies ($1,500). Continue high efficiency process research to further develop the technology base for efficient beneficiation, handling and marketing of coal fines. Initiate research at outside facilities for advanced technologies for enhanced carbon recovery from coal ($245). Conduct in-house laboratory and bench scale research on solid fuels technologies to enhance utilization of coal waste products, improve coal fines processing, and prepare coal/biomass/waste feedstocks to lower emissions of greenhouse gases ($905). Conduct research at outside facilities for preparation of coal/biomass/waste for cofiring applications ($609). (Total $3,259) (NETL, B&R, TBD)	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. ($2,230) (NETL, TBD)	coal quality data base on trace elements ($390). 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 ($1,843). (Total $2,233) (NETL, TBD)
	Tailored Carbon Feedstocks: Conduct in-house laboratory and bench scale research on solid fuels technologies for the manufacture	Tailored Carbon Feedstocks: Continue research for advanced technologies for the development of premium carbon products from	Premium Carbon Products: Conduct technical/economic assessments and laboratory and bench scale research on

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

Activity	FY 1999	FY 2000	FY 2001
Solid Fuels and Feedstocks (formerly Coal Preparation) (Cont'd)	of carbon products ($700). Initiate research at outside facilities for advanced technologies for the production of tailored feedstocks for transportation fuels and premium carbon products ($996) (Total $1,696) (NETL, TBD)	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)	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 ($1,450). Advanced Separations: Conduct research in the areas of advanced technologies for solid-solid and solid-liquid separations directed toward fuels production and use ($377). (Total $1,727) (NETL, Penn State, TBD)
	No activity. ($0)	No activity. ($0)	International Coal Characterization: Conduct a comprehensive coal testing program in conjunction with U.S. equipment suppliers to gain foreign coal quality information to assist in the successful introduction of U.S. coal utilization technology in international markets. ($495) (TBD)

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

Activity	FY 1999	FY 2000	FY 2001
	Fund technical and program management support. ($51)	Fund technical and program management support. ($43)	Fund technical and program management support. ($45)
	$5,006	$4,300	$4,500
Advanced Fuels Research	Conduct research on coprocessing of coal, resid and waste materials, and biomass which could lead to clean transportation fuels with reduced CO_2 byproduct production. Conduct research on improved and innovative methods for preparing coal-derived liquids by the Consortium for Fossil Fuel Liquefaction Science. Conduct laboratory activity to develop an extract concept for producing carbon materials such as carbon electrodes. Initiate exploratory research to improve understanding of the techniques to produce carbon fiber materials. ($950) (NETL, Univ. Of KY, WVU)	Conduct research to identify liquid fuels that are suitable as chemical storage agents for hydrogen and 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)	C-1 Chemistry: Cosponsor investigation of the chemistry of monocarbon compounds for the 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 studies on fossil fuel decarbonization for hydrogen and nano-structured hydrogen storage media and catalysts ($839). (Total $1,628) (NETL, CFFLS, TBD)
	Initiate PRDA to conduct	Conduct research on new and	Molecular Modeling and Catalyst

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

Activity	FY 1999	FY 2000	FY 2001
Advanced Fuels Research (Cont'd)	laboratory research on improved and innovative concepts for producing liquid transportation fuels and chemicals which will be highly efficient, achieve improved environmental performance with reduced CO_2 byproduct production. ($781) (TBD)	improved methods for producing liquid transportation fuels and chemicals which will be highly efficient, achieve improved environmental performance with reduced CO_2 byproduct. ($850) (TBD)	Development: Conduct studies on molecular modeling for the hydrocracking of F-T wax to diesel. ($200) (SNL, Chevron, TBD)
	No activity. ($0)	Study options for incorporation of fuel and chemical modules in Vision 21 plants. ($50) (NETL)	Advanced Concepts: Conduct studies of extractive processes for production of fuels and chemical from coal. Investigate advanced concepts in support of transportation fuels and chemicals. Study options for incorporation of fuel and chemical modules in Vision 21 plants. ($350) (WVU, NETL)
	Fund technical and program management support. ($18)	Fund technical and program management support. ($22)	Fund technical and program management support. ($22)
	$1,749	$2,200	$2,200

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

Activity	FY 1999	FY 2000	FY 2001
Steelmaking	No activity. ($0)	Conduct industry cost-shared demonstration of a revolutionary coke making process that produces metallurgical grade coke at lower cost and with virtually zero emissions. ($6,633) (TBD)	No activity. ($0)
	No activity. $(0)	Fund technical and program management support. ($67)	No activity. ($0)
	$0	$6,700	$0
Fuels, Total	$16,710	$20,275	$15,700

DEPARTMENT OF ENERGY
FY 2001 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**:

Activity	FY 1999	FY 2000	FY 2001	$Change	%Change
Import/Export Authorization	$2,173	$2,173	$2,300	$127	6%
Total, Import/Export Authorization	$2,173	$2,173	$2,300	$127	6%

II. B. **Laboratory and Facility Funding Schedule**: Import/Export Authorization (Cont'd)

Activity	FY 1999	FY 2000	FY 2001	$Change	%Change
All Other	$2,173	$2,173	$2,300	$127	6%
Total, Import/Export Authorization	$2,173	$2,173	$2,300	$127	6%

III. **Performance Summary**:

Activity	FY 1999	FY 2000	FY 2001
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)
	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. (19 FTEs) ($1,357)	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)	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) ($1,484)

III. **Performance Summary**: Import/Export Authorization (Cont'd)

Activity	FY 1999	FY 2000	FY 2001
Import/Export Authorization (Cont'd)	Process 75 electricity export applications and 10 new construction permits. Amend 110 existing permits to required open access. Monitor and analyze international and domestic electricity trade. Participate in FERC proceedings. Participate in international studies and trade negotiations. NEPA compliance activities. ($630)	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)	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)
	Provide management and administrative support. ($136)	Provide management and administrative support. ($136)	Provide management and administrative support. ($136)
Import/Export Authorization, Total	$2,173	$2,173	$2,300

DEPARTMENT OF ENERGY
FY 2001 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 CO_2. 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 long-range Fossil Energy objectives.

In order to achieve these goals, a Center of Excellence for Advanced Research for Energy Plants of the Future is being developed. This center will allow applied research to be conducted now to produce a “technology base” from which the energy plants of the future will be designed, built and operated.

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

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 the development of the Vision 21 concept. It will involve novel concepts for CO_2 capture and sequestration, and virtual demonstration plants. 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 produce fuels with significantly lower greenhouse gas content than is currently available to control environmentally harmful emissions (NO_x, CO_2) 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 universities.

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 2001 Performance Measures in furtherance of the above goals include:

- A high gas flux oxygen separation device will be tested. Such a technology will result in greatly reduced cost of oxygen separation from mixed gas streams.
- Acquire more advanced computational capability to permit development of dynamic simulations of key plant components. Acquire visualization software and develop simulations of key plant components.
- Provide between 15 and 20 grants to teams of university students and professors to perform research ranging from fundamental 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.

II. A. **Funding Schedule**: ADVANCED RESEARCH

Activity	FY 1999	FY 2000	FY 2001	$Change	%Change
Coal Utilization Science	$4,280	$6,250	$5,250	$-1,000	-16%
Materials	6,066	7,000	7,350	350	5%
Technology Crosscut					
Coal Technology Export	845	845	1,350	505	60%
Bioprocessing of Coal	1,082	1,350	1,350	0	0%
Environmental Activities	2,200	2,000	2,000	0	0%
Technical & Economic Analyses	700	750	721	-29	-4%
International Program Support	750	1,000	1,000	0	0%
International Capacity Building	0	0	1,000	1,000	100%
Center of Excellence	0	0	3,000	3,000	100%
Subtotal, Technology Crosscut Research	5,577	5,945	10,421	4,476	75%
University Coal Research	2,831	3,000	3,000	0	0%
HBCUs, Education and Training	876	1,000	1,000	0	0%
Total, Advanced Research	$19,630	$23,195	$27,021	$3,826	16%

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

	FY 1999	FY 2000	FY 2001	$Change	%Change
Argonne National Lab (East)	$1,055	$982	$982	$0	0%
Idaho National Engineering Lab	325	325	383	58	18%
National Energy Technology Laboratory	2,400	2,400	2,400	0	0%
Los Alamos National Lab	300	500	650	150	30%
Oak Ridge National Lab	3,935	3,935	4,100	165	4%
Pacific Northwest Lab	693	693	870	177	26%
Sandia National Laboratories	300	400	510	110	28%
Ames National Laboratory	90	40	190	150	375%
All Other	9,839	13,227	16,066	2,839	21%
Total, Advanced Research	$19,630	$23,195	$27,021	$3,676	16%

III. **Performance Summary**: ADVANCED RESEARCH

Activity	FY 1999	FY 2000	FY 2001
Coal Utilization Science	Redirect research toward the Grand Challenges of the Virtual Demonstration Plant and CO_2 capture, sequestration, and CO_2 offset, in support of the Vision 21 concept of a power and fuels complex. Initiate studies to determine additional data sets necessary to meet the needs of the Vision 21 concept and the Virtual Demonstration. Initiate competitive solicitation to develop critical enabling technologies for advanced power and fuel systems, and new concepts that will significantly reduce or eliminate environmental impacts of coal utilization with special focus on greenhouse gases that affect global climate change. Continue research in basic coal combustion processes, evolution of contaminants and hazardous air toxics, fundamental carbon studies, and advanced predictive models. Complete data collection and coding of first generation structurally-based char reactivity model for predicting levels of unburned carbon resulting from low NOx combustion. Discontinue coal	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 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 CO_2. ($6,187) (NETL, SNL, MIT, TBD)	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 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 CO_2 at large scale (1 kg). ($4,947) (NETL, SNL, LANL, TBD)

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

Activity	FY 1999	FY 2000	FY 2001
Coal Utilization Science (Cont'd)	slurry combustion work and transfer the technology to the appropriate line program. Conclude study of ash effects on char reactivity and continue laboratory study of low NOx mechanisms. Address CO_2 issue by preparing phase I biomass cofiring guidelines. ($4,237) (NETL, SNL, MIT, Brown U, TBD)		
	No activity. ($0)	No activity. ($0)	Initiate collaborative efforts with Basic Energy Science on the Strategic Simulation Initiative to develop a new generation of combustion simulation computational models. ($250) (TBD)
	Fund technical and program management support. ($43)	Fund technical and program management support. ($63)	Fund technical and program management support. ($53)
	$4,280	$6,250	$5,250
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.	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.	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.

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

Activity	FY 1999	FY 2000	FY 2001
Materials (Cont'd)	These include the high- and very high-temperature intermetallic alloys and oxidation/sulfidation resistant coatings; fabrication processes; high temperature filters; gas separation ceramic membranes; solid state electrolytes; and carbon fiber composite molecular sieves. Continue support of high priority activities that contribute substantially to the efficiency of advanced power systems, including ceramic composite heat exchangers, nondestructive evaluation techniques, fuel cells; and oxide dispersion strengthened iron aluminides. ($5,459) (ANL, INEL, ORNL, PNL)	These include resistant coatings; fabrication processes; filters; ceramic membranes; solid state electrolytes; carbon fibers; ceramic heat exchangers; and non-destructive evaluation techniques. ($5,695) (ANL, INEL, ORNL, PNL)	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. ($5,835) (ANL, INEL, ORNL, PNL)
	Initiate solicitation to support break-through concepts to develop materials capable of achieving very low cost hydrogen and oxygen separation from mixed gas streams. These are critical enabling technologies to be able to deploy advanced fossil energy ultra-clean fuel and power systems. ($545) (TBD)	Continue breakthrough concepts to develop materials for achieving very low cost hydrogen and oxygen separation from mixed gas streams and for stablizing greenhouse gases. These are critical enabling technologies to deploy Vision 21 energy plants. ($1,235) (TBD)	Increase support to breakthrough concepts to develop materials for achieving very low cost hydrogen and oxygen separation from mixed gas streams and for stablizing greenhouse gases. These are critical enabling technologies to deploy Vision 21 energy plants. ($1,441) (AMES, NETL, SNL, TBD)

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

Activity	FY 1999	FY 2000	FY 2001
Materials (Cont'd)	Fund technical and program management support. ($62)	Fund technical and program management support. ($70)	Fund technical and program management support. ($74)
	$6,066	$7,000	$7,350
Technology Crosscut - Coal Technology Export	Continue efforts to support deployment of cleaner coal and power generation systems internationally. Pursue opportunities identified by the Houston Conference on the Strategic Value of Clean Fossil Fuel Systems for the international sale of U.S. clean coal technologies and continue 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. Continue efforts in the Pacific Rim including sharing best practice information with utilities. ($845) (TBD)	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 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)	Enhance ongoing effort and 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 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. ($1,350) (TBD)
	$845	$845	$1,350

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

Activity	FY 1999	FY 2000	FY 2001
Technology Crosscut - Bioprocessing of Coal	Develop processes for fuels that have a significantly lower unit content of greenhouse gases (carbon) then currently available fuels to reduce the impact on global climate change. Demonstrate at pilot scale biological conversion of coal synthesis gas to ethanol, and continue research on novel coal bioconversion processes to enhance economics and environmental acceptability of coal. Investigate the use of electrochemically supplied electron carriers in synthesis gas fermentations. Develop biofiltration system for removal of NO_x from combustion gas streams. ($1,071) (ORNL, INEL, TBD)	Develop biological processes to reduce CO_2 production and to sequester CO_2. Complete evaluation of electro-chemically supplied electron carriers in synthesis gas fermentations. Develop biofiltration for removal of NO_x from combustion gases. Develop biological CO_2 sequestration by conversion into useful products such as liquid fuels and investigate global, natural CO_2 mitigation strategies such as whitings and ocean scale algae sequestration. ($1,336) (ORNL, INEL, TBD)	Develop biological processes for fuels that have a significantly lower unit content of greenhouse gas than currently available fuel to reduce the impact on global climate change. Continue development of biofiltration for removal of NO_x from combustion gases and deveop new biomineralization techniques for carbon sequestration. Continue to develop biological CO_2 sequestration by conversion into useful products such as liquid fuels and investigate global, natural CO_2 mitigation strategies such as whitings and ocean scale algae sequestration. ($1,336) (ORNL, INEL, TBD)
	Fund technical and program management support. ($11)	Fund technical and program management support. ($14)	Fund technical and program management support. ($14)
	$1,082	$1,350	$1,350
Technology Crosscut - Environmental Activities	Continue analyses of issues associated with air and water quality, solid waste disposal, and toxic substances, and global climate change. Continue emission trends and forecast studies. ($1,980) (ANL, ICF, Resource Dynamics, TMS, PNL, TBD)	Continue analyses of issues associated with air and water quality, solid waste disposal, and toxic substances, and global climate change. Continue emission trends and forecast studies. ($1,790) (ANL, ICF, Resource Dynamics, TMS, PNL, TBD)	Continue analyses of issues associated with air and water quality, solid waste disposal, and toxic substances, and global climate change. Continue emission trends and forecast studies. ($1,790) (ANL, ICF, Resource Dynamics, TMS, PNL, TBD)

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

Activity	FY 1999	FY 2000	FY 2001
Technology Crosscut - Environmental Activities (Cont'd)	Provide environmental, safety and health, safeguards and security and National Environmental Policy Act (NEPA) assistance and assessment support to field offices. ($220) (TMS)	Provide environmental, safety and health, safeguards and security and National Environmental Policy Act (NEPA) assistance and assessment support to field offices. ($210) (TMS)	Provide environmental, safety and health, safeguards and security and National Environmental Policy Act (NEPA) assistance and assessment support to field offices. ($210) (TMS)
	$2,200	$2,000	$2,000
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 new fossil fuel technology; provide analytical support for fossil related Energy Policy Act implementation. Conduct critical studies to identify major challenges, "leapfrog" technologies, and advanced concepts that are applicable to fossil energy systems, and have the potential to improve their efficiency, cost, and/or environmental performance. ($700) (ANL, ICF, EIA, Resource Dynamics, TMS, CO School of Mines, ITCORP, TBD)	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" 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)	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" technologies, and advanced concepts that are applicable to fossil energy systems, and have the potential to improve their efficiency, cost, and/or environmental performance. ($721) (ANL, ICF, EIA, Resource Dynamics, TMS, TBD)
	$700	$750	$721

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

Activity	FY 1999	FY 2000	FY 2001
Technology Crosscut - International Program Support	Support Fossil Energy in developing collaborative technical activities with international performers in the coal and advanced power system area. Maintain active relationships with international organizations such as the World Energy Council (WEC) and United States Energy Association (USEA). Join with other coal-using and coal-producing nations in funding expert-level analyses and reviews of coal supplies and characteristics, technology and economics of coal utilization, pathways for mitigation of environmental impacts, and international financing of coal projects and other topics as conducted by the International Energy Agency Coal Research (IEACR) and widely distributed to users in the U.S. Continue support of programmatic efforts in the Pacific Rim and focus on activities in China. Initiate Environment Corp activities in conjunction with the U.S.-China Energy and Environmental Center function. ($750) (TBD)	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 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)	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 States Energy Board (SSEB) and the National Association of State Energy Officials (NASEO). Implement Environmental Corps activities in China and activitiesof 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

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

Activity	FY 1999	FY 2000	FY 2001
Technology Crosscut - International Program Support (Cont'd)			opportunities for power systems in targeted countries. ($1,000) (TBD)
	$750	$1,000	$1,000
Technology Crosscut - International Capacity Building	No activity. ($0)	No activity. ($0)	Develop and implement programs and projects, including workshops and seminars, which will provide knowledge and information on policy development and implementation and technology transfer on cleaner power systems, their economic and environmental attributes and the use of clean coal technology, distributed power generation and cleaner power systems as a means of furnishing possible solutions to the emerging electrification needs of African, Turkish, South American, Eastern European and Middle Eastern communities. ($1,000) (TBD)
	$0	$0	$1,000

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

Activity	FY 1999	FY 2000	FY 2001
Technology Crosscut - Advanced Research for Energy Plants Center of Excellence	No activity. ($0)	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 universities and collaborate with other DOE programs for simulation, materials, fabrication/manufacturing research. ($2,970) (NETL)
	No activity .($0)	No activity. ($0)	Fund technical and program management support. ($30)
	$0	$0	$3,000
Technology Crosscut, Subtotal	$5,577	$5,945	$10,421
University Coal Research	Support grants at U.S. universities which emphasize longer-term research that will accelerate technology development and identify breakthrough technologies for the next century, and address scientific and technological issues that are key to achieving FE's strategic objectives. Increase the number of critical key research areas while ensuring the research efforts remain focused to accelerate the identification of solutions for energy and environmental problems	Support grants at U.S. universities which emphasize longer-term research that will accelerate technology development and 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.	Support grants at U.S. universities which emphasize longer-term research that will accelerate technology development and 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.

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

Activity	FY 1999	FY 2000	FY 2001
University Coal Research (Cont'd)	associated with 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. ($2,762) (TBD)	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. ($2,930) (TBD)	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. ($2,930) (TBD)
	Support the undergraduate 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)	Support the undergraduate 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)	Support the undergraduate 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)
	Fund technical and program management support. ($29)	Fund technical and program management support. ($30)	Fund technical and program management support. ($30)
	$2,831	$3,000	$3,000
HBCUs, Education and Training	Support an expanded HBCU annual technology transfer symposium (to include other minority institutions) and research activities (8 to 10 awards) (open competition to 117	Conduct research activities with HBCU and other minority institutions and support an HBCU annual technology transfer symposium. ($990) (TBD)	Conduct research activities with HBCU and other minority institutions and support an HBCU annual technology transfer symposium. ($990) (TBD)

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

Activity	FY 1999	FY 2000	FY 2001
HBCUs, Education and Training	HBCUs and other minority institutions). ($867) (TBD)		
	Fund technical and program management support. ($9)	Fund technical and program management support. ($10)	Fund technical and program management support. ($10)
	$876	$1,000	$1,000
Advanced Research, Total	$19,630	$23,195	$27,021

DEPARTMENT OF ENERGY
FY 2001 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 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 ("immature") and is located in such areas as: deep formations, gas-bearing shales, below basalt formations, hydrates, deep water, and remote areas --Gulf of Mexico and Alaska. However, the resource base is expanding with progress in geologic knowledge and advanced exploration and recovery technology. Underinvestment in research could cause scarcity or high costs in economic gas supplies, however, this scarcity or cost will not be attributable to an inadequate resource base.

National Issues and Drivers:

- A **secure supply** of **reasonably priced energy** is a prerequisite to U.S. economic strength in the global economy.
- Gas accounts for **one-third of total U.S. energy consumption** (consumption is projected to increase despite energy efficiency improvements).
- **Growing energy demand will increase U.S. dependence on petroleum and gas imports** (gas imports will increase from about 3 Tcf in 1997 to about 5.5 Tcf in 2015 mainly from Canada).
- Study the potential for development of **gas hydrates**, a new and potentially significant natural gas resource by characterizing the resource, determining its role in the global carbon cycle and evaluating its potential as an energy source for potentially satisfying expected increases in power industry demand, which in the long run may become a major contributor to the Nation's economic growth, energy security, and environmental quality. (The U.S. gas hydrate resource base is estimated at 320,000 TCF, an amount 2000 times known U.S. natural gas reserves.)
- Development of **advanced gas technologies** is essential to optimize the production of domestic energy resources, to enable the clean processing and use of lower quality domestic gas, to enhance the deliverability of natural gas, and to assist the domestic transportation industry to achieve EPA Tier II Vehicle Emission Standards (proposed) by producing a sulfur free liquid fuel for use either as a blending agent in the near- to mid-term, or as a neat fuel in the long term.
- **Global competition** is causing the gas industry to curtail basic and applied RD&D (major petroleum companies' RD&D spending fell 34 percent from 1991 to 1998, and expenditures are shifting toward near-term product and technical services).
- Advanced technologies are critical to sustaining high paying industry jobs and continued **global leadership in technology**.

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

- Natural gas offers part of the solution to global efforts to **reduce greenhouse gas emissions** - producing up to 50% less CO_2 than coal and 20-30% less than oil.

Program Drivers for the Natural Gas Technologies Program: Departmental and Program strategic plans; recommendations of the President's Committee of Advisors on Science and Technology (PCAST) (FY 2001 budget of $38.8 million for gas production/ processing technologies including $2 million in 2001 for a science-based methane hydrates program); the "Comprehensive National Energy Strategy" (CNES); proposed EPA Tier II Vehicle Emission Standards; and recommendations of the National Petroleum Council. A key environmental goal of the Office of Fossil Energy Strategic Plan is to support R&D policies and improved regulatory practices that can moderate future price increases and fuel 25 percent of the anticipated 6 Tcf increase in domestic natural gas production through 2010.

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

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 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 and Pittsburgh, Pennsylvania, manages the gas technology program implementation activities.

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

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) reduce the cost and improve the effectiveness of gas recovery from mature fields; and (c) minimize overall environmental impact of drilling-related operations and waste disposal. In the Advanced Diagnostics & Imaging Systems Program (formerly Low Permeability Formations and Resources & Reserves Assessment) 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 funding is requested to identify and assess the potential productivity of deep gas reservoirs in priority basins to reduce exploration and production risks. The office will continue to support the Secondary Gas Recovery project for increasing recovery efficiency and for extending the productive life of mature fields. 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). Finally, technology transfer activities will be continued addressing independent producers via internet, newsletters and workshops.

Gas Hydrates: Efforts are underway to enable safe and economic production of gas from hydrates and assess their impact on the global carbon cycle. In this program, funding is requested for resource characterization and seismic survey activities.

Infrastructure: Efforts are being directed to enhance energy system reliability with the Nation's natural gas pipelines and gas storage facilities. Advanced technology research and demonstration projects are directed to ensure the transmission reliability, operational flexibility of utility distribution pipeline systems, to increase the consumer benefits from existing underground storage facilities, reduce the investment required to maintain affordable storage service, 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 can determine storage well damage mechanisms and prevent or remediate storage field deliverability decline, 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 or gas transmission and distribution lines, to develop longer life, high-strength non-corrosive pipeline materials to reduce methane leaks from Russian oil and gas operations by developing smart automated inside pipeline inspection sensor system and repair technology, and to develop portable optical imaging technology to detect natural gas leaks in pipelines, gas storage facilities, and gas processing facilities both domestically and internationally. Studies will also be undertaken on the overall reliability of the system in its increasing integration with the electric grid. The International programs will include efforts to transfer these technologies and best industry practices to the former Soviet Union.

Emerging Processing Technology: The primary focus of this program area is to develop technologies needed to prepare low-quality gas and gas found in locations remote from conventional pipelines, e.g., Alaska North Slope, and Gulf of Mexico, for transport, conventional combustion use, and/or use as ultra-clean liquid motor vehicle fuels. Program efforts include development of advanced membrane and other separation technologies to enhance hydrogen sulfide (H_2S), carbon dioxide (CO_2), and nitrogen (N_2) removal from raw gas; development of

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

innovative processes to chemically convert natural gas to readily transportable, competitively priced liquid transportation fuels as well as blending agents able to improve the environmental acceptability of petroleum-based fuels; and other advanced efforts to upgrade, concentrate and otherwise prepare natural gas for use. Collaborative program efforts initiated in FY 1998 with Fossil Energy's transportation fuels and chemicals program and the Office of Energy Efficiency and Renewable Energy's Heavy Vehicle Technologies and Hydrogen programs in furthering applicable Fischer-Tropsch gas-to-liquids technology and advanced motor vehicle fuel production will continue, in conjunction with the Ultra-Clean Transportation Fuels Initiative.

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 2001, 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 soils that have been contaminated with hydrocarbons or produced water, 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:

The Natural Gas Technology Program is developing knowledge and technologies that will increase natural gas production by almost 3.8 Tcf per year by 2020. Additionally, environmental operating costs will be decreased by $6 billion, cumulative to 2010. Activities in FY 2001 that contribute to this ultimate goal include:

- Complete laboratory testing of new nitrogen removal technology that could reduce the costs of upgrading low quality gas by 40 to 80% by 2010.
- 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
- Quantify a hydrate deposit by correlating core samples with geophysical and well log data.
- Initiate development of a national pipeline model incorporating incident analysis, which will lead to improved approaches for managing multiple systems operations in emergencies.
- 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.
- Begin laboratory scale test operations of novel ITM-syngas ceramic membrane reactor to reduce gas-to-liquid fuel conversion costs and initiate construction of first stage scale-up of ITM reactor capable of producing a barrel a day.

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

Activity	FY 1999	FY 2000	FY 2001	$Change	%Change
Exploration and Production	$12,598	$14,252	$12,430	$-1,822	-13%
Gas Hydrates	492	2,960	2,000	-960	-32%
Infrastructure	975	1,000	13,200	12,200	1220%
Emerging Processing Technology	8,945	10,168	8,500	-1,668	-16%
Effective Environmental Protection	2,938	3,217	2,620	-597	-19%
Total, Natural Gas Technologies	$25,948	$31,597	$38,750	$7,153	23%

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

	FY 1999	FY 2000	FY 2001	$Change	%Change
Argonne National Lab (East)	$202	$75	$75	$0	0%
Idaho National Engineering Lab	663	50	475	425	850%
Lawrence Berkeley Lab	1,165	470	1,140	670	143%
Lawrence Livermore National Laboratory	560	275	200	-75	-27%
Los Alamos National Laboratory	770	450	665	215	48%
National Energy Technology Laboratory	1,344	1,119	1,169	50	4%
Oak Ridge National Lab	200	0	50	50	??
Pacific Northwest Laboratory	503	775	450	-325	-42%
Sandia National Laboratories	563	579	639	60	10%
All Other	20,481	28,579	34,337	5,758	20%
Total, Natural Gas Technologies	$25,948	$31,597	$38,750	$7,228	23%

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

Activity	FY 1999	FY 2000	FY 2001
Exploration and Production	Advanced Drilling, Completion, and Stimulation (DCS): Continue support of industry led cooperative research, development, and deployment of reduced-cost products and cleaner, higher efficiency processes. 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. ($4,157) (NETL, Oklahoma Univ., EG&G, Maurer/Halburton, Sperry Sun, Drilling Eng'g Assoc., Novatek, Mauer, Tempress, Tech Int., Penn St., TBD)	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. ($5,581) (NETL, Oklahoma Univ., Sperry Sun, Drilling Eng'g Assoc., Novatek, Mauer, Tempress, Tech Int., TBD)	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. ($4,000) (NETL, Novatek, Mauer, Tempress, ACPT, Tech Int., TBD)
	Advanced Diagnostics and Imaging Systems: Continue research in low-permeability	Advanced Diagnostics and Imaging Systems: Continue research in low-permeability	Advanced Diagnostics and Imaging Systems: Continue research in low-permeability

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

Activity	FY 1999	FY 2000	FY 2001
Exploration and Production (Cont'd)	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. ($5,485) (EG&G, LBL, SNL, Coleman, Adv. Res., UPRC, Marine Board, TBD)	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. ($5,628) (NETL, LBL, SNL, ICF, USGS, Marine Board, TBD)	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. ($5,276) (NETL, LBL, SNL, USGS, Marine Board, ARI, N. Mex. Tech., TBD)
	Multi NL/Industry Partnership: Support R&D in exploration and production technologies in projects identified by industry partners. ($975) (LLNL, LANL, INEL)	Multi NL/Industry Partnership: Support R&D in exploration and production technologies in projects identified by industry partners. ($1,000) (National Labs)	Multi NL/Industry Partnership: Support R&D in exploration and production technologies in projects identified by industry partners. ($1,000) (National Labs)
	Secondary Gas Recovery: Continue tests of methodologies in the Appalachian Basin and the offshore Gulf Coast. ($780) (BEG, WV Consortium)	Secondary Gas Recovery: Continue tests of methodologies in the Appalachian Basin and the offshore Gulf Coast. ($800) (BEG, WV Consortium)	Secondary Gas Recovery: Continue tests of methodologies in the Appalachian Basin and the offshore Gulf Coast. ($800) (BEG, WV Consortium)
	Stripper Wells Revitalization: Conduct engineering assessment	Stripper Wells Revitalization: Conduct engineering assessment	Stripper Wells Revitalization: Continue engineering assessments

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

Activity	FY 1999	FY 2000	FY 2001
Exploration and Production (Cont'd)	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. ($487) (TBD)	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. ($500) (TBD)	of wells to determine candidate areas for restimulation; test and evaluate impact of revitalization techniques on the productive life of wells. ($500) (TBD)
	Technology Transfer: Support industry led efforts in technology transfer. ($585) (PTTC)	Technology Transfer: Support industry led efforts in technology transfer. ($600) (PTTC)	Technology Transfer: Support industry led efforts in technology transfer. ($730) (PTTC)
	Provide technical and program management support. ($129)	Provide technical and program management support. ($143)	Provide technical and program management support. ($124)
	$12,598	$14,252	$12,430
Gas Hydrates	Initiate characterization efforts and seismic surveys for assessment of supply potential. ($487) (USGS, NRL, Colo. Sch. Of Mines, TBD)	Expand resource characterization and seismic survey activities in the onshore and offshore areas. ($2,930) (TBD)	Continue resource characterization and seismic survey activities in onshore and offshore areas. ($1,980) (TBD)
	Provide technical and program management support. ($5)	Provide technical and program management support. ($30)	Provide technical and program management support. ($20)
	$492	$2,960	$2,000
Infrastructure	Storage Technology: Continue support to industry for deliverability enhancement, gas measurement and advanced storage concepts. ($965) (ARI, MSU, IGS, TBD)	Storage Technology: Continue support to industry for deliverability enhancement, gas measurement and advanced storage concepts. ($990) (ARI, PNL, LLNL, TBD)	Storage Technology: Continue support to industry for deliverability enhancement, reservoir management, gas metering and measurement, and advanced storage concepts

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

Activity	FY 1999	FY 2000	FY 2001
Infrastructure (Cont'd)			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. ($2,178) (ARI, TBD)
	No activity. ($0)	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, conduct research on obstacle detection systems for horizontal boring applications for laying distribution pipelines, develop

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

Activity	FY 1999	FY 2000	FY 2001
Infrastructure (Cont'd)			portable real-time video imaging technology to detect natural gas leaks, develop gas system reliability analysis and distributed resource system integration model. Studies will also be undertaken on the overall reliability of the system in its increasing integration with the electric grid. ($4,950) (TBD)
	No activity. ($0)	No activity. ($0)	**International Clean Energy Initiative**: Initiate an Asian-Pacific Economic Council (APEC) Natural Gas Initiative that identifies policies and regulatory practices to increase private capital formation for natural gas infrastructure development in the Philippines, China, Peru, Indonesia, Vietnam, Papua New Guinea, Malaysia, and Columbia. This program will be co-managed with the Office of International Affairs ($990). Reduce methane leaks from Russian oil and gas operations, which are estimated at 1 TCF per year equivalent to about 108 million metric tons of carbon a year. Improve development of he following

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

Activity	FY 1999	FY 2000	FY 2001
Infrastructure (Cont'd)			technologies will be transferred and applied: pipeline leak and intrusion detection system using optical methods; a portable natural gas video imaging system that has application as a aircraft survey device for natural gas pipelines; pipeline inspection sensors with internal leak sealing capabilities; low-cost, structurally reliable internal pipeline coating material to inhibit the corrosive action of gas; and improved corrosion-inhibition treatment alternatives in gas gathering lines ($4,950) (Total $5,940) (TBD)
	Provide technical and program management support. ($10)	Provide technical and program management support. ($10)	Provide technical and program management support. ($132)
	$975	$1,000	$13,200
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 of novel conversion concepts.	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 of novel conversion concepts.	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 cost-shared development and field testing of promising

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

Activity	FY 1999	FY 2000	FY 2001
Emerging Processing Technology (Cont'd)	Continue cost-shared development of innovative hydrogen plasma pyrolysis and other chemical conversion, and small-scale physical conversion technologies for the production of transportable liquids from natural gas. Continue material, seal and reactor development 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. ($6,614) (INEL, LANL-Cryenco, K&M, LBNL, Okla Univ., Air Products, ANL, PNL, Pa. State U., NETL, TBD)	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. ($6,253) (U. of AK-Fairbanks, INEL, LANL-Cryenco, LBNL, Air Products, PNL, PSU, CAER, NETL, TBD)	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. ($6,482) (U.of AK-Fairbanks, LANL-Cryenco, LBL, Air products, PNNL, PSU, CAER, NETL, TBD)

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

Activity	FY 1999	FY 2000	FY 2001
Emerging Processing Technology (Cont'd)	Gas Tech Information: Continue support of an international center for information on natural gas technologies. ($315) (GTI)	Gas Tech Information: Continue support of an international center for information on natural gas technologies. ($318) (GTI)	Gas Tech Information: Continue support of an international center for information on natural gas technologies. ($318) (GTI)
	Gas Upgrading: Continue research in low-quality gas upgrading, including development of improved sulfur removal processes and development of advanced concepts of readying high nitrogen unmarketable gas for use. Continue development of advanced hybrid gas separation technologies. Continue multi-strata upgrading and utilization. ($1,925) (NETL, Arctech, SNL, MTR, SRI, Texas A&M, TBD)	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. ($1,615) (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-strate upgrading and utilization. ($1,615) (SNL, NETL, Texas A&M, TBD)
	No activity. ($0)	Initiate Phase III of coal mine methane project. ($1,880) (TBD)	No activity. ($0)
	Provide technical and program management support. ($91)	Provide technical and program management support. ($102)	Provide technical and program management support. ($85)
	$8,945	$10,168	$8,500

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

Activity	FY 1999	FY 2000	FY 2001
Effective Environmental Protection	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. ($405) (TBD, ICF)	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) (TBD, ICF)	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) (TBD)
	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 and costs of alterative environmental compliance strategies, application of advanced research and new methods of detecting and controlling air emissions (including particulate	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 and costs of alterative environmental compliance strategies, application of advanced research and new methods of detecting and controlling air emissions (including particulate	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 environmental compliance strategies, application of advanced research and new methods of detecting and controlling air emissions from gas equipment and facilities. Continue development

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

Activity	FY 1999	FY 2000	FY 2001
Effective Environmental Protection (Cont'd)	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. ($2,235) (Greenhill, Natl. Labs, State of Miss., TBD)	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)	of treatment and disposal technologies for gas exploration and wastes. Continue cooperative efforts to establish scientifically based regulations. ($1,729) (Natl. Labs, TBD)
	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 address environmental challenges to expanded natural gas production. ($250) (IOGCC)	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 address environmental challenges to expanded natural gas production. ($1,031) (IOGCC, TBD)	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 address environmental challenges to expanded natural gas production. ($440) (TBD)
	Provide technical and program management support. ($30)	Provide technical and program management support. ($32)	Provide technical and program management support. ($26)
	$2,930	$3,217	$2,620
Natural Gas Technologies, Total	$25,948	$31,597	$38,750

DEPARTMENT OF ENERGY
FY 2001 CONGRESSIONAL BUDGET REQUEST

FOSSIL ENERGY RESEARCH AND DEVELOPMENT

OIL TECHNOLOGY

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

Current Situation: The United States imports more than one-half of its crude oil. Seventy-four percent of this imported crude oil comes from politically unstable regions of the world. Two-thirds of the known U.S. oil resource remains unrecovered after conventional production -- a significant target for advanced technologies. About 17,000 wells per year are abandoned -- and much of the U.S. oil resource is left in place. It is estimated that as much as 80 percent of the U.S. remaining oil resource could be abandoned by 2020 without advanced recovery technologies and cost-effective ways of meeting environmental requirements.

National Issues and Drivers:

- A **secure supply** of **reasonably priced energy** is a prerequisite to U.S. economic strength in the global economy.
- Oil accounts for **over one-third of total U.S. energy consumption** and **97 percent of transportation fuels** (consumption is projected to increase despite energy efficiency improvements).
- **Growing energy demand will increase U.S. dependence on petroleum imports** (imports are projected to grow to almost 70 percent of crude oil supply by 2020, and imported oil is one of the largest factor in the negative U.S. trade balance).
- Development of **advanced oil technologies** is essential to **efficiently optimize the production** of domestic energy resources while **preserving the environment**, not only in domestic exploration and production activities, but also in the processing of domestic and imported crudes where the industry faces increasing technical challenges to meet new transportation fuel standards for the 21st Century.
- The **U.S. is a mature oil-producing region** and domestic oil production is more difficult and more costly than overseas production (an estimated two-thirds of all U.S. oil remains in the ground where much of it is isolated in deep, complex reservoirs or in environmentally sensitive areas -- high costs of operations and environmental compliance are placing U.S. producers at a competitive disadvantage with foreign producers).
- Advanced technologies are critical to sustaining high paying industry jobs and continued **global leadership in technology**. (U.S. exports account for 40 percent of the world's petroleum equipment and services.)

Program Drivers for the Oil Technology Program are: Departmental and Program strategic plans; recommendations of the President's Committee of Advisors on Science and Technology (PCAST); the "Comprehensive National Energy Strategy" (CNES); and recommendations of the National Petroleum Council. Key energy security goals of the CNES and the Office of Fossil Energy Strategic Plan are to stop the decline in domestic oil production by 2005 and improve the capability of the Nation's petroleum industry to increase the supply of secure, domestic oil by an average of 500,000 barrels per day during the 2000-2010 period over the 5.5 million barrels per day

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

forecast by EIA, respectively. These goals will be accomplished by finding new sources of oil, more effectively producing known resources, and more effectively converting crude oil into useful products along with significantly reducing and resolving the environmental issues associated with domestic oil production and processing.

Federal Roles and Responsibilities in Oil Technology Research are to: (1) promote reliable energy supplies at reasonable costs; (2) provide strategic guidance for national energy policy; (3) support efficient and sustainable use of domestic energy resources; (4) protect the environment and public safety; (5) enhance the value of Federal lands (27% of oil production is on Federal lands); (6) enhance global market opportunities for U.S. energy technologies; (7) contribute to U.S. science and technology leadership; (8) apply a unique national perspective to technology development that is independent of company specific or State-specific interests; and (9) 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; (3) Effective Environmental Protection; and (4) Ultra Clean Fuels. Program planning and support and technology transfer are integral components of each of the key areas. The DOE National Petroleum Technology Office (NPTO) 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 a range of projects designed to enhance the efficiency and environmental quality of domestic oil operations. These R&D programs are conducted in partnership with industry, 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.

Exploration and Production research consists of Advanced Drilling, Completion, and Stimulation systems (ADCS), Advanced Diagnostics and Imaging Systems (ADIS), Multi National Lab/Industry Partnership, 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 helps industry by providing 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 are a series of "cradle-to-grave" activities that together improve 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

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

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 continuing development of these technologies will stimulate domestic exploration, development and production; and maintain U.S. worldwide leadership in technology development which translates into high-paying U.S. jobs through the increased worldwide export and application of these technologies. Objectives include development and deployment of technologies that can provide a refined quantitative "picture" of underground resources and their associated environments; better usage of naturally occurring phenomena such as fractures, permeability channels and barriers to fluid flow; more efficient targeted well placement, thus reducing the number of wells, the associated costs and increasing project economic viability; and minimizing the number of well locations thus reducing the size and number of surface environmental impacts. An additional objective is to enhance oil production from Federal lands.

The Multi National Laboratory/Industry Partnership activities represent an industry-driven program utilizing a wide range of technologies to effectively recover more oil. Technologies represented include adaptation of defense-related technologies and super-computation capabilities for use in the discovery and development of new and existing oil and gas fields. Activities include 163 industry partners who are participating in 45 projects in the following areas: oil and gas recovery; diagnostics and imaging; drilling, completion, and stimulation; advanced computational technology; and environmental protection. Projects are reviewed by industry representatives and are at least 50 percent cost-shared.

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 consists of six main areas which are directed toward recovering the 200 billion barrels of currently unrecoverable oil through advanced methods while at the same time helping the smaller producer with day-to-day 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. Legislative, regulatory and policy initiatives in oil supply, environmental and processing must be based on the best available information to support program goals.

Reservoir Life Extension/Management work focuses on advanced technologies for extraction of hydrocarbons from known (discovered) oil reservoirs. These activities 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. Laboratory research and evaluation of past advanced field trials in large, promising Class 1, 2, and 3 reservoirs will continue, as well as demonstration and testing of technologies

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

specifically targeted for the independent operator. Native American Initiatives for increased oil production while minimizing environmental or cultural impacts will continue.

This program will continue to foster improvement in recovery technology diagnosis and imaging of reservoirs and drilling, completion and stimulation technologies through demonstrations. The technologies are conveyed to industry users through an aggressive technology transfer program. Much of the technology transfer work is accomplished through the Petroleum Technology Transfer Council with its 10 regional centers.

The preferred Petroleum Upstream Management Practices (PUMP) program aims to stop the decline in domestic oil production by 2005, an objective of the Comprehensive National Energy Strategy (CNES). The program is designed to provide a short-term supplement to mid- and long-term R&D. PUMP will delineate on 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 through field demonstration, develop best practices databases, and use existing technology transfer mechanisms to address a regional need or issue. These projects should provide integrated solutions to technological, regulatory, environmental, and data constraints and must be ready for quick implementation and rapid results in order to increase the oil supply in the near term.

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 lower 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. In addition, the environmental program's goals are to improve environmental performance, expand the capabilities of State and Federal governments to make more cost-effective, risk-based regulatory decisions promoting sound science and common sense, and to improve communication and technology transfer among industry, government, the Native Tribes, and the public toward balancing national energy, economic and environmental objectives.

Ultra Clean Fuels will initiate research through both competitive solicitations and the National Laboratory/Industry Partnership to develop technology to overcome barriers to make very low sulfur, clean-burning transportation fuels. The goal of the Ultra-Clean Transportation Fuels Initiative (UCTFI) is to promote, in partnership with the refining and transportation industries, the development of technologies that will produce ultra-clean, high performance transportation fuels for the 21st Century from both petroleum and non-petroleum sources. These will enable the introduction of advanced, highly efficient fuel/engine combinations being developed by the Department such as Partnership

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

for a New Generation of Vehicles (PNGV) which offer the promise of lower regional emissions and greater than double the miles per gallon of fuel. In the near term, ultra-clean transportation fuels can be produced from improved or new refinery upgrading technology. In the mid- to longer term, ultra-clean transportation fuels from natural gas and other carbonaceous feedstocks would enjoy a high level of compatibility with the existing infrastructure, and could provide environmental benefits due to their suitability for use in advanced, high-efficiency vehicle engines.

In summary, this oil research program, in partnership with industry and its stakeholders, will develop cutting edge processing technologies to better convert crude oil into transportation products, develop technologies to minimize waste production and environmental damage and demonstrate the effectiveness of this technology supporting the Nation's energy security and science and technology leadership goals. Science and technology leadership is furthered by the core 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 by special initiatives for Historically Black Colleges and Universities and Native American Tribes.

Performance Measures:

The Oil Technology Program is developing knowledge and technologies that will increase hydrocarbon production by more than 4 billion barrels of oil and 14 TCF of natural gas over the next twenty years. This increased production will result in more than $4 billion of additional Federal and royalty revenues. Additionally, environmental compliance costs will be decreased by $5 billion, cumulative to 2010. Activities in FY 2001 that contribute to this ultimate goal include:

- Complete demonstration of four advanced secondary and tertiary technologies, increasing near-term incremental production by 1.1 million barrels of oil, and a long-term production by over 2 billion barrels of oil.
- Demonstrate the field application of a shoulder mounted, portable video methane leak detection system that can be used to significantly reduce costs of leak monitoring at refineries and other facilities while reducing harmful air emissions. Annual savings of $500,000 per year per refinery, on average, would result from regulatory acceptance and application of this technology.
- Complete development of state-of-the-art compact 3-phase fluid separation technology which will reduce costs of fluid separation by 70% on each application of the technology.
- Initiate a program to develop and produce ultra clean fuels from conventional crude oil, petroleum coke, refinery wastes, natural gas, or coal utilizing teams composed of energy developers, engine manufacturers, architectural and engineering firms, and equipment vendors.

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

Activity	FY 1999	FY 2000	FY 2001	$Change	%Change
Exploration and Production	$26,719	$28,408	$20,800	$-7,608	-27%
Reservoir Life Extension/Management	10,887	14,694	11,066	-3,628	-25%
Effective Environmental Protection	9,738	10,820	10,703	-117	-1%
Emerging Processing Technology Applications	0	3,330	0	-3,330	-100%
Ultra Clean Fuels	0	0	10,000	10,000	0%
Total, Oil Technology	$47,344	$57,252	$52,569	$-4,683	-8%

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

	FY 1999	FY 2000	FY 2001	$Change	%Change
Argonne National Lab (East)	$538	$400	$400	$0	0%
Brookhaven National Lab	243	300	198	-102	-34%
Idaho National Environmental and Engineering Lab	1,340	710	1,160	450	63%
Lawrence Berkeley Lab	990	800	800	0	0%
Lawrence Livermore National Lab	579	750	250	-500	-67%
Los Alamos National Laboratory	511	350	176	-174	-50%
Oak Ridge National Laboratory	1,210	1,385	1,510	125	9%
Pacific Northwest Laboratory	200	200	200	0	0%
Sandia National Laboratories	500	450	0	-450	-100%
All Other	41,233	51,917	47,875	-4,042	-8%
Total, Oil Technology	$47,344	$57,262	$52,569	$-4,693	-8%

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

Activity	FY 1999	FY 2000	FY 2001
Exploration and Production	Advanced Drilling, Completion, Stimulation: Continue the advanced research and high temperature/high pressure experimentation on theology and cuttings transport in energized fluids (gas assisted, foam, mist, etc.) In horizontal and small diameter wellbores using the DOE Flow Loop. Continue research on the more environmentally benign three phase separation technology development for reduced cost and improved efficiency on offshore platforms and onshore fields. Continue to upgrade and expand the current DOE suite of risk based decision-making tools used most by industry. ($2,132) (Univ. of Tulsa/LSU, WU, PRRC, Va. Polytec, AWU, U. of Houston, TBD)	Advanced Drilling, Completion, Stimulation: Continue capability upgrades that allow the advanced research and 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. 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/LSU, WU,	Advanced Drilling, Completion, Stimulation: Continue capability upgrades in Phase 4 of the unique Advanced Cuttings Transport 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. ($2,000) (PRRC, Univ of Tulsa, Va Polytech, WU, LSU, NMIMT, TBD)

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

Activity	FY 1999	FY 2000	FY 2001
Exploration and Production (Cont'd)		LLNL, LANL, INEEL, Va. Polytech, Univ. Houston, NMIMT, AWU, TBD)	
	Advanced Diagnostics and Imaging Systems: Continue advanced reservoir diagnostic and imaging systems work including, advanced micro seismic 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. 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 mulitphase relative permeabilities in steady and unsteady-state conditions under broad temperature and pressure conditions, and investigate influences of rock-fluid interactions on these critical parameters. Develop integrated geological, geophysical and engineering data	Advanced Diagnostics and Imaging Systems: Continue advanced reservoir diagnostic and imaging systems work including, advanced mircoseismic 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 mulitphase relative permeabilities in steady and unsteady-state conditions under broad temperature and pressure conditions, and	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 and

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

Activity	FY 1999	FY 2000	FY 2001
Exploration and Production (Cont'd)	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. Investigate reservoir pressure/gas saturations, wettability and matrix block size on spontaneous imbibition in fractured reservoirs for improved oil recovery. Continue to develop comprehensive detailed lithostratigraphic/climatic models for the development of both clastic and carbonate sedimentary basins by universities, national labs, and industry. ($6,982) (LLNL, SNL, ANL, RERI, TBD, Univ. of Alabama, Hopi Tribe, LBL, Stanford, Univ. of KS, ORNL, Cal	investigate 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 Appalachians. Investigate reservoir pressure/gas saturations, wettability and matrix	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. ($4,735) (LLNL, LBNL, ORNL, ANL, INEEL, RERI, Stanford, 8 MegaPRDA contracts, PRDA-TBD)

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

Activity	FY 1999	FY 2000	FY 2001
Exploration and Production (Cont'd)	Tech, INEEL)	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. ($7,045) (LLNL, SNL, ORNL, LBL, Stanford, RERI, ANL, TBD, Univ. of Alabama, NRC, Cal Tech)	
	Multi National Lab/Industry Partnership: Continue to adapt and transfer technologies that advance understanding of the characteristics 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	Multi National Lab/Industry Partnership: Continue to adapt and transfer technologies that advance understanding of the characteristics 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	Multi National Lab/Industry Partnership: Continue to adapt and transfer technologies that advance understanding of the characteristics 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

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

Activity	FY 1999	FY 2000	FY 2001
Exploration and Production (Cont'd)	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. ($7,064) (NL)	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) (NL-TBD)	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. ($5,445) (NL-TBD)
	Reservoir Efficiency Processes: Continue reservoir life extension studies toward commercialization of the use of foams for the extraction of low viscosity heavy oil and light oil. Continue to advance thermal methods for heavy oil extraction and screen potential heavy oil recovery processes. Continue to enhance thermal methods for light oil recovery through mechanistic studies. Continue to develop MEOR methods to develop surfactant and other oil recovery agents from waste products which helps lower environmental damage from the disposal of these wastes. Continue low cost oil recovery methods using wettability alternations and alkaline-surfactant-polymer (ASP) methods. Continue research to improve the sweep	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 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 MEOR methods to develop surfactant and other oil recovery agents from waste products which helps lower environmental damage from the disposal of these wastes.	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 MEOR methods. 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 novel processes which will aid oil recovery from naturally fractured reservoirs. ($5,655) (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, LBL,

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

Activity	FY 1999	FY 2000	FY 2001
Exploration and Production (Cont'd)	efficiency and recovery efficiency of gas flooding using more environmentally benign chemicals. Continue the analysis of the Hopi Black Mesa Basin using advanced exploration tools and test new ideas in the next high priority basin. ($6,552) (LBL, INEEL, NMIMT, TRW, USGS/Rice, Columbia Univ., TX RR Comm., AWU, ORNL, TBD)	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 Basin ($6,855) (TBD, INEEL, LBL, NMIMT, TRW)	INEEL, TBD)
	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	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	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

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

Activity	FY 1999	FY 2000	FY 2001
Exploration and Production (Cont'd)	continue technical and analytical support tasks. Continue project impact/oversight/analysis efforts. Support the contractor review workshop for program evaluation ($3,715) (IOGCC, Brashear, RMC, TRW, TU, TBD) Fund technical and program management support. ($274)	continue technical and analytical support tasks ($3,700). Continue project impact/oversight/analysis efforts. Support the contractor review workshop for program evaluation ($600). (Total $4,300) (IOGCC, RMC, TRW, Univ. of Tulsa, TBD) Fund technical and program management support. ($284)	continue technical and analytical support tasks ($2,157). Continue project impact/oversight/analysis efforts. Support the contractor review workshop for program evaluation ($600). (Total $2,757) (IOGCC, RMC, TRW, Univ. of Tulsa, TBD) Fund technical and program management support. ($208)
	$26,719	$28,408	$20,800
Reservoir Life Extension/ Management	Recovery Field Demonstrations: 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. ($6,860) (Ensign, Binger, Michigan Tech, Luff, U. of KS, TU, Plains-IL, Venoco, UTS, U. of Alabama)	Recovery Field Demonstrations: 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. ($6,722) (Ensign, Binger, Michigan Tech, Luff, U. of KS, TU, Plains-IL, Venoco, UTS, U. of Alabama)	Recovery Field Demonstrations: 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. ($4,000) Identify the successes from previous Independents projects. ($300) Identify the most promising technologies identified in the Class Revisit or research with Independents projects and commence advanced research on two or three technologies. ($500)

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

Activity	FY 1999	FY 2000	FY 2001
Reservoir Life Extension/ Management (Cont'd)			(Total $4,800) (Ensign, Binger, Michigan Tech, Luff, U. of KS, TU, Plains-IL, Venoco, UTS, U. of Alabama, TBD)
	Increase Production from Marginal Wells: Increase production from marginal wells by conducting reservoir life extension projects such as: continue cost-shared reservoir management techniques for marginal wells. Continue cost-shared projects with small operators for innovative technologies to improve production efficiency and extend the life of in marginal wells at risk of abandonment ($752) (TXRRC, TBD)	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. Improve-ment can come through decreased operating or environmental costs or improved equipment design. ($1,040) (TBD)	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. ($422) 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 successful training initiative for Native American decision makers. ($500) (Total $922) (TBD)
	Technology Transfer: Continue technology outreach by supporting regional workshops providing complete packages of applicable results from Class Demonstration and other projects to assist oil	Technology Transfer: Continue technology outreach by supporting regional workshops providing complete packages of applicable results from Class Demonstration and other projects to assist oil	Technology Transfer: Continue technology outreach by supporting regional workshops providing complete packages of applicable results from Class Demonstration and other projects to assist oil

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

Activity	FY 1999	FY 2000	FY 2001
Reservoir Life Extension/ Management (Cont'd)	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; 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. ($3,163) (PTTC, RMC, TBD)	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; 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. ($3,185) (PTTC, RMC, SPE, TBD)	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. 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.) ($3,233) (PTTC, RMC, TBD)
	No activity. ($0)	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	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,

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

Activity	FY 1999	FY 2000	FY 2001
Reservoir Life Extension/ Management (Cont'd)		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. ($3,600) (TBD)	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 regulatory streamlining activities will be targeted to address key regional constraints in two regions using PUMP advanced oil recovery technology. ($2,000) (TBD)
	Fund technical and program management support. ($112)	Fund technical and program management support. ($147)	Fund technical and program management support. ($111)
	$10,887	$14,694	$11,066
Effective Environmental Protection	Program Planning and Analysis: Continue analysis of industry environmental trends and maintain performance measure data for program planning and technology transfer. Continue to enhance cooperative efforts with industry, states, federal agencies and others to promote effective environmental protection and resolve regional environmental constraints to sustained oil production and efficient oil resource recovery.	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. ($825) (ANL, ICF, PERF, SPCE, ALO, DynCorp,

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

Activity	FY 1999	FY 2000	FY 2001
Effective Environmental Protection (Cont'd)	Coordinate with 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) (ANL, ICF, SPE, KWT/Aspen, ALO, IOGCC)	(ANL, ICF, PERF, SPCE, DynCorp, EPA, TBD)	TBD)
	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. Generate independent quality scientific data to help implement national policy in streamlining and improving existing regulations and laws. ($1,451) (IOGCC, ORNL, INEEL, TXRRC, PNL, LLNL, U. of KY, Nat'l Labs, TBD)	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, TBD)	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 ($800). Generate independent quality scientific data to help implement national policy in streamlining and improving existing regulations and laws ($602). (Total $1,402) (IOGCC, ORNL, U. of KY, Nat'l Labs, TBD)

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

Activity	FY 1999	FY 2000	FY 2001
Effective Environmental Protection (Cont'd)	Risk Assessment: Continue to provide credible scientific data for regulatory decision making. Continue cooperative efforts with regulatory and industry groups to establish environmentally acceptable end-points. Continue research to assess and 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 support for development of compatible data management systems between state and Federal agencies. 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 ($2,760). 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	Risk Assessment: Continue to provide credible scientific data for regulatory decision making. Continue research to assess and 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 ($3,257). 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	Risk Assessment: Provide credible scientific data for regulatory decision making. Continue research to assess and mitigate 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 ($3,194). 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. ($802). (Total $3,996) (GWPC, Natl. Labs, BNL, INEEL, ANL, BLM, LBL, PERF, IGT, DynCorp, TBD)

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

Activity	FY 1999	FY 2000	FY 2001
Effective Environmental Protection (Cont'd)	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 ($1,374). (Total $4,134) (GWPC, BNL, LBL, ORNL, SNL, Nat'l Labs, WSPA, IGT, ANL, INEEL, DynCorp, ITC, PNL, LANL, USGS, MGS, Thermo Retec, TBD)	($1,630). (Total $4,887) (GWPC, Natl. Labs, BNL, INEEL, ANL, ORNL, LLNL, LBL, PERF, TBD)	
	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 ($1,877). (Total $3,328) (TBD, Natl Labs, ANL, ORNL, INEEL, BNL, OERB, TU, PNL, TXRRC)	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, Air/Waste Mgmt, TU)	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). In keeping with PCAST recommendations, perform research to make fuels that have fewer pollutants and fewer emissions affecting global climate change ($2,922). (Total $4,373) (TBD, Natl Labs, ORNL, INEEL, PNL, OERB, TU)

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

Activity	FY 1999	FY 2000	FY 2001
Effective Environmental Protection (Cont'd)	Fund technical and program management support. ($100)	Fund technical and program management support. ($108)	Fund technical and program management support. ($107)
	$9,738	$10,820	$10,703
Emerging Processing Technology Applications	No activity. ($0)	The R&D activity will provide data to validate viability of biodesulfurization of diesel fuel for application in small refineries. ($3,297) (TBD)	No activity. ($0)
	No activity. ($0)	Fund technical and program management support. ($33)	No activity. ($0)
	$0	$3,300	$0
Ultra Clean Fuels	No activity. ($0)	No activity. ($0)	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. ($9,900) (TBD)
	No activity. ($0)	No activity. ($0)	Fund technical and program management support. ($100)
	$0	$0	$10,000
Oil Technology, Total	$47,344	$57,252	$52,569

DEPARTMENT OF ENERGY
FY 2001 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, the National Petroleum Technology Office (NPTO) in Tulsa, Oklahoma, 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.) and to achieve compliance with Federal, state and local safety and health requirements. 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. A RCRA corrective action agreement with the U.S. Environmental Protection Agency (EPA) requires the investigation and remediation of soil and groundwater contamination at a Windsor, Connecticut site. Occupational Safety and Health Administration (OSHA) inspections of the ARC site resulted in the issuance of Notices of Unsafe or Unhealthful Working Conditions as well as Notification of Failure to Abate Alleged Violations which identified safety and health hazards. Groundwater and soil monitoring/remediation is also required at the NETL and ARC sites to ensure compliance with Federal, state and local requirements.

FY 2001 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 asbestos, lead, mercury and PCB site surveys and remove hazardous materials at ARC.
- Complete eight lead and asbestos abatements at the NETL. Complete public address systems at PGH-Phase I-RD Plateau.
- Plug and abandon natural gas well at NETL MGN site.
- Upgrade gas alarms in 5 NETL buildings and continue to address ventilation deficiencies at NETL sites.
- Complete security and emergency management program at ARC.

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

- Complete environmental cleanup of Connecticut coal gasification site.
- Reduce the generation of hazardous waste at NETL by 50% compared to the 1993 baseline year.
- Reduce landfilled sanitary (office) waste at NETL to 100 tons.
- Reduce electrical energy consumption at the ARC by 15%.
- Reduce sanitary waste from routine operations at ARC by 20%.
- Increase purchases of environmentally preferable products and services at ARC to 100% where competitively available and performance standards are met.

II. A. **Funding Schedule**:

Activity	FY 19998	FY 2000	FY 2001	$Change	%Change
CERCLA Remedial Actions	$3,525	$2,122	$2,700	$578	27%
RCRA Remedial Actions	2,423	2,345	1,988	-357	-15%
Other ES&H Actions	5,052	5,533	4,353	-1,180	-21%
Total, Fossil Energy Environmental Restoration	$11,000	$10,000	$9,041	$-959	-10%

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

Activity	FY 1999	FY 2000	FY 2001	$Change	%Change
All Other	$11,000	$10,000	$9,041	$-959	-10%
Total, Fossil Energy Environmental Restoration	$11,000	$10,000	$9,041	$-959	-10%

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

Activity	FY 1999	FY 2000	FY 2001
CERCLA Remedial Actions	Continue cleanup of Rock Springs sites. ($750) (Army Corps of Engineers)	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 Hoe Creek site. ($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 Hannah Site revegetation. ($50)	Continue Hannah Site revegetation. ($35)	Continue Hannah Site revegetation. ($50)
	Continue with Phase II NETL risk assessment documentation. ($60)	No activity. ($0)	No activity. ($0)
	Continue preliminary assessment/site investigations of NETL inactive projects. ($425)	No activity. ($0)	Implement new CERCLA site investigations and project closeouts. ($100) (TBD)
	Continue cleanup of soil and groundwater at former NETL liquefaction sites. ($530) (TBD)	No activity. ($0)	Continue cleanup of soil and groundwater at former NETL liquefaction sites. ($75) (TBD)
	Perform onsite CERCLA-type remediation assessments at NETL. ($50) (TBD)	Perform onsite CERCLA-type remediation assessments at NETL. ($100) (TBD)	Perform onsite CERCLA-type remediation assessments at NETL. ($60) (TBD)

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

Activity	FY 1999	FY 2000	FY 2001
CERCLA Remedial Actions (Cont'd)	Implement CERCLA PRP Response Activities (e.g. Western Processing). ($860) (TBD)	Implement CERCLA PRP Response Activities ($200) (TBD)	Implement CERCLA PRP Response Activities, e.g., Connecticul coal gasification site. ($1,546) (TBD)
	$3,525	$2,122	$2,700
RCRA Remedial Actions	Continue NETL on-site remediation activities such as lead and asbestos abatement; underdrain leachate remediation; waste minimization and pollution prevention activities; toxic chemical management program upgrades; hazardous material and waste compliance activities; PCB removal; resolution of fecal coliform in stormwater; improvements in stormwater catch basin; replacementt of ozone depleting substances; and closeout of inactive waste ponds. ($1,723) (TBD)	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 problems. ($1,310) (TBD)

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

Activity	FY 1999	FY 2000	FY 2001
RCRA Remedial Actions (Cont'd)	Initiate RCRA cleanup actions at Albany Research Center including characterizing and resolving chemical and radioactive storage, labeling; handling; and disposal problems. ($700) (TBD)	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)	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)
	$2,423	$2,345	$1,988
Other ES&H Actions	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. ($4,446) (TBD)	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)	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. ($3,537) (TBD)

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

Activity	FY 1999	FY 2000	FY 2001
Other ES&H Actions (Cont'd)	No activity. ($0)	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)
	Initiate site-wide safety and health corrective actions at Albany Research Center including training, machine guarding, lockout/tagout, and fume hoods. ($496) (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 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)
	Technical and management support. ($110)	Technical and management support. ($110)	Technical and management support. ($90)
	$5,052	$5,533	$4,353
Fossil Energy Environmental Restoration, Total	$11,000	$10,000	$9,041

DEPARTMENT OF ENERGY
FY 2001 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, the National Energy Technology Laboratory (NETL), and the National Petroleum Technology Office (NPTO). The Headquarters staff is responsible for overall direction of the programs that include 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 National NETL and NPTO perform 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**:

Activity	FY 1999	FY 2000	FY 2001	$Change	%Change
Headquarters Program Direction					
Salaries and Benefits	$9,282	$9,662	$10,700	$1,038	11%
Travel	420	489	489	0	0%
Contract Services	5,347	5,865	5,778	-87	-1%
Subtotal, Headquarters Program Direction	15,049	16,016	16,967	951	6%

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

Activity	FY 1999	FY 2000	FY 2001	$Change	%Change
Field Program Direction					
Salaries and Benefits	27,830	29,152	31,085	1,933	7%
Travel	1,344	1,398	1,499	101	7%
Contract Services	25,258	28,913	25,513	-3,400	-12%
Subtotal, Field Program Direction	54,432	59,463	58,097	-1,366	-2%
Total, Program Direction and Management Support	$69,481	$75,479	$75,064	$-415	-1%

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

	FY 1999	FY 2000	FY 2001	$Change	%Change
National Petroleum Technology Office	$3,782	$4,161	$4,161	$0	0%
National Energy Technology Laboratory	50,650	55,302	53,936	-1,366	-2%
All Other	15,049	16,016	16,967	951	6%
Total, Program Direction and Management Support	$69,481	$75,479	$75,064	$-415	-1%

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

Activity	FY 1999	FY 2000	FY 2001
Headquarters Program Direction - Salaries and Benefits	Provide funds for 96 FTE's at Headquarters. This staff implements and communicates policy to the ETC's, sets program objectives, develops program plans and evaluates alternative strategies; develops and defends budget requests; approves procurement plans; and monitors work progress. ($9,282)	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; develops and defends budget requests; approves procurement plans; and monitors work progress. ($9,662)	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; develops and defends budget requests; approves procurement plans; and monitors work progress. ($10,700)
	$9,282	$9,662	$10,700
Travel	Provide funds for travel in support of the activities stated above. Both domestic and international travel are conducted. ($420)	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. ($489)
	$420	$489	$489
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. ($1,000) (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)	Provide for contractual services that are generic to the entire FE program. Included are items such as computer services, technical and management support services. ($1,428) (TBD)

III. **Performance Summary**: PROGRAM DIRECTION AND MANAGEMENT SUPPORT (Cont'd)

Activity	FY 1999	FY 2000	FY 2001
Headquarters Program Direction (Cont'd) - Contract Services	Fund SBIR in the amount of $6,526 from prior year and/or various R&D program funds within the Fossil Energy R&D account. ($0)	Fund SBIR in the amount of $6,917 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 the Small Business Technology Transfer (STTR) in the amount of $391 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 $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)
	Provide for the operation, maintenance and upgrading of FE headquarters-wide network and desktop workstation computer systems and televideo units. ($785)	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. ($750)
	Provide for printing services. ($30) (TIC)	Provide for printing services. ($80) (TIC)	Provide for printing services. ($50) (TIC)
	Upgrade electronic records management systems. ($100)	Upgrade electronic records management systems. ($100)	Upgrade electronic records management systems. ($100)
	Provide working capital fund. ($3,432)	Provide working capital fund. ($3,450)	Provide working capital fund. ($3,450)
	$5,347	$5,865	$5,778

III. **Performance Summary**: PROGRAM DIRECTION AND MANAGEMENT SUPPORT (Cont'd)

Activity	FY 1999	FY 2000	FY 2001
Headquarters Program Direction, Subtotal	$15,049	$16,016	$16,967
Field Program Direction Salaries and Benefits	Provide funds for NETL and NPTO indirect staff of 314 (NETL - 288; NPTO - 26) FTEs. 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 (NETL - $25,520, NPTO - $2,310) (Total $27,830)	Provide funds for NETL and NPTO indirect staff of 324 (NETL - 297; NPTO - 27) FTEs. 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. 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. (NETL - $26,632, NPTO - $2,520) (Total $29,152)	Provide funds for NETL and NPTO indirect staff of 339 (NETL - 312; NPTO - 27) FTEs. 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. 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. (NETL - $28,565, NPTO - $2,520) (Total $31,085)
	$27,830	$29,152	$31,085

III. **Performance Summary**: PROGRAM DIRECTION AND MANAGEMENT SUPPORT (Cont'd)

Activity	FY 1999	FY 2000	FY 2001
Travel	Provide funds for travel in support of the above activities in the attainment of program goals, both on the domestic front and abroad. (NETL - $1,083, NPTO - $261) (Total $1,344)	Provide funds for travel in support of the above activities in the attainment of program goals, both on the domestic front and abroad. (NETL - $1,137, NPTO - $261) (Total $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. (NETL - $1,238, NPTO - $261) (Total $1,499)
	$1,344	$1,398	$1,499
Contract Services	Provide substantial funding of facility operations, maintenance, finance, AOSS support, administrative, management and technical support. (NETL - $24,047, NPTO - $1,211) (Total $25,258)	Provide substantial funding of facility operations, maintenance, finance, AOSS support, administrative, management and technical support. (NETL - $27,533, NPTO - $1,380) (Total $28,913)	Provide substantial funding of facility operations, maintenance, finance, AOSS support, administrative, management and technical support. (NETL - $24,133, NPTO - $1,380) (Total $25,513)
	$25,258	$28,913	$25,513
Field Program Direction, Subtotal	$54,432	$59,463	$58,097
Program Direction and Management Support, Total	$69,481	$75,479	$75,064

DEPARTMENT OF ENERGY
FY 2001 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, at the National Petroleum Technology Office (NPTO), 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, NPTO, and ARC.

II. A. **Funding Schedule**:

Activity	FY 1999	FY 2000	FY 2001	$Change	%Change
Construction	$2,600	$2,600	$2,000	$-600	-23%
Total, Plant and Capital Equipment	$2,600	$2,600	$2,000	$-600	-23%

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

	FY 1999	FY 2000	FY 2001	$Change	%Change
All Other	$2,600	$2,600	$2,000	$-600	-23%
Total, Plant and Capital Equipment	$2,600	$2,600	$2,000	$-600	-23%

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

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

DEPARTMENT OF ENERGY
FY 2001 CONGRESSIONAL BUDGET REQUEST

FOSSIL ENERGY RESEARCH AND DEVELOPMENT

COOPERATIVE RESEARCH AND DEVELOPMENT

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

The Cooperative Research and Development program addresses national priority objectives by supporting strategic Fossil Energy research of high merit and relevance to the U.S. market that is selected and funded collaboratively by federal and non-federal parties. It currently 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.

II. A. **Funding Schedule**:

Activity	FY 1999	FY 2000	FY 2001	$Change	%Change
Cooperative Research and Development	$6,657	$7,389	$5,836	$-1,553	-21%
Total, Cooperative Research and Development	$6,657	$7,389	$5,836	$-1,553	-21%

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

Activity	FY 1999	FY 2000	FY 2001	$Change	%Change
All Other	$6,657	$7,389	$5,836	$-1,553	-21%
Total, Cooperative Research and Development	$6,657	$7,389	$5,836	$-1,553	-21%

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

Activity	FY 1999	FY 2000	FY 2001
Cooperative Research and Development	Provide support for cooperative research programs at WRI ($3,309) and UNDEERC ($3,308) which are 50-50 cost-shared with non-federal clients. ($6,617) (WRI, UNDEERC)	Provide support for cooperative research programs at WRI ($3,674) and UNDEERC ($3,675) which are 50-50 cost-shared with non-federal clients. ($7,349) (WRI, UNDEERC)	Provide support for cooperative research programs at WRI ($2,898) and UNDEERC ($2,898) which are 50-50 cost-shared with non-federal clients. ($5,796) (WRI, UNDEERC)
	Fund technical and program management support. ($40)	Fund technical and program management support. ($40)	Fund technical and program management support. ($40)
Cooperative Research and Development, Total	$6,657	$7,389	$5,836

DEPARTMENT OF ENERGY
FY 2001 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. FY 2001 performance measures include:

- Construct high temperature refractory test facility equipment to test and improve the performance of commercially available refractories for IGCC applications.
- Complete the proof-of-principle and demonstrate continuous titanium processing utilizing a cold crucible induction melting process. Assess tradeoffs between processing, materials, and properties.
- Complete initial laboratory experiments on oxidation and sulfidation resistant cast stainless steel developed at ARC for process streams in advanced heat recovery and hot gas cleanup systems employed with advanced power generation systems (IGCC, PFBC, and IGFC).

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

Activity	FY 1999	FY 2000	FY 2001	$Change	%Change
Advanced Metallurgical Processes	$5,000	$5,000	$5,225	$225	5%
Total, Advanced Metallurgical Processes	$5,000	$5,000	$5,225	$225	5%

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

	FY 1999	FY 2000	FY 2001	$Change	%Change
All Other	$5,000	$5,000	$5,225	$225	5%
Total, Advanced Metallurgical Processes	$5,000	$5,000	$5,225	$225	5%

III. **Performance Summary**:

Activity	FY 1999	FY 2000	FY 2001
Advanced Metallurgical Processes	Initiate research identified during FY 1998 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	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	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 guild viable domestic commercial capabilities in waste-free environmentally benign materials

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

Activity	FY 1999	FY 2000	FY 2001
Advanced Metallurgical Processes (Cont'd)	Federal agencies to build viable domestic 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)	industry and with State and Federal agencies to build viable domestic 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)	production, energy production 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. ($5,173) (ARC)
	Fund technical and program management support. ($50)	Fund technical and program management support. ($50)	Fund technical and program management support. ($52)
	$5,000	$5,000	$5,225
Advanced Metallurgical Processes, Total	$5,000	$5,000	$5,225

Climate Change Technology Initiative (CCTI)
Departmental Crosscut

(dollars in thousands)

	FY 1999 Enacted	FY 2000 Enacted	FY 2001 Request	$ Change	% Change
Energy & Water Development					
Energy Supply:					
Solar and Renewable	$332,319	$310,116	$409,500	$99,384	32.0%
Nuclear Energy	0	4,976	5,000	24	0.5%
Subtotal, Energy Supply	332,319	315,092	414,500	99,408	31.5%
Science	13,135	33,000	36,700	3,700	11.2%
Subtotal, Science	13,135	33,000	36,700	3,700	11.2%
Subtotal, Energy & Water	345,454	348,092	451,200	103,108	29.6%
Interior and Related Agencies					
Energy Conservation R&D ..	518,378	590,242	659,500	69,258	11.7%
Fossil Energy R&D	23,880	38,438	56,100	17,662	45.9%
Energy Information Administration	2,500	3,000	2,500	-500	-16.7%
Subtotal, Interior and Related Agencies	544,758	631,680	718,100	86,420	13.7%
Total, DOE	$890,212	$979,772	$1,169,300	$189,528	19.3%