

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), \$519,305,000, to remain available until expended, of which \$5,000,000 shall be derived by transfer of unobligated balances from “SPR Petroleum Account”; of which \$13,200,000 shall be used to support research and development contracts on technological approaches to reduce, avoid, or capture greenhouse gas emissions, to be awarded pursuant to competitive solicitations; and of which \$130,000,000 are to be made available, after coordination with the private sector, for a request for proposals for a Clean Coal Power Initiative providing for competitively-awarded research, development, and demonstration projects to reduce the barriers to continued and expanded coal use: Provided, That no project may be selected for which sufficient funding is not available to provide for the total project: Provided further, That funds shall be expended in accordance with the provisions governing the use of funds contained under the heading “Clean Coal Technology” in 42 U.S.C. 5903d: Provided further, That the Department may include provisions for royalties or other means of repayment of Government contributions to individual projects, including repayments from sale and licensing of technologies from both domestic and foreign transactions: Provided further, That such repayments shall be retained by the Department for future coal-related research, development and demonstration projects, subject to appropriation in advance: Provided further, That any technology selected under this program shall be considered a Clean Coal Technology, and any project selected under this program shall be considered a Clean Coal Technology Project, for the purposes of 42 U.S.C. § 7651n, and Chapters 51, 52, and 60 of title 40 of the Code of Federal Regulations.

Note.—A regular 2003 appropriation for this account had not been enacted at the time the budget was prepared; therefore, this account is operating under a continuing resolution (P.L. 107-229, as amended). The amounts included for 2003 in this budget reflect the Administration’s 2003 policy proposals.

Explanation of Change

.....of which \$5,000,000 shall be derived by transfer of unobligated balances from “SPR Petroleum Account”;.....

This change provides for the transfer of \$5,000,000 of unobligated balances from the SPR Petroleum Account.

.....of which \$13,200,000 shall be used to support research and development contracts on technological approaches to reduce, avoid, or capture greenhouse gas emissions, to be awarded pursuant to competitive solicitations;.....

This change provides funding for the National Climate Change Technology Initiative (NCCTI). Funds for NCCTI are also requested in: Energy Supply for Nuclear Energy (\$2,300,000), Energy Conservation (\$9,500,000), Energy Efficiency and Renewable Energy (\$15,000,000).

.....provided further that no part of the sum herein made available shall be used for the field testing of nuclear explosives in the recovery of oil and gas.....

Language submitted with the FY 2003 Congressional budget was eliminated in the FY 2004 budget request. Historical efforts have proven that this approach is ineffective in producing oil and gas and the Department believes measures currently in place are sufficient.

FOSSIL ENERGY RESEARCH AND DEVELOPMENT

Executive Summary

Mission

The mission of the Fossil Energy (FE) Program is to create public benefits by enhancing U.S. economic, environmental, and energy security. The program carries out three types of activities: (1) managing and performing energy-related research that reduces market barriers to the reliable, efficient and environmentally sound production and use of fossil fuels; (2) partnering with industry and others to advance clean and efficient fossil energy technologies toward commercialization in the U.S. and international markets; and (3) supporting the development of information and policy options that benefit the public by ensuring access to adequate supplies of affordable and clean energy.

To ensure that federally funded and developed technologies and related analysis are relevant to market and public needs and are transferred into commercial applications, Fossil Energy research, development and demonstration (RD&D) is carried out in joint partnerships with the private sector utilizing a variety of mechanisms such as cost-shared contracts, targeted outreach activities, and cooperative research and development agreements.

Goals and Objectives

The U.S. relies on fossil fuels for about 85 percent of the energy it consumes. Many forecast that high U.S. reliance on these fuels will continue for decades. For example, the Energy Information Administration's *2002 Annual Energy Outlook* projects that fossil fuel reliance could exceed 85 percent in 2020. Accordingly, a key goal of the Department's fossil energy activities is to ensure that economic benefits from moderately priced fossil fuels, and a strong domestic industry that creates export-related jobs, are compatible with the public's expectation for exceptional environmental quality and reduced energy security risks.

Departmental Goal

Promote the development and deployment of energy systems and practices that will provide current and future generations with energy that is clean, efficient, reasonable prices, and reliable.

Strategic Objectives

ER 4: Create public/private partnerships to provide technology to ensure continued electricity production from the extensive U.S. fossil fuel resource, including control technologies to permit reasonable-cost compliance with emerging regulations, and ultimately, by 2015, zero emission plants (including carbon) that are fuel-flexible, and capable of multi-product output and efficiencies over 60 percent with coal and 75 percent with natural gas

ER 4-1: Support the President's Clear Skies Initiative by having technologies ready for commercial demonstration by 2005 with the potential to reduce: Mercury by 50-70

Percent at 70 percent of today's cost of \$50,000-\$70,000/lb of mercury; NOx to < 0.15 lb/mmBtu at ¾ cost of SCR, currently \$80-100/kW; PM2.5 by 99.99 percent for less than \$50-\$70/kW; and acid gases by 95 percent for less than \$100-\$120/kW. By 2010, test technologies for advanced cooling, mercury reduction by 90 percent at 70 percent of today's cost of \$50,000-\$70,000/lb of mercury, and 66 percent increase in byproducts utilization

ER 4-2: By 2008, develop advanced power systems capable of achieving 50 percent thermal efficiency at a capital cost of \$1000/kW or less for a coal-based plant.

ER 4-3: By 2007 demonstrate at a pilot plant scale, technologies to reduce the cost of carbon separation and capture from new coal-based power systems by 75 percent compared to current systems (\$200/tonne carbon in year 2000). By 2012, develop technologies that result in less than a 10 percent increase in the cost of new energy services to separate, capture, transport, and sequester carbon using either direct or indirect systems.

ER 4-4: By 2010 increase the robustness of distributed generation and thereby lower vulnerability of the electricity grid by introducing prototypes of: a) modular fuel cells with 10-fold cost reduction (\$400/kW) with 40-50 percent efficiency; b) fuel cell-turbine hybrids with 60-70 percent efficiency adaptable for coal.

ER5: By 2015, develop technologies to expand the 2003 domestic oil and gas economically recoverable resource base by 430 million barrels of oil and 85 trillion cubic feet of natural gas (TCF) with minimal environmental impact and lower by 25 percent the cost of hydrogen from natural gas. According to the USGS, EIA, and MMS, the economically recoverable oil resource base is estimated to be 120 billion barrels at \$18/bbl and 149 billion barrels at \$30/bbl; the gas base is estimated to be 740 TCF at \$2.00/mcf and 920 TCF at \$3.50/mcf in 2002.

ER 5-1: Develop advanced technologies and employ scientifically based policy options to increase the Nation's economically recoverable resources by 15 Tcf for natural gas and 140 million barrels for oil by 2008; reduce future costs of exploration and production by \$10 billion. According to the USGS, EIA, and MMS, the economically recoverable oil resource base is estimated to be 120 billion barrels at \$18/bbl and 149 billion barrels at \$30/bbl; the gas base is estimated to be 740 Tcf at \$2.00/mcf and 920 Tcf at \$3.50/mcf in 2002.

ER 5-2: By 2015, conduct scientific analyses and develop and field test a suite of methane hydrate characterization and diagnostic technologies that will provide a reliable inventory of Alaskan methane hydrate resources and resolve global environmental implications of natural methane hydrate instability. By 2008, reduce the cost of producing hydrogen from natural gas by 15 percent.

Program Evaluation

The Office of Fossil Energy completed Investment Criteria Scorecards for all R&D program elements in response to the President's Management Agenda initiative, as well as assessments for the OMB's Program Assessment Rating Tool (PART). Based on PART, a number of concerns were identified:

- In many cases annual performance measures were not judged adequate. These will be addressed as the Department moves toward a new, comprehensive system (Joule) in FY03 for tracking program progress.
- Program benefits estimation was another area of concern, and their linkage to program outputs. This will receive considerable attention in FY03, building on work currently underway and results of the National Academy of Sciences study on R&D benefits.
- Some oil and gas programs were identified as low priority for the reasons stated above, and questions concerning the appropriateness of the Federal role. The Office of Fossil Energy has completed its Top to Bottom Review, and is beginning to implement it. The review provides a solid first step towards a new program direction, focusing on specific goals and emphasizing results in order to more effectively carry out the President's energy plan. Certain program areas and projects that do not address the specific goals of this new direction have been terminated.

Significant Accomplishments and Program Shifts

The FY 2004 Fossil Energy R&D Program features a number of significant changes. The carbon sequestration program includes the following new initiatives:

- **Regional Carbon Sequestration Partnerships:** These partnerships will focus on promoting the infrastructure for wide-scale deployment of mitigation technologies, emphasizing
 - Bringing low-cost, value-added CO₂ capture and storage to the commercial implementation stage before 2012
 - Establishing the longer-term capability for determining the lowest-cost capture and sequestration approaches for applications such as power generation, through early demonstration activities.
- **National Climate Change Technology Initiative (NCCTI):** This is a Presidential initiative to ensure that technology is available to significantly reduce greenhouse gas emissions. It includes a series of open competitive solicitations, aimed at exploring concepts, technologies and advanced technical approaches that could, if successful, contribute in significant ways to: (a) future reductions in, or avoidances of, greenhouse gas (GHG) emissions; (b) GHG capture and sequestration; (c) conversion of GHGs to beneficial use; and/or (d) enhanced monitoring and measuring of GHG emissions, inventories and fluxes in a variety of settings. A portion of the sequestration budget will be included in a departmental pool for open solicitations to fund high-value applied research initiatives. All energy-related areas will be considered for awards from the pool.
- **Carbon Sequestration Leadership Initiative:** The focus is a U.S.-led Carbon Sequestration Leadership Forum that will promote the formation of international partnerships. It will create

closer coordination among potential participants, encourage RD&D collaboration, and help ensure that the financial and intellectual resources are available needed to accomplish overall technology objectives.

One of the most difficult targets for GHG reduction is the transportation sector. One option is to move toward the widespread use of hydrogen, which would need to be produced with negligible GHG emissions. The FY 2004 proposed budget includes new research on ways to produce large quantities of moderate-cost hydrogen from natural gas and coal, while capturing and sequestering carbon dioxide emissions in the process

A number of activities will no longer be funded or are consolidated with other activities in FY 2004. Under Coal and Power Systems, these include liquid transportation fuels from coal, and pressurized fluidized bed combustion

A number of oil and gas programs have been eliminated or significantly reduced. Programs that were eliminated include arctic research, national laboratory partnership, seismic and other imaging technology, and field demonstrations. Program areas that were reduced and/or refocused include methane hydrates, drilling technology, and enhanced oil recovery. For example, future enhanced oil recovery projects will be designed to complement the President's climate change goals, and therefore will concentrate more on CO₂ enhanced recovery.

Major External Influences

FE programs are influenced by three major administration priorities:

- **President's Clear Skies Initiative:** On February 14, 2002, President Bush proposed the most significant step America has taken to reduce emissions from U.S. power plants. His "Clear Skies" initiative promises dramatic emission reductions – approximately 70 percent for SO₂, NO_x, and mercury. The proposed budget supports this initiative through RD&D for low-cost control technology to reduce emissions of mercury and other pollutants from existing power plants, and to greatly expand the economically recoverable domestic natural gas resource.
- **The President's commitments on climate change:** President Bush announced in February 2002 that he was committing the United States to an aggressive new strategy to cut GHG emissions over the next decade. Under the goals set by the President, U.S. GHG intensity 18 percent would be reduced by 2012 through voluntary reductions. In addition, the government will increase efforts to improve scientific understanding of the global climate system to determine if further actions are warranted, and work toward the long-term stabilization of atmospheric GHG concentrations at safe levels. The proposed budget directly supports NCCTI and other R&D to reduce GHG emissions from new coal plants by significantly increasing efficiency, and targeting development of technologies for capture and sequestration of carbon dioxide.
- **Energy and Economic Security:** The energy security of the United States can be jeopardized in two major ways – one, by an increasing vulnerability to unstable sources of energy outside of our borders, and two, by relying too heavily on any one energy resource. The first is reflected primarily by our growing dependence on foreign oil; the second can be more subtle – restricting,

rather than diversifying our energy sources or reducing competition in the energy market. One can have national security implications, but both can impose dramatic and harmful impacts on our nation's economic health and the prospects for continued economic growth. The proposed budget supports energy and economic security through RD&D to increase domestic oil production, and in the longer-term, by seeking ways to produce moderate-cost hydrogen from fossil fuels with near-zero emissions, and cost-effective technology to tap the immense natural gas hydrate resource.

The success of Fossil Energy research programs depends on several other factors that are outside the control of the Department of Energy. Most significant of the outside influences are the price of energy commodities such as coal, oil and gas, the rate of economic growth, and the rate of improvement or price change of competing technologies. The Department's funding allocations attempt to anticipate as many of these factors as possible and to select a portfolio of research activities that can allow flexibility under a wide range of scenarios. The Department is committed to ongoing improvement of its benefits estimation work and will continue to analyze the contributions that Federal research can make to this constantly evolving field.

Funding Summary

(dollars in thousands)

	FY 2002 Comp. Approp.	FY 2003 Request	FY 2004 Base	FY 2004 Request	FY 2004 Request vs. Base	
					\$ Change	% Change
President's Coal Research Initiative						
Clean Coal Power Initiative						
Operating Expenses	146,065	150,000	150,000	130,000	-20,000	-13.3%
Central Systems						
Operating Expenses.....	93,784	84,950	84,950	86,000	1,050	1.2%
Sequestration						
Operating Expenses.....	31,486	44,000	44,000	62,000	18,000	40.9%
Fuels						
Operating Expenses.....	33,814	5,000	5,000	5,000	0	0.0%
Advanced Research (formerly AR&TD)						
Operating Expenses.....	27,821	31,650	31,650	37,500	5,850	18.5%
Subtotal President's Coal Research Initiative	332,970	315,600	315,600	320,500	4,900	1.6%
Other Power Systems						
Distributed Generation Systems						
Operating Expenses.....	56,678	49,500	49,500	47,000	-2,500	-5.1%
Gas						
Natural Gas Research						
Operating Expenses.....	44,069	22,590	22,590	26,555	3,965	17.6%
Petroleum						
Oil Technology						
Operating Expenses.....	56,244	35,400	35,400	15,000	-20,400	-57.6%
Program Direction and Management Support						
Operating Expenses	86,000	84,700	88,172	92,785	4,613	5.2%
Plant and Capital Equipment						
Construction.....	13,450	2,000	2,000	3,000	1,000	50.0%
Fossil Energy Environmental Restoration						
Operating Expenses	9,900	9,715	9,715	9,715	0	0.0%
Import/Export Authorization						
Operating Expenses	2,400	2,500	2,500	2,750	250	10.0%

Advanced Metallurgical Processes						
Operating Expenses	5,200	5,300	5,300	10,000	4,700	88.7%
Energy Efficiency Science Initiative						
Operating Expenses	6,000	0	0	0	0	0.0%
Cooperative Research and Development						
Operating Expenses	8,023	6,000	6,000	6,000	0	0.0%
Prior Year Offsets						
Operating Expenses	-9,000	-14,000	-14,000	-14,000	0	0.0%
Use of previously appropriated clean coal funds.....	-33,700	-40,000	-40,000	0	40,000	-100.0%
<i>Transfer from SPR Petroleum Account (non-add)</i>	<i>0</i>	<i>0</i>	<i>0</i>	<i>(-5,000)</i>	<i>(-5,000)</i>	<i>0.0%</i>
Rescission for Travel and Administration - Operating Expenses	-450	0	0	0	0	0.0%
Total, Fossil R&D.....	577,784	479,305	482,777	519,305	36,528	7.6%
Summary						
Operating Expenses	564,334	477,305	480,777	516,305	35,528	7.4%
Construction	13,450	2,000	2,000	3,000	1,000	50.0%
Total, Fossil Energy R&D	577,784	479,305	482,777	519,305	36,528	7.6%
Additional net budget authority to cover the cost of fully accruing retirement (non-add).....	(4,373)	(4,850)	(4,850)	(5,064)	(214)	-4.0%
Staffing (FTEs)						
Headquarters	112	147	147	147		
Field	558	624	624	624		
Total Staffing	670	771	771	771		

Congressional Items of Interest

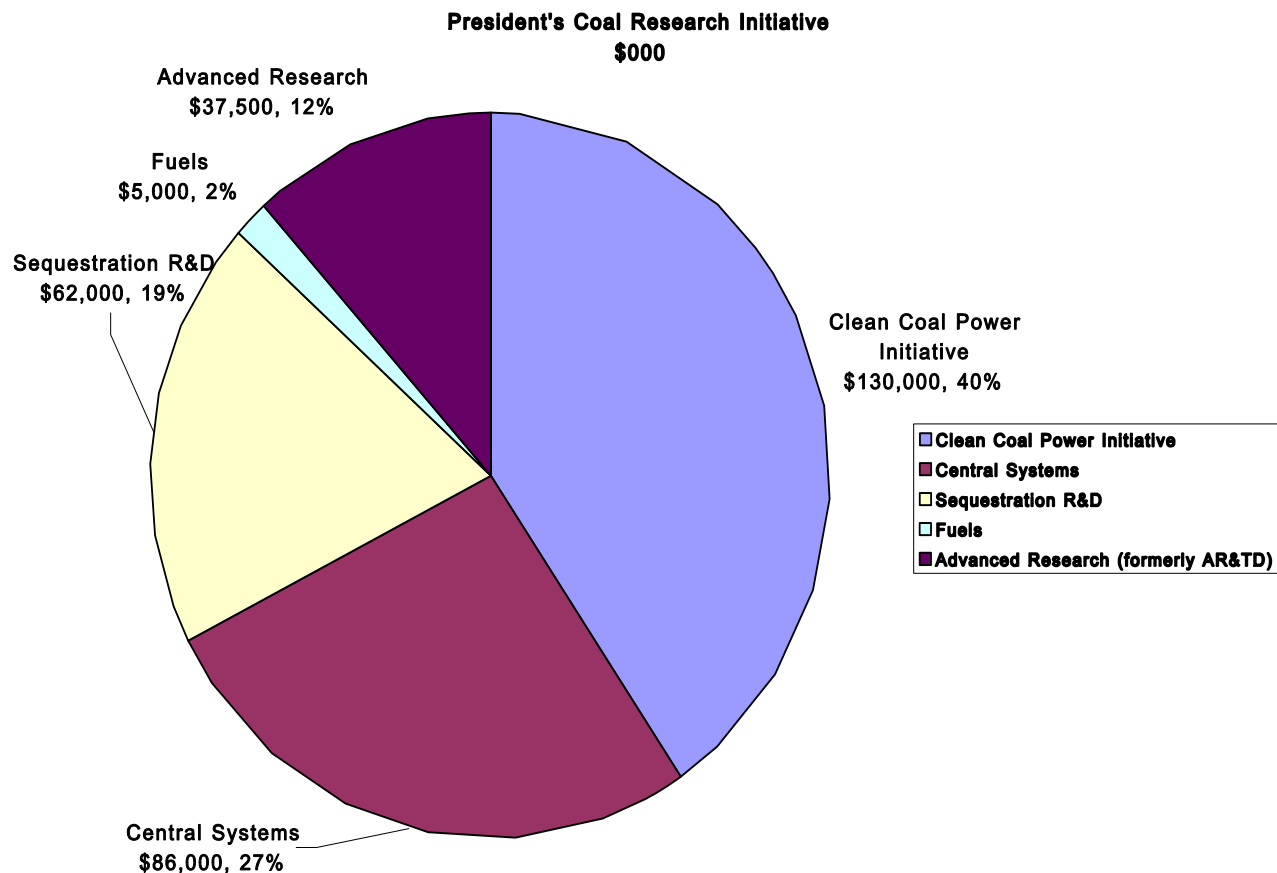
(dollars in thousands)

	FY 2002	FY 2003	FY 2004	\$Change	%Change
NETL Office/Laboratory Building	\$11,000	\$0	\$0	\$0	0.0%
Total, Plant and Capital Equipment	\$11,000	\$0	\$0	\$0	0.0%

President's Coal Research Initiative

The goal of President's Coal Research Initiative is to produce public benefits by conducting research and development on coal-related technologies that will improve coal's competitiveness in future energy supply markets. The Administration strongly supports coal as an important part of our energy portfolio. This request carries out the President's campaign commitment to spend \$2 billion on clean coal research over 10 years.

In keeping with a goal of the President's Management Agenda to avoid duplication and reduce waste, the President's FY 2003 budget transferred the activities in the Clean Coal Technology program to the Clean Coal Power Initiative activity in the Fossil Energy Research and Development program. This change streamlines management and coordination by bringing all coal research under the umbrella of the President's Coal Research Initiative. All activities formerly in the Clean Coal Technology account will be carried out in the Fossil Energy Research and Development account allowing continuation of the projects currently underway. Thus, all existing commitments will be honored, but if surplus funds become available or deobligated they will be available to the Clean Coal Power Initiative (CCPI) program.



The President's Coal Research Initiative consists of the Clean Coal Power Initiative, an industry-led, cost-shared research and development program; Central Systems, targeting central station power generation

equipment; Sequestration R&D, researching ways to mitigate or separate and dispose of greenhouse gas from combustion; and Advanced Research, a set of cross-cutting long-term research projects that can potentially contribute to many aspects of the coal research program. Each of these programs is described in detail in separate sections below.

Prior year dollars from the Clean Coal Technology Demonstration Program will be redirected in FY 2004 to support the Integrated Sequestration and Hydrogen Research Initiative, focused on answering all critical research questions with regard to the technical capability and feasibility of generating electricity from coal, co-producing hydrogen, and capturing and sequestering the CO₂ produced in the process. Using heavily instrumented geologic formations, it will validate the scientific and technological feasibility of storing large volumes of CO₂ in highly stressed geologic formations, and assure permanent storage without any migration or leakage of CO₂. If any leakage is found, countermeasures will be researched and validated. It is estimated that this project will require 10-15 years (nominally 12 years) to complete.

Research and Development Investment Criteria and the Program Assessment and Rating Tool (PART)

In August of 2001, President's Management Agenda called for "Better R&D Investment Criteria" at the Department of Energy's applied R&D programs. As a part of this effort, the programs in the President's Coal Research Initiative evaluated their investments on their Federal role, on the merit and plan of proposals submitted, and on performance, viewing historical performance and the prospective benefits that might accrue from the selection of particular activities. This data, along with additional information was incorporated into a new tool applied to programs throughout the government to evaluate success: the program assessment and rating tool, or PART. As with any new management effort, the initial implementation was not flawless (see the Performance and Management Assessments volume of the President's Budget for FY 2004 for a discussion of the tool itself.) However, the PART tool provided important information on the performance of programs, as well as providing clear guidance to programs about the standards by which they will be evaluated.

In the case of the President's Coal Research Initiative, the PART found that while these programs have a clear purpose and a demonstrated ability to articulate potential public benefits, the scores reflect the fact that the Department has not established adequate annual performance measures. Steps have been taken by the Department to develop measures that are closely linked to the Administration's goals and to add rigor and accountability to the performance measures reporting system. In addition, PART found that too high a proportion of funding has in the past been directed at lower-priority activities. The program was found to have a heavy weighting toward commercial-scale demonstration activities, which should primarily be the responsibility of private sector interests.

The PART process, through its public accountability mechanisms, has brought new thinking to the process of performance measurement, both in the coal programs and throughout the Department of Energy. However, the Department is still working to establish adequate annual performance measures; and the Department needs to continue to add rigor to its benefits modeling process. While it still does not consistently use the methods recommended by the National Academy of Sciences, the Department is making progress.

Program Benefits

Each year, DOE estimates the benefits of program activities to support Government Performance and Results Act (GPRA) reporting. Methods are complex and vary by program. This spring, benefits estimates and a complete explanation of methodology and assumptions will be posted on the Department's website. An overview of the methods used for the coal program is provided below.

Benefits estimates for the coal-related portion of the Fossil Energy Program are based primarily on computer runs using the National Energy Modeling System (NEMS). NEMS is used for the Energy Information Administration's 2003 Annual Energy Outlook (AEO). Borrowing from methodology used in the National Academy of Science's 2001 report on retrospective DOE R&D benefits, readiness dates for advanced technologies for scenarios with and without DOE-supported R&D were estimated. Alternative scenarios included such things as the President's Clear Skies and carbon reduction initiatives, as well as variations in key parameters such as natural gas price. Benefits result from reduced capital and operating costs, higher efficiencies, technology transfer (private sector deployment) and other attributes included in the NEMS model.

Fuel price assumptions are particularly important. NEMS allows the price of both coal and gas delivered to electric generators to vary with supply, demand and productivity assumptions. For example, the price for coal in the 2003 AEO reference case in 2005 is \$1.22 mmBTU, falling to \$1.10 in 2025. For gas, the 2003 AEO reference case is \$3.27 in 2005, rising to \$4.60 in 2025.

While NEMS was used to estimate most benefits for the President's Coal Research Initiative, other models were used for aspects not captured by NEMS, such as the National Energy Technology Laboratory's (NETL) Multi-pollutant Cost and Characterization (MC²) model and the Carbon Sequestration National Benefits Analysis 2002.

Benefit estimates will be further refined prior to posting on the Fossil Energy website. Preliminary runs show significant benefits for all R&D areas in one or more of the scenarios investigated.

Clean Coal Power Initiative

Program Mission

Coal is the most abundant U.S. energy resource, with domestic reserves exceeding the energy potential of the world's oil reserves. About 90% of all coal produced in the U.S. is used for electricity generation, and over half of our Nation's electricity is produced by coal-fired power plants. Meeting our Nation's rising demands for clean, reliable, and affordable electricity will require the use of coal for the foreseeable future. We must therefore develop and demonstrate technologies that will enable the continued use of coal to meet our growing demand for electricity in an environmentally sound manner.

The Bush Administration is advancing its new vision in clean coal research. The Clean Coal Power Initiative (CCPI) is an effort within the Department of Energy's Fossil Energy program that combines industry investments in research and development with federal matching funds for research, development and demonstration of advanced technologies on coal-fired power plants. As part of this Presidential Initiative, the administration is requesting \$130 million in FY 2004 to fund joint government-industry-funded research projects on new technologies that can enhance the reliability, efficiency, and environmental performance of coal-fired power generators. FY 2004 funding will support the second round of projects under the Clean Coal Power Initiative, incorporating the latest advances in clean coal technologies. The CCPI responds to the National Energy Policy call to address the reliability and affordability of the Nation's electricity supply, particularly from its coal based generation, and is a key component of the President's commitment to research and development of clean coal technologies to meet this challenge. By enabling advanced technology to overcome technical and financial risks and bringing them to the point of commercial readiness, the CCPI facilitates the movement of technologies into the market place that are emerging from the core research and development activities and directly responds to President's Clear Skies Initiative and Global Climate Change Initiative to reduce emissions of air pollutants and carbon dioxide.

The CCPI is a cooperative, cost shared program between the government and industry to rapidly research, develop, and bring to commercial readiness emerging technologies in coal-based power generation. The Nation's power generators, equipment manufacturers, coal producers and others help identify the most critical barriers to coal's use in the power sector.

Beginning with the FY 2003 budget, the activities formerly carried out under the Clean Coal Technology account have been shifted to CCPI in keeping with the goals of the President's Management Agenda to consolidate programs and eliminate duplication. This change will result in improved coordination and management of the coal R&D efforts. Existing commitments to projects will be carried out under this program. However, in the event of deobligations or other cost savings, any prior year funds will be made available to the CCPI program for the next round of solicitation.

In FY 2003, the first round of CCPI projects will commence. NEPA will be completed for three of six PPII projects and most PPII projects will be under construction or in operation. In FY 2004, the first round of CCPI projects will be underway and CCPI funding will be in place to support a solicitation for a second round of projects.

Program Strategic Performance Goals

CCPI is a crosscutting program which is designed to advance technologies from across all technology areas. Though the projects that will be funded with the FY 2004 funding have yet to be selected, it is expected that the technologies that are ultimately funded in this round will support PSPGs ER 4-1, ER 4-2, and ER 4-3. To aid in the management and performance tracking of the CCPI program, a set of annual goals along with a Midterm Performance Goal, which is equivalent in scope to a PSPG, have been developed. They are:

Midterm Performance Goal: Develop advanced coal-based power generation technologies that: improve efficiency from 2002 baseline of 40% to 50% by 2010, with environmental and economic performance capable of achieving 90% Hg removal at a cost of 70% of current technology by 2010, 0.15 lb/MMBtu NO_x at 75% of the cost of current technology (Selective Catalytic Reactors), and lower capital costs for gasification technologies from \$1200 per kilowatt of capacity;; co-produce heat, fuels, chemicals or other useful byproducts; and, provide a deployment-ready suite of advanced technologies that can produce substantial near-, mid-, and long-range economic and environmental public benefits.

Annual Performance Targets and Results

FY 2002 Results	FY 2003 Updated Targets	FY 2004 Targets
Complete construction and start operations of Circulating Atmospheric Fluidized Bed demonstration project at Jacksonville, FL.	<p>Complete CCPI Round 1 solicitation, proposal evaluations and project selections to assemble the initial portfolio of advanced technologies capable of improving the economic and environmental performance of coal-based electric power generation facilities.</p> <p>Complete NEPA process for 3 out of the 6 active PPII projects and initiate construction or operations phases for several of the projects.</p> <p>Complete sufficient implementation activities on remaining projects to resolve any barrier issues.</p> <p>Complete demonstration tests</p>	<p>Initiate at least 60% of the industrial projects selected under the competitive CCPI solicitation, and initiate a second competitive solicitation.</p> <p>Initiate construction or operations for all projects under the competitive PPII for demonstration of technologies with potential to improve the economic, environmental performance, or efficiency of coal-based power plants.</p> <p>Complete demonstration tests under the CCT program for a coal-based advanced circulating fluidized bed combustor power system and provide comprehensive documentation of the system and its efficiency, economics, and environmental</p>

on the LPMeOH coal-to-methanol conversion project and provide comprehensive documentation of the system and its efficiency, economics, and environmental performance for use by industry in assessing the merit for further commercial deployment of the technology.

performance for use by industry in assessing the merit for further commercial deployment of the technology.

Funding Profile

(dollars in thousands)

	FY 2002 Comp. Approp.	FY 2003 Request	FY 2004 Base	FY 2004 Request	FY 2004 Request vs. Base	
					\$ Change	% Change
Clean Coal Power Initiative	\$146,065	\$150,000	\$150,000	\$130,000	\$-20,000	-13.3%
Total, Clean Coal Power Initiative.	\$146,065	\$150,000	\$150,000	\$130,000	\$-20,000	-13.3%

Funding by Site

(dollars in thousands)

	FY 2002	FY 2003	FY 2004	\$Change	%Change
All Other	\$146,065	\$150,000	\$130,000	\$-20,000	-13.3%
Total, Clean Coal Power Initiative.....	\$146,065	\$150,000	\$130,000	\$-20,000	-13.3%

Site Description

All Other

The Department's Clean Coal Power Initiative program, within the Fossil Energy Research and Development program, funds research at major performers at non-DOE locations. Examples of these performers include Otter Tail Power Corp. with UNDEERC and W. L. Gore & Associates, Tampa Electric, Universal Aggregates, LLC., Sunflower Electric Power Corp., CONSOL Energy, Inc., TIAX, LLC., JEA, Air Products Liquid Phase Conversion Co., and Kentucky Pioneer Energy, Ltd. with Fuel Cell Energy and Global Energy.

Detailed Program Justification

(dollars in thousands)

	FY 2002	FY 2003	FY 2004
Clean Coal Power Initiative	146,065	150,000	130,000
■ Clean Coal Power Initiative	144,565	148,500	128,700
<p>In support of the President’s Coal Research Initiative, continue the Clean Coal Power Initiative (CCPI) to research, develop, and bring to commercial readiness advanced clean coal-based technologies that enhance electricity reliability, increase generation capacity, and provide clean, affordable power. Provide funding to support a second round of projects under the Clean Coal Power Initiative (CCPI), incorporating the latest advances in clean coal technologies, and issue the second solicitation. <i>Participants to be determined.</i></p> <p>FY 2003 and FY 2002, within the CCPI program, issues the initial competitive solicitation and make selections of projects. Initiated pre-award activities on all projects. Began planning activities for the second solicitation. Within the Power Plant Improvement Initiative (PPII) program, awarded cooperative agreements to 4 of the 6 active projects and completed NEPA activities on 3 of those 4 projects. Began test operations on the Advanced Hybrid Particulate Collector and began construction on the Neural Network-Sootblower Optimization project. In the Clean Coal Technology (CCT) program, completed the Environmental Impact Statement for the Kentucky Pioneer project and began fabrication of the fuel cell portion of the project. Continued test operations on the Circulating Fluid Bed Combustor and LPMeOH coal-methanol projects. <i>Participants included: Otter Tail Power Corp. with UNDEERC and W. L. Gore & Associates, Tampa Electric, Universal Aggregates, LLC., Sunflower Electric Power Corp., CONSOL Energy, Inc., TIAX, LLC., JEA, Air Products Liquid Phase Conversion Co., and Kentucky Pioneer Energy, Ltd. with Fuel Cell Energy and Global Energy.</i></p>			
■ Program Support	1,500	1,500	1,300
Fund technical and program management support.			
Total, Clean Coal Power Initiative	146,065	150,000	130,000

Explanation of Funding Changes

FY 2004 vs. FY 2003 (\$000)

Clean Coal Power Initiative

- Decrease in Clean Coal Power Initiative due to more focused second round -19,800

solicitation

■ Program Support.....

-200

Total Funding Change.....

-20,000

Central Systems

Program Mission

As part of the President's Coal Research Initiative, the overall goal of the Central Systems Program is to provide the critical research that can dramatically reduce coal power plant emissions and significantly improve efficiency to reduce carbon emissions. The National Energy Policy recommends that the Department continue to develop advanced clean coal technology with a goal of deploying high efficiency coal power plants achieving zero emissions. Further, the President's Clear Skies Initiative is supported by the development of advanced emission control technology and related byproducts as part of the research portfolio under Central Systems. The President's Climate Change Initiative over the longer term is supported through technology for advanced power plants that can nearly double the average efficiency of today's fleet of coal power plants, thereby significantly reducing carbon emissions.

The growing national economy relies increasingly on electricity supply that is secure, affordable, and reliable. This is especially true in the face of concerns over national energy security as well as electricity generation market restructuring. In addition, compliance with more stringent environmental regulations requires reduced emissions from electric power plants. Further, new technology is needed to develop much cleaner and more efficient plants to replace and augment an aging power generation infrastructure. Electricity demand from both natural gas and coal is projected to increase significantly through the year 2015 to meet increased energy demand in the U.S. (Annual Energy Outlook, 2002).

The program elements for Central Systems include technology developed for existing plants, advanced systems, and Vision 21 are as follows:

- Innovations for Existing Plants (IEP) - The IEP program element has a near-to-mid term focus on improving overall power plant efficiency (thereby reducing carbon emission) and developing advanced cost-effective environmental control technologies for retrofitting to existing powerplants and other coal technologies such as integrated gasification combine cycle (IGCC). These advanced systems and technologies have direct application to new plants as well. The research is also directed at the environmentally sound use and disposal of coal byproducts and at novel systems and technologies to minimize the impact of electricity production on water availability and quality. The IEP program directly supports the goals and objectives of the President's February 14, 2002 Clear Skies Initiative that calls for substantial reductions in mercury, NO_x, and SO₂ emissions from power plants. Results of this advanced research are used by those who develop, design, manufacture and operate both existing and advanced systems across the entire spectrum of coal utilization technologies not only to improve efficiencies, but also to improve environmental performance. This program's crosscutting efforts address the cost-effective removal of pollutant causing contaminants from fossil fueled systems while maximizing the efficient recycling of all by products.
- Integrated Gasification Combined Cycle (IGCC) - The IGCC program supports both the President's Clear Skies Initiative and climate change goals by enhancing the thermal efficiency of converting coal to electricity, providing the potential for over 50% reduction in CO₂ compared to today's technologies, and through its performance goals of achieving near-zero emissions of SO₂, NO_x,

mercury, and other pollutants. The IGCC program conducts research that fosters the development and deployment of fuel-flexible gasification-based processes for converting carbon-based feedstocks to electricity, steam, and a broad range of chemicals, including ultra-clean transportation fuels like hydrogen. In order to achieve the full potential of IGCC, significant advances must be made to reduce the capital and operating and maintenance costs and to improve both the reliability and the overall system availability. In FY 2004, emphasis will be placed on gas stream purification to meet quality requirements for use with fuel cells and conversion processes; advanced gasification concepts for multi-fuel capability; development of technologies with multi-fuel capabilities; enhanced process efficiency; and reduced costs for producing oxygen and hydrogen and reducing greenhouse emissions. 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.

- Pressurized Fluidized Bed (PFB) - This program was redirected in prior years to support advanced combustion hybrid concepts for Vision 21. In FY 2004, specific technologies from this category are being folded into the Gasification activity so to enhance the integration of hybrid combustion/gasification concepts, including support for the test activity at the Wilsonville Power Systems Development Facility (PSDF).
- Turbines - The High Efficiency Engines and Turbines (HEET) program builds on technology created in the Advanced Turbines Systems (ATS) Program. The HEET Program is focused on key technologies needed to enable the development of advanced turbines and engine modules for fuel flexible energy plants. Developing advanced turbines with fuel flexibility is critical as many of the advanced, coal-fired power generation technologies currently being developed or demonstrated will incorporate modified gas turbine systems. The HEET Program is an investment in secure U.S. electric power production which is clean and efficient and is fuel-flexible, highly reliable, maintainable, durable, affordable.

During FY 2003, DOE will have completed the concept studies to run ATS and other machines on coal syngas, as well as ATS machines in coal and natural gas based integrated hybrid power modules, demonstrated the Clean Energy Systems 10MW low-emission steam generator, demonstrated an integrated sensor suite for real-time monitoring of an advanced turbine's operational performance, and demonstrated in-situ single crystal blade welding and repair techniques. In FY 2004, the R&D will focus on combustor performance and design using coal derived syngas, models/simulation tools for low-emission combustion systems, and tools that can predict reliability, availability, and maintainability.

Vision 21 is an integration of advanced power systems R&D. This integrated development effort will lead to the deployment of a family of plants that converts a combination of feedstocks (e.g., coal, natural gas, biomass, and opportunity fuels such as, petroleum coke or heavy oil resid (refinery wastes)) to electricity, heat (e.g., steam), and a suite of high-value products that may include synthesis gas, hydrogen, chemicals, and saleable by-products (e.g., sulfur and ash or slag). Research and development continues on key enabling technologies, supporting R&D, and systems analyses, simulations and integration through the government/industry/laboratory/university cost-shared partnership based on the gasification route in the Vision 21 technology roadmap. Alternate technology paths for Vision 21 will be

studied at the concept level in FY 2004.

Program Specific Performance Goals

ER 4-1: Innovations for Existing Plants: Support the President’s Clear Skies Initiative by having technologies ready for commercial demonstration by 2005 with the potential to reduce: Mercury by 50 - 70 percent at 70 percent of today’s cost of \$50,000-\$70,000/lb of mercury; NO_x to less than 0.15 lb/mmBtu at ¾ cost of SCR, currently \$80-\$100/Kw; PM2.5 by 99.99 percent FOR LESS THAN \$50-\$70/Kw; and acid gases by 95 percent. By 2010, test technologies for advanced cooling, mercury reduction by 90 percent at 70 percent of today’s cost of \$50,000-\$70,000/lb of mercury; and 66 percent increase in byproducts utilization.

Performance Indicator: Number of tests of technologies that offer reductions in emissions and/or costs of mercury, NO_x, particulate, and acid gasses.

Annual Performance Targets and Results

FY 2002 Results	FY 2003 Updated Targets	FY 2004 Targets
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Innovations for Existing Plants:

Complete Phase I report characterizing concentration and composition for ambient PM2.5 emissions as input to the EPA PM2.5 National Ambient Air Quality Standards (NAAQS) review. This data will identify the impact of emission sources on air quality.

Initiate projects for developing technologies to address emerging electric utility/water issues and combustion byproducts utilization and disposal.

Complete preliminary field testing of alternative mercury control technologies representing two approaches for achieving 50% or greater removal.

Complete fine particulate monitoring in the Upper Ohio River Valley region; complete field testing of alternative particulate matter collection technologies representing at least two approaches for achieving 99.99% removal;

Complete a total of three initial tests of the leachability and volatilization of mercury from coal byproducts, of advanced separation techniques for combustion ash, and of advanced approaches for cooling. The coal byproducts leachability tests will determine what if any mercury leachability issues exist for the byproducts tested, which is critical to allow the safe use and disposal of the byproducts. Advanced cooling technologies will be identified to determine low costs approaches to comply with potential water restrictions.

Complete six initial pilot-scale tests for development of performance data on an

initiate research on PM_{2.5} and mercury transport and deposition.

Initiate developmental testing of SCR catalysts for reducing NO_x emissions from alternatively fueled boilers.

advanced concept potentially capable of 90% mercury capture. This information will be used in identifying further development needs and opportunities as a potential technological option to achieve anticipated Federal regulations for mercury emission control.

Complete development and dissemination of data on regional fine particulate and fine particulate data analysis methods. This would determine the amount and type of emissions from coal-fired power plants, and inform decision-making on regulatory initiatives by Federal and state agencies and the R&D requirement for new control technologies.

Complete pilot scale testing on advanced ultra-low-nitrogen oxide burner systems that achieve .15 lbs/mmBTU NO_x. Successful completion of this pilot scale testing clears the way for commercial scale demonstration of this low cost, low NO_x emissions technology.

ER 4-2: Advanced Systems: By 2008, develop advanced power systems capable of achieving 50% thermal efficiency at a capital cost of \$1000/kW or less for a coal-based plant. (same as ER 4-2) .

Performance Indicator: Number of tests of critical component technologies needed to achieve advanced power systems goal of 50 percent thermal efficiency and \$1,000/kW.

Annual Performance Targets and Results

FY 2002 Results	FY 2003 Updated Targets	FY 2004 Targets
<p>Complete initial tests of the IGCC transport gasifier to confirm the feasibility of the technology to significantly improve reliability, cost effectiveness, and efficiency for producing electricity and other products.</p>	<p>Establish a 1-5 tpd facility capable of determining engineering feasibility, defining technical performance, and establishing operating costs for oxygen separation using membrane technology.</p> <p>Complete initial laboratory-scale performance testing of hydrogen separation membranes using simulated gas streams.</p> <p>Complete initial laboratory tests to determine performance capabilities of sorbents, sieves, and membranes for removing mercury, sulfur, nitrogen, and CO₂ from gas streams.</p> <p>Conduct gasification support tests on leachability of gasifier residues, improved refractories, and oxygen-blown gasification of alternative fossil fuel feedstocks, and develop a simulator for a Vision 21 plant.</p> <p>Develop technical and cost information sufficient for DOE decision-making on the viability of proceeding with plans for construction of a co-production plant.</p> <p>Complete conceptual studies to assess ATS and other machines for operation on coal syngas, as</p>	<p>Complete an initial pilot-scale test of an oxygen transport membrane system that has the potential to increase the efficiency and reduce the cost of oxygen-blown integrated gasification combined-cycle systems to 50% efficiencies at \$1000 kWe by 2008.</p> <p>Complete initial screening of materials and fabrication techniques that will be used in a sub-scale module that will be scaleable to a Vision 21 plant, and develop of bench-scale exposure data required to identify and select hydrogen membranes capable of supporting integrated gasification combined-cycle plant operating conditions that will achieve 60% efficiencies at \$850 to \$900 /kWe by 2015, while producing a concentrated, high-pressure stream of carbon dioxide for sequestration.</p> <p>Complete fabrication of an ammonia and mercury removal test module to be integrated with a pilot-scale gasifier to be available for testing in FY 2005.</p> <p>Complete development of preliminary performance data for a hybrid gasification system. These data will provide information needed to establish</p>

well as, ATS machines in coal and natural gas based integrated hybrid power modules, complete demonstration of a low-emission steam generator, demonstrated an integrated sensor suite for real-time monitoring of an advanced turbine's operational performance, and demonstrated in-situ single crystal bladewelding and repair techniques.

In the area of advanced systems initiated work on gas turbine combustor and nozzle systems for fuel flexible low-NO_x performance in IGCC applications for designs that are capable of meeting Vision 21 performance requirements.

Continued technology base development in the areas of thermal barrier coatings, emission reductions, combustion stability, heat transfer and aerodynamics in turbines for coal derived synthesis gas.

feasibility of a concept design that can achieve 50% efficiencies at \$1000/kWe by 2008.

Complete report on combustion performance testing (FY03-50 hrs., FY04-150 hrs.) with variable fuel characteristics such as coal syngas and combustor geometry. This report will help establish the feasibility of trap vortex combustion and the lean pre-mixed combustion conditions for low emissions (< 3 ppm NO_x) gas turbines. These combustion techniques are critical to gas turbines for low emissions, low-cost and highly efficient coal-based IGCC power plants.

Define detailed combustor design requirements for fuel flexible gas turbines. These designs will lead to subscale component testing. Fuel flexible combustors will make possible gas turbines with low emissions for application in low-cost highly efficient coal-based IGCC power plants.

Complete assessment and report on process weld conditions and critical parameters on micro structure characterization of single crystal turbine blade failure mechanisms. This information will be publically disseminated for use by single crystal component developers in the power and defense industries. Initiate prototype validation tests (FY04-8,000 hrs., FY05-4,000 hrs.) of a non-

destructive evaluation (NDE) technique for predicting failure of thermal barrier and metallic coatings. Tests will be implemented on a W501FD gas turbine. This activity, if successful, will lead to a fully integrated NDE system. Results could be used to reduce gas turbine life cycle costs in advanced power plants.

Complete assessment of turbine mechanical faults (bearings, rotor-dynamic, structural, etc.) using vibration signatures with neural-network based fault classifiers. These signatures and fault classifiers will form the basis for a diagnostic monitoring software platform for predicting machine health. Ultimately these results can be used to reduce gas turbine life cycle cost in highly efficient coal-based IGCC power plants.

Complete development of a computational software tool-set for designing the next generation of advanced power plants applicable to low-cost highly efficient coal-based IGCC power plants. This software tool will be used to reduce concept development time and cost for advanced power plants.

Complete design specifications and cost estimates for balance-of-plant (BOP) components applicable to sub-MW fuel cell turbine hybrid systems. These BOP components will support the testing of more efficient and advanced hybrid power systems.

Hybrid fuel cell turbine power systems support the evolution of highly efficient (75 % for natural gas, 60 % for coal) near zero-emissions MW-scale fuel cell turbine hybrid power plants applicable to Vision 21 power plants.

Funding Profile

(dollars in thousands)

	FY 2002 Comp. Approp.	FY 2003 Request	FY 2004 Base	FY 2004 Request	FY 2004 Request vs. Base	
					\$ Change	% Change
Central Systems						
Innovations for Existing Plants	\$22,973	\$21,200	\$21,200	\$22,000	\$800	3.8%
Advanced Systems:						
Integrated Gasification						
Combined Cycle	41,990	40,650	40,650	51,000	10,350	25.5%
Pressurized Fluidized Bed	10,720	9,100	9,100	0	-9,100	-100.0%
Turbines	18,101	14,000	14,000	13,000	-1,000	-7.1%
Subtotal, Advanced Systems	70,811	63,750	63,750	64,000	250	0.4%
Total, Central Systems	\$93,784	\$84,950	\$84,950	\$86,000	\$1,050	1.2%

Funding by Site

(dollars in thousands)

	FY 2002	FY 2003	FY 2004	\$Change	%Change
Argonne National Lab (East)	\$1,624	\$1,550	\$1,044	\$-506	-32.6%
Brookhaven National Laboratory	300	200	200	0	0.0%
Idaho Nat'l Engineering & Environmental Lab	180	180	0	-180	0.0%
Lawrence Berkeley National Lab	200	200	200	0	0.0%
Los Alamos National Lab	2,171	450	1,364	914	203.1%
National Energy Technology Laboratory	11,234	11,852	11,665	-187	-1.6%
Oak Ridge National Lab	707	625	215	-410	-65.6%
All Other	77,368	69,893	71,312	1,419	2.0%
Total, Central Systems	\$93,784	\$84,950	\$86,000	\$1,050	1.2%

Site Description

Argonne National Laboratory (East)

The Argonne National Laboratory (ANL), located in Argonne, Illinois, is a major multi-program laboratory managed and operated for the U.S. Department of Energy (DOE) by the University of

Fossil Energy Research and Development/
President's Coal Research Initiative/
Central Systems

FY 2004 Congressional Budget

Chicago under a performance-based contract. Argonne research for the Fossil Energy Central Systems program supports concepts for various technologies for central systems.

Brookhaven National Laboratory

The Brookhaven National Laboratory (BNL), located on Long Island, New York, conducts research and development in the area of Central Systems to support concepts for various technologies for central systems.

Idaho National Engineering and Environmental Laboratory

The Idaho National Engineering and Environmental Laboratory (INEEL), located outside of Idaho Falls, Idaho, conducts research and development in the area of Central Systems to support concepts for various technologies for central systems.

Lawrence Berkeley National Laboratory

The Lawrence Berkeley National Lab (LBNL), located in Berkeley, California, conducts research and development in the area of Central Systems to support concepts for various technologies for central systems.

Los Alamos National Laboratory

The Los Alamos National Laboratory (LANL), located in Los Alamos, New Mexico, conducts research and development in the area of Central Systems to support concepts for various technologies for central systems.

National Energy Technology Laboratory

The National Energy Technology Laboratory (NETL), located in Morgantown, West Virginia, Pittsburgh, Pennsylvania, and Tulsa, Oklahoma, is a multi-purpose laboratory, owned and operated by the U.S. Department of Energy. NETL conducts and implements science and technology development programs for the Department in energy and energy-related environmental systems. NETL's key functions are to shape, fund, and manage extramural (external) RD&D projects, conduct on-site science and technology research, and support energy policy development and best business practices within the Department.

Oak Ridge National Laboratory

The Oak Ridge National Laboratory (ORNL), located in Oak Ridge, Tennessee, conducts research and development in the area of Central Systems. ORNL is a leader in the development and assessment of advanced materials that are applicable to advanced coal based power generation systems such as Vision 21.

All Other

The Department's Central Systems program, within the Fossil Energy and Development program, funds research at major performers at non-DOE locations. An example of these performers include the Albany Research Center focusing on various advanced materials and process-related concepts.

Detailed Program Justification

(dollars in thousands)

	FY 2002	FY 2003	FY 2004
Innovations for Existing Plants	22,973	21,200	22,000

The FY 2004 request emphasizes development and field testing of retrofit mercury, NO_x, particulate matter, and acid gas (SO₃, HCl, and HF) control technologies, mercury emission, transport, and deposition assessment, technological solutions to emerging energy-water issues such as cooling water requirements, determining PM_{2.5} source-receptor relationships as they relate to coal-fired power plant emissions, and environmental characterization of coal-combustion and gasification and other advanced power system byproducts.

■ **Super Clean Systems** 1,450 1,485 1,485

Super Clean Systems research focuses on reducing emissions of primary oxides associated with NO_x and SO_x pollution in support of the Clear Skies Initiative. The work will complete Ultra-low NO_x Burner development, and continue development and pilot-scale testing of novel NO_x control technology concepts selected under the FY 2002 Broad Based Solicitation and under an FY 2003 targeted solicitation. *Participants include: GTI, Praxair, Wiley, Precision Combustion, TBD.*

FY 2003 and FY 2002 funding continued development of ultra-low NO_x combustion systems, oxygen-enhanced combustion, Methane-deNO_x technology, and approaches to controlling NO_x in cyclone boilers. Initiate dense-phase-reburn research under the FY 2002 Broad Based solicitation. *Participants included: MTI, GTI, Praxair, REI, Alstom, Wiley, Precision Combustion.*

■ **Fine Particulate Control/Air Toxics** 14,338 13,860 13,860

In support of Clear Skies Initiative, continue Phase II field testing of advanced mercury control technologies to achieve 50-70% mercury removal directed at lower rank coals and balance-of-plant issues. Continue bench- and pilot-scale development of novel technology to achieve 90%+ mercury capture. Develop fine particulate and acid gas control and sensor technology selected under FY 2002 solicitation. Continue with more comprehensive modeling assessment of fine particulate and mercury source-receptor relationships. Continue projects selected in FY 2003 to address energy-water issues. *Participants include: ATS, CONSOL, URS, CMU, SRI, Powerspan, Apogee, TVA, UMD, BNL, LBL, RBD.*

FY 2003 and FY 2002 funding continued field testing of two advanced mercury control technologies - sorbent injection and wet-FGD enhancement - to achieve 50-70% mercury control and continued pilot-scale development of six novel mercury control concepts capable of achieving

+90% control. Completed pilot-scale development and testing of additives to improve fine particulate capture in ESPs, alkaline injection for controlling acid gas emissions, and an advanced fine particle separation technology. Completed collection of ambient PM_{2.5} samples from the upper Ohio River Valley region. Initiated development of on-line continuous SO₃ analyzer and study of in-plume mercury reactions. *Participants included: ATS, LSR, CONSOL, ADA-ES, MTI, Southern Research Institute, CMU, URS, UNDEERC, Apogee, REI, Powerspan, GE-EERC, BNL, ANL, TVA.*

(dollars in thousands)

FY 2002	FY 2003	FY 2004
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■ **In-House** 3,300 3,663 3,960

Research and systems analysis is conducted on novel multi-pollutant control, mercury control and characterization, by-product characterization, and water-related issues in support of zero-emissions for Vision 21 and Clear Skies. Provide for customer service and business activities. *Participants include: NETL.*

FY 2003 and FY 2002 funding continued development of mercury control technologies and characterization of mercury emissions in 500 lb/hour combustor and collection of ambient PM_{2.5} data from Pittsburgh campus monitoring site. Continued evaluation of mercury and other metal leachates from coal combustion byproducts. *Participants included: NETL.*

■ **Waste Management** 1,450 1,980 2,475

Continue assessment of environmental impacts of coal combustion and gasification byproducts and solid residues, focusing on mercury and other trace metals. Conduct joint industry/government R&D activities to maximize recycle use of coal utilization byproducts for various market applications, and facilitate technology transfer. Continue development of byproduct treatment and separation technology selected under FY 2003 Broad Based solicitation. Initiate projects selected under the FY 2003 targeted solicitation to maximize water utilization efficiency with minimal environmental impact. *Participants include: WVU, PPL, UNDEERC.*

FY 2003 and FY 2002 funding continued development of ozone-based unburned carbon separation technology and evaluation of mercury leaching and volatilization from coal byproducts. Initiated assessment of coal drying technology to reduce cooling water makeup requirements. Continued development of high-volume applications for coal byproducts. *Participants included: University of Kentucky, PPL Generation, EPRI, UNDEERC, Lehigh University, CONSOL, WVU.*

(dollars in thousands)

FY 2002	FY 2003	FY 2004
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■ **Vision 21** 2,200 0 0

No activity. Beginning in FY 2003 and continuing in FY 2004, activities that are focused on efficiency issues are addressed under the Advanced Research Materials program.

FY 2002 research focused on developing advanced materials for enhancing power plant efficiency including supercritical cycles applicable to "Vision 21" goals of developing higher efficiency systems ultimately driving to lower pollution levels (new zero). *Participants included: Siemens-Westinghouse.*

■ **Program Support**..... 235 212 220

Fund technical and program management support.

Advanced Systems	70,811	63,750	64,000
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Advanced Systems focus on the development of critical enabling technologies and systems for new, cost-competitive plants with increasingly higher efficiencies and inherent ultra-low emissions that support the President's Clear Skies and Global Climate Change initiatives, leading ultimately to near-zero emission Vision 21 power plants compatible with carbon sequestration.

Integrated Gasification Combined Cycle 41,990 40,650 51,000

■ **Gasification Systems Technology**..... 21,700 20,988 29,700

Gasification: Continue to develop and test the oxygen-blown transport gasifier and associated particulate control devices at the PSDF to reduce cost and improve reliability of gasifier technology. Primary focus at the PSDF will be on oxygen-blown operations to provide options for producing hydrogen and capturing CO₂ and multi-fuel capability to enhance the applicability of the technology. Validate the oxygen-blown transport gasifier CFD model using data generated from the PSDF and the Transport Reactor Development Unit (TRDU) using various coal feedstocks. Utilize the TRDU to pre-screen coal feedstocks, alternative feed systems, and process conditions to provide guidance for testing at the PSDF. Develop advanced materials for refractories and thermocouples to improve refractory performance and improve gasifier reliability. Test prototype refractory bricks in a commercial coal gasifier to demonstrate performance under actual operating conditions, and begin to install a novel high temperature measurement device to demonstrate improved gasifier performance and process control. Continue development of other advanced technologies such as burner flame monitoring, refractory wear monitoring, diffusion coatings, etc. to improve the reliability, availability, and performance of gasifiers. Investigate fundamental pre-competitive technology issues and needs to improve gasification process performance and reliability through the Gasification Technology Research Consortium. **Gas Cleaning/ Conditioning** - Efforts are directed to obtaining near-zero emissions from gasification based systems including construction of a gas cleanup module at PSDF to pave the way for Vision 21 testing of advanced modules for carbon capture and near-zero emission gas cleaning technologies. Development of advanced sorbents for achieving ultra-low sulfur levels of all contaminants at moderate temperatures. Operate the Gas Process Development Unit's (GPDU) using the RT13 sorbent at moderate temperatures in the transport mode to provide design data for scale-up of the technology. Continue validation of the transport desulfurizer CFD model using data from the GPDU and data generated in a pilot-scale test facility integrated with a coal gasifier.

Develop the novel Selective Catalytic Oxidation of Hydrogen Sulfide (SCOHS) technology and begin bench-scale evaluations for proof-of-concept testing of the technology to demonstrate ultra-low sulfur emissions at reduced cleanup costs. *Participants include: SCS, NETL, UNDEERC, Fluent, RTI, Albany, ChevronTexaco, VPI, FluoreScience, IET, GTI, GEC, MSE, SRI, Comb Spec.*

In FY 2003, the transport gasifier and associated particulate control devices will be further developed under oxygen-blown conditions at the PDSF. The TRDU will pre-screen coal feedstocks and process conditions for testing at the PDSF. Bituminous coals will be processed at the PSDF to determine the applicability of the gasifier for high rank coals. A new dry coal feed system will be evaluated to reduce cost and improve performance over conventional lock hopper feed systems. Performance of new refractory bricks under simulated gasifier conditions will be evaluated, and if successful, bricks will be installed in high wear areas of Eastman Chemicals' coal gasifier in Kingsport, TN. Development of technologies to improve the reliability, availability, and performance of gasifiers will continue with testing of one high-temperature measurement device on the TECO IGCC gasifier. The Gas Process Development Facility (GPDU) will be operated using the EXSO3 sorbent developed previously for hot gas desulfurization and will transition to lower temperature operations to support the scale-up of the RT13 sorbent. Development of the Selective Catalytic Oxidation of Hydrogen Sulfide (SCOHS) process will continue to confirm process performance at the laboratory scale in preparation for future bench-scale testing.

In FY 2002, continued development of the transport gasifier which provided the basis for the proposal for a demonstration facility in the CCPI solicitation. Preliminary modifications were completed to permit the first demonstration of oxygen-blown operation of the transport gasifier at the PSDF. The TRDU provided guidance on the design and operation of the gasifier based on screening studies. A new refractory material was developed and patented that has potential for increasing refractory life by five times that of today's materials. Full-size bricks were produced by a commercial refractory manufacturer. Installation of one high-temperature measurement device was initiated on the TECO IGCC gasifier, and a second device is beginning scale-up for possible testing at the Wabash River IGCC plant and/or Eastman's Kingsport, TN, gasifier to improve process control and reliability. A sulfur sorbent was successfully produced with appropriate attrition resistance for use in a transport reactor while simultaneously achieving sulfur levels of 1 ppm. Shakedown of the GPDU progressed well and is ready for initial sorbent operation.

Participants include: SCS, NETL, UNDEERC, Fluent, RTI, Albany, ChevronTexaco, VPI, FluoreScience, IET, GTI, GEC, MSE, SRI, Comb Spec.

(dollars in thousands)

	FY 2002	FY 2003	FY 2004
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<p>■ Systems Analysis/Product Integration</p>	3,652	2,921	3,960
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Complete engineering designs of Early Entrance Coproduction Plants for clean fuels like hydrogen and high efficiency power productions as pre-Vision 21 concepts. Continue systems analyses for research guidance and product outreach activities. Update the worldwide gasification

database. Establish size of standardized IGCC plants from market analysis and begin design of modular unit to reduce plant cost, shorten plant startup schedule, and improve system reliability. *Participants include: NETL, CTC, E2S, Mitretek, SFA, Pacific, Texaco, Parsons, WMPI, GE, KBR, Praxair.*

In FY 2003, work is continuing on risk mitigation for the Early Entrance Co-production Plants and the results were used to update the preliminary process design and analysis. The co-production design optimization study is being completed and a comprehensive report will be issued. Systems studies are being conducted to evaluate the cost and performance improvements of all technologies being developed and will be used to develop a comprehensive program roadmap. The biannual update of the world-wide gasification database was performed.

In FY 2002, continued development of engineering analysis and the conduct of risk reduction R&D for the Early Entrance Co-production Plant. Progress on the WMPI project led to a proposal in the CCPI solicitation. Task 1 of the design optimization study was completed and was used as the basis of the Nordic Energy proposal in the CCPI solicitation. A comprehensive report was issued describing the industry perspective on future markets and technology needs for gasification.

Participants included: NETL, CTC, E2S, Mitretek, SFA Pacific, ChevronTexaco, Parsons, WMPI, GE, KBR, Praxair, Global Energy, Dow Corning, Dow Chemical, Siemens Westinghouse, Methanex, Nexant.

■ **Vision 21** 16,208 16,334 16,830

To achieve the Vision 21 program goals, develop novel technologies that lead to ultra-high efficiencies, near-zero emissions, carbon capture for sequestration and the production of hydrogen for ultra-clean fuels and powers. Scale-up and test ceramic membrane modules for advanced air separation at the 1-5 ton/day scale to reduce the cost of oxygen and pave the way for the economical capture of CO₂. Begin initial planning of 50 ton/day membrane modules for integration with a gasifier and gas turbine. Investigate improved membrane materials, fabrication techniques, and module design for H₂/CO₂ separations to address capture of CO₂ and for producing low-cost hydrogen from coal. Conduct life testing of advanced ceramic hydrogen membranes and develop conceptual process designs. Construct a polymer hydrogen membrane module for integrated testing with a pilot-scale coal gasifier to address performance under actual process conditions. Construct skid-mounted unit for the development of the low temperature hydrate technology to demonstrate effective carbon management by separating hydrogen and carbon dioxide and begin preliminary site evaluation for integration with a gasifier. Investigate advanced gas cleaning technologies to meet near-zero emission requirements in response to the Clean Skies Initiative. Begin testing of an advanced sulfur cleanup technology integrated with a pilot-scale coal gasifier to evaluate process performance under realistic conditions. Construct skid-mounted process units for mercury, ammonia, and chloride control for possible integrated testing with a pilot-scale coal gasifier. Complete conceptual design and economic analysis of a novel coal gasification concept for producing hydrogen and sequestration-ready CO₂ that has potential for cost reductions over conventional approaches.

Participants include: APCI, Praxair, ANL, Concepts NREC, Ceramatec, Texaco, PSU, Penn, Bechtel, LANL, RTI, Medal, Protech, IGT, Siemens-Westinghouse, NETL, REI, GEERC, INT, Eltron, Praxair, Coors, INEEL, Sud Chemie, SRI, ORNL, McDermott, KBR.

In FY 2003, negotiations with ChevronTexaco will be completed on the testing of the RT13 advanced transport sorbent integrated with their pilot-scale coal gasifier. The transport desulfurizer module will be designed, constructed, and installed in preparation for a 500-1000 hour test run. Investigation of ammonia, chloride, and mercury removal approaches will focus on obtaining sufficient performance and process data to design modules for integration with a pilot-scale coal gasifier. Laboratory scale testing of advanced ceramic air separation membranes will be completed to provide process design data for the 1-5 TPD engineering-scale unit and to finalize the design of the commercial-scale modules. Preliminary investigations of potential sites for integrated testing of the membrane modules with a gasifier and gas turbine will commence. Development of ceramic-based H₂/CO₂ membranes will focus on further increases in H₂ flux to achieve commercially relevant flux targets. Development of the polymer-based membrane for H₂/CO₂ separation will focus on further testing of the membrane to improve CO₂ flux and to obtain engineering data for the design of a module for integration with a pilot-scale coal gasifier. Engineering data will be obtained from a laboratory-scale flow unit for the CO₂ hydrate process to establish the design basis for a skid-mounted unit. Initial study on the feasibility of a novel gasification concept for producing hydrogen and sequestration-ready CO₂ will be completed.

In FY 2002, continued the development of advanced air separation membranes, with both projects focusing on scale-up of the technologies for 1-5 TPD oxygen production level. Full-scale membranes that achieve the commercial target flux were successfully produced. The advanced RT13 sulfur sorbent performed successfully using a simulated coal-based synthesis gas, and negotiations with ChevronTexaco were initiated for integrated testing with a pilot-scale coal gasifier. Advanced ceramic membranes for H₂/CO₂ separation achieved an order of magnitude increase in flux while a polymer-based membrane has attracted the interest of ChevronTexaco. Scale-up and testing of a latter membrane are part of the negotiations with ChevronTexaco. The formation of CO₂ hydrates in a continuous flow unit was successfully demonstrated and preliminary economic analyses show a substantial improvement in cost and efficiency over conventional technologies.

Participants included: APCI, Praxair, ANL, Concepts NREC, Ceramatec, ChevronTexaco, PSU, Penn, Bechtel, LANL, RTI, Medal, Protech, IGT, Siemens-Westinghouse, NETL, REI, GEERC, INT, Eltron, Coors, INEEL, Sud Chemie, SRI, ORNL, McDermott, KBR.

(dollars in thousands)

	FY 2002	FY 2003	FY 2004
■ Program Support Fund technical and program management support.	430	407	510
Pressurized Fluidized Bed	10,720	9,100	0
■ Gas Stream Cleanup	4,090	5,445	0
This activity concluded and folded into gasification activity.			

FY 2003 and FY 2002 funding continued development of hot gas filters, a number of hot gas filter

materials, certain designs validated and a broad fail safe development initiated at the PSDF. Pilot plant testing of partial gasification Vision 21 modules was undertaken and the first tests of various coal and biomass were completed, including one run oxygen in place of air. *Participants included: Southern Co.*

■ **Hybrid Combustion**..... 3,110 3,069 0

This activity concluded and folded into gasification activity.

FY 2003 and FY 2002 funding continued development of Vision 21 hybrid system enhancements and design optimization studies were undertaken as well as development of novel hybrid concepts. Two hybrid site specific repowering studies were completed and accepted by participating utilities. *Participants included: NETL, Alstom*

■ **Vision 21** 3,410 495 0

This activity concluded and folded into gasification activity.

In FY 2003 and FY 2002, Vision 21 combustion kinetic studies and testing were initiated and development of viable codes were undertaken. Investigations were begun into the feasibility of enabling Vision 21 combustion technologies such as chemical looping. *Participates included: Fluent.*

■ **Program Support**..... 110 91 0

Fund technical and program management support.

Turbines..... 18,101 14,000 13,000

■ **Vision 21** 2,542 0 0

This activity is continued in the High Efficiency Engines and Turbines (HEET) subprogram described below.

In FY 2003, this activity is continued in the High Efficiency Engines and Turbines (HEET) subprogram described below. In FY 2002, preliminary studies were completed that identified advance turbine hybrid systems for application to coal-based Vision 21 power systems. Sub-MW hybrid power systems were operated with outstanding thermal efficiencies. *Participants included:*

(dollars in thousands)

	FY 2002	FY 2003	FY 2004
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■ **High Efficiency Engines and Turbines (HEET)**..... 15,374 13,860 12,870

In support of developing power modules for zero-emission Vision 21 plants, conduct R&D in four program areas to include: 1) simple and combined cycle development, 2) advanced systems analysis, 3) hybrid cycles, and 4) technology base development. Simple and combined cycle development will pursue the adaptation of existing and advanced gas turbines for application to coal derived synthesis gas as well as ways of reducing the life cycle cost of these machines when

operated on coal derived gas. Advanced system analysis will assess revolutionary concepts for application and integration into Vision 21 power systems. The hybrid cycles area will resolve component, integration, control and operational issues for fuel-flexible and robust performance in Vision 21 power plants. The technology base area will provide the basic underpinning for the program areas resolving materials, heat transfer, aerodynamics and combustion technical issues as new machines and systems are applied to coal derived gases. *Participants include: GE, SWPC, EPRI, NETL, U. of CA-Irvine, CFD Research, ORNL, ANL.*

In FY 2003, the HEET program will complete studies to assess ATS and other machines for operation on coal syngas, as well as ATS machines in coal and natural gas based integrated hybrid power modules, complete demonstration of low-emission steam generator, demonstrate an integrated sensor suite for real-time monitoring of an advanced turbine’s operational performance, and demonstrate in-situ single crystal blade welding and repair techniques.

In FY 2002, the HEET program evaluated techniques for low NO_x combustion through trapped vortex combustion and catalytic combustion. Preliminary studies were completed that identified advance turbine hybrid systems for application to coal-based Vision 21 power systems. Sub-MW hybrid power systems were operated with outstanding (53 percent as compared with current technologies between 20 and 40 percent) thermal efficiencies. Progress was made towards reducing life-cycle costs through condition monitoring and materials evaluations.

Participants included: GE, SWPC, Solar, EPRI, NETL, SCIES, U. of CA-Irvine, CFD Research, ORNL, ANL.

■ Program Support	185	140	130
Fund technical and program management support.			
Total, Central Systems	93,784	84,950	86,000

Explanation of Funding Changes

FY 2004 vs. FY 2003 (\$000)

Innovations for Existing Plants

■ Increase in In-House research due to additional research on advanced emission control technology.....	297
■ Increase in Waste Management due to additional research into solids by-products utilization.....	495
■ Program Support	8

Advanced Systems

Integrated Gasification Combined Cycle (IGCC)

■ Increase in Gasification Systems Technology due to transfer of activity from Pressurized Fluidized Bed.....	8,712
■ Increase in Systems Analysis/Production Integration due to additional analyses of new concepts including gasification hybrids	1,039
■ Increase in Vision 21 due to transfer of activity from Pressurized Fluidized Bed	496
■ Increase in Program Support due to additional studies	103
Pressurized Fluidized Bed	
■ Decrease in Gas Stream Cleanup due to discontinuation of activity and transfer to ICGG	-5,445
■ Decrease in Hybrid Combustion due to discontinuation of activity and transfer to IGCC	-3,069
■ Decrease in Vision 21 due to discontinuation of activity and transfer to IGCC	-495
■ Program Support in this area eliminated	-91
Turbines	
■ Decrease in High Efficiency Engines and Turbines (HEET) due to reduced effort in combustion NO _x control	-990
■ Program Support.....	-10
Total Funding Change	<u>1,050</u>

Sequestration R&D

Program Mission

The mission of the Sequestration R&D program is to create public benefits by discovering and developing ways to economically separate and permanently store (sequester), or to offset, greenhouse gas emissions from the combustion of fossil fuels. A successful research and development effort will allow the continued use of economical fossil fuels during the transition to a hydrogen economy.

About 90% of coal produced in the United States is used for electricity generation and over half of all electricity is produced by coal-fired power plants. Including electricity generated by oil and natural gas-fired power plants, approximately 70% of all electricity produced in the United States is generated from fossil fuels. The continued use of fossil fuels to generate affordable electricity is critically important to the United States economy and the power generation industry needs to maintain a diversified fuel mix to ensure adequate energy supplies at a reasonable price. The continued use of fossil fuels has many environmental challenges, and sustained use could be severely limited unless satisfactory solutions can be found to overcome these environmental challenges, especially with regard to global climate change. For example, the ability to cut the carbon dioxide (CO₂) emissions in the United States by over 16 percent.

Since electric generation is expected to grow and fossil fuels will continue to be the dominant fuel source, there is growing recognition that the public/private collaboration must be part of the solution to curbing greenhouse gas emissions by capturing and permanently sequestering carbon dioxide. The President's recently announced climate change goal is to significantly reduce the greenhouse gas intensity of the United States economy over the next 10 years, while sustaining the economic growth needed to finance investment in new, clean energy technologies. The Carbon Sequestration Program directly supports these and several National Energy Policy (NEP) goals targeting the development of new technologies, market mechanisms, and international collaboration to reduce greenhouse gas intensity and greenhouse gas emissions. The development of carbon capture and sequestration technologies must play a key role if the United States is to set a path to slow the growth of greenhouse gas emissions, and -- if the emerging science justifies -- to stop and then reverse that growth.

The DOE is developing a portfolio of technologies and mitigation strategies designed to reduce the emissions of greenhouse gases using a two-prong approach: (1) Making energy systems more efficient; and; (2) Capture and sequestration of greenhouse gases. The first approach is being addressed by the core fossil energy coal, oil and gas programs and "Vision 21" that is seeking to almost double the current average efficiency of existing coal power plants by 2015. The second approach is being addressed by the Carbon Sequestration R&D Program. The Carbon Sequestration Program is developing a portfolio of technologies that hold great potential to reduce greenhouse gas emissions. The Program will focus primarily on the following areas:

- Developing capture and separation technologies that dramatically lower the costs of reducing carbon dioxide emissions from fossil fuel process treatment.

- Promoting development of the infrastructure required for wide-scale deployment of greenhouse gas mitigation technologies.

The programmatic time line is to develop to a state of commercial readiness a portfolio of safe and cost effective greenhouse gas capture, storage and mitigation technologies by 2012, leading to substantial market penetration beyond 2012. Technology developments within the Sequestration Program are expected to significantly contribute to the President's goal of reducing greenhouse gas intensity by 18% by 2012 and would play a critical role should it be necessary to stabilize greenhouse gas emissions in the United States.

In addition to maintaining core R&D, the Sequestration Program will focus on the follows programmatic thrusts:

- Provide funding support and management assistance for the President's National Climate Change Technology Initiative (NCCTI) competitive solicitation. The NCCTI competitive solicitation is intended to promote applied research, via a series of open competitive solicitations, aimed at exploring concepts, technologies and advanced technical approaches that could, if successful, contribute in significant ways to (a) further reductions in, or avoidance of, greenhouse gas (GHG) emissions; (b) GHG capture and sequestration; and/or (c) conversion of GHGs to beneficial use. The intent of this solicitation is to have all the various technologies that can potentially contribute to the reduction of greenhouse gas emissions or concentrations compete head-to-head based on GHG mitigation. While other projects and programs can contribute to greenhouse gas solutions, those solicitations have required that projects meet other pre-selected technological criteria (solar, nuclear, fossil, ocean, etc.) for consideration. This solicitation will be operated and funded jointly with the Office of Nuclear Energy and the Office of Energy Efficiency and Renewable Energy.
- Pursue sequestration strategies that support zero emissions and waste from energy conversion facilities. These strategies would include the sequestration of greenhouse gases and conventional pollutants and effluents" or waste products, and combine low-cost CO₂ capture with efficiency benefits from new generation technology to achieve low-cost net greenhouse gas emissions reduction. Technology options will be pursued that offer optional pathways to zero emissions energy plants by enabling total sequestration of effluent streams. This activity enables sequestration opportunities that support both the Clear Skies and climate change initiative.
- Strengthen U.S. and DOE leadership in carbon sequestration by pursuing global public/private R&D partnerships. In addition to seeking new opportunities, emphasis will be places on strengthening and expanding existing cooperative efforts with Canada, Japan, Australia, Italy, Norway, and the European Union.
- Accelerate planning of regional carbon sequestration partnerships. This activity focuses on promoting development of the infrastructure for wide-scale deployment of mitigation technologies and place more emphasis on bringing low-cost, value-added CO₂ capture and storage to the commercial implementation stage before 2012, while establishing the longer-term capability for addressing capture and sequestration from power generation, through early

demonstration activities. These partnerships will (1) identify regional opportunities and benefits; (2) create a baseline and characterize a region by match source and sink opportunities; (3) address safety, permitting, public acceptance; and (4) provide technology validation for regional capture and storage opportunities.

- Increase R&D focus on restoration of disturbed lands. Strengthen and expand R&D, including collaboration with the Department of Agriculture, Department of Interior and the Environmental Protection Agency to produce near-term benefits that directly contribute to the 2012 greenhouse gas intensity goal of the Global Climate Change Initiative.
- Accelerate Novel Sequestration Systems R&D to create expanded and new means of storing or reusing carbon and other greenhouse gas residuals that provide additional pathways to near zero emissions energy facilities of the future. Strong emphasis will be placed on technologies that offer permanent “solid” storage using chemical/biological pathways to inert, benign solids and useful products. These efforts will be coordinated with the DOE Office of Science, National Academy of Sciences, the IEA/GHG and other science organizations involved in this area.
- Aggressively pursue a new R&D thrust on non-CO₂ greenhouse gases, with emphasis on mitigating methane emissions. Cooperative efforts with Department of Agriculture and the Environmental Protection Agency R&D on mitigation strategies related to landfills, coalbeds and fugitive emissions will enable leveraging of R&D funds and could produce near-term benefits that directly contribute to the 2012 greenhouse gas intensity goal of the Global Climate Change Initiative.

Program Specific Performance Goal

ER 4-3: By 2007 demonstrate at a pilot plant scale, technologies to reduce the cost of carbon separation and capture from new coal-based power systems by 75 percent compared to current systems (\$200/tonne carbon in year 2000). By 2012, develop technologies that result in less than 10 percent increase in the cost of new energy services to separate, capture, transport, and sequester carbon using either direct or indirect systems.

Performance Indicator: Number of tests of strategies, concepts and technologies required to reduce the cost of carbon capture by 70 percent.

Annual Performance Targets and Results

FY 2002 Results	FY 2003 Updated Targets	FY 2004 Targets
Complete the injection of 2,500 tons of CO ₂ into a depleting oil reservoir to monitor the	Establish modular carbon dioxide capture test facility. This facility will accelerate	Provide funding support and management assistance to the President’s National Climate

transport of CO₂ and verify predictive geologic models on reservoir integrity.

development and testing of emerging low-cost separation and capture technologies while facilitating partnerships with leading technology developers and academic institutions.

Change Technology Initiative (NCCTI) competitive solicitation. Ensure complementary linkages between NCCTI and carbon sequestration program.

Complete initial set of field tests of advanced monitoring and verification methods for carbon inventories on natural and engineered terrestrial systems and establish a database for mid-continent planning of geological storage projects.

Initiate start-up of at least five regional carbon sequestration partnerships. Partnerships to identify best regional technology options and source/sink locations for capture and sequestration.

Initiate evaluations of three novel concepts, comprising integrated sequestration with enhanced coal bed methane recovery, mineral carbonation, and CO₂ flooding during enhanced oil recovery and establish initial recommendations for long-term monitoring of CO₂ geological storage to assure acceptability as a safe, long-term storage option.

Complete initial field tests and development of preliminary standard procedures for advanced monitoring and verification of carbon inventories that will achieve cost reductions and improved measurement speeds in conducting soil and forest carbon measurements on disturbed, unproductive, and productive lands. Success will be measured by reducing the cost from more than \$10/sample to less than \$2/sample.

Complete initial planning, field testing, or analyses of sequestration concepts involving saline aquifer storage, ocean storage, and scientific feasibility of CO₂ storage as hydrate on the ocean floor, and complete initial comparative evaluation of energy technology scenarios to identify promising concepts for CO₂ sequestration.

Develop a catalytic reduction technology to mitigate methane emissions from coal mine ventilation air. By converting methane to carbon dioxide and capturing the thermal energy, greenhouse gas potential is reduced by 87% compared to fugitive methane emission.

Complete endurance testing of polymeric membranes. Validate performance of oxygen transport membrane. Complete pilot

verification of dry regenerable sorbents. These activities are expected to lead to 10-30% reduction in the cost of capture.

Complete site design and development for the slant hole application for coal seam sequestration. Complete deep well and geologic characterization in saline aquifer in West Virginia. These activities will quantify storage potential and validate these sequestration options.

Funding Profile

(dollars in thousands)

	FY 2002 Comp. Approp.	FY 2003 Request	FY 2004 Base	FY 2004 Request	FY 2004 Request vs. Base	
					\$ Change	% Change
Sequestration R&D	\$31,486	\$44,000	\$44,000	\$62,000	\$18,000	40.9%
Total, Sequestration R&D	\$31,486	\$44,000	\$44,000	\$62,000	\$18,000	40.9%

Funding by Site

(dollars in thousands)

	FY 2002	FY 2003	FY 2004	\$Change	%Change
Argonne National Lab	\$120	\$120	\$0	-\$120	-100.0%
Idaho Nat'l Engineering and Environmental Lab ..	862	862	0	-862	-100.0%
Lawrence Berkeley National Lab	450	1,050	150	-900	-85.7%
Lawrence Livermore National Lab	355	350	250	-100	-28.6%
Los Alamos National Lab	1,545	1,705	250	-1,455	-85.3%
National Energy Technology Lab	5,597	7,425	6,930	-495	-6.7%
Oak Ridge National Lab	633	682	550	-132	-19.4%
Pacific Northwest National Lab	170	0	0	0	??
Sandia National Lab	450	900	0	-900	-100.0%
All Other	21,304	30,906	53,870	22,964	74.3%
Total, Sequestration R&D	\$31,486	\$44,000	\$62,000	\$18,000	40.9%

Site Description

Argonne National Laboratory

The Argonne National Laboratory (ANL), located in Argonne, Illinois, is a major multi-program laboratory managed and operated for the U.S. Department of Energy (DOE) by the University of Chicago under a performance-based contract. Argonne research for the Fossil Energy Sequestration R&D program supports DOE strategies to capture CO₂ from existing and advanced fossil fuel conversion systems.

Idaho National Engineering and Environmental Laboratory

The Idaho National Engineering and Environmental Laboratory (INEEL), located outside of Idaho Falls, Idaho, conducts research on breakthrough concepts to separate and capture CO₂.

Lawrence Berkeley National Laboratory

The Lawrence Berkeley National Lab (LBNL), located in Berkeley, California, conducts research and development on geologic sequestration approaches and measurement, monitoring, and verification protocols.

Lawrence Livermore National Laboratory

The Lawrence Livermore National Lab (LLNL), located in Livermore, California, conducts research and development in the area of Sequestration R&D to increase the knowledge base in geologic and oceanic sequestration.

Los Alamos National Laboratory

The Los Alamos National Laboratory (LANL), located in Los Alamos, New Mexico, conducts research and development in the area of Sequestration R&D to lower the costs of CO₂ capture, provide fundamental scientific information on engineered terrestrial sequestration approaches, and develop advanced instrumentation to measure and validate terrestrially sequestered carbon.

National Energy Technology Laboratory

The National Energy Technology Laboratory (NETL), located in Morgantown, West Virginia, Pittsburgh, Pennsylvania, and Tulsa, Oklahoma, is a multi-purpose laboratory, owned and operated by the U.S. Department of Energy. NETL conducts research and development activities in carbon sequestration technologies, focusing on advanced CO₂ separation and capture concepts for both existing and advanced fossil fuel conversion systems, developing and validating modeling methodologies that are transparent and based on laboratory and field data that assess the effectiveness and efficiency of geologic sequestration and provide a sound basis for large-scale demonstration projects, developing and testing measurement, monitoring, and verification protocols, and the role of hydrates in deep ocean sequestration concepts.

Oak Ridge National Laboratory

The Oak Ridge National Laboratory (ORNL), located in Oak Ridge, Tennessee, conducts research and development in the area of Sequestration R&D to further geologic sequestration concepts, including measurement, monitoring and verification, and to understand the important soil parameters that facilitate terrestrial sequestration.

Pacific Northwest National Laboratory

The Pacific Northwest National Laboratory (PNNL), located in Richland, Washington, conducts research and development in the area of Sequestration R&D to accelerate implementation of large-scale engineered terrestrial sequestration approaches, and provides rationale and strategy related to global energy issues related to greenhouse gas mitigation approaches.

Sandia National Laboratory

The Sandia National Laboratory (SNL), located in Albuquerque, New Mexico, conducts research and development in the area of Sequestration R&D on injection of CO₂ into depleted oil and gas formations, and advanced monitoring methodologies based on advances seismic concepts.

All Other

The Department's Sequestration R&D program, within the Fossil Energy and Development program, funds research at major performers at non-DOE locations. Examples of these performers include the CO₂ Capture Project (CCP), a collaborative effort involving nine major international energy companies, that has the goal of developing advanced technologies to significantly (75%) reduce the costs of capturing CO₂ from fossil fuel energy systems, an advanced fossil fuel conversion process with inherent CO₂ capture (Alstom), development of a combined membrane-fossil fuel combustion system that would produce a pure stream of CO₂ for sequestration (Praxair), and testing a regenerable sorbent system capable of capturing CO₂ from advanced coal gasification systems (RTI).

The Sequestration R&D program also funds research at major colleges and universities—developing an accurate cost and performance model for CO₂ capture systems (CMU); using hardwoods to restore mine lands (University of Kentucky); developing a carbon management geographic information system (MIT)—and at non-governmental organizations such as the Nature Conservancy who is developing a carbon accounting system for large forest ecosystems.

Detailed Program Justification

(dollars in thousands)

	FY 2002	FY 2003	FY 2004
Sequestration	31,486	44,000	62,000

The Carbon Sequestration Program is developing a portfolio of technologies that holds great potential to reduce greenhouse gas emissions.

■ Greenhouse Gas Control	26,164	36,135	41,250
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Refocus core R&D program toward meeting the goals of in the following areas: developing efficient, low-cost, advanced CO₂ separation and capture concepts; identifying issues associated with carbon sequestration in differing geologic formations, and reducing the cost, and environmental uncertainties (including storage stability, permanence, rates and characteristics of migration) of large-scale carbon sequestration through innovative Public-Private R&D partnerships. Close collaboration with the carbon management science programs and activities in the Office of Science will be maintained for the purposes of applying promising basic science principles to novel concepts, thereby providing an integrated approach to advancing the science and technology of carbon sequestration. *Participants include: NETL, LANL, Battelle, Praxair, Dakota Gasification, ARI, Nature Conservancy, Univ. Of KY, Univ. of TX, VA Tech, MIT, Princeton University, Consol, IEA, TBD.*

FY 2003 and FY 2002 funding continued development of models and predictive tools that will be required to assess the effectiveness of sequestration, advanced CO₂ capture approaches that are significantly less costly (capital and energy penalty costs), practical sequestration technologies specific to the types of geologic reservoirs found in the U.S., advanced fossil fuel conversion systems that produce a concentrated stream of CO₂ ready for sequestration, and measures to capture and control non-CO₂ greenhouse gases, and issue a solicitation for the Integrated Sequestration and Hydrogen Initiative. *Participants included: RTI, Media Processing Technology, LBNL, LLNL, ORNL, Texas Tech University, University of Kansas, TVA, MBARI, Alabama Geological Survey, Ohio University, PSU, University of Utah, OSU.*

■ Focus Area for Carbon Sequestration Science	5,000	7,425	6,930
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Refocus activities toward the areas of capture, geologic and deep ocean CO₂ sequestration, establish the scientific and technical bases needed to cost-effectively capture and permanently sequester CO₂. *Participants include: NETL.*

FY 2003 and FY 2002 funding continued development of wet scrubber systems to concentrate CO₂ from coal-fired power plants, facilities to test and evaluate advanced CO₂ capture systems applicable to both existing and advanced coal conversion processes and determine CO₂ flow characteristics in brine formations and coal seams, a state-of-the-art facility to mimic the formation of CO₂ hydrates in the deep ocean, and models to predict the extent of and verify sequestration of CO₂ in brine formations and in coals seams. *Participants included: NETL*

(dollars in thousands)

	FY 2002	FY 2003	FY 2004
■ National Climate Change Technology Initiative	0	0	13,200
<p>Provide funding support and management assistance for the President’s National Climate Change Technology Initiative (NCCTI) competitive solicitation. The NCCTI competitive solicitation is intended to promote applied research, via a series of open competitive solicitations, aimed at exploring concepts, technologies and advanced technical approaches that could, if successful, contribute in significant ways to (a) further reductions in, or avoidance of, greenhouse gas (GHG) emissions; (b) GHG capture and sequestration; and/or (c) conversion of GHGs to beneficial use. This solicitation will be operated and funded jointly with the Office of Nuclear Energy and the Office of Energy Efficiency and Renewable Energy. <i>Participants to be determined.</i></p> <p>No FY 2003 and FY 2002 funding was requested for this activity in this account.</p>			
■ Program Support	322	440	620
Fund technical and program management support.			
Total, Sequestration R&D	31,486	44,000	62,000

Explanation of Funding Changes

	FY 2004 vs. FY 2003 (\$000)
■ Increase in Greenhouse Gas Control due to expansion of base programs	5,115
■ Decrease in Focus Area for Carbon Sequestration Science due to decreased level of in-house effort	-495
■ Increase in National Climate Change Technology Initiative due to start of new initiative.....	13,200
■ Increase in Program Support due to additional feasibility studies	180
Total Funding Change	18,000

Fuels

Program Mission

The mission of the Fuels program is to create public benefits by conducting the research necessary to promote the transition to a hydrogen economy. Research will target reducing costs and increasing efficiency of derived hydrogen from coal feedstocks as part of the Freedom Fuel Initiative.

Currently, the United States imports approximately 11 million barrels per day of petroleum crude and finished products (55% of consumption). By 2020 imports are projected to rise to 17.5 million barrels per day of crude and refined products (67% of consumption). Coal-derived hydrogen can be an important part of a strategy to diversify and expand our domestic fuel resource base, reduce emissions from the transportation sector, and help limit our reliance on imported oil.

In addition to energy security issues, major challenges facing transportation are urban and regional air pollution and emissions of greenhouse gases. EIA 2000 data indicates that of man-made emissions, the U.S. transportation sector is responsible for nearly 80 percent of the carbon monoxide (CO), over one half of the nitrogen oxides (NO_x), and 40 percent of the volatile organic compounds (VOC). Vehicles are responsible for about 35% of the U.S. energy sector's carbon dioxide production. As the Nation transitions toward advanced engine platforms, ultra-low emission vehicles and eventually to near-zero emission vehicles, such as the Administration's recently announced fuel cell-powered "FreedomCAR", the demand for hydrogen will increase dramatically. Our large domestic resources of coal can provide high volume, low-cost, ultra-pure hydrogen for fuel cells in the longer term.

Research will address the development of technologies to produce, distribute and store hydrogen as an affordable, safe fuel for consumers. Specifically, this research activity will encompass a technology envelope that begins with the separation of hydrogen from mixed gas streams and conclude with the interface of the hydrogen with fuel cells and other end-use systems. In FY 2004, research will target the development of technologies (1) capable of economically producing large quantities of pure hydrogen from coal-derived synthesis gas, (2) capable of safely and economically storing, distributing and handling hydrogen derived from coal gasification processes for end-use in the utility, transportation, commercial, industrial and residential markets, and (3) that will enable hydrogen from coal feedstocks to play a major role in the transition to sustainable hydrogen based energy systems.

Centralized production of hydrogen from coal feedstocks will produce a concentrated stream of carbon dioxide which will facilitate its economic capture and sequestration. There are two routes to supplying hydrogen from these advanced coal gasification facilities. A portion of the hydrogen can be separated from the mixed gas stream (i.e. synthesis gas) which is produced during the gasification process and then stored for distribution. The other alternative is to produce, via synthesis gas conversion processes, zero-sulfur, high hydrogen content coal-derived fuels that can be moved through the present distribution system, then reformed at facilities in close proximity to the customer or directly on-board the vehicle.

Program Strategic Performance Goals

The Fuels Program supports Strategic Objective ER-4 through Program Strategic Performance Goal (PSPG) ER4-2 as well as through the development of other technologies not currently covered under a PSPG. To aid in the management and performance tracking of the Fuels Program, a set of annual goals, along with a Midterm Performance Goal, which is equivalent in scope to a PSPG has been developed. It is:

Performance Indicator

- By 2010, complete development of modules capable of co-producing hydrogen from coal at \$30/barrel crude oil equivalent (no incentives or tax credits) when integrated with advanced coal power systems.

Annual Performance Targets and Results

FY 2002 Results	FY 2003 Updated Targets	FY 2004 Targets
Complete dlaboratory scale test operations of novel ITM-syngas ceramic membrane reactor to reduce gas-to-liquid fuel conversion costs. (Met goal)	Complete development and communication of a hydrogen program and implementation plans. Continue development of ITM membrane technology at reduced pace leading to the scaleup of the concept at the SEP level.	Implement a coal derived hydrogen program by conducting a solicitation to identify at least two organizations (projects) to establish the feasibility of emerging alternate coal-based hydrogen technologies including advanced separations.

Funding Profile

(dollars in thousands)

	FY 2002 Comp. Approp.	FY 2003 Request	FY 2004 Base	FY 2004 Request	FY 2004 Request vs. Base	
					\$ Change	% Change
Transportation Fuels and Chemicals	\$25,002	\$5,000	\$5,000	\$5,000	\$0	0.0%
Solid Fuels and Feedstocks.....	4,896	0	0	0	0	0.0%
Advanced Fuels Research.....	3,916	0	0	0	0	0.0%
Total, Fuels	\$33,814	\$5,000	\$5,000	\$5,000	\$0	0.0%

Funding by Site

(dollars in thousands)

	FY 2002	FY 2003	FY 2004	\$Change	%Change
Los Alamos National Laboratory	\$100	\$200	\$0	\$-200	-100.0%
National Energy Technology Laboratory	4,050	1,280	0	-1,280	-100.0%
Pacific Northwest National Laboratory	150	0	0	0	0.0%
All Other	29,514	3,520	5,000	1,480	42.0%
Total, Fuels	\$33,814	\$5,000	\$5,000	\$0	0.0%

Site Description

Los Alamos National Laboratory

The Los Alamos National Laboratory (LANL), located in Los Alamos, New Mexico, is conducting research on a novel thermo-acoustic natural gas liquefaction process that requires no electric power to product LNG. The liquefier energy is provided by the combustion of a portion of the natural gas feed.

National Energy Technology Laboratory

The National Energy Technology Laboratory (NETL), located in Morgantown, West Virginia, Pittsburgh, Pennsylvania, and Tulsa, Oklahoma, is a multi-purpose laboratory, owned and operated by the U.S. Department of Energy. NETL conducts and implements science and technology development programs for the Department in energy and energy-related environmental systems. NETL's fuels research is focused on developing technologies to reduce the costs of producing and storing coal-derived hydrogen. Specifically: 1) a unique facility has been established to test materials capable of separating hydrogen from mixed gas streams; 2) catalytic membranes are being developed to enhance the reaction of carbon monoxide with water to produce hydrogen; 3) computational methods are being used to optimize the separation of hydrogen from coal-derived liquids; and 4) novel carbon materials are being tested to safely store hydrogen at high density.

Pacific Northwest Laboratory

The Pacific Northwest Laboratory (PNNL), located in Richland, Washington, is conducting research to develop sealing materials and technology which are needed for the development of ceramic membrane modules for gas separation required to cheaply produce synthesis gas and hydrogen.

All Other

The Department's Fuels Program, within the Fossil Energy and Development program, funds research at major performers at non-DOE locations. Examples of these performers include APCI, Texaco and Praxair.

Detailed Program Justification

(dollars in thousands)

	FY 2002	FY 2003	FY 2004
Transportation Fuels and Chemicals	25,002	5,000	5,000

This program conducts laboratory and process research to develop advanced technology for producing ultra clean fuels and hydrogen from coal by use of gasification technology possibly with coproduction of electricity and other products. Because of budget priorities funding is requested for only longer-term hydrogen research.

■ Reactor/Process Development	1,950	0	0
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No funding is requested for this activity in FY 2004.

No funding was requested in FY 2003. FY 2002 funding maintained and conducted facility upgrading of an alternative fuels facility for production of synthesis gas liquid fuel products. Continued slurry F-T reactor design data base activity. Also, continued feasibility study, R&D, and design of the Early Entrance Coproduction Plant with industry consortium with prior year funding. *Participants included: APCI, WMPI, Texaco.*

■ Systems Engineering	250	0	0
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No funding is requested for this activity in FY 2004.

No funding was requested in FY 2003. FY 2002 funding continued technical, economic, and environmental analyses. *Participants included: Mitretek, Rand, NETL.*

■ Syngas Membrane Technology	6,413	4,950	0
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This activity will be continued within the oil and gas programs.

FY 2003 and FY 2002 funding continued exploratory research activities of novel conversion concepts of promising chemical and small-scale physical conversion technology innovations. Continued research and development of a novel syngas ceramic membrane technology to enhance Fischer-Tropsch (F-T) gas conversion for environmentally superior liquid fuels and hydrogen. Conducted fundamental supporting fuels research at NETL. *Participants included: APCI, NETL, LANL, Univ. Of Alaska, Canmet, Praxair.*

■ Ultra Clean Fuels	16,149	0	0
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In FY 2004, no funds are requested and ultra-clean natural gas and petroleum feedstock projects will be transferred to the oil and gas programs.

FY 2003 funding continued cost-shared industrial research for the development of ultra-clean fuels technology for fossil resources (natural gas, petroleum, coal) using prior year funding. FY 2002 funding continued cost-shared industrial research for the development of ultra-clean fuels technology for fossil resources (natural gas, petroleum, coal). Conduct ultra-clean diesel fuels

research. *Participants included: Praxair, ICRC/Syntroleum, Conoco, RTI, Petrostar, Envires, University of Alaska, NETL.*

(dollars in thousands)

FY 2002	FY 2003	FY 2004
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■ **Hydrogen from Coal Research**..... 0 0 4,950

Initiate hydrogen from coal initiative by competitive procurement. Identify appropriate organizations to (1) establish the feasibility of emerging alternate coal-based hydrogen technologies, (2) investigate advanced separation technologies, and (3) utilize a combination of experimental and advanced computational methods to determine optimal reaction chemistries for producing hydrogen from coal-derived fuels. *Participants include: NETL.*

No funding was requested in FY 2003 and FY 2002 for this activity.

■ **Program Support**..... 240 50 50

Fund technical and program management support.

Solid Fuels and Feedstocks..... 4,896 0 0

Research will be undertaken to provide advanced technologies to produce clean high value carbon products from coal such as high purity carbon electrodes and specialty graphite. Composite fuels comprised of coal and waste biomass for greenhouse gas reduction and separation technology for producing additional clean coal from wastes.

■ **Tailored Carbon Feedstocks**..... 4,846 0 0

No funding is requested for this activity in FY 2004.

FY 2003 funding was used to conduct: 1) technical/economic assessments and laboratory and bench scale research on technologies for the manufacture of carbon products; and 2) conduct research at outside facilities for advanced technologies for premium carbon products from coal via an industry-led and cost-shared consortium using prior year funding. FY 2002 funding was used to: 1) conduct technical/economic assessments and laboratory and bench scale research on technologies for the manufacture of carbon products; 2) conduct research at outside facilities for advanced technologies for premium carbon products from coal via an industry-led and cost-shared consortium; and 3) continued research in the areas of advanced technologies for solid-solid and solid-liquid separations. *Participants included: NETL, Penn State.*

■ **Program Support**..... 50 0 0

Fund technical and program management support.

Advanced Fuels Research..... 3,916 0 0

Provide the scientific underpinning for the development of advanced ultra clean liquid fuels and hydrogen technology from coal.

(dollars in thousands)

	FY 2002	FY 2003	FY 2004
■ Advanced Research	3,884	0	0
No funding is requested for this activity in FY 2004.			
No funding was requested for this activity in FY 2003. FY 2002 funding continued cosponsored investigation of the chemistry of monocarbon compounds (C-1 Chemistry) for the production of hydrogen, syngas, strategic chemicals and transportation fuels with the EE Office of Advanced Automotive Technologies. Investigated advanced extraction concepts for producing advanced extraction products from coal. Conducted fundamental supporting fuels research at NETL. <i>Participants included: NETL.</i>			
■ Program Support	32	0	0
Fund technical and program management support.			
Total, Fuels	33,814	5,000	5,000

Explanation of Funding Changes

	FY 2004 vs. FY 2003 (\$000)
Transportation Fuels and Chemicals	
■ Decrease in Syngas Membrane Technology due to the conversion of natural gas to synthesis gas activity being transferred to the Oil and Gas programs	-4,950
■ Increase in Hydrogen from Coal Research due to the re-emphasis to longer term objectives with hydrogen from coal, with sequestration being an important avenue for production of abundant hydrogen in an environmentally sound and affordable manner	4,950
Total Funding Changes	0

Advanced Research

Program Mission

The Advanced Research Program works to create public benefits through 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 public benefits from these activities because the improvement of programs and regulatory activities will help to maximize their benefits and lower their costs. 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 research. The public benefits from these activities because the long-term, high-risk activities target areas where industry is reluctant to invest. These research activities can produce public benefits such as increased energy efficiency, reduced pollution, or more reliable power supplies. For example, the university-based research programs include the University Coal Research program and the Historically Black Colleges and Universities and Other Minority Institutions (HBCU/OMI) program, address 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. Fossil Energy, through these activities, always attempts to encourage the leveraging of research and development funds while promoting U.S. industrial interests and to use them as opportunities to achieve responsible international consensus and opinion on technical business assessment and policy issues.

The crosscutting fundamental and applied research programs focus upon developing the technology base in the enabling science and technology areas that are critical to the successful development of both superclean, very high efficiency coal-based power systems and coal-based fuel systems with greatly reduced or no net emissions of CO₂. These systems are encompassed in the Vision 21 energyplex. Advanced Research seeks a greater understanding of the physical, chemical, biological and thermodynamic barriers to achieving economic, technologic, and environmental goals and identifies 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, an Advanced Research focus area on Computational Energy Sciences was established at the National Energy Technology Laboratory (NETL). This focus area will conduct simulations and modeling activities to produce a "technology base" from which the energy plants of the future will be designed, built and operated.

The Coal Utilization Science subprogram focuses on research pertinent to all coal utilization systems, with specific attention paid to increasing our knowledge of the principal mechanisms that control coal

conversion processes. It will address issues affecting the utilization of coal, and its primary thrust is in support of the development of the Vision 21 concept. It will involve novel concepts for CO₂ capture and sequestration, such as mineral carbonation, and virtual simulations and modeling of components and subsystems. It will also include research on instrumentation and diagnostics to support the development of 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 materials for advanced gas separation and particulate removal, 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 subprogram is to conduct biological research to produce clean fuels and to reduce greenhouse gas emissions (NO_x, SO_x, and CO₂) from existing and new powerplants. The University Coal Research and HBCU/OMI subprograms are both education and training programs that support competitively awarded research grants at U.S. colleges and universities to address Fossil Energy's highest priority research needs.

Program Strategic Performance Goal

Approximately three quarters of the Advanced Research Program funding supports Program Strategic Performance Goal (PSPG) ER-2. The remainder supports education along with scientific efforts not directly related to any of the current PSPGs. Because of this, the Advanced Research Program has developed a set of annual goals along with a Midterm Performance Goal, which is equivalent in scope to a PSPG, to help track performance. They are:

Performance Indicator

- Midterm Performance Goal: Sustain US preeminence in fossil fuel technology by supporting development of material, computational method, and control system knowledge needed to bridge gaps between science and advanced engineering. Allow development, by 2010, of enabling technologies that support the goals of Vision 21 power systems.

Annual Performance Targets and Results

FY 2002 Results	FY 2003 Targets	FY 2004 Targets
Note: Annual targets for Advanced Research were not proposed prior to FY2003	Prepare and evaluate novel sensors and new materials for high temperature, oxidative environments to improve control, increase efficiency and performance, and/or achieve lower emissions of CO ₂ and other pollutants.	Complete qualification testing of ferritic alloys for the ultra supercritical (greater than 1250°F temperature, greater than 4700 psia pressure) steam cycle, use of these alloys will reduce capital costs by 3%, cut emissions by 6% and maintain

Complete preparation and communication of consolidated Advanced Research program and program implementation plans that incorporate guidance from workshops with external stakeholders.

Provide student and faculty training and education through selection of 8 students to participate in the undergraduate internship program for fossil energy and environmental science research and through 15 total awards under the University Coal Research and HBCU/OMI programs for research on critical needs for enabling Vision 21 power systems.

low cost of electricity.

Complete tests of 8 sensors and components with potential to provide improved process control, higher operating efficiencies, and reduced costs, through better management of solids flow, solids composition, and system temperature, in advanced coal power systems potentially capable of achieving goals of the National Energy Policy.

Provide student and faculty training and education through selection of 8 students to participate in the undergraduate internship program for fossil energy and environmental science research and through 15 total awards under the competitive University Coal Research and Historically Black Colleges and Universities/Other Minority Institution programs for research on critical needs to achieve the efficiency and environmental goals established under the National Energy Policy and the President's Clear Skies Initiative for coal technologies.

Funding Profile

(dollars in thousands)

	FY 2002 Comp. Approp.	FY 2003 Request	FY 2004 Base	FY 2004 Request	FY 2004 Request vs. Base	
					\$ Change	% Change
Advanced Research						
Coal Utilization Science	\$6,354	\$8,000	\$8,000	\$9,000	\$1,000	12.5%
Materials	6,821	9,000	9,000	12,000	3,000	33.3%
Technology Crosscut						
Coal Technology Export.	800	800	800	1,000	200	25.0%
Bioprocessing of Coal	1,350	1,350	1,350	1,500	150	11.1%
Environmental Activities .	1,900	2,000	2,000	2,000	0	0.0%
Technical & Economic Analyses	750	1,000	1,000	1,000	0	0.0%
International Program Support	950	1,000	1,000	1,000	0	0.0%
Focus Area for Computational Energy Science	5,000	3,000	3,000	3,000	0	0.0%
Subtotal, Technology Crosscut Research						
	10,750	9,150	9,150	9,500	350	3.8%
University Coal Research	2,922	4,000	4,000	5,000	1,000	25.0%
HBCUs, Education and Training	974	1,500	1,500	2,000	500	33.3%
Total, Advanced Research	\$27,821	\$31,650	\$31,650	\$37,500	\$5,850	18.5%

Funding by Site

(dollars in thousands)

	FY 2002	FY 2003	FY 2004	\$Change	%Change
Ames National Laboratory	\$230	\$230	\$280	\$50	21.7%
Argonne National Lab (East).....	988	988	988	0	0.0%
Idaho Nat'l Engineering & Environmental Lab	570	570	570	0	0.0%
Los Alamos National Lab	600	600	100	-500	-83.3%
National Energy Technology Laboratory.....	5,620	5,970	5,970	0	0.0%
Oak Ridge National Lab	4,290	4,435	5,720	1,285	29.0%
Pacific Northwest Lab	770	770	690	-80	-10.4%
Sandia National Laboratories.....	550	550	650	100	18.2%
All Other	14,433	17,767	22,812	5,045	28.4%
Total, Advanced Research.....	\$27,821	\$31,650	\$37,500	\$5,850	18.5%

Site Description

Ames National Laboratory

The Ames National Laboratory, located in Ames, Iowa, conducts research and development in the area of Advanced Research on virtual simulations and high temperature materials.

Argonne National Laboratory (East)

The Argonne National Laboratory (ANL), located in Argonne, Illinois, is a major multi-program laboratory managed and operated for the U.S. Department of Energy (DOE) by the University of Chicago under a performance-based contract. Argonne research for the Fossil Energy Advanced Research program supports DOE strategies to develop non-destructive testing examination of materials and mineral sequestration kinetics.

Idaho National Engineering and Environmental Laboratory

The Idaho National Engineering and Environmental Laboratory (INEEL), located outside of Idaho Falls, Idaho, conducts research and development in the area of Advanced Research on materials development and bio-processing research.

Los Alamos National Laboratory

The Los Alamos National Laboratory (LANL), located in Los Alamos, New Mexico, conducts research and development in the area of Advanced Research to model mineral sequestration and develop hydrogen separation membranes.

National Energy Technology Laboratory

The National Energy Technology Laboratory (NETL), located in Morgantown, West Virginia, Pittsburgh, Pennsylvania, and Tulsa, Oklahoma, is a multi-purpose laboratory, owned and operated by the U.S. Department of Energy. NETL conducts and implements science and technology development programs for the Department in energy and energy-related environmental systems. NETL's key functions are to shape, fund, and manage extramural (external) RD&D projects, conduct on-site science and technology research, and support energy policy development and best business practices within the Department.

Oak Ridge National Laboratory

The Oak Ridge National Laboratory (ORNL), located in Oak Ridge, Tennessee, conducts research and development in the area of Advanced Research to develop materials and perform bio-processing research.

Pacific Northwest Laboratory

The Pacific Northwest Laboratory (PNNL), located in Richland, Washington, conducts research and development in the area of Advanced Research to perform materials research and environmental analyses.

Sandia National Laboratories

The Sandia National Laboratory (SNL), located in Albuquerque, New Mexico, and Livermore, California, conducts research and development in the area of Advanced Research to develop hydrogen separation membranes and conduct fundamental combustion research.

All Other

The Department's Advanced Research program, within the Fossil Energy and Development program, funds research at major performers at non-DOE locations. An example of these performers include the Albany Research Center which conducts research on materials and mineralization sequestration processes.

Detailed Program Justification

(dollars in thousands)

	FY 2002	FY 2003	FY 2004
Coal Utilization Science	6,354	8,000	9,000
■ Coal Utilization Science (Core)	6,291	7,920	6,831

Conduct research to enable reduction or elimination of environmental impacts of coal use; focus on greenhouse gases that may affect global climate change. Sensors and Controls: Complete pilot-scale tests of select gasification and combustion sensors; complete feasibility tests of other sensor development projects selected under FY 2002 solicitations. Select fewer projects for award under FY 2003 solicitations. Issue solicitation for development techniques focusing on application of nanotechnology to control and optimize Vision 21 plant efficiencies and emission performance. Continue stochastic modeling and systems analysis of Vision 21 concepts. Complete Round 2 course grid simulations and computational workbench projects and continue projects selected under round III of broad-based agency Vision 21 solicitation to develop critical enabling technologies for advanced power and fuel systems and in support of Vision 21. Investigate basic combustion and gasification chemistry to discern rates and mechanisms that control emissions behavior of coal under advanced and conventional combustion gasification conditions to efficiently minimize NO_x, SO_x, air toxics, and other pollutants in support of the Clear Skies Initiative. Develop predictive models as a tool for designers of Vision 21 plants. Demonstrate the feasibility of the in-situ CO₂ mineral sequestration concept through laboratory tests of drill-core samples and maintain minimum levels of fundamental lab-scale research to addresses process

design issues. *Participants include: NETL, SNL, CMU, U. of Pittsburgh, Princeton, ARC.*

FY 2003 and FY 2002 funding continued development of instrumentation, diagnostics and controls for advanced power systems; model testing and research for Virtual Demonstration plant; development of critical enabling technologies in support of Vision 21; fundamental coal combustion research; and research on fundamental mechanisms for CO₂ mineral sequestration process. *Participants included: Ames Research Lab, SNL, ARC, LANL.*

(dollars in thousands)

FY 2002	FY 2003	FY 2004
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■ **Mercury Control**..... 0 0 2,079

Conduct fundamental research on mercury formation and control. As part of anew sensors and control solicitation, develop sensors to detect and monitor mercury emissions. Develop atmospheric modeling (plume chemistry and deposition) with a focus towards mercury.

Participants to be determined.

No funding was requested for this activity in FY 2003 and FY 2002..

■ **Program Support**..... 63 80 90

Fund technical and program management support.

Materials	6,821	9,000	12,000
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■ **High Temperature Materials Research**..... 4,870 5,015 4,740

Develop improved materials for high-temperature, high-pressure heat exchangers, high-temperature inorganic membranes, and activated carbons for next generation, ultra clean fossil energy power systems. Develop new alloys to include intermetallics, advanced austenitic alloys, advanced ferritic alloys, and oxide-dispersion-strengthened alloys. Functional materials research addresses hot-gas particulate filters, gas separation membranes, and physical absorbents, i.e, advanced carbons and non-destructive evaluation techniques. *Participants include: ANL, INEEL, ORNL, Ames, Huntington Alloys, NETL.*

FY 2003 and FY 2002 funding continued development of the high temperature structural and functional materials that are critical enabling technologies needed to achieve the highly efficient, economical and environmentally clean fossil energy power systems for Vision 21. *Participants included: ANL, INEEL, ORNL, Eltron, Ames, Huntington Alloys, NETL.*

■ **Materials for Ultra Supercritical and Gas Separation Systems**..... 1,881 3,895 4,640

Develop alloys for ultra supercritical systems with operating temperatures raised to 1400-1600°F; ensure the weldability of these high temperature materials, and develop the base materials technology needed to develop steam turbines capable of operating at the ultra supercritical

temperature and pressure conditions which are critical to the success of not only the ultra supercritical program, but also the Vision 21 program. Pursue breakthrough concepts to develop materials for achieving very low cost hydrogen and oxygen separation from mixed gas streams and for stabilizing greenhouse gases for Vision 21 energy plants. *Participants include: LANL, SNL, ORNL, PNNL, ARC, Energy Industries of Ohio.*

FY 2003 and FY 2002 funding supported development of alloys for ultra supercritical systems and new materials able to separate hydrogen and oxygen and for stabilizing greenhouse gases at very low costs. These are critical enabling technologies needed to make deployment of Vision 21 energy plants possible. *Participants included: LANL, SNL, ORNL, PNNL, ARC, Energy Industries of Ohio.*

(dollars in thousands)

	FY 2002	FY 2003	FY 2004
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■ **Materials for Mercury Control**..... 0 0 500

Evaluate novel materials for the conversion or removal of mercury from process streams.
Participants to be determined.

No funding was requested for this activity in FY 2003 and FY 2002..

■ **Materials for Advanced Fuel Cell Concepts**..... 0 0 2,000

Develop advanced concepts that utilize carbon material from coal directly in a fuel cell. Such a concept will permit high and intermediate temperature fuel cells to directly convert carbon to electrical power without the need of an intermediate coal gasification step. National Laboratories may also contribute materials research in support of other advanced fuel cell concepts.
Participants to be determined.

No funding was requested for this activity in FY 2003 and FY 2002..

■ **Program Support**..... 70 90 120

Fund technical and program management support.

Technology Crosscut	10,750	9,150	9,500
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Coal Technology Export..... 800 800 1,000

■ **Coal Technology Export**..... 800 800 1,000

Sustain continued support for collaboration of zero emission technologies 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 and deployment of U.S. clean coal technologies and advanced power systems. Continue pursuit of 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. This funding level will support fewer conferences and site visits. *Participants to be determined.*

FY 2003 and FY 2002 funding continued development of training, conferences, site visits, and information and technical exchanges in order to promote the deployment of cleaner energy. *Participants included: Latin America, China, Australia, Africa, India.*

(dollars in thousands)

	FY 2002	FY 2003	FY 2004
Biotechnology of Coal	1,350	1,350	1,500
■ Biotechnology of Coal	1,336	1,336	1,485

Initiate large scale testing to develop toxin to safety control zebra mussels as a means of improving the efficiency and reliability of existing power plants. Initiate development of technical protocol for screening marine microalgae for maximum biofixation and its conversion into alternative fuels. 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. Investigate global, natural CO₂ mitigation strategies such as whittings and ocean scale algae sequestration. Continue development of biogeochemical environmental remediation of ammonia discharges associated with coal wastes from existing power plants. In furtherance of launching the hydrogen economy, investigate biohydrogen generation from carbon containing waste products to determine food sources that will support microbial growth and hydrogen production, conduct tests at bench scale. Investigate novel bio-environmental remediation processes related to coal conversion technology. *Participants include: ORNL, INEEL, U. State of NY, Cal. State U.*

FY 2003 and FY 2002 funding continued development of CO₂ mitigation strategies, such as whittings; develop toxin for control of zebra mussels; and biohydrogen generation from carbon containing waste products. *Participants included: ORNL, INEEL, U. of State of NY, Calif. State U.*

■ Program Support	14	14	15
Fund technical and program management support.			
Environmental Activities	1,900	2,000	2,000
■ Environmental Analyses and Studies	1,710	1,800	1,800

Continue, at a reduced level, 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. *Participants include: ANL, ICF, Resource Dynamics, TMS, PNNL.*

FY 2003 and FY 2002 funding continued environmental issues analyses of ambient, water, solid effluents, and global climate change and conducted emission trends and forecast studies.

Participants included: ANL, ICF, Resource Dynamics, TMS, PNNL.

(dollars in thousands)

FY 2002	FY 2003	FY 2004
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■ **Environmental Related Support to Field Offices** 190 200 200

Provide environmental, safety and health, safeguards and security and National Environmental Policy Act (NEPA) assistance and assessment support to field offices. *Participants include: TMS.*

FY 2003 and FY 2002 funding continued support to provide environmental, safety and health, safeguards and security, and National Environmental Policy Act (NEPA) assistance and assessment support to field offices. *Participants included: TMS.*

Technical and Economic Analyses 750 1,000 1,000

■ **Technical and Economic Analyses** 750 1,000 1,000

Continue studies supporting multi-year planning FE strategy and program formulation; conduct contract fewer 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. *Participants include: ANL, ICF, EIA, Resource Dynamics, TMS.*

FY 2003 and FY 2002 funding continued studies supporting multi-year planning, FE strategy and program formulation; conducted contract studies on issues that crosscut FE programs including strategic benefits of and new markets for fossil fuel technology. Conducted 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. *Participants included: ANL, ICF, EIA, Resource Dynamics, TMS.*

International Program Support 950 1,000 1,000

■ **International Program Support** 950 1,000 1,000

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 universities and other non-governmental organizations. Focus on expanding cleaner energy technology power systems activities in Southern and Western regional African countries, Eastern Europe, the Pacific Rim, Russia and Newly Independent States, South Asia/Near East, Western Europe, and the Western Hemisphere. Determine opportunities for cleaner power systems and clean fuels from coal in targeted countries. *Participants to be determined.*

FY 2003 and FY 2002 funding continued the maintenance and heightening of established relationships with national and international organizations with emphasis on collaboration, transfer, and deployment of zero emission technologies. *Participants included: WEC, USEA, SSEB, universities and other non-governmental organizations.*

(dollars in thousands)

	FY 2002	FY 2003	FY 2004
Focus Area for Computational Energy Science.....	5,000	3,000	3,000
■ Focus Area for Computational Energy Science.....	4,950	2,970	2,970

NETL is to continue the development of virtual demonstration capability using mathematical simulations and modeling to improve the speed and reduce the costs of technology systems that have high efficiencies with near-zero emissions to reduce the effects on global warming. Develop simulations that couple fluid flow, chemical reactions, heat generation, heat transfer, and electrochemistry for modeling multi-dimensional transients in fuel cells, heat engines, gasifiers, and other crucial unit processes in Vision 21 plants. Complete CFD models of fuel cells, turbines, and gasifiers. Enhance multi-phase flow models (MFIx) with meshing, large eddy simulations and chemistry and heat transfer improvements. Integrate subsystem component modules and dynamic system models to simulate a first case Vision 21 plant. Continue to perform data reduction and data extraction on extensive information available from simulations of advanced energy plants for incorporation into codes being developed. Eliminate supercomputing science consortium supporting activity. *Participants include: NETL.*

FY 2003 and FY 2002 funding continued development of models and dynamic simulations of advanced energy plants, including modeling tools for sub-elements in turbines and fuel cells. Integration of subsystem component modules and dynamic system models into virtual models. Supercomputing Science Consortium support in advanced simulations utilizing high performance computing and communications. *Participants included: NETL, CMU, U. of WVa., State of WVa., PSCC, U. of Pittsburgh.*

■ Program Support.....	50	30	30
Fund technical and program management support.			

University Coal Research.....	2,922	4,000	5,000
■ University Coal Research	2,892	3,960	4,950

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; continue to support critical key research areas to include Vision 21, global climate change, materials, sensors and controls, and by-products from coal. Breakthrough technologies for the measurement, characterization, and the development of cost-effective control technologies for fossil coal-based mercury emissions will also be sought. Continue collaboration through joint proposals involving

university and industry teams, and teams with three or more universities. Continue to explore novel approaches and innovative concepts developed in other scientific and technological areas that will assist in developing breakthrough technologies for coal utilization. Decrease follow-on support to previous grantees of the Innovative Concepts Phase Two Program. Continue support to the undergraduate internship program to allow students having science and engineering majors to perform fundamental research in the areas of environmental science and fossil energy, where graduate level courses or relevant degrees are not offered in these areas at their institutions. Extend the supporting of grants to include studies of regulatory and legal impacts on fossil energy technologies. *Participants to be determined.*

FY 2003 and FY 2002 funding provided competitively awarded research grants to U.S. colleges and universities to address Fossil Energy's highest priority research needs, supported joint proposals involving university and industry teams of researchers, and continued to explore novel approaches and innovative solutions to achieve technological breakthroughs for clean coal utilization and support to Vision 21. *Participants included: Various colleges and universities.*

(dollars in thousands)

	FY 2002	FY 2003	FY 2004
■ Program Support	30	40	50
Fund technical and program management support.			
HBCUs, Education and Training	974	1,500	2,000
■ HBCUs, Education and Training	964	1,485	1,980
Conduct research activities with HBCU and other minority institutions and support an HBCU annual technology transfer symposium. <i>Participants to be determined.</i>			
FY 2003 and FY 2002 funding continued research activities at HBCU and other minority institutions and supported HBCU annual technology transfer symposium. <i>Participants included: Various colleges and universities.</i>			
■ Program Support	10	15	20
Fund technical and program management support.			
Total, Advanced Research	27,821	31,650	37,500

Explanation of Funding Changes

FY 2004 vs. FY 2003 (\$000)

Coal Utilization

- Increase in Coal Utilization due to fundamental mercury research, development of mercury and nanotechnology sensors, and atmospheric modeling 1,000

Materials

- Increase in Materials research in ultra supercritical materials, mercury control, and support to Coal and Power fuel cell program..... 3,000

Technology Crosscut

Coal Technology Export

- Increase in Coal Technology Export due to additional international commitments to enhance markets for U.S. coal 200

Bioprocessing of Coal

- Increase in Bioprocessing of Coal due to investigation of novel bioprocessing systems 150

University Coal Research

- Increase in University Coal Research will provide for provide support to develop mercury control technologies..... 1,000

HBCUs, Education and Training

- Increase in HBCUs, Education and Training will provide for increased activities at HBCU's and other minority institutions 500

Total Funding Change 5,850

Distributed Generation Systems

Program Mission

Distributed Generation Systems: Fuel Cells: The objectives of the Fuel Cell activity are ((1) to provide the necessary technology base development of fuel cell systems for electric utility, industrial, and commercial/residential markets; and (2) to provide technologies that improve U.S. international competitiveness in this new manufacturing industry. Fuel cells and other innovative power systems are being developed for distributed generation applications that can create public benefits by enhancing the overall efficiency, security and reliability of the Nation's energy supply. The Fuel Cells Program supports the President's climate change goals by increasing the efficiency of electricity production, creating the potential for over 50% reduction in CO₂. Further, it supports the Clear Skies Initiative with near zero NO_x, SO_x, and mercury emissions, and it supports energy security goals through multi-fuel capability (less dependence on one fuel), and less vulnerable distributed generation.

To complement electricity supply from central generation systems, distributed systems offer another form of energy diversity through 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 generators, and even connected to a central system grid. These systems may be owned and/or operated by utilities, utility customers, and third parties. Fuel cell systems are capable of reducing criteria pollutants well below current New Source Performance Standard levels, reducing non-criteria pollutants such as CO₂ and acid rain precursors, and reducing thermal emissions to the environment. Fuel Cells are important systems for carbon management options because of their inherently low emissions and ultra-high efficiency.

Fuel cell applications in distributed generation systems offer potential opportunities for cost-effectively meeting peak demand without the need for costly investments in transmission and distribution. They can be used to provide clean power to remote end users; and can provide new business opportunities in both utility and non-utility owners.

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, fuel flexible, modular power systems with lower cost, higher quality electricity, and significantly lower carbon dioxide emissions than current plants, as well as near-zero levels of pollutants.

The current strategy is to develop clean high efficiency fossil fueled powerplants: Near-term (2004-2006) - develop and conduct initial proof-of-concept tests of the Solid State Energy Conversion Alliance (SECA) low-cost, 3-10 kilowatt solid-state fuel cell modules for distributed and auxiliary power unit applications; Mid-term (2010) - develop and test SECA fuel cell prototype modules capable of manufacture of \$400 per kilowatt (a ten-fold reduction from today's cost), and develop combined cycle \$400 per kilowatt gas-based fuel cell/turbine hybrids under Vision 21 Hybrids that will enable the design of coal-fueled hybrid powerplants; Long-term (2010-2015) - 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, fuel flexible, integrated fuel cell/turbine hybrids systems

for natural gas and coal-based plants. Fuel cell systems have specifically identified goals which coincide with coal-based and other fuel-flexible Vision 21 power modules and concepts in the 2010 to 2015 time frame.

The Advanced Research subactivity within the Fuel Cell program supports the program objectives by conducting research to identify new, highly innovative electrochemical technology concepts and by solving fundamental crosscutting high-temperature electrochemical issues. This subactivity also supports SECA core technology materials work and direct carbon fuel cells.

With the conclusion of molten carbonate fuel cells stack development in FY 2003, the Fuel Cell Systems subactivity will support advanced fuel cell systems development and testing in a variety of crosscutting areas.

The Fuel Cell/Turbine Hybrids subactivity under Vision 21 provide a rapid way to deploy the fuel cell technology into broader applications. Integration of the fuel cell and turbine into a single system lowers system costs 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. Hybrid power modules are important element of the Department's policy for carbon management.

The Innovative Concepts subactivity includes the Solid-State Electricity Conversion Alliance (SECA), a new paradigm for fuel cells development. The objective of the SECA is to drastically reduce fuel cells costs to make them a broadly applicable and more widespread commodity in the competitive, mature distributed generation and auxiliary power markets. The SECA program incorporates an integrated strategy to address the technical barriers of solid-state fuel cell systems within the cost constraint of \$400 per kilowatt for a complete system. The project global benefits of SECA includes 0.24%-0.5% reduction in the U.S. CO₂ emissions projected by EIA in 2012, which corresponds to about 42 million tons per year in CO₂ reduction. Additional management benefits can be expected to accrue with the introduction of SECA hybrid systems. Work under SECA core program includes, gas processing (reforming and cleanup), power electronics, controls and diagnostics, heat recovery, modeling and simulation, and material and manufacturing/ fabrication research at universities and national laboratories. SECA industry teams are engaged in the development of common modules for diverse applications in multiple and mobile market applications. SECA includes exploration of designs that combine functions to reduce size, weight, and costs.

The government's industrial partnerships in the SECA program can be expected to provide the following benefits within the next ten years, if the \$400 per kW target is achieved:

- World-wide sale of \$3.2 billion per year, including domestic sales of \$1 billion per year based on a 10% share of expected electricity demands.
- The potential to provide domestic fuel cell to a market of 25 million homes in the U.S. and 50 million homes in Europe.

- Approximately \$800 million per year from the sale of auxiliary power units for trucks, which can substantially reduce the emissions from idling trucks engines.
- Virtual elimination of NO_x from stationary and transportation applications, and 50% reduction of CO₂ through the use of highly efficient (60%) hybrid fuel cell systems.

Novel Generation Concepts: The Fossil Energy R&D program is committed to searching for promising new ideas for low-cost, low-pollutant power generation. In recent years, Fossil Energy R&D has funded research on the Ramgen engine, an innovative power systems technology. The Ramgen system is capable of utilizing a variety of fuel gases including waste gases, and components show potential for adaption to other power systems. To ensure the participation of high-potential technologies, the power systems group will continue to openly solicit new fossil-fuel based power generation technology that shows promise of improved efficiencies and/or lower emissions through the novel concepts program.

Program Strategic Performance Goals

ER 4-4: BY 2010, increase the robustness of distributed generation and thereby lower vulnerability of the electricity grid by introducing prototypes of: a) modular fuel cells with 10-fold cost reduction (\$400/kW) with 40-50 percent efficiency; b) fuel cell-turbine hybrids with 60-70 percent efficiency adaptable for coal.

Annual Performance Targets and Results

FY 2002 Results	FY 2003 Updated Targets	FY 2004 Targets
<p>Communicate fuel cell program objectives and results and conduct peer-reviews through conferences, workshops, and web-site tools.</p> <p>Restart and test the 220-kW hybrid solid oxide fuel cell (SOFC)-microturbine powerplant at the National Fuel Cell Research Center. If successful, this test will verify the commercial design for this particular SOFC technology for DG or CHP applications.</p> <p>Complete demonstration of a commercial-scale, 250 kW Molten Carbonate Fuel Cell</p>	<p>Communicate fuel cell program objectives and results and conduct peer-reviews through conferences, workshops, and web-site tools. Manage the PSPG R&D portfolio through assessment of results and selection of new projects to fill portfolio gaps.</p> <p>Conduct field tests necessary to establish feasibility of high temperature fuel cell hybrids and novel systems, including design, procurement, construction, and testing.</p> <p>Conduct cost reduction R&D programs involving near-term</p>	<p>Perform assessment of the merit and progress of (and plans for) activities in the fuel cell program for achieving the efficiency and cost objectives for advance power generation, using peer reviews, conferences, or workshops, and disseminate the objectives and results of the fuel cell activities, including web-site dissemination, for use and potential deployment application or technology innovation by industry and other researchers.</p> <p>Complete construction of two test units and detailed design of</p>

(MCFC) power plant system. This test will verify the commercial design for the MCFC technology for the combined heat and power (CHP) or distributed generation (DG) market and, if successful will justify the construction of a MCFC manufacturing facility in the U.S.

developers, Siemens Westinghouse and Fuel Cell Energy, for the fuel cells, including manufacturing and balance of plant (BOP) components.

The SECA industrial teams shall conduct stack design and testing, including manufacturing approaches, and materials and balance of plant (BOP) systems optimization leading to the demonstration of prototypes.

Conduct contracted and in-house SECA core technology of crosscutting and proof-of-concept R&D for transfer to one or more industrial teams, including know-how, patents, licenses, reports, papers in peer reviewed journals, etc.

a third concept for later conduct of field tests necessary to establish feasibility of high temperature fuel cell hybrids and novel systems. These tests planned for FY2005 will prove feasibility of 60-70% hybrid systems for integration into Vision 21 power plants.

Continue SECA industry teams' evaluations and testing (100 hour tests) of fuel cell stack designs, manufacturing methods, candidate materials, and balance of plant subsystems with potential for demonstration as integrated systems. This effort will lead to testing of prototypes capable of achieving SECA cost reductions and efficiency goals.

Continue SECA Core Program to perform the transfer of patents, licenses, technical data, and other knowledge products resulting from fuel cell concept tests and supporting research to one or more SECA industrial teams. This technology transfer will aid SECA industry teams in achieving cost reduction and energy efficiency goals.

Funding Profile

(dollars in thousands)

	FY 2002 Comp. Approp.	FY 2003 Request	FY 2004 Base	FY 2004 Request	FY 2004 Request vs. Base	
					\$ Change	% Change
Fuel Cells						
Advanced Research	\$3,895	\$3,000	\$3,000	\$10,000	\$7,000	233.3%
Fuel Cell Systems.....	13,147	10,000	10,000	6,000	-4,000	-40.0%
Vision 21 Hybrids.....	13,152	11,500	11,500	5,000	-6,500	-56.5%
Innovative Systems Concepts	26,484	22,500	22,500	23,500	1,000	4.4%
Subtotal, Fuel Cells	56,678	47,000	47,000	44,500	-2,500	-5.3%
Novel Generation.....	0	2,500	2,500	2,500	0	0.0%
Total, Distributed Generation Systems	\$56,678	\$49,500	\$49,500	\$47,000	-\$2,500	-5.1%

Funding by Site

(dollars in thousands)

	FY 2002	FY 2003	FY 2004	\$Change	%Change
Argonne National Lab (East).....	\$1,000	\$1,000	\$1,000	\$0	0.0%
National Energy Technology Laboratory.....	2,340	2,000	2,900	900	45.0%
Pacific Northwest Lab	4,771	3,500	4,250	750	21.4%
All Other	50,998	44,500	40,200	-4,300	-9.7%
Total, Distributed Generation Systems	\$56,678	\$49,500	\$47,000	-\$2,500	-5.1%

Site Description

Argonne National Laboratory (East)

The Argonne National Laboratory (ANL), located in Argonne, Illinois, is a major multi-program laboratory managed and operated for the U.S. Department of Energy (DOE) by the University of Chicago under a performance-based contract. Argonne research for the Fossil Energy Distributed Generation Systems program supports the DOE-SECA core technology program.

Pacific Northwest Laboratory

The Pacific Northwest Laboratory (PNNL), located in Richland, Washington, conducts research and development in the area of Distributed Generation Systems in support of the DOE-SECA program. PNNL is a major participant in the Solid State Energy Conversion Alliance.

National Energy Technology Laboratory

The National Energy Technology Laboratory (NETL), located in Morgantown, West Virginia, Pittsburgh, Pennsylvania, and Tulsa, Oklahoma, is a multi-purpose laboratory, owned and operated by the U.S. Department of Energy. NETL conducts and implements science and technology development programs for the Department in energy and energy-related environmental systems. NETL's key functions are to shape, fund, and manage extramural (external) RD&D projects, conduct on-site science and technology research, and support energy policy development and best business practices within the Department.

All Other

The Department's Distributed Generation Systems program, within the Fossil Energy and Development program, funds research at major performers at non-DOE locations. Examples of these performers include the SECA industry teams and SECA core technology teams.

Detailed Program Justification

(dollars in thousands)

	FY 2002	FY 2003	FY 2004
Fuel Cells	56,678	47,000	44,500

The focus of the Fuel Cells program is to develop, for widespread deployment, clean reliable fuel cells and fuel cell hybrids for distributed generation and Vision 21 applications through low-cost, ultra-clean, and ultra-high efficiencies.

Advanced Research	3,895	3,000	10,000
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■ Advanced Research	3,855	2,970	9,900
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Fund research to develop a fundamental understanding of processes that limit the performance of high temperature electrochemical systems. Such systems have applications in fossil energy conversion, energy storage, and electrolysis. Parallel experimental and modeling activities, research conducted by HiTEC will eventually lead to new concepts and technologies in fossil fuel utilization. *Participants to be determined.*

FY 2003 and FY 2002 funding continued generic research to capitalize on the intrinsic high efficiency and environmentally benign characteristics of advanced electrochemical technology. Research will be conducted to identify new highly innovative electrochemical technology concepts and to solve fundamental crosscutting issues. *Participants included: ANL, PNNL.*

■ Program Support	40	30	100
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Fund technical and program management support.

Fuel Cell Systems	13,147	10,000	6,000
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Fossil Energy Research and Development/
Other Power Systems/
Distributed Generation Systems

FY 2004 Congressional Budget

(dollars in thousands)

	FY 2002	FY 2003	FY 2004
■ Fuel Cell Systems	13,012	9,900	5,940
<p>With the conclusion of molten carbonate fuel cells stack development in FY 2003, this subactivity will support advanced fuel cell systems development and testing in a variety of crosscutting areas in FY 2004.</p> <p>FY 2003 and FY 2002 funding continued cost-shared cost reduction and performance improvement on one full molten carbonate system for market entry by the private sector; continue supportive distributed generation infrastructure, economic and market study assessments and system assessments and evaluations. <i>Participants included: FCE.</i></p>			
■ Program Support	135	100	60
<p>Fund technical and program management support.</p>			
Vision 21 Hybrids	13,152	11,500	5,000
■ Vision 21 Hybrids	13,017	11,385	4,950
<p>Conduct a redirected Vision 21 enabling cost reduction and performance enhancement program with low-cost Vision 21 fuel cell/turbine hybrid technologies; explore Vision 21 zero-emissions system concepts; conduct system studies and explore fuel flexibility and integration issues as permitted. <i>Participants include: NETL, GE, FCE, Siemens.</i></p> <p>FY 2003 and FY 2002 funding continued 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 system studies and explore fuel flexibility and integration issues as permitted. <i>Participants included: SWPC, NETL, GE, FCE.</i></p>			
■ Program Support	135	115	50
<p>Fund technical and program management support.</p>			
Innovative Systems Concepts	26,484	22,500	23,500
■ Innovative Systems Concepts	26,213	22,275	23,265
<p>SECA - Develop four concept designs for prototype mid- to high-temperature low-cost solid state fuel cell systems; develop SECA core technology for materials to reduce manufacturing costs, enhance performance, and develop innovative sensors and converters; initiate designs of hybrid coal-based SECA systems. <i>Participants include: GE/Honeywell, Siemens Westinghouse, Delphi, Cummins-McDermott, PNNL, NETL.</i></p> <p>FY 2003 and FY 2002 funding continued the mid- to high-temperature low-cost SECA solid state fuel cell program; fund multiple SECA industrial teams and a core technology program; conduct</p>			

coal-based SECA-hybrid integration studies as permitted. *Participants included: McDermott, ADL, NL, NETL.*

(dollars in thousands)

FY 2002	FY 2003	FY 2004
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■ **Program Support**..... 271 225 235

Fund technical and program management support.

Novel Generation	0	2,500	2,500
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The current focus of the Novel Generation program is on the development of simple and powerful, low-cost, low-pollutant power systems based on ramjet technology called Ramgen, that can utilize a variety of fuels including greenhouse gases, and that can operate at high efficiencies for distributed generation and in a hybrid configuration for Vision 21 applications. To ensure the participation of high-potential technologies, the power systems group will continue to openly solicit new fossil-fuel based power generation technology that shows promise of improved efficiencies and/or lower emissions through the novel concepts program.

Novel Generation 0 2,500 2,500

■ **Supporting Technologies** 0 2,475 2,475

Continue to openly solicit new fossil-fuel based power generation technology that shows promise of improving efficiencies and/or lower emissions through the novel concepts program.
Participants to be determined.

FY 2003 funding was used to issue a solicitation for novel generation systems. In FY 2002, this activity was carried out under the Turbines program. *Participants included: Ramgen.*

■ **Program Support**..... 0 25 25

Fund technical and program management support.

Total, Distributed Generation Systems..... **56,678 49,500 47,000**

Explanation of Funding Changes

FY 2004 vs. FY 2003 (\$000)

Fuel Cells

Advanced Research

- Increase in Advanced Research due to enhanced research on electrochemistry;

direct carbon fuel cell development; and supporting research for SECA core technology program	6,930
■ Increase in Program Support will provide for detailed studies	70
Fuel Cell Systems	
■ Decrease in Fuel Cell Systems due to the completion of the FEC molten carbonate fuel cell stack development program (non-hybrids)	-3,960
■ Program Support	-40
Vision 21 Hybrids	
■ Decrease in Vision 21 Hybrids due to the completion of the SWPC SOFC module development program	-6,435
■ Decrease in Program Support due to reduced effort in market analyses	-65
Innovative Systems Concepts	
■ Increase in Innovative Systems Concepts due to initiation of designs for coal-based SECA systems.....	990
■ Program Support	10
Total Funding Change	-2,500

Natural Gas Technologies

Program Mission

The mission of the Natural Gas Technologies Program is to create public benefits by investing in research that the gas industry would not take on itself: long-term, high-risk research with potentially high payoffs for the public. These payoffs include a cleaner environment, more secure and stable supplies and new potential resources. The President's National Energy Policy states that 21st century technology is the key to environmental protection and new energy production, and Federal research can augment industry's technology development efforts in ways that target the public interest. These efforts will help the industry ensure that adequate supplies of reasonably-priced natural gas is available to meet expected future demands, while also ensuring that they are developed in an environmentally sound manner.

Fossil Energy programs are being realigned to specifically support the President's climate change, Clear Skies, and energy security goals. Through the implementation of the President's Management Agenda, the Natural Gas Technologies and Oil Technology programs completed Investment Criteria Scorecards of all program elements. The programs also completed the Program Assessment Rating Tool (PART) for all program elements. Analysis of PART showed that the program did not link annual goals to long-term benefits. In addition, the program was determined to have poor results and to duplicate industry work.

The budget now reflects the funding requested to implement the program mission and goals, such as Sustainable Supply, Hydrogen from Gas, and Environmental Science. This allows the program to phase out projects and activities that are neither productive nor integral to the program's mission and goals. Investments will maximize the efficiency of taxpayer dollars by focusing solely on activities that require a Federal presence to attain the President's goals of energy security, Clear Skies, and climate change.

For example, the President's climate change and security goals are addressed through participation in potentially high-payoff research and technology development in methane hydrates and a new effort on hydrogen from natural gas. Methane hydrates, ice-like formations in Alaska and offshore, contain more energy than all other fossil energy resources. Developing the ability to economically produce this resource has the potential to shift the world energy balance. Natural gas will be integral in the transition to a hydrogen economy, and the program will target ways to reduce the cost of creating hydrogen fuels as part of the Freedom Fuel effort. Improving environmental compliance and lowering cost to producers can help support the President's Clear Skies Initiative, ensuring that the growing role of natural gas, particularly in power generation, can be met with reliable and affordable supplies in an environmentally sound manner. Targeting university-based, long-term projects, the President's energy security priority is addressed by ensuring that research and technology development support a knowledge base for a vibrant U.S. oil and gas industry. This includes research that supports sound policy decision-making and makes the U.S. the world leader in cutting edge technology that meets the challenge of efficient production while protecting the environment.

Program Strategic Performance Goals

Sub-programs in the Natural Gas Technologies program support two Program Strategic Performance Goals (PSPG):

ER5-1: By 2008, develop advanced technologies and employ scientifically based policy options to increase the Nation's economically recoverable resource by 15 trillion cubic feet (Tcf) for natural gas and 140 million barrels for oil and reduce future costs of exploration and production by \$10 billion. According to the USGS, EIA, and MMS, the economically recoverable oil resource base is estimated to be 120 billion barrels at \$18/bbl. and 149 billion barrels at \$30/bbl; the gas base is estimated to be 740 Tcf at \$2.00/thousand cubic feet (mcf) and 920 Tcf at \$3.50/mcf in 2002.

ER5-2: By 2015, conduct scientific analyses and develop and field test a suite of methane hydrate characterization and diagnostic technologies that will do the following: provide a reliable inventory of Alaskan methane hydrate resources and resolve global environmental implications of natural methane hydrate instability. By 2008, reduce the cost of producing hydrogen from natural gas by 15 percent.

Each of the four sub-programs under Natural Gas Technologies has a set of performance measures including subprogram goals, performance indicators, and annual targets. The Sustainable Supply activity, performed within the Exploration and Production subprogram, and the Environmental Science activity, performed within the Effective Environmental Protection subprogram, support the Department's Program Strategic Performance Goal (PSPG) ER5-1, and have the following goal:

- By 2008, develop and field test a suite of natural gas technologies with the potential to expand the domestic economically-recoverable resource in existing conventional and unconventional reservoirs by 14 trillion cubic feet (Tcf) and reduce the environmental impact of the upstream natural gas industry by reducing the number of wells required to discover and produce a given volume of resource by 30 percent. (Economically recoverable resources were estimated to be 740 Tcf at \$2.00/mcf and 920 Tcf at \$3.50/mcf in 2002.)

The Gas Hydrates subprogram supports PSPG ER5-2 and has the following goals:

- By 2015, conduct scientific analyses and develop and field test a suite of methane hydrate characterization and diagnostic technologies that will:
 - develop knowledge and technologies necessary for the future commercial production of methane from hydrates, while protecting the environment.
 - resolve the global environmental implications of natural methane hydrate instability, and provide reliable inventory of the Arctic methane hydrate resources.

The Hydrogen from Natural Gas activity, performed within the Emerging Processing Technology subprogram, supports PSPG ER 5.2 and has the following goals:

- By 2008, reduce the cost of producing and separating hydrogen from natural gas by 15 percent.

Performance Indicators

The indicator for progress in the Sustainable Supply activity will be as follows:

- Annual estimates of the change in economically-recoverable resources (ERR) attributable to program activities. ERR is defined as the segment of the nation's total gas endowment that is recognized as being available for profitable production under prevailing technologies and prices assuming standard industry economic hurdle rates.

The indicators for progress in the Hydrogen from Natural Gas activity with the Gas Hydrates subprogram will be as follows:

- Improved understanding of the role of naturally-occurring hydrate on global climate, global carbon cycle, and the evolution of the sea-floor are published.
- Improved assessment of the nature, volume, and technical and economic recoverability of Arctic resources.
- Reduced cost of hydrogen from natural gas and reduced environmental impacts.

Annual Performance Targets and Results

FY 2004 annual proposed targets and associated quarterly milestones continue to be refined using OMB's guidance to better link annual outputs to long-term outcomes and to reflect the refocusing of the research into areas with a strong Federal role. Effective Environmental Protection performance targets for both the Natural Gas Technologies and Oil Technology programs are contained in the Oil Technology section of this budget listing.

Program Benefits

Each year Fossil Energy estimates the benefits of program activities to support Government Performance and Results Act (GPRA) reporting. Methods are complex and vary by program. The Oil and Gas Programs have traditionally used two separate economic and engineering modeling systems to calculate selected economic and energy security benefits. In 2002, a two-year effort, involving external peer review, was begun to integrate these two separate modeling systems into one system for improved simulation of resource and market conditions, and consistency of technology assumptions and model outputs. Under the previous two model systems, deficiencies, such as the assumption of unlimited industry capital availability, could result in an overestimation of industry's response to DOE's R&D products. Conversely, deficiencies, such as only modeling upstream R&D activities and not calculating the synergistic benefits of oil and gas R&D efforts, could result in an underestimation of the benefits of DOE programs.

The new model will provide the following expected benefits:

- Complimentary technology development in oil and gas research.
- Full R&D program activities can be modeled.

- Ability to calculate synergistic benefits of the oil program on gas production and the gas program on oil production.

As part of the effort to conform to the President’s Management Agenda in a shorter-term, Fossil Energy has undertaken an integrated program benefits analysis of oil, natural gas, coal and power systems research within Fossil Energy to develop Fossil Energy-wide program benefits estimates. This analysis, using the Energy Information Administration National Energy Modeling System (NEMS) and scheduled to be completed in mid-2003, is examining all Fossil Energy research programs on a common basis with respect to modeling assumptions and should enable aggregate and comparative assessments of the benefits of Fossil Energy research programs. This spring, a complete explanation of methodology and assumptions will be posted on the Department’s website.

FY 2002 Results	FY 2003 Updated Targets	FY 2004 Targets
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ER 5.1

Demonstrate safe economic slimhole drilling technology in actual use under Arctic conditions. This technology can significantly reduce cost and environmental impacts. (ER5-1) (Met goal)

Develop and demonstrate two technologies to detect and quantify areas of high fracture density in currently uneconomic low permeability gas reservoirs. This program has the near-term commercial potential to double average per-well productivity. (ER5-1) (Met goal)

Research: Complete basin model for the Wind River basin and well site selection in the Greater Green River Basin to evaluate integrated remote sensing, seismic surveys and basin structural analysis to differentiate gas-bearing from uneconomic fractured reservoirs.

Complete a conceptual model of regional water distribution to help operators avoid poor production areas.

Development: Conduct two field tests of improved drilling technology that will improve the productivity of gas reservoirs and reduce drilling costs.

Conduct two field tests of technologies to improve natural fracture detection to increase the percentage of economically producing wells of all wells drilled. Build and have field-ready an initial prototype of a 400 megahertz receiver array to

Research: Complete and release software that more accurately predicts well performance in fractured gas reservoirs by integrating seismic and fracture models into production simulator.

Complete assessment of gas-in-place for new basins.

Demonstration: Conduct one field test of improved technology for enhanced stripper well production.

Conduct one field test of enhanced drill pipe telemetry system to improve data transmission from bottom of wellbore to surface.

Conduct one field test of advanced fracture stimulation

ER5.2

400-geophone receiver array to improve seismic resolution necessary to locate economically productive gas zones.

Research: Complete hydrate modeling for Alaska drilling program.

Report strength and thermal property tests at national labs.

Develop prototype Raman Spectroscopy to use lasers to define hydrate molecular structure.

Development: Complete initial report of improved hydrate coring device on Ocean Drilling Program, Leg 204.

Drill one test well to determine aerial extent of hydrate occurrence in Alaska.

Complete evaluation of hydrate occurrence in Gulf of Mexico to understand the interaction of hydrate and seafloor stability.

design for tight sands.

Research: Refine hydrate models based on results of lab and field work.

Issue the first competitive solicitations for Hydrogen from Gas initiative to study the fundamental science of hydrogen production and separation from natural gas.

Development: Complete small methane hydrate coring project in the Gulf of Mexico.

Issue final reports: improved hydrate coring device on Ocean Drilling Program, Leg 204; resource assessment of hydrates in Alaska.

Down-select from existing hydrogen production research projects initially funded under different programs.

Award competitively selected, cost-shared, cooperative agreements to develop advanced technologies to produce hydrogen at lower cost.

Funding Profile

(dollars in thousands)

	FY 2002 Comp. Approp.	FY 2003 Request	FY 2004 Base	FY 2004 Request	FY 2004 Request vs. Base	
					\$ Change	% Change
Exploration and Production	\$19,964	\$15,450	\$15,450	\$14,000	\$-1,450	-9.4%
Gas Hydrates	9,568	4,500	4,500	3,500	-1,000	-22.2%
Infrastructure	9,809	0	0	0	0	100.0%
Emerging Processing Technology	2,191	0	0	6,555	6,555	100.0%
Effective Environmental Protection .	2,537	2,640	2,640	2,500	-140	-5.3%
Total, Natural Gas Technologies ...	\$44,069	\$22,590	\$22,590	\$26,555	\$3,965	17.6%

Funding by Site

(dollars in thousands)

	FY 2002	FY 2003	FY 2004	\$Change	%Change
Argonne National Lab (East)	\$231	\$226	\$0	\$-226	100.0%
Idaho National Engineering Lab	100	0	0	0	0.0%
Lawrence Berkeley Lab	900	555	350	-205	-36.9%
Lawrence Livermore National Laboratory	95	0	0	0	0.0%
National Energy Technology Laboratory	1,125	400	1,150	750	187.5%
Oak Ridge National Laboratory	200	0	0	0	0.0%
Pacific Northwest Laboratory	443	0	0	0	0.0%
Sandia National Laboratories	872	175	0	-175	-100.0%
All Other	40,103	21,234	25,055	3,821	18.0%
Total, Natural Gas Technologies	\$44,069	\$22,590	\$26,555	\$3,965	17.6%

Site Description

Argonne National Laboratory (East)

The Argonne National Laboratory (ANL), located in Argonne, Illinois, is a major multi-program laboratory managed and operated for the U.S. Department of Energy (DOE) by the University of Chicago under a performance-based contract. Argonne research for the Fossil Energy Natural Gas Technologies program in FY 2002 and FY 2003 supports Drilling, Completion and Stimulation technology development and Environmental Science R&D. No activities are planned in FY 2004

Idaho National Engineering and Environmental Laboratory

The Idaho National Engineering and Environmental Laboratory (INEEL), located outside of Idaho Falls, Idaho, in FY 2002 and FY 2003 supports research and development in the area of Natural Gas

Technologies for environmental technology development, drilling technology and microbial analysis of gas hydrates. In FY 2004 no activity is planned.

Lawrence Berkeley National Laboratory

The Lawrence Berkeley National Lab (LBNL), located in Berkeley, California, in FY 2002 and FY 2003 conducts research and development in the area of Natural Gas Technologies for environmental analysis and modeling, heavy oil upgrading, reservoir characterization, and gas hydrates characterization. Some reservoir characterization activities will continue in FY 2004.

Lawrence Livermore National Laboratory

The Lawrence Livermore National Lab (LLNL), located in Livermore, California, in FY 2002 and FY 2003, conducts research and development in the area of Natural Gas Technologies for environmental emissions analysis, reservoir geophysics, and hydrates properties

National Energy Technology Laboratory

The National Energy Technology Laboratory (NETL), located in Morgantown, West Virginia, Pittsburgh, Pennsylvania, and Tulsa, Oklahoma, is a multi-purpose laboratory, owned and operated by the U.S. Department of Energy. NETL conducts and implements science and technology development programs for the Department in energy and energy-related environmental systems. NETL's key functions area to shape, fund, and manage extramural (external) RD&D projects, conduct on-site science and technology research, and support energy policy development and best business practices within the Natural Gas Program. NETL has unique capability in hydrogen testing and computational chemistry. These functions will continue in FY 2004.

Oak Ridge National Laboratory

The Oak Ridge National Laboratory (ORNL), located in Oak Ridge, Tennessee, in FY 2002 and FY 2003, conducts research and development in the area of Natural Gas Technologies for oil processing environmental mitigation technologies and characterization of gas hydrates. ORNL has unique capabilities in petroleum product physical measurements. No specific activities are planned in FY 2004.

Pacific Northwest National Laboratory

The Pacific Northwest National Laboratory (PNNL), located in Richland, Washington, in FY 2002 and FY 2003, conducts research and development in the area of Natural Gas Technologies reservoir geophysics and hydrate characterization. No activity is planned in FY 2004.

Sandia National Laboratory

The Sandia National Laboratory (SNL), located in Albuquerque, New Mexico, in FY 2002 and FY 2003, conducts research and development in the area of Natural Gas Technologies for air emissions detection, measurement while drilling technology, and reservoir geomechanical analysis.

All Other

The Department's Natural Gas Technologies program, within the Fossil Energy and Development program, funds research at major performers at non-DOE locations. Examples of these performers include partnerships 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. University research supported by this program contributes to U.S. technological leadership.

Detailed Program Justification

(dollars in thousands)

	FY 2002	FY 2003	FY 2004
Exploration and Production	19,964	15,450	14,000

This program aims to develop technologies that will overcome major market and technological barriers to increase domestic supply of natural gas at reasonable prices without harm to the environment.

■ **Sustainable Supply** 0 0 13,860

Establish new industry-led, university consortia-based program (innovations and invention) to develop crosscutting, breakthrough technologies needed to ensure continued supply of oil and gas beyond 2015. Research will focus on long-term, high-risk, high potential payout projects that may revolutionize the way gas is supplied in the U.S. Program will focus on resource-tailored technologies to find and produce gas from non-conventional reservoirs with minimal environmental impact. Develop technologies for hostile environments (extreme pressure, temperature, and corrosion) encountered in drilling deeper than 16,000 feet. Determine constraints to expanding coalbed methane production in eastern basins.

DOE will continue the National industry-driven Stripper Well Consortium to investigate multiple technologies to improve stripper well production and prevent the abandonment of 8% of total U.S. production. In addition, DOE will support industry-led efforts in technology transfer through workshops and publications focused on the small- to mid-sized independents.

To assure efficient and reliable availability of natural gas to end users, DOE will initiate a National, industry-driven consortium in gas storage (similar to the Stripper Well Consortium), to improve the reliability and efficiency of the existing storage system. The program will also conduct complementary R&D in advanced storage concepts and collect data and develop models for improved LNG facilities siting.

Participants to be determined.

There was no activity in FY 2002 and FY 2003.

(dollars in thousands)

FY 2002	FY 2003	FY '2004
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■ **Advanced Drilling, Completion and Stimulation** 5,309 8,515 0

No activity in FY 2004. Technologies for drilling greater than 16,000 feet included in Sustainable Supply above.

FY 2003 and FY 2002 funding continued development of real-time fracture height growth diagnostic tool, ultra-light weight cement for deep water applications, high-pressured coiled tubing drilling system, mud hammer, long-term, revolutionary technologies such as laser drilling and perforations, technologies for drilling deeper than 16,000 feet including high performance drilling and completion systems, advanced coatings and hardening of “Smart” systems and sensors. *Participants included: NETL, Novatek, Mauer, Tempress, Tech Int., Cementing Solutions, Real-Tme Zone, Terra Tek, GTI, TBD*

■ **Advanced Diagnostics and Imaging Systems** 5,013 4,580 0

No activity in FY 2004.

FY 2003 and FY 2002 funding continued development of infill drilling optimization in the San Juan basin and Delaware basin of New Mexico, next generation of fracture detection technologies, long-term sustainability of gas supply study in Rocky Mt. basins, improved completion technologies, solutions to high water production problems in tight sand regions, super high resolution seismic tools and shear wave imaging. *Participants included: NETL, ARI, Stanford, LBL, SUNY, SNL, Paulsson Geophysical, University of Texas, Cementing Solutions, N. Mex. Tech.*

■ **Multi National Laboratory/Industry Partnership** .. 2,800 0 0

No activity in FY 2003 and FY 2004 as the program was not aligned with the President’s Management Agenda efforts and R&D Investment Criteria guidance to promote competitive awards.

FY 2002 funding continued to support a mix of fundamental and applied research in exploration and production projects identified by industry partners as key, high-risk and long-term. *Participants included: National Labs.*

■ **Secondary Gas Recovery Program** 693 500 0

No activity in FY 2004.

FY 2003 and FY 2002 funding continued secondary gas recovery studies in Northern Gulf of Mexico and other major producing basins in U.S. *Participants included: Univ. Texas.*

■ **Stripper Wells Revitalization** 748 1,200 0

In FY 2004, this activity will continue under the Sustainable Supply effort described above.

FY 2003 and FY 2002 funding continued National, industry-driven consortium to investigate

multiple technologies to improve stripper well production. *Participants included: Penn St. Univ.*

(dollars in thousands)

	FY 2002	FY 2003	FY 2004
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■ Technology Transfer	599	500	0
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In FY 2004, this activity will continue under the Sustainable Supply effort described above.

FY 2003 and FY 2002 funding continued industry led efforts in technology transfer. *Participants included: PTTC.*

■ Deep Trek	3,400	0	0
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This activity will continue under Sustainable Supply effort described above. (Also see Advanced Drilling, Completion and Stimulation.)

This activity was combined with Advanced Drilling Completion and Stimulation in FY 2003. In FY 2002 funding continued development of technologies for drilling deeper than 16,000 feet below the earth’s surface, including high performance drilling and completion systems, advanced coatings and hardening of “Smart” systems and sensors, low friction, wear resistant coatings/materials. *Participants included: SNL*

■ Coal Bed Methane Water Filtration Research	950	0	0
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No funding is requested for this activity in FY 2004.

No funding requested in FY 2003. FY 2002 funding concluded stratigraphic work to determine location of constructed wetlands in association with large scale coal bed methane production facility.

■ Arctic Research	247	0	0
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No funding requested for this activity in FY 2004

FY 2002 funding continued Arctic Research program for peer reviewed research, conducted outreach and served as liaison between the State and DOE. No funding was requested in FY 2003.

■ Program Support	205	155	140
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Fund technical and program management support.

Gas Hydrates	9,568	4,500	3,500
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Gas Hydrates, located in Alaska and offshore of the U.S., contain huge resources of natural gas (if only 1% were economically producible, we could triple our resource base). In addition to their potential as a resource, hydrates appear to have implications for the global climate. Significant research is needed to provide the knowledge and technology to understand the global climate impact of hydrates by 2010, and commercially produce gas from hydrates starting in 2015-2020, when more conventional resources decline. Because this research is high risk and long-term, and

could potentially lower the value of current reserves, there is little incentive for industry to take the lead in hydrate development.

(dollars in thousands)

FY 2002	FY 2003	FY 2004
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■ **Gas Hydrates**..... 9,470 4,455 3,465

In FY 2004 the program will support one ongoing joint industry project needed to drill and test wells in the Gulf of Mexico. Activities related to safe production of oil and gas offshore will be transferred to the private sector beneficiaries. *Participants include: TBD, Chevron Texaco*

FY 2003 and FY 2002 funding continued industry-led field activities to drill and collect samples of naturally occurring hydrate from Alaska permafrost for characterization, Joint Industry Project to understand safety and seafloor stability issues in the Gulf of Mexico, national lab work and Gulf of Mexico Seafloor Monitoring work.. *Participants included: U. Miss., Chevron Texaco, BP, Maurer.*

■ **Program Support**..... 98 45 35

Fund technical and program management support.

Infrastructure..... 9,809 0 0

This program develops technology to ensure the reliability and integrity of transmission and utility distribution pipeline systems, to reduce stress corrosion and cracking of gas pipelines, to detect damage to pipelines, and to determine pipeline wall integrity.

■ **Storage Technology**..... 2,420 0 0

In FY 2004, this activity has been combined with the Sustainable Supply program described above.

No funding was requested in FY 2003. FY 2002 funding continued development of technologies for deliverability enhancement and reservoir management, support to industry for metering and measurement, and advanced storage concepts. These activities include development of a direct energy meter for storage applications, and support of large capacity, storage in granitic rock. *Participants included: ARI, Schlumberger-Holditch, Furness-Newburge, NYSEG, TBD*

■ **Delivery Reliability**..... 7,289 0 0

No activity in FY 2004.

In FY 2003, to reduce duplication in government programs, the President’s budget transferred \$5 million in budget authority associated with this activity to the Office of Pipeline Safety in the Department of Transportation. FY 2002 funding continued research directed to ensure the reliability and integrity of the gas transmission and distribution network, develop smart automated inside pipeline inspection sensor systems, conduct research on obstacle detection systems for horizontal boring applications for laying distribution pipelines, develop systems capable of

detecting external force damage, develop technology to improve the efficiency for reciprocating and turbo compressors, and develop advance technology capable of determining pipeline wall integrity. *Participants included: SWRI, Tuboscope, NYGAS, GTI, Battelle, CSU, ARC, ANL, INEEL, LLNL, SNL, ORNL, PNNL, NETL, TBD.*

(dollars in thousands)

FY 2002	FY 2003	FY 2004
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■ **Program Support**..... 100 0 0

Fund technical and program management support.

Emerging Processing Technology..... 2,191 0 6,555

In keeping with the National Energy Policy and the President’s Freedom Car Initiative, the Emerging Processing Technology program has been redirected toward research on innovative methods to produce hydrogen from natural gas. Research will also be conducted on the capture of CO₂ generated during the process, which is in line with the President’s Climate Change Initiative. FY 2004 activities will be built on past hydrogen related efforts of the Clean Fuels Program. The most promising includes work on membranes to produce hydrogen directly from natural gas and to separate both the reactant oxygen from air in the resultant product gas streams. Additional FY 2004 activities will be to competitively solicit, from industry, academia, and National Laboratories, new ideas on hydrogen production, CO₂ capture, and related supporting needs to produce and deliver hydrogen to the potential user.

■ **Hydrogen From Gas**..... 0 0 6,490

In FY 2004, initiate tests of prototype hydrogen production technologies. Award projects for hydrogen production and capture of associated carbon dioxide from competitive solicitation and National laboratory call for proposals. *Participants include: NETL, TBD.*

No funding was requested in FY 2003 and FY 2002.

■ **International Center for Gas Technologies** 247 0 0

No activity in FY 2004.

FY 2002 funding continued support of an international center for information on natural gas technologies. No funding was requested in FY 2003. *Participants included: GTI*

■ **Coal Mine Methane** 1,921 0 0

No activity in FY 2004.

No funding requested in FY 2003. FY 2002 funding continued Phase III of coal mine methane projects.

(dollars in thousands)

FY 2002	FY 2003	FY 2004
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■ Program Support	23	0	65
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Fund technical and program management support.

Effective Environmental Protection	2,537	2,640	2,500
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This program seeks to reduce the environmental impacts of gas operations and reduce the cost of environmental compliance through a combination of technology development, risk assessment, and regulatory streamlining. In FY2004 the program will emphasize research that will improve access to onshore public lands, especially in the Rocky Mountain Region, where much of the undiscovered domestic natural gas resource is located and where environmental issues threaten to significantly impede recovery of that resource.

■ Environmental Science	0	0	2,475
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Conduct targeted initiatives to define and solve specific problems in key focus areas, specifically: 1) environmental barriers to coal bed methane production including the use of coal bed methane water as a resource for beneficial uses, and 2) air quality issues affecting natural gas production. Develop objective, credible scientific data for regulatory decisions as part of a program-wide environmental strategy for maintaining sustainable supplies of natural gas. *Participants include: NETL, National Labs, TBD.*

In FY 2002 and 2003, project activities were funded in separate key activities described below.

■ Program Planning Data and Analysis	424	426	0
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Activity continued in Environmental Science above.

FY 2003 and FY 2002 funding continued 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. *Participants to be determined.*

■ Technology Development	1,711	1,000	0
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Activity continued in Environmental Science above.

FY 2003 and FY 2002 funding continued efforts to develop and demonstrate technologies for improving the environmental performance of all gas exploration and production. *Participants to be determined.*

■ Outreach and Technology Transfer	376	1,188	0
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Activity continued in Environmental Science above.

FY 2003 and FY 2002 funding continued 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. *Participants to be determined.*

(dollars in thousands)

	FY 2002	FY 2003	FY 2004
■ Program Support	26	26	25
Fund technical and program management support.			
Total, Natural Gas Technologies	44,069	22,590	26,555

Explanation of Funding Changes

FY 2004 vs. FY 2003 (\$000)

Exploration and Production

■ Initiate Sustainable Supply to refocus on activities that can create public benefits which industry would not carry out absent Federal assistance	13,860
■ Redirect appropriate Federal activities to Sustainable Supply from Advanced Drilling, Completion, and Stimulation	-8,515
■ Redirect appropriate Federal activities to Sustainable Supply from Advanced Diagnostics and Imaging Systems.....	-4,580
■ Redirect appropriate Federal activities to Sustainable Supply from Secondary Gas Recovery	-500
■ Combine Stripper Wells Revitalization with Sustainable Supply	-1,200
■ Combine Technology Transfer with Sustainable Supply	-500
■ Program Support	-15

Gas Hydrates

■ Decrease in Gas Hydrates due to termination of several joint industry projects	-990
■ Program Support.....	-10

Emerging Processing Technology

■ Initiate Hydrogen From Gas.....	6,490
■ Program Support increase due to initiation of program	65

Effective Environmental Protection

■ Increase due to combined effort in Environmental Science	2,475
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■ Combine Program Planning Data and Analysis with Environmental Science	-426
■ Combine Outreach and Technology Transfer with Environmental Science	-1,000
■ Combine Technology Development with Environmental Science	-1,188
■ Program Support.....	-1
Total Funding Change.....	<u>3,965</u>

Oil Technology

Program Mission

The mission of the Oil Technology Program is to create public benefits by investing in research that the oil industry would not take on itself: long-term, high-risk research with potentially high payoffs for the public. These payoffs include a cleaner environment, more secure and stable supplies and new potential resources. The President's National Energy Policy states that 21st century technology is the key to environmental protection and new energy production, and federal research can augment industry's technology development efforts in ways that target the public interest. The activities of this program will help the industry ensure that supplies of oil are accessible to enhance our Nation's energy security, while also ensuring that the resources are developed in an environmentally sound manner.

Fossil Energy programs are being realigned to specifically support the President's climate change and energy security goals. Through the implementation of the President's Management Agenda, the Natural Gas and Oil Technology programs completed Investment Criteria Scorecards of all program elements and also completed were 19 "mini" scorecards down to the project level. The programs also completed the Program Assessment Rating Tool (PART) for all program elements. Analysis of PART showed that the program did not link annual activities and their products to long-term benefits. In addition, the program was determined to have poor results and to duplicate industry work.

The budget delineates program goals such as Enhanced Oil Recovery/CO₂ Injection, Domestic Resource Conservation, and Environmental Science as funding categories. This allows the program to phase out projects and activities that are neither productive nor important to the program's mission and goals. Investments will maximize the efficiency of taxpayer dollars by focusing solely on activities that require a Federal presence to attain the President's climate change and energy security goals.

For example, the President's climate change goal is addressed through ensuring that research and technology development support effective management practices of carbon and greenhouse gases to reduce their concentration in the atmosphere. This includes the use of carbon dioxide injection to revitalize domestic energy production while sequestering carbon. When appropriate, collaborations with other Federal agencies, industry, academia, and states will be used to accomplish this goal. America's energy security can be enhanced by ensuring that research and technology development support a vibrant U.S. oil and gas industry that continues to be the base for global exploration and production. This includes research that supports solid policy decision-making and technology development that allows for greater access to energy resources with no environmental impact.

Program Strategic Performance Goal

Sub-programs in the Oil Technology Program support the following Program Strategic Performance Goal (PSPG):

ER5-1: By 2008, develop advanced technologies and employ scientifically based policy options to increase the Nation's economically recoverable resource by 15 trillion cubic feet (Tcf) for natural gas and 140 million barrels for oil and reduce future costs of exploration and production by \$10 billion. According to the USGS, EIA, and MMS, the economically recoverable oil resource base is estimated to be 120 billion barrels at \$18/bbl. and 149 billion barrels at \$30/bbl; the gas base is estimated to be 740 Tcf at \$2.00/thousand cubic feet (mcf) and 920 Tcf at \$3.50/mcf in 2002.

Three subprograms make up the Oil Technology program. The performance measures are listed in the table below. The Enhanced Oil Recovery/CO₂ Injection activity, performed within the Exploration and Production subprogram and the Domestic Resource Conservation activity, performed with the Reservoir Life Extension/Management sub-program, support the Department's PSPG ER5-1, and has the following goal:

- By 2008, develop and field test a suite of technologies with the potential to increase the economically recoverable resource by 140 million barrels of oil and 0.3 TCF of natural gas from existing and frontier resources and reduced costs of \$0.1 Billion.

The Environmental Science activity, performed within the Effective Environmental Protection subprogram, supports the PSPG ER5-1 and has the following goal:

- By 2008, develop and demonstrate technologies in oil and gas environmental management with potential to reduce costs of environmental protection in field operations by \$10 billion with some production increases while improving the Nation's air, water, and soil quality.

Performance Indicators

The performance indicators for the Enhanced Oil Recovery/CO₂ Injection and Domestic Resource Conservation activities will be as follows:

- Annual estimates of economically recoverable oil resources attributable to program activities.
- Increased revenue from royalty payments and dollars saved from production lower costs.

The performance indicator for the Environmental Science activity will be as follows:

- Smaller environmental impact of production and recovery operations as a result of technologies developed.

Annual Performance Targets and Results

FY 2004 annual proposed targets and associated quarterly milestones continue to be refined using OMB's guidance to better link annual outputs to long-term outcomes and to reflect the refocusing of the research into areas with a strong Federal role. Effective Environmental Protection performance targets for both the Natural Gas Technologies and Oil Technology programs are contained in the Oil Technology section of this budget listing.

Program Benefits

Each year Fossil Energy estimates the benefits of program activities to support Government Performance and Results Act (GPRA) reporting. Methods are complex and vary by program. The Oil and Gas Programs have traditionally used two separate economic and engineering modeling systems to calculate selected economic and energy security benefits. In 2002, a two-year effort, involving external peer review, was begun to integrate these two separate modeling systems into one system for improved simulation of resource and market conditions, and consistency of technology assumptions and model outputs. Under the previous two model systems, deficiencies, such as the assumption of unlimited industry capital availability, could result in an overestimation of industry's response to DOE's R&D products. Conversely, deficiencies, such as only modeling upstream R&D activities and not calculating the synergistic benefits of oil and gas R&D efforts, could result in an underestimation of the benefits of DOE's programs.

The new model will provide the following expected benefits:

- Complimentary technology development in oil and gas research.
- Full R&D program activities can be modeled.
- Ability to calculate synergistic benefits of both programs.

As part of the effort to conform to the President's Management Agenda in a shorter-term, Fossil Energy has undertaken an integrated program benefits analysis of oil, natural gas, coal and power systems research within Fossil Energy to develop Fossil Energy-wide program benefits estimates. This analysis, using the Energy Information Administration National Energy Modeling System (NEMS) and scheduled to be completed in mid-2003, is examining all Fossil Energy research programs on a common basis with respect to modeling assumptions and should enable aggregate and comparative assessments of the benefits of Fossil Energy research programs.

FY 2002 Results	FY 2003 Updated Targets	FY 2004 Targets
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ER5-1

Demonstrate a small-diameter, light-weight composite drill pipe for ultra-short radius drilling that will lower overall exploration/production costs. (ER5-1) (Met goal)

Research: Issue one solicitation for Micro-hole technologies research for enabling improved access and minimizing environmental impact.

Develop six conceptual models and techniques related to chemical flooding, reservoir and flow simulation, and reservoir

Research: Award one project on Micro-hole technologies drilling research for future applications on state and Federal lands and waters, and addressing nearer-term barriers.

Develop advanced techniques for simulation and modeling of non-conventional reservoirs to

characterization for enhancing oil recovery technologies. Complete analysis of bench-scale reverse osmosis in produced water treatment equipment to increase resource recovery without impacting the environment.

Construct greenhouse prototype for phytoremediation for coalbed methane produced water to determine feasibility of its use for agriculture.

Development: Conduct field tests for oil field centrifuge control systems using fuzzy logic to reduce the cost of waste disposal using an environmentally-sound approach.

Conduct improved oil recovery techniques; seismic sonic stimulation (1 project), data acquisition (2 projects), fracture model interpretation (1 project), and steamflood simulation (1 project) in existing light and heavy oil reservoirs at sites ranging from Alaska to Utah.

Conduct 5 bench tests in surfactant behavior, and in paraffin deposition, for enhanced oil recovery technologies.

Participate in 66 regional workshops for accelerated technology transfer to U.S. independent producers.

Develop kinetics for model compounds to be used in enzymatic and biomimetic

improve oil recovery in existing fields.

Prepare baseline characterization of Wyoming and Montana groundwater systems and coalbed methane production.

Development: Sponsor International Petroleum Environmental Conference (IPEC) to increase availability of advanced environmental technology.

Accelerate transfer of technology to U.S. producers, especially the small independent companies through 25 regional workshops and co-sponsor the IOR Symposium.

Pioneer two actions to provide scientific data and analyses to enable states and other Federal agencies to make more cost-effective regulatory and policy decisions that increase oil or natural gas supplies to American consumers.

catalysts for upgrading heavy crude oils.

Funding Profile

(dollars in thousands)

	FY 2002 Comp. Approp.	FY 2003 Request	FY 2004 Base	FY 2004 Request	FY 2004 Request vs. Base	
					\$ Change	% Change
Exploration and Production.....	\$33,207	\$16,400	\$16,400	\$2,000	\$-14,400	-87.8%
Reservoir Life Extension/Management.....	12,611	9,500	9,500	5,000	-4,500	-47.4%
Effective Environmental Protection.....	10,426	9,500	9,500	8,000	-1,500	-15.8%
Total, Oil Technology.....	\$56,244	\$35,400	\$35,400	\$15,000	\$-20,400	-57.6%

Funding by Site

(dollars in thousands)

	FY 2002	FY 2003	FY 2004	\$Change	%Change
Argonne National Lab (East)	\$100	\$0	\$0	\$0	0.0%
Idaho Natl. Engineering & Environmental Lab	110	204	0	-204	-100.0%
Lawrence Berkeley Lab.....	200	0	0	0	0.0%
Lawrence Livermore National Lab	1,630	0	0	0	0.0%
Los Alamos National Lab	1,493	48	0	-48	-100.0%
National Energy Technology Lab	850	1,710	900	-810	-47.4%
Oak Ridge National Laboratory.....	2,377	500	0	-500	-100.0%
Sandia National Lab	1,975	0	0	0	0.0%
All Other	47,509	32,938	14,100	-18,838	-57.2%
Total, Oil Technology	\$56,244	\$35,400	\$15,000	\$-20,400	-57.6%

Site Description

No FY 2004 funding planned for National Labs other than NETL.

The following labs received FY 2002-2003 funding in the described areas.

Argonne National Laboratory (East)

The Argonne National Laboratory (ANL), located in Argonne, Illinois, is a major multi-program laboratory managed and operated for the U.S. Department of Energy (DOE) by the University of Chicago under a performance-based contract. Argonne research for the Fossil Energy Oil Technology program supports DOE strategies to support oil and gas environmental research.

Idaho National Engineering and Environmental Laboratory

The Idaho National Engineering and Environmental Laboratory (INEEL), located outside of Idaho Falls, Idaho, conducts research and development in the area of Oil Technology to support microbial enhanced oil recovery (MEOR) and environmental research.

Lawrence Berkeley National Laboratory

The Lawrence Berkeley National Lab (LBNL), located in Berkeley, California, conducts research and development in the area of Oil Technology to support EOR and environmental modeling.

Lawrence Livermore National Laboratory

The Lawrence Livermore National Laboratory (LLNL), located in Livermore, California, conducts research and development in the area of Oil Technology to support environmental and reservoir modeling.

Los Alamos National Laboratory

The Los Alamos National Laboratory (LANL), located in Los Alamos, New Mexico, conducts research and development in the area of Oil Technology to support seismic and drilling research.

National Energy Technology Laboratory

The National Energy Technology Laboratory (NETL), located in Morgantown, West Virginia, Pittsburgh, Pennsylvania, and Tulsa, Oklahoma, is a multi-purpose laboratory, owned and operated by the U.S. Department of Energy. NETL conducts and implements science and technology development programs for the Department in energy and energy-related environmental systems. NETL's key functions are to shape, fund, and manage extramural (external) RD&D projects, conduct on-site science and technology research, and support energy policy development and best business practices within the Department. Specific onsite expertise in EOR, environmental science, computational chemistry, and policy analysis supports the Oil Technology Program.

Oak Ridge National Laboratory

The Oak Ridge National Laboratory (ORNL), located in Oak Ridge, Tennessee, conducts research and development in the area of Oil Technology to support environmental and oil processing research.

Sandia National Laboratory

The Sandia National Laboratory (SNL), located in Albuquerque, New Mexico, conducts research and development in the area of Oil Technology to support geophysical and reservoir management research.

All Other

The Department's Oil Technology program, within the Fossil Energy and Development program, funds research at major performers at non-DOE locations. Examples of these performers include partnerships with industry, universities, 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.

Detailed Program Justification

(dollars in thousands)

	FY 2002	FY 2003	FY 2004
Exploration and Production	33,207	16,400	2,000

This program aims to develop technologies that will overcome major market and technological barriers to increase domestic supply of oil at reasonable prices while protecting the environment. In FY 2004, the Exploration and Production program will be refocused on Enhanced Oil Recovery (EOR) and CO₂ injection technologies. The oil remaining after conventional production (377 billion barrels) cannot be recovered without the application of EOR technologies. Carbon dioxide flooding is a proven EOR technology that prolongs the life of some mature oilfields and can potentially contribute to long-term climate change goals.

■ EOR/CO₂ Injection	0	0	1,980
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Reservoirs will be identified based upon economics, technological issues, and feasibility for benefit from CO₂ (currently a waste stream) injection. Technology to make CO₂ flooding applicable to a wider class of reservoirs will be pursued. Oil reservoirs will be mapped with locations of existing power plants and the price and/or incentives for CO₂ that would be needed to make the project economical. Flooding scenarios will be considered to leave maximum CO₂ in the reservoir. Program success will offer options for future carbon management policy choices. *Participants to be determined.*

There was no activity in FY 2003 and FY 2002.

(dollars in thousands)

FY 2002	FY 2003	FY 2004
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■ **Advanced Drilling, Completion and Stimulation** 2,500 1,500 0

No funding is requested for this activity in FY 2004.

FY 2003 and FY 2002 funding continued upgrades to the Advanced Cuttings Transport Facility that allowed high-temperature/high-pressure experimentation on energized fluids (air, mist, gas assisted, foam, etc.) and synthetic drill fluids, cements, and transport of fluids in horizontal and inclined wellbores. *Participants included: PRRC, University of Tulsa, National Labs, NETL.*

■ **Advanced Diagnostics and Imaging Systems** 6,284 4,500 0

No funding is requested for this activity in FY 2004.

FY 2003 and FY 2002 funding continued development of advanced reservoir diagnostics and imaging systems to optimize oil discovery and recovery. Developed quantitative engineering parameters that control rock-fluid interactions which impact oil production. Continued fundamental geoscience efforts focusing on geoscience/engineering reservoir characterization on naturally fractured reservoirs. *Participants included: Cal Tech, National Labs, NAS, ERCH.*

■ **Multi-National Laboratory/Industry Partnership and National Laboratory Supporting Research** 5,850 0 0

No funding is requested for this activity in FY 2004.

No funding was requested in FY 2003. FY 2002 funding continued the transfer of technologies that advance understanding of the characteristics and producibility from oil reservoirs. *Participants included: National Labs*

■ **Reservoir Efficiency Processes** 7,627 4,236 0

No funding is requested for this activity in FY 2004.

FY 2003 and FY 2002 funding continued development of improved gas flooding recovery methods and advanced the state-of-the-art in reservoir simulation. *Participants included: NETL, TBD.*

■ **Analysis and Planning**..... 3,080 2,500 0

No funding is requested for this activity in FY 2004. Appropriate planning and analysis activities will be undertaken in the relevant program areas.

FY 2003 and FY 2002 funding continued technical planning and analysis support for implementing and evaluating effective and efficient oil technology research programs. Enhanced and maintained statistical data, models and supporting systems to evaluate petroleum policy

options and to enhance metrics capabilities. Validated the effectiveness of the oil technologies to meet programmatic and agency goals. *Participants included: RMC, IOGCC, TRW.*

(dollars in thousands)

	FY 2002	FY 2003	FY 2004
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■ Fundamental Research - PRIME	3,900	3,500	0
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No funding is requested for this activity in FY 2004.

FY 2003 and FY 2002 funding continued development of PRIME continued pre-application research focused on the development of exploration and production technologies. General areas include remote sensing/geochemical survey and improved resolution of 3-component seismic, slimhole tools for logging and testing, remote wireless monitoring and control tools, and advanced petroleum recovery technologies. *Participants to be determined*

■ Arctic Research	3,642	0	0
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No activity in FY 2004.

No funding was requested in FY 2003. FY 2002 funding continued peer reviewed and coordinated research conducted through Fossil Energy and Energy Efficiency. Also perform outreach and serve as a liaison between the State and DOE. *Participants to be determined*

■ Program Support	324	164	20
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Fund technical and program management support.

Reservoir Life Extension/Management	12,611	9,500	5,000
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In FY 2004, the Reservoir Life Extension/Management program will be refocused on Domestic Resource Conservation which will target partnerships with industry and academia to foster cost effective technologies and encourage best practices and approaches to conserve reservoir access to marginal well fields that make up 40% of our domestic production. The goal is to optimize Federal efforts to maintain U.S. domestic oil production capacity and enhance access to the remaining oil resource target.

In previous years, Reservoir Life Extension/Management focused on shorter-term research with a much clearer commercial payoff to industrial participants. Given the industry's incentive to continue this type of research on its own, Federal funding was redirected to longer-term, higher risk efforts that can help preserve U.S. academic and technological leadership in this area.

■ Domestic Resource Conservation	12,482	9,405	4,950
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In FY 2004, elements include: 1) Key technology prototype development, such as micro-hole technologies, for enabling improved access and minimizing environmental impact; 2) Technology transfer with special emphasis on independents; and, 3) Policy analysis and planning to prioritize

program efforts and provide policy evaluations to maximize impact on domestic oil recovery over a wide range of technological and economical conditions. *Participants to be determined.*

FY 2003 and FY 2002 funding continued analysis of past projects to capture their benefits. Selected competitive projects that partner with independents to accelerate field testing and use of effective technologies. Addressed critically underdeveloped resources owned and managed by Native American Tribes and Corporations. Disseminated petroleum RD&D results to domestic stakeholders. Developed mechanisms that foster communication between industry and researchers. Continued to expedite the use of cost effective, more efficient, environmental friendly technologies that increase recovery. Continued support of Minority Education Initiative; continued to provide other energy related educational opportunities. Populated the Internet-accessible database of “best practices” resulting from the PUMP projects and conferences. Solicitation for “PUMP” projects to address short-term demonstrations of critical technologies in specific regions. *Participants included: INEEL, Penn State, HQ, APTA, CEED, COMET, GWPC, U. of Ok, PTTC, RMC, NETL, other National Labs, TBD.*

(dollars in thousands)

	FY 2002	FY 2003	FY 2004
■ Program Support	129	95	50
Fund technical and program management support.			
Effective Environmental Protection	10,426	9,500	8,000

The Effective Environmental Protection program will continue the Environmental Science subprogram which focuses on technologies and practices that reduce the environmental impact of oil exploration, production, and processing while minimizing the cost of effective environmental protection and compliance. The program supports the President’s Clear Skies Initiative by reducing emissions from all aspects of oil production and processing. The program supports energy security by helping to overcome the environmental barriers that limit access to domestic resources. The program supports the recommendations of the National Energy Policy by encouraging additional recovery from existing wells, providing science and technology to allow additional oil development on Federal lands and providing answers to environmental questions that are limiting oil exploration and production in the National Petroleum Reserve - Alaska. The overall objective is to help balance the need to develop the Nation’s energy resources while maintaining our environmental values. It fills critical information and technical gaps that are needed to produce and process the Nation’s energy needs without sacrificing environmental quality.

■ Environmental Science	0	0	7,920
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In FY 2004, conduct targeted initiatives to define and solve specific problems in key focus areas, specifically: 1) management of produced water and use of produced water as a resource for beneficial uses; and, 2) ensuring maximum sustainable access to oil and gas resources on Federal lands. An outreach program will be conducted to ensure that accurate information about the impacts of oil and gas development is presented to the public. Develop objective, credible scientific

data for regulatory decisions as part of a program-wide environmental strategy for maintaining U.S. oil production capacity. *Participants include: NETL, National Labs, BLM, TBD*

FY 2003 and FY 2002 funding was included in the activities below.

(dollars in thousands)

	FY 2002	FY 2003	FY 2004
<p>■ Program Planning and Data Analysis</p> <p>In FY 2004, activity combined in Environmental Science activity above.</p> <p>FY 2003 and FY 2002 funding continued analysis of industry environmental trends and available technologies. Maintained performance measurement data for program planning and technology transfer. Provided energy and economic analyses for legislative and regulatory initiatives related to oil environmental issues. Provided analysis of refinery related environmental issues and regulations. <i>Participants included: PERF, National Labs, EPA</i></p>	823	900	0
<p>■ Streamline State/Tribal/Federal Regulations</p> <p>In FY 2004, activity combined in Environmental Science activity above</p> <p>FY 2003 and FY 2002 funding continued development of streamlined, in cooperation with Federal and State agencies, environmental regulations and regulatory processes with emphasis on reducing permitting times for refinery upgrades and domestic production from public lands, while maintaining environmental protection. The objective of this key activity was to increase domestic production and refinery capacity by reducing the cost of compliance. <i>Participants included: ORNL and other NationalLabs, University of Tulsa, IOGCC.</i></p>	1,515	2,705	0
<p>■ Risk Assessment</p> <p>In FY 2004, activity combined in Environmental Science activity above.</p> <p>FY 2003 and FY 2002 funding continued development of credible scientific data for regulatory decision making in all aspects of exploration, production, and processing. <i>Participants included: National Laboratories, BLM, PERF, GWPC</i></p>	3,618	1,800	0
<p>■ Technology Development.....</p> <p>In FY 2004, activity combined in Environmental Science activity above.</p> <p>FY 2003 and FY 2002 funding continued development of technologies to reduce produced water handling costs and explored innovative refinery technologies that could significantly reduce CO₂ emissions. <i>Participants included: NETL and other National Laboratories, University of Tulsa, GEER.</i></p>	4,363	4,000	0
<p>■ Program Support</p> <p>Fund technical and program management support.</p>	107	95	80

Total, Oil Technology	56,244	35,400	15,000
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Explanation of Funding Changes

FY 2004 vs. FY 2003 (\$000)

Exploration and Production

- Decreases consist of termination of work in Advanced Drilling, Completion and Stimulation, Advanced Diagnostics and Imaging Systems, Partnership Program, PRIME, Advanced Technologies for High Risk Resources; and Arctic Research. Planning and Analysis is reduced because the program is being realigned to specifically support the President’s climate change and energy security goals -14,256
- Program Support..... -144

Reservoir Life Extension/Management

- Decreases consist of termination of work in Technology Development with Independents, Native American Program, Field Demonstrations, and PUMP. Outreach & Technology Transfer is reduced because the program is being realigned to specifically support the President’s climate change and energy security goals -4,455
- Program Support..... -45

Effective Environmental Protection

- Decreases consist of termination of research on processing heavy crudes and improving refinery processes; research on lower priority environmental issues, such as remediation, NORM, air emissions, and work with the Natural Gas and Oil Technology Partnership -1,485
- Program Support -15

Total Funding Change.....			<u>-20,400</u>
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Cooperative Research and Development

Program Mission

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

Funding Profile

(dollars in thousands)

	FY 2002 Comp. Approp.	FY 2003 Request	FY 2004 Base	FY 2004 Request	FY 2004 Request vs. Base	
					\$ Change	% Change
Cooperative Research and Development.....	\$8,023	\$6,000	\$6,000	\$6,000	\$0	0%
Total, Cooperative Research and Development.....	\$8,023	\$6,000	\$6,000	\$6,000	\$0	0%

Funding by Site

(dollars in thousands)

	FY 2002	FY 2003	FY 2004	\$Change	%Change
All Other.....	\$8,023	\$6,000	\$6,000	\$0	0%
Total, Cooperative Research and Development...	\$8,023	\$6,000	\$6,000	\$0	0%

Detailed Program Justification

(dollars in thousands)

	FY 2002	FY 2003	FY 2004
Cooperative Research and Development.....	8,023	6,000	6,000
■ Cooperative Research and Development	7,983	5,960	5,960

Provide support for cooperative research programs at WRI and UNDEERC which are 50-50 cost-shared with non-federal clients. Funding will be split evenly between the two participants.

FY 2003 and FY 2002 funding provided support for cooperative research programs at WRI and UNDEERC which are 50-50 cost-shared with non-federal clients. Funding was be split evenly between the two participants.

(dollars in thousands)

	FY 2002	FY 2003	FY 2004
■ Program Support	40	40	40
Fund technical and program management support.			
Total, Cooperative Research and Development	8,023	6,000	6,000

Explanation of Funding Changes

Funding in FY 2004 remains at the FY 2003 level.

Fossil Energy Environmental Restoration

Program Mission

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 the Morgantown (MGN), West Virginia, Pittsburgh (PGH), Pennsylvania, and Tulsa, Oklahoma sites, and the Albany Research Center (ARC) at Albany, Oregon. Activities include those necessary to protect workers and the public from exposure to hazardous conditions and materials (e.g., fires, carcinogens, asbestos, lead, etc.), identify and correct safety and health hazards, improve workplace monitoring and industrial safety programs, achieve compliance with Federal, state and local environment, safety, and health requirements, including Department of Energy (DOE) initiatives, and implement initiatives related to achieving best-in-class performance. Activities also include environmental protection, and cleanup activities on-site, and at several former off-site research and development locations. Groundwater and soil monitoring/remediation is also required at the NETL and ARC sites to ensure compliance with Federal, state and local requirements.

Performance Indicator

FY 2004 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.

- # Continue to implement NETL chiller replacement (to eliminate ozone-depleting substances) activities .
- # Upgrade gas alarm systems in NETL buildings.
- # Maintain risk management programs and Federal permit compliance status at NETL.
- # Conduct remediation activities at Rock Springs and Hoe Creek, WY sites.
- # Conduct environmental monitoring and surveillance activities (air, water, wastewater) in support of permit maintenance.
- # Conduct ES&H training according to job hazard analyses.
- # Complete a series of lead and asbestos abatement actions and remove hazardous materials at ARC.
- # Upgrade emergency response and security programs at ARC.
- # Continue with equipment/facility upgrades and infrastructure repairs, including facility evaluations/upgrades at ARC.
- # Implement specific ES&H plans and programs to achieve objectives and targets of ISO 14001 and OSHA VPP systems.
- # Complete lead and asbestos abatement actions at NETL, including Building 921 (PGH) exterior asbestos, and Building 86 (PGH) asbestos and lead removal.
- # Complete indoor air quality/ventilation fixes for NETL R&D buildings including indoor air quality fixes in Building 86 (PGH) and small scale fixes in MGN.
- # Continue decontamination/decommissioning of selected NETL-PGH R&D buildings.
- # Implement new activities to meet waste minimization and energy efficiency goals.
- # Implement NETL emergency power systems for ES&H critical operations.
- # Maintain programs for purchasing environmentally preferable products and services.

Reduce sanitary waste from routine operations at ARC.

Funding Profile

(dollars in thousands)

	FY 2002 Comp. Approp.	FY 2003 Request	FY 2004 Base	FY 2004 Request	FY 2004 Request vs. Base	
					\$ Change	% Change
CERCLA Remedial Actions	\$2,449	\$2,000	\$2,000	\$1,910	\$-90	-4.5%
RCRA Remedial Actions	2,125	2,300	2,300	2,052	-248	-10.8%
Other ES&H Actions	5,326	5,415	5,415	5,753	338	6.2%
Total, Fossil Energy Environmental Restoration	\$9,900	\$9,715	\$9,715	\$9,715	\$0	0.0%

Funding by Site

(dollars in thousands)

	FY 2002	FY 2003	FY 2004	\$Change	%Change
All Other	9,900	9,715	9,715	0	0.0%
Total, Fossil Energy Environmental Restoration	\$9,900	\$9,715	\$9,715	\$0	0.0%

Detailed Program Justification

(dollars in thousands)

	FY 2002	FY 2003	FY 2004
CERCLA Remedial Actions	2,449	2,000	1,910
# Rock Springs Sites	800	800	600

Continue second year of full-scale cleanup of Rock Springs sites (~7 year program). *Participants include: Army Corps of Engineers.*

FY 2003 and FY 2002 funding continued cleanup of the Rock Springs sites, with full-scale cleanup beginning in FY 2003. *Participants included: Army Corps of Engineers.*

■ **Hoe Creek Site** 300 300 310

Continue third year of full-scale cleanup of Hoe Creek site (~7 year program). *Participants include: Army Corps of Engineers.*

FY 2003 and FY 2002 funding continued full-scale cleanup of the Hoe Creek site. *Participants included: Army Corps of Engineers.*

■ **Hannah Site Revegetation**..... 70 70 25

Continue Hannah Site revegetation (~10 year program).

FY 2003 and FY 2002 funding continued Hannah Site revegetation.

(dollars in thousands)

FY 2002	FY 2003	FY 2004
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■ **NETL Preliminary Site Investigations** 200 300 445

Implement three additional off-site investigations and remediations related to project closeouts, based on results of risk analyses.

FY 2003 and FY 2002 funding continued implementation of ne CERCLA site investigations and project closeouts.

■ **NETL Site Remediation** 30 30 30

Perform on-site building and soil type remediation assessments at NETL (re-assessment).

FY 2003 and FY 2002 funding provided for on-site CERCLA-type remediation assessments at NETL.

■ **CERCLA PRP Response Activities** 1,049 500 500

Implement CERCLA PRP Response Activities.

FY 2003 and FY 2002 funding continued implementation of CERCLA PRP Response Activities.

RCRA Remedial Actions 2,125 2,300 2,052

■ **NETL On-Site Remediation** 1,355 1,550 1,407

Continue NETL on-site corrective, preventive, and improvement activities such as; lead and asbestos abatement; upgrading chemical handling facilities; waste minimization and pollution prevention activities including managing residual wastes; environmental management plan implementation required for maintenance of ISO 14001 certifications; surface water compliance; and site support contractor RCRA related maintenance activities.

FY 2003 and FY 2002 funding continued NETL on-site corrective, preventive, and improvement activities such as; lead and asbestos abatement; hazardous material and waste compliance; ; waste minimization and pollution prevention activities including managing residual wastes; environmental management plan implementation required for maintenance of ISO 14001 certifications; surface water compliance; and site support contractor RCRA related maintenance activities.

■ **Albany Research Center RCRA** 770 750 645

Continue ARC RCRA cleanup actions including abating lead and asbestos exposures; resolving chemical storage and labeling monitoring soil and groundwater; upgrading ventilation and air pollution control system; and improving air emission management, materials handling, and waste disposal activities.

FY 2003 and FY 2002 funding continued ARC RCRA cleanup actions including abating lead and asbestos exposures; characterizing and resolving chemical storage and labeling; monitoring soil and groundwater; upgrading ventilation and air pollution control system; and improving air emission management, materials handling, and waste disposal activities.

(dollars in thousands)

	FY 2002	FY 2003	FY 2004
Other ES&H Actions	5,326	5,415	5,753
■ Other ES&H Actions at NETL	4,300	4,310	4,535

Maintain regulatory and Integrated Safety Management/ISO 14001 programs (emergency management, occupational medicine and health, safety, environmental management, ergonomics, training, and fire protection) at NETL. Identify safety improvements required to achieve external OSHA-type certifications. Identify and implement safety-related security improvements. Continue to execute environmental objectives and targets under NETL’s ISO 14001 programs, including incremental and continued achievement of DOE’s pollution prevention and energy leadership goals. Conduct highest priority indoor and CFC-related air quality fixes.

FY 2003 and FY 2002 funding maintained regulatory and Integrated Safety Management/ISO 14001 programs (emergency management, occupational medicine and health, safety, environmental management, ergonomics, training, and fire protection) at NETL. . Continued to execute environmental objectives and targets under NETL’s ISO 14001 programs, including incremental and continued achievement of DOE’s pollution prevention and energy leadership goals. Conducted highest priority indoor and CFC-related air quality fixes.

■ **ES&H Corrective Action at NETL Tulsa Site** 15 15 15

Continue ES&H program activities at NPTO including inspections, emergency management and drills, training, etc. Expand environmental management system to Tulsa site.

FY 2003 and FY 2002 funding continued ES&H program activities at NETL Tulsa site including inspections, emergency management and drills, training, etc.

■ **ES&H Corrective Action at ARC** 911 990 1,103

Continue ARC safety and health programs and corrective actions including monitoring and surveillance; and emergency preparedness and security improvements. Upgrade indoor air quality and ventilation systems; medical and industrial hygiene services; fire detection and suppression systems; walking surfaces; personal protective equipment maintenance; facility seismic evaluations; and training.

FY 2003 and FY 2002 funding continued ARC safety and health programs and corrective actions including monitoring and surveillance; and emergency preparedness and security improvements. Upgrade indoor air quality and ventilation systems; medical and industrial hygiene services; fire detection and suppression systems; walking surfaces; personal protective equipment maintenance; facility seismic evaluations; and training.

(dollars in thousands)

	FY 2002	FY 2003	FY 2004
■ Program Support	100	100	100
Fund technical and program management support.			
Total, Fossil Energy Environmental Restoration	9,900	9,715	9,715

Explanation of Funding Changes

	FY 2004 vs. FY 2003 (\$000)
■ Decrease in CERCLA Remedial Actions due to the need to increase funding of Other ES&H Actions including air emission upgrades (e.g., ventilation and indoor air quality deficiencies, emission of toxic substances from R&D projects, and the release of volatile organic compounds from maintenance operations, etc.)	-90
■ Decrease in RCRA Remedial Actions due to the need to increase funding of Other ES&H Actions including upgrading fire protection programs, control of chemical exposures for workers, and enhancing energy management.	-248
■ Increase in Other ES&H Actions due to the need to address outstanding ES&H compliance issues such as those addressed above.	338
Total Funding Change	0

Import/Export Authorization

Program Mission

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. In addition, the program 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 assures 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.

Funding Profile

(dollars in thousands)

	FY 2002 Comp. Approp.	FY 2003 Request	FY 2004 Base	FY 2004 Request	FY 2004 Request vs. Base	
					\$ Change	% Change
Import/Export Authorization	\$2,400	\$2,500	\$2,500	\$2,750	\$250	10.0%
Total, Import/Export Authorization	\$2,400	\$2,500	\$2,500	\$2,750	\$250	10.0%

Funding by Site

(dollars in thousands)

	FY 2002	FY 2003	FY 2004	\$Change	%Change
All Other	\$2,400	\$2,500	\$2,750	\$250	10.0%
Total, Import/Export Authorization	\$2,400	\$2,500	\$2,750	\$250	10.0%

Detailed Program Justification

(dollars in thousands)

	FY 2002	FY 2003	FY 2004
Import/Export Authorization	2,400	2,500	2,750
<ul style="list-style-type: none"> ■ Import/Export Authorization..... 	2,300	2,400	2,630
<p>Modify or rescind 3 conversion orders. Process 50 certifications of coal capability and 3 exemptions. Process 220 gas import/export applications. Provide support for consultations with U.S. trading partners. Provide regulatory compliance and industry monitoring. Provide petroleum policy support for ASFE. Process 103 electricity export applications and 11 construction permits. Monitor and analyze international and domestic electricity trade. Participate in FERC proceedings, international studies, and trade negotiations. Perform NEPA compliance activities.</p> <p>FY 2003 funding provided for activities to modify or rescind 3 conversion orders. Process 50 certifications of coal capability and 3 exemptions. Process 200 gas import/export applications. Provide support for consultations with U.S. trading partners. Provide regulatory compliance and industry monitoring. Provide petroleum policy support for ASFE. Process 100 electricity export applications and 10 construction permits. Monitor and analyze international and domestic electricity trade. Participate in FERC proceedings, international studies, and trade negotiations. Perform NEPA compliance activities. FY 2002 funding provided for activities to modify or rescind 3 conversion orders. Process 50 certifications of coal capability and 3 exemptions. Process 100 gas import/export applications. Provide support for consultations with U.S. trading partners. Provide regulatory compliance and industry monitoring. Provide petroleum policy support for ASFE. Process 50 electricity export applications and 5 construction permits. Monitor and analyze international and domestic electricity trade. Participate in FERC proceedings, international studies, and trade negotiations. Perform NEPA compliance activities.</p>			
<ul style="list-style-type: none"> ■ Program Support..... 	100	100	120
Fund technical and program management support.			
Total, Import/Export Authorization	2,400	2,500	2,750

Explanation of Funding Changes

	FY 2004 vs. FY 2003 (\$000)
<ul style="list-style-type: none"> ■ Increase in Import/Export Authorization due to an increase in the number of import/export applications, and construction permits processed 	250
Total Funding Change	250

Energy Efficiency Science Initiative

Program Mission

Energy Efficiency Science Initiative seeks to identify and fund “bridging” research and development (R&D) that falls between fundamental exploratory science and pre-commercial applied R&D by stimulating R&D that maximizes synergies among different research fields, technologies, investigator communities, and end-use applications. It also cuts across traditional energy end-use sectors by emphasizing distributed power generation applications for industrial and buildings systems, transportation, and stationary power. This initiative expands on existing cooperative efforts between FE and EE in areas such as natural gas-fueled turbine and fuel cell technologies, combined heat, power and cooling applications, hydrogen production, and carbon emission sequestration. This effort also involves extensive coordination with the Office of Science in pursuing follow-on research in areas critical to energy efficiency and clean energy development, such as basic biosciences, heat transfer, new materials, catalysts, and computational science.

Funding Profile

(dollars in thousands)

	FY 2002 Comp. Approp.	FY 2003 Request	FY 2004 Base	FY 2004 Request	FY 2004 Request vs. Base	
					\$ Change	% Change
Energy Efficiency Science Initiative.....	\$6,000	\$0	\$0	\$0	\$0	0.0%
Total, Energy Efficiency Science Initiative.....	\$6,000	\$0	\$0	\$0	\$0	0.0%

Funding by Site

(dollars in thousands)

	FY 2002	FY 2003	FY 2004	\$Change	%Change
All Other	\$6,000	\$0	\$0	\$0	0.0%
Total, Energy Efficiency Science Initiative	\$6,000	\$0	\$0	\$0	0.0%

Detailed Program Justification

(dollars in thousands)

	FY 2002	FY 2003	FY 2004
Energy Efficiency Science Initiative.....	6,000	0	0
■ Energy Efficiency Science Initiative	5,940	0	0

No funding is requested for this activity in FY 2004.

No funding is requested for this activity in FY 2003. In FY 2002, EE and FE competitively solicited applications for cooperative agreements to advance research and development of energy technologies at universities and the private sector. Four priority areas of interest identified include: material science, fuels and chemistry science, sensor and control science, and energy conversion science.

(dollars in thousands)

	FY 2002	FY 2003	FY 2004
■ Program Support Fund technical and program management support.	60	0	0
Total, Energy Efficiency Science Initiative	6,000	0	0

Program Direction and Management Support

Program Mission

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

In FY 2003 and FY 2004, all program direction and management support costs associated with the Clean Coal Technology program have been combined with those of Fossil Energy Research and Development under this account.

In addition to combining the FE R&D and Clean Coal Technology appropriations, the majority of increases are the result of pay raises granted in FY 2003. We do not anticipate any reductions-in-force (RIF) for FY 2004, based on this request. Increases in travel are the result of increased airline, hotel and rental car increases. Increases to contract services are the result of normal inflation occurring in the service sector for those items we procure.

Funding Profile

(dollars in thousands)

	FY 2002 Comp. Approp.	FY 2003 Request	FY 2004 Base	FY 2004 Request	FY 2004 Request vs. Base	
					\$ Change	% Change
Headquarters Program Direction						
Salaries and Benefits.....	\$11,900	\$11,480	\$11,950	\$13,650	\$1,700	14.2%
Travel.....	538	660	660	770	110	16.7%
Contract Services	6,262	7,680	7,680	8,280	600	7.8%
Subtotal, Headquarters Program Direction.....	18,700	19,820	20,290	22,700	2,410	12.2%
Field Program Direction						
Salaries and Benefits.....	33,498	34,305	35,710	37,464	1,754	4.9%
Travel.....	1,520	1,434	1,434	1,450	16	1.1%
Contract Services	32,282	29,141	30,738	31,171	433	1.4%
Subtotal, Field Program Direction.	67,300	64,880	67,882	70,085	2,203	3.4%

	FY 2002 Comp. Approp.	FY 2003 Request	FY 2004 Base	FY 2004 Request	FY 2004 Request vs. Base	
					\$ Change	% Change
Total, Program Direction and Management Support ^{c/}	\$86,000	\$84,700	\$88,172	\$92,785	\$4,613	5.2%
Additional net budget authority to cover the cost of fully accruing retirement (non-add)	(4,373)	(4,850)	(4,902)	(5,064)	(162)	(3.3%)

c/ If CCT program direction were included in FY 2002 the total would be \$104,373,000.

Funding by Site

(dollars in thousands)

	FY 2002	FY 2003	FY 2004	\$Change	%Change
National Energy Technology Laboratory.....	67,300	64,880	70,085	5,205	8.0%
All Other.....	18,700	19,820	22,700	2,880	14.5%
Total, Program Direction and Management Support	\$86,000	\$84,700	\$92,785	\$8,085	9.5%

Detailed Program Justification

(dollars in thousands)

	FY 2002	FY 2003	FY 2004
Headquarters Program Direction	18,700	19,820	22,700
Salaries and Benefits.....	11,900	11,480	13,650

Provide funds for 127 FTE's (includes 17 FTE's transferred from the CCT account) at Headquarters. This staff implements and communicates policy to the NETL's and other field offices, sets program objectives, develops program plans and evaluates alternative strategies; develops and defends budget requests; approves procurement plans; and monitors work progress.

FY 2003 funding provided funds for 127 FTE's (includes 17 FTE's transferred from the CCT account) at Headquarters. FY 2002 funding provided funds for 110 FTE's (Fossil Energy R&D only) at Headquarters. Salaries and benefits for the CCT staff were provided under the CCT account in FY 2002. This staff implements and communicates policy to the NETL's and other field offices, sets program objectives, develops program plans and evaluates alternative strategies; develops and defends budget requests; approves procurement plans; and monitors work progress.

Travel.....	538	660	770
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Provide funds for travel in support of the activities stated above. Both domestic and international travel are conducted.

FY 2003 funding provided for travel in support of the activities stated above. FY 2002 funding

provided for Fossil Energy R&D Headquarters staff only; at that time Clean Coal Technology travel was funded under the CCT account. Both domestic and international travel were conducted.

(dollars in thousands)

	FY 2002	FY 2003	FY 2004
Contract Services	6,262	7,680	8,280
<ul style="list-style-type: none"> Technical and Management Support Services 	1,845	3,180	3,780
<p>Provide for contractual services that are generic to the entire FE program. Included are items such as computer services, technical and management support services.</p> <p>FY 2003 funding provided for contractual services that are generic to the entire FE program. FY 2002 funding provided for Fossil Energy R&D Headquarters contract services only, at that time Clean Coal Technology contract services were funded under the CCT account. Included are items such as computer services, technical and management support services.</p>			
<ul style="list-style-type: none"> Computer Systems and Support 	800	1,000	1,000
<p>Provide for the operation, maintenance and upgrading of FE headquarters-wide network and desktop workstation computer systems and televideo units.</p> <p>FY 2003 and FY 2002 funding provided for the operation, maintenance and upgrading of FE headquarters-wide network and desktop workstation computer systems and televideo units.</p>			
<ul style="list-style-type: none"> Working Capital Fund 	3,617	3,500	3,500
<p>Provides funding for the Departments working capital fund.</p> <p>In FY 2003 and FY 2002, provided funding for the Department's working capital fund.</p>			
<ul style="list-style-type: none"> Small Business and Innovative Research (SBIR) 	0	0	0
<p>Fund SBIR in the amount of \$8,129,0000 from prior year and/or various R&D program funds within the Fossil Energy R&D account.</p> <p>FY 2003 and FY 2002 funded SBIR in the amount of \$7,512,000 and \$11,561,000, respectively, using prior year and/or various R&D program funds with the Fossil Energy R&D account.</p>			
<ul style="list-style-type: none"> Small Business Technology Transfer (STTR) 	0	0	0
<p>Fund STTR in the amount of \$603,000 from prior year and/or various R&D program funds within the Fossil Energy R&D account.</p> <p>FY 2003 and FY 2002 funded STTR in the amount of \$497,000 and \$695,000, respectively, using prior year and/or various R&D program funds with the Fossil Energy R&D account.</p>			
Field Program Direction	67,300	64,880	70,085

Salaries and Benefits..... 33,498 34,305 37,464

Provide funds for NETL staff of 348 FTEs (includes 49 FTE's transferred from the CCT account). Activities of the staff include project management, product development, contract management, and other service activities related to program and site support. It is anticipated that 20 FTEs of the 348 FTEs will be paid via reimbursable agreements, therefore, salaries and benefits associated with these FTEs are not included in the budget estimate.

FY 2003 funding provided for NETL staff of 330 FTEs (includes 49 FTE's transferred from the CCT account). FY 2002 funding provided for NETL staff of 339 FTEs (does not include 49 FTE's funded in CCT account). Activities of the staff include project management, product development, contract management, and other service activities related to program and site support. Nine of the FTEs in both years were paid via reimbursable agreements, therefore, salaries and benefits associated with these FTEs are not included in the budget estimate.

(dollars in thousands)

FY 2002	FY 2003	FY 2004
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Travel..... 1,520 1,434 1,450

Provide funds for travel in support of the above activities in the attainment of program goals, both on the domestic front and abroad.

FY 2003 funding provided for travel in support of the activities stated above. FY 2002 funding provided for Fossil Energy R&D field; at that time Clean Coal Technology travel was funded under the CCT account. Both domestic and international travel were conducted.

Contract Services 32,282 29,141 31,171

Provide funding for facility operations, maintenance, finance, information automation, administrative, management and technical support.

FY 2003 and FY 2002 funding provided for facility operations, maintenance, finance, information automation, administrative, management and technical support. In FY 2002, those activities related to the Clean Coal Technology program were funded under the CCT account.

Total, Program Direction and Management Support .. **86,000 84,700 92,785**

Explanation of Funding Changes

FY 2004 vs. FY 2003 (\$000)

Headquarters Program Direction

■ Mandatory pay increase..... 2,170

■ Increase in Travel	110
■ Increase in Contract Services	600
Field Program Direction	
■ Mandatory pay increase.....	3,159
■ Increase in Travel	16
■ Increase in Contract Services	2,030
Total Funding Change	<u>8,085</u>

Plant and Capital Equipment

Program Mission

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

Funding is requested for general plant projects at the National Energy Technology Laboratory (NETL) sites and the Albany Research Center (ARC). No funding is requested for the 7-year project for construction, renovation, furnishing, and demolition or removal of buildings at NETL facilities in Morgantown, West Virginia, and Pittsburgh, Pennsylvania. General plant projects include repairs, improvements, alteration and additions that are essential to the safe, environmentally acceptable and efficient operations of NETL sites and ARC. Of the 71 government-owned, permanent buildings on the sites, 4 are in "poor" condition (i.e., incapable of supporting research mission requirements), and 18 will reach the end of their expected useful life span of 40 years by 2005. As a result, the budget requests a 50% increase in funds to meet the FY 2004 schedule of funds for Facilities Infrastructure/Renovation. The Department believes that a high priority should be placed on the maintenance and renovation of existing facilities, maximizing the use of the existing capital stock, before more facilities are added.

Funding Profile

(dollars in thousands)

	FY 2002 Comp. Approp.	FY 2003 Request	FY 2004 Base	FY 2004 Request	FY 2004 Request vs. Base	
					\$ Change	% Change
Construction.....	\$13,450	\$2,000	\$2,000	\$3,000	\$1,000	50.0%
Total, Plant and Capital Equipment	\$13,450	\$2,000	\$2,000	\$3,000	\$1,000	50.0%

Funding by Site

(dollars in thousands)

	FY 2002	FY 2003	FY 2004	\$Change	%Change
All Other	\$13,450	\$2,000	\$3,000	\$1,000	50.0%
Total, Plant and Capital Equipment	\$13,450	\$2,000	\$3,000	\$1,000	50.0%

Detailed Program Justification

(dollars in thousands)

	FY 2002	FY 2003	FY 2004
■ GPP at NETL and ARC.....	2,450	2,000	3,000

Provide for General Plant Projects (GPP) at the NETL, and ARC.

FY 2003 and FY 2002 funding provided for General Plant Projects (GPP) at the NETL, and ARC.

(dollars in thousands)

	FY 2002	FY 2003	FY 2004
■ NETL Office/Lab Building	11,000	0	0
No funding is requested for this activity.			
No funding was requested in FY 2003. FY 2002 funding provided for the acquisition of land adjacent to the Morgantown site and for building design. Funds will also be used to renovate several buildings, relocate and renovate several laboratories, demolish and prepare the site for a new building, extend parking facilities and enhanced security measures			
Total, Plant and Capital Equipment	13,450	2,000	3,000

Explanation of Funding Changes

	FY 2004 vs. FY 2003 (\$000)
■ Increase in GPP funding to address urgently need infrastructure repairs	1,000
Total Funding Change	1,000

Advanced Metallurgical Research

Program Mission

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.

Program Strategic Performance Goal

The program's goal is to create public benefits by carrying out long-term, high risk research on materials that are key to the energy industry. Projects are focused on areas where there are large potential public benefits, but where industry would not invest on its own. The program addresses the full life cycle of materials production and cost-effective processing of improved materials through to their disposal and recycling. For example, 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. This is an area where the benefits to any single firm may be too low to attract investment, but will sum to large economic improvements if applied throughout the economy.

Another focus is to develop and demonstrate technologies that will create public benefits by reducing waste and pollution. For example, for the last four years the Program has sought ways to sequester CO₂, a greenhouse gas, by converting it to a stable mineral form; such a process, if proved practical and economic, could contribute to Fossil Energy's goal of a zero emission power plant. Thus, 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.

Performance Indicator

- Demonstrate the development of two cost-effective materials for inclusion in Vision 21 systems developed by the Advanced Metallurgical Processes Program for advanced power systems' applications by obtaining agreements with private and public sector organizations and conducting performance tests in actual full scale systems.
- Provide solutions to environmental emission problems related to fossil energy systems. Reduce projected total process costs for CO₂ sequestration via the formation of mineral carbonates by 10 percent.
- The research at ARC directly contributes to Fossil Energy's objectives by providing information on the performance characteristics of materials being specified for power systems. The Program will publish 15 articles in referred journals, 15 articles in proceedings of National and International

Conferences, and 10 technical reports based upon the research conducted.

- The program at ARC stresses full participation with industry through partnerships and will establish 10 cooperative agreements in FY 2004.

Annual Performance Targets and Results

FY 2002 Results	FY 2003 Updated Targets	FY 2004 Targets
<p>Note: Annual targets for Advanced Metallurgical Research were not proposed prior to FY 2003.</p>	<p>Complete laboratory proof-of-concept testing of ARC developed refractory, and place test panels of the refractory in a commercial gasifier utilizing coal as the primary feedstock.</p> <p>Complete acquisition of engineering data from operation of Prototype I flow-through mineral carbonation reactor, and design a second prototype reactor based on these results.</p> <p>Develop test method for conducting high-temperature, dual environment testing of corrosion-resistant alloys to serve as interconnects in solid oxide fuel cells.</p>	<p>Identify and obtain agreement with a private sector organization to insert 15 refractory bricks into the liner of a single commercial slagging gasifiers that utilizes coal as the primary feedstock over a 6 month period. Refractories for public utility systems constitute less than 1 percent of all refractories produced, with coal gasification systems comprising only a small part of this total. With less than a handful of slagging coal gasifiers for power production in the United States, refractory manufacturers have little incentive to develop materials for a coal gasifier market. Gasifier users identified refractory service life as <i>the</i> most important limitation to on-line availability, and an on-line availability greater than 90 percent needed for widespread commercialization. In collaboration with partners in the refractory industry, develop and produce refractory bricks that have demonstrated at least double average current performance with lifetimes of 3 years for slagging gasifier applications.</p> <p>Develop methods that are</p>

economically and technically feasible for the sequestration of CO₂ as mineral carbonates. Focus research activities to address the technical, economic, and environmental concerns related to mineralization of CO₂.

Construct a Prototype II continuous bench scale mineral carbonation reactor. Operate the system during a 2 month period and produce 10,000 kg of product for environmental and potential by-product characterization. Complete the bench scale demonstration of the potential for in-situ mineral carbonation on bulk Columbia River Basalt Group (CRBG) samples.

Develop and produce a metallic interconnect material which reduces current materials' costs by 80 percent, has at least 25,000 hours of service lifetime, and meets all mechanical and electrical properties for solid state fuel cell applications up to 800⁰ C. Produce a 50lb ingot of a candidate material rolled into 30 to 60 feet of sheet material for prototype testing.

Evaluate potential for prototype micro-channel reactors with embedded catalyst-coated membranes in reformer and/or hydrogen filter applications. Conduct a minimum of 10 tests on a single optimized substrate/coating configuration with the goal of producing 2 prototypes for additional testing.

Funding Profile

(dollars in thousands)

	FY 2002 Comp. Approp.	FY 2003 Request	FY 2004 Base	FY 2004 Request	FY 2004	
					Request vs. Base	
					\$ Change	% Change
Advanced Metallurgical Research	5,200	5,300	5,300	10,000	4,700	88.7%
Total, Advanced Metallurgical Research	\$5,200	\$5,300	\$5,300	\$10,000	\$4,700	88.7%

Funding by Site

(dollars in thousands)

	FY 2002	FY 2003	FY 2004	\$Change	%Change
All Other	5,200	5,300	10,000	4,700	88.7%
Total, Advanced Metallurgical Research	\$5,200	\$5,300	\$10,000	\$4,700	88.7%

Site Description

All Other

The Department's Advanced Metallurgical Research program, within the Fossil Energy and Development program, currently funds research at the Albany Research Center (ARC), located in Albany, Oregon. ARC is a DOE-owned and operated laboratory authorized to conduct Advanced Metallurgical Processes research. ARC's function is to conduct research in support of FE programs with the aim of developing, testing, and transferring advanced materials technologies for energy systems.

Detailed Program Justification

(dollars in thousands)

	FY 2002	FY 2003	FY 2004
Advanced Metallurgical Research	5,200	5,300	10,000
■ Advanced Metallurgical Processes	5,148	5,247	9,900

Continue research to contribute to Fossil Energy's Vision 21 Systems by extending component service lifetimes through the improvement and protection of current materials, by the design of new materials, and by defining the service operating conditions for new materials in order to ensure their safe and effective use. Emphasis is placed on high-temperature erosion testing and modeling in environments anticipated for Vision 21 concepts, on the development of sulfidation/oxidation resistant materials, and development and repair of refractory materials, for coal gasifiers. The Albany Research Center will participate in an effort to develop, fabricate and evaluate the performance of materials to be used in solid oxide fuel cell applications. These could include metallic interconnects, seals, heat exchanger materials and reformer materials to support

the Solid State Energy Conversion Alliance's (SECA's) goal of significantly reducing the cost of producing commercial, environmentally friendly solid oxide fuel cells. Continue research focused on developing an economically and environmentally acceptable integrated process for disposal of carbon dioxide. Emphasis is placed on mineral carbonation to improve the kinetics and to address total system issues such as engineering feasibility, system costs, and the impact of the total approach on the true net environment impact. *Participants include: ARC.*

FY 2003 and FY 2002 funding continued development of advanced refractories for IGCC applications, CO₂ sequestration via mineral carbonation, advanced austenitic steels, and microchannel reactors for reformer and heat exchanger applications. *Participants included: ARC*

(dollars in thousands)

	FY 2002	FY 2003	FY 2004
■ Program Support	52	53	100
Fund technical and program management support.			
Total, Advanced Metallurgical Research	5,200	5,300	10,000

Explanation of Funding Changes

	FY 2004 vs. FY 2003 (\$000)
■ Increase in Advanced Metallurgical Processes due to initiation of fuel cell and in-situ mineral carbonation research efforts	4,653
■ Program Support	47
Total Funding Change	4,700

