

GAO

Fact Sheet for the Chairman
Subcommittee on Energy and Power
Committee on Energy and Commerce
House of Representatives

June 1989

FOSSIL FUELS

Status of DOE-Funded Clean Coal Technology Projects as of March 15, 1989



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Resources, Community, and
Economic Development Division

B-230504

June 29, 1989

The Honorable Philip R. Sharp
Chairman, Subcommittee on
Energy and Power
Committee on Energy and Commerce
House of Representatives

Dear Mr. Chairman:

On April 13, 1989, we testified before your Subcommittee on the status of the nine demonstration projects that the Department of Energy (DOE) has funded under the Clean Coal Technology (CCT) program (GAO/T-RCED-89-25).¹ As subsequently requested by your office, this fact sheet provides a more detailed discussion on the status of each of these projects as of March 15, 1989.

In summary, as stated in our testimony, seven of the nine funded clean coal technology projects were not progressing as planned. Furthermore, DOE does not yet know the effect these delays will have on estimated project completion dates and DOE's share of total project costs. Specifically, the seven projects were experiencing coordination, equipment, and financing problems that caused delays in completing project phases, cost overruns, and proposed project modifications. The other two projects that were funded in late 1988 to replace withdrawn proposals were on schedule and were not experiencing cost increases. Appendix I discusses the status of the nine projects. Appendix II lists the projects, their sponsors, and estimated costs.

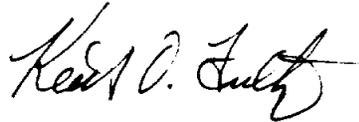
To update the status of the projects, we reviewed DOE project files and interviewed DOE's Pittsburgh, Pennsylvania, and Morgantown, West Virginia, Energy Technology Centers' program officials who monitor the funded projects. We did not contact the projects' sponsors. We discussed the factual information with DOE officials responsible for the CCT program and incorporated their comments where appropriate.

¹Our March report, Fossil Fuels: Commercializing Clean Coal Technologies (GAO/RCED-89-80, Mar. 29, 1989), discussed the status of these projects through December 31, 1988. Our testimony updated the status as of March 15, 1989.

B-230504

As arranged with your office, we plan to distribute copies of this fact sheet to the Secretary of Energy and other interested parties. Please call me at (202) 275-1441 if you have any questions about this fact sheet. Major contributors are listed in appendix III.

Sincerely yours,

A handwritten signature in black ink, appearing to read "Keith O. Fultz". The signature is written in a cursive style with a large, sweeping initial "K".

Keith O. Fultz
Director, Energy Issues

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ABBREVIATIONS

CCT	Clean Coal Technology
DOE	Department of Energy
EPA	Environmental Protection Agency
GAO	General Accounting Office

STATUS OF FUNDED CLEAN COAL TECHNOLOGYPROJECTS AS OF MARCH 15, 1989

As of March 15, 1989, DOE had funded nine projects designed to encourage the commercialization of emerging clean coal technologies by providing federal funding of up to 50 percent of a demonstration project's cost. Industry and other nonfederal sources provide the balance of project financing. Each project consists of three major phases for which DOE can provide funding: (1) project design and permitting, (2) construction and startup, and (3) operation (demonstration). As of March 15, 1989, five of the nine funded projects were in the design and permitting phase, one project was concurrently in design and construction, and three projects were in the demonstration phase. A summary of the status of the nine projects follows.

ADVANCED CYCLONE COMBUSTOR PROJECT

In March 1987, DOE and the Coal Tech Corporation (Coal Tech) of Marion, Pennsylvania, entered into an agreement to demonstrate Coal Tech's advanced cyclone combustor in retrofit applications. Standard combustors, or burners, attached to boilers mix air with coal, provide ignition, and discharge the burning mixture into the boiler, heating water to produce steam. Coal Tech's advanced cyclone combustor, which will replace a standard burner, removes ash in liquid form before discharging the mixture into the boiler for final combustion. The cyclone uses multistage burning to control nitrogen oxide emissions. Sulfur is removed by two separate sorbent mechanisms inside the combustor or by injecting a sorbent into the boiler.¹

When the agreement was signed, the project was expected to be completed by March 1989 and to cost about \$786,000. DOE's share was about \$393,000, or 50 percent. However, the project will not be completed within these estimates. In the fall of 1987, the agreement was modified to transfer about \$38,000 from the project's demonstration phase to its construction phase to cover cost overruns. In February 1989, DOE approved a modification to the agreement extending the project's completion date by 3-1/2 months (to June 1989) because of equipment operating problems. In late February 1989, Coal Tech submitted a request to DOE for additional funding to extend the project's completion date by

¹A sorbent is an agent that chemically reacts with and neutralizes sulfur dioxide emissions during the burning of coal.

another 6 months (to Dec. 1989). This extension, which was under consideration by DOE as of March 15, 1989, would add about \$200,000 to the project's cost. According to the terms of the agreement, DOE, at its discretion, can fund up to about \$100,000 of this request.

According to program officials at DOE's Energy Technology Center in Pittsburgh, Pennsylvania, problems in feeding coal to the boiler and ash buildup in the combustor have resulted in some modifications to the project's design and prevented Coal Tech from achieving the project's demonstration goal of burning 1 ton of coal per hour. The officials told us that the combustor has burned coal at the rate of one-half ton per hour with positive emissions reductions. However, the design rate of 1 ton per hour must be achieved and maintained to adequately demonstrate the project. If the extension is approved, it will permit the completion of an additional 300 hours of testing.

UNDERGROUND COAL GASIFICATION PROJECT

In December 1987, DOE and Energy International, Inc., of Pittsburgh, Pennsylvania, entered into an agreement to design, build, and operate a commercial ammonia/urea² plant about 8 miles west of Rawlins, Wyoming. The plant will be supplied with gas produced by underground coal gasification--a process which burns coal to decompose and gasify additional coal to produce fuel.

This project has had persistent financing problems. Although this project was selected for the program in July 1986, the agreement was not signed until December 1987 because Energy International had difficulty in financing the project. When the agreement was signed, the private financing was contingent on Congress' extending a nonconventional fuels production investment tax credit, which was signed into law in November 1988. As of March 15, 1989, 4 months after the extension of the investment tax credit, the private financiers had not agreed to back the project. According to a program official at DOE's Energy Technology Center in Morgantown, West Virginia, the financiers believe that, even with this extension, Energy International will not be able to produce fuel in time to qualify for this credit, which could affect the project's economic viability and Energy International's ability to repay the financiers.

When the agreement was signed, the project was expected to be completed by March 1991. However, the project's design completion

²A basic nitrogenous compound used in plastics and fertilizers.

date has been extended about 15-1/2 months, and the start of the construction phase, which was originally scheduled to begin in March 1988, is already more than 1 year behind schedule. This slippage occurred because Energy International could not start the construction phase until it secured adequate private financing to build and operate the project. According to DOE officials, a decision on extending the project's estimated completion date will not be made until Energy International secures adequate financing for the project.

Project costs have also increased. The project was expected to cost \$70.1 million, of which DOE's share was about \$11.8 million, or 16.8 percent. However, the project agreement has been modified three times to reflect cost increases of about \$43 million (\$1.9 million for design, \$42 million for construction, and \$500,000 less for demonstration). These modifications were primarily necessary because the project was redesigned to gasify more coal. DOE had transferred about \$500,000 of its funds that were earmarked for the project's construction phase to cover cost increases in the design phase. This shifting of funds will not increase DOE's \$11.8 million commitment to the project. Under the agreement, Energy International is required to finance total project costs exceeding the \$70.1 million estimate.

LIMESTONE INJECTION
MULTISTAGE BURNER PROJECT

In June 1987, DOE and the Babcock and Wilcox Company of Alliance, Ohio, entered into an agreement for taking over and extending an Environmental Protection Agency (EPA)-funded limestone injection multistage burner demonstration project at the Ohio Edison Edgewater Plant in Lorain, Ohio. The project will inject a sorbent into the boiler and the exhaust to control sulfur dioxide emissions. Low nitrogen oxide burners will be used to control nitrogen oxide emissions. These burners, which can replace conventional coal burners, control nitrogen oxide emissions by injecting coal and air so that combustion takes place in an oxygen-deficient environment. Additional air is added in a second stage to complete the combustion process.

The EPA-funded project was designed to use one coal and sorbent combination, while the DOE-funded project will demonstrate the process with different coals and sorbents. The DOE-funded project will also demonstrate a process (Coolside process) in which a sorbent and water are injected into the exhaust.

When DOE signed the agreement, the project was estimated to be completed by December 1990 and to cost about \$19 million. DOE's share was about \$8 million, or 39.1 percent. According to

Pittsburgh center program officials, the project's completion date will slip 3 to 4 months because of delays in completing testing under the EPA project. This delayed construction of the Coolside equipment and the start of the DOE-funded project's demonstration phase, which was to begin in October 1988. A revised completion date for the DOE-funded project had not been established.

In January 1989, DOE modified the agreement to transfer about \$550,000 from the project's construction phase to its design phase to cover cost overruns. This transfer involved about \$130,000 of DOE funds and about \$420,000 of the sponsor's funds. DOE program officials told us in April 1989 that they anticipated an additional cost overrun of up to \$250,000 for the project's design and construction phases, but would not have a more precise estimate for several months. They also said that they did not know whether the project's total cost would increase because of the delays.

In March 1989, DOE authorized Babcock and Wilcox to start the project's demonstration phase. The demonstration phase is scheduled to run 2 years, including 6 months for reporting and dismantling the equipment after testing is completed.

GAS REBURNING/SORBENT
INJECTION PROJECT

In July 1987, DOE and the Energy and Environmental Research Corporation of Irvine, California, entered into an agreement to demonstrate that sorbent injection and gas reburning controls sulfur oxide and nitrogen oxide emissions and is suitable for retrofit applications. The technology will be demonstrated on three different types of boilers owned by three utilities. These three boiler types represent most of the coal-fired boilers used by utilities in the United States.

The project will use sorbent injection to control sulfur dioxide emissions and gas reburning to control nitrogen oxide emissions. Gas reburning divides the combustion process into three stages: (1) the primary stage, where coal is burned with only enough air for combustion, (2) the reburning stage, where natural gas is injected to produce an oxygen-deficient condition that converts some of the nitrogen oxide emissions to nitrogen, and (3) the burnout stage, where air is injected to burn the remaining fuel.

When the agreement was signed, the project was expected to take 4-1/2 years (to Dec. 1991) and cost about \$30 million. DOE's share was to be about \$15 million, or 50 percent. However, both the project's schedule and cost are being revised.

The project's design for all three sites was to have been completed in October 1988. In July 1988, the sponsor requested a 6-month extension to April 1989, which DOE approved. According to the Pittsburgh center's Program Director, the extension was needed to satisfy federal environmental requirements and to resolve coordination problems with the three utilities. In addition, the sponsor had projected a cost overrun in the project's design phase because of these problems.

In December 1988, the sponsor deferred design work and proposed changing the project to reduce costs. The sponsor had projected a total project cost increase of \$13 million to \$15 million on the basis of firmer cost estimates as the detailed design work progressed. Pittsburgh center program officials said that they have discussed the matter with the sponsor and that, in March 1989, they requested the sponsor to prepare a formal proposal discussing options and recommendations to reduce the project's cost. DOE expected to receive this proposal in April 1989, and indicated that the sponsor would recommend deferring work at one utility site. According to DOE, this would reduce the project's cost to about \$28 million, or about \$2 million less than originally estimated. However, because the demonstrations at the three sites are to be started at different times, DOE officials said that they did not know what effect, if any, this change would have on the project's estimated completion date.

On March 13, 1989, DOE modified the agreement to transfer about \$1.2 million from the project's demonstration phase to its design phase to cover design cost increases. This modification also extended the design phase to October 1989 to allow time for the sponsor to restructure the project and complete the design work. DOE and the sponsor shared equally in this transfer of project funds. The transfer increased the project's design phase cost estimate from \$3.5 million to \$4.7 million.

TIDD PRESSURIZED FLUIDIZED-BED COMBUSTOR PROJECT

In March 1987, DOE and the Ohio Power Company of Columbus, Ohio (a subsidiary of American Electric Power), entered into an agreement to design, construct, and operate a pressurized fluidized-bed combustion combined cycle plant. The project will repower the Ohio Power Company's Tidd facility in Brilliant, Ohio, and will utilize many of the plant's existing components.

A fluidized-bed combustor, or burner, consists of pulverized coal with air flowing, at about 3 feet per second, through it to maintain the coal in a turbulent suspended state while it is burned. Sulfur dioxide emissions are reduced by adding a sorbent

to the combustor. In addition, since it operates at a lower temperature than a conventional coal burner, it produces about one-half the nitrogen oxide emissions. Pressurizing the combustor permits its exhaust gases to be used to power a gas turbine to produce electricity, while the steam generated by it drives a steam turbine producing electricity, thus, the term "combined cycle."

When the agreement was signed, the project was expected to take 6 years (to Mar. 1993) and cost \$167.5 million. DOE's share was about \$60.2 million, or 35.9 percent. However, the project's completion date and total cost estimates have been revised.

Before DOE can sign an agreement, it must submit a project report to the Congress and allow time for congressional review. After signing the agreement, Ohio Power waited about 3 months until DOE signed the agreement before finalizing an order with an equipment vendor. As a result, Ohio Power lost its position in the vendor's production schedule, which delayed delivery and installation of the equipment by about 7 months. This delay has increased the project's estimated cost by \$2.5 million (to \$170 million) and extended its estimated completion date by 7 months (to Oct. 1993).

As of March 15, 1989, Ohio Power projected an additional 6-percent cost overrun (\$10.2 million) because of inflation and more firm cost estimates. Under the terms of the agreement, Ohio Power is responsible for all cost overruns. According to a Morgantown center program official, the project was proceeding in accordance with its revised schedule.

ADVANCED COAL GASIFICATION COMBINED CYCLE POWER GENERATION PROJECT

In January 1988, M.W. Kellogg Company of Houston, Texas, and Bechtel Development Company of San Francisco, California, entered into an agreement with DOE to design, build, and operate an advanced integrated gasification combined cycle power generation plant near Johnstown, Pennsylvania. In the gasification process, crushed coal, limestone, air, and steam are fed into a gasifier, which converts the mixture to a gas. A sorbent is used in the process to remove sulfur dioxide.

The project was designed to convert 551 tons of coal per day into a fuel for burning in a turbine generator to produce electricity. In addition, steam produced by heat from the turbine's exhaust and from the gasification process is used to power a steam turbine generator and produce additional electric power. The sponsors planned on selling the electricity produced by the plant to a utility.

When the agreement was signed, the project was to take 5-3/4 years (to Oct. 1993) and cost about \$244 million. DOE's share was \$87.5 million, or 36 percent. However, DOE amended the agreement three times to extend the completion date for the project's preliminary engineering and analysis design phase by a total of 9 months (from July 1988 to Apr. 1989). In addition, DOE modified the agreement twice (in July and Sept. 1988) to transfer \$800,000 from the project's detailed design phase to its preliminary engineering and analysis design phase. The transferred funds were equally divided between DOE and the sponsors.

According to the Morgantown center's Deputy Program Director, the slippage occurred because the sponsors were unable to formalize an agreement, as planned, with an electric utility company to buy the power generated by the plant. This agreement was needed before DOE would permit the project to proceed to its preliminary design and permitting phase, which was to have begun in July 1988 and to last until early 1989.

In November 1988, citing better economic and market advantages, the sponsors requested DOE's approval to redesign the project. Rather than building a complete power station in Pennsylvania, the sponsors proposed repowering an existing power plant in New York with an integrated gasification combined cycle power unit. In addition, the plant would be owned and operated by the utility, not the sponsors. The sponsors estimated that the total project costs would decrease by about 25 percent (to about \$190 million) since existing facilities and equipment would be used, rather than a new power plant. This change could also reduce the time required for the project's construction.

In February 1989, DOE requested additional information from the sponsors to evaluate their proposal. This information was to be submitted to DOE in mid-April 1989. If the proposal is approved, a revised project schedule and cost estimate will be prepared. However, according to a center official, DOE's contribution to the project's cost would not be reduced, but would remain at \$87.5 million.

PROTOTYPE COMMERCIAL
COAL/OIL COPROCESSING PROJECT

In December 1987, DOE and Ohio Ontario Clean Fuels, Inc., of Warren, Ohio, entered into an agreement to design, build, and operate a prototype commercial coal/oil coprocessing plant in Warren, Ohio. The project will simultaneously liquefy coal and upgrade heavy residual oils to produce liquid fuels that are low in sulfur, nitrogen, and trace metals and high in heating value. Although these fuels can be used either directly as utility boiler

fuel to generate electricity or refined for transportation use, Ohio Ontario planned to sell the fuels to refineries.

When the agreement was signed, the project was expected to last 7 years (to Dec. 1994) and had an estimated cost of about \$226 million. DOE's share was \$45 million, or about 20 percent. However, as of March 15, 1989, Ohio Ontario was revising the project's schedule and cost estimates.

Final project design was to start in the fourth quarter of 1988, but had not begun as of March 15, 1989. According to the Pittsburgh center's Program Director, the project was behind schedule because of Ohio Ontario's slow start and regulatory and economic problems. Because Ohio Ontario was having difficulty in obtaining the necessary environmental permits for the project site, it did not want to do extensive design work for that site and then, if the permits could not be obtained, have to do the same design work for another site. In addition, the estimated costs of distributing the produced fuels had increased significantly, thereby affecting the project's economic viability.

In December 1988, Ohio Ontario proposed to DOE that it would enter into an agreement with a utility to burn the plant's fuels rather than sell the fuels on the open market to refineries. Such an arrangement would provide Ohio Ontario with a user for the fuels as well as a site for the demonstration project, since the project would be built at the utility's location. In February 1989, Ohio Ontario and DOE agreed that Ohio Ontario would submit a formal proposal for restructuring the project (with revised project milestone schedules, cost estimates, and third-party agreements) by June 1989.

Although DOE officials had projected in November 1988 that the project's completion date would slip to January 1996 (about 13 months), they have since indicated that a revised date would not be established until they review the sponsor's proposal for restructuring the project.

CIRCULATING FLUIDIZED-BED COMBUSTOR PROJECT

In October 1988, DOE and the Colorado-Ute Electric Association, Inc., of Montrose, Colorado, entered into an agreement to demonstrate a circulating fluidized-bed combustion boiler, which had been installed in May 1987 at the sponsor's Nucla generating station. Under the agreement, DOE is to share in the cost of demonstrating and evaluating this boiler. This is a replacement project, which was selected for the program in October 1987.

This technology burns coal at a relatively low temperature, which reduces nitrogen oxide emissions, and uses a sorbent to control sulfur dioxide emissions. In addition, the unburned coal, sorbent, and fly ash are removed from the exhaust gases and recycled to the combustor for increased efficiency.

When the agreement was signed, the project's demonstration was estimated to take nearly 2 years (to Aug. 1990) and cost about \$54.1 million. DOE's share was about \$20 million, or 37 percent. According to a Morgantown center program official, the project encountered some equipment operating problems in early 1989. However, by mid-February 1989, the problems had been corrected, and the plant was operating again. Despite the operating problems, the Morgantown center official did not expect the project's completion date or cost estimate to change because some flexibility is built into the project's schedule to accommodate some slippages. As of March 15, 1989, Colorado-Ute was conducting performance tests at the plant.

ADVANCED SLAGGING
COMBUSTOR PROJECT

This replacement project was also selected for the program in October 1987. In November 1988, DOE and TRW, Inc., of Redondo Beach, California, entered into an agreement to demonstrate TRW's advanced slagging combustor at a commercial electric utility site in Stony Point, New York, and at TRW's industrial-scale slagging combustor test facility in Cleveland, Ohio.

TRW's combustor will replace a standard combustor and control sulfur and nitrogen oxide pollutants. A sorbent is injected into the combustor to control sulfur emissions. Nitrogen oxide pollutants are reduced by burning coal in staged combustion. In addition, the coal ash is removed from the combustor in liquid form before final combustion takes place inside the boiler.

When the agreement was signed, the project was expected to take 3 years (to Sept. 1991) and cost about \$49 million. DOE's share was about \$24 million, or 48 percent. According to Pittsburgh center program officials, as of March 15, 1989, the project was in its design stage and proceeding on schedule.

FUNDED CLEAN COAL TECHNOLOGY DEMONSTRATION PROJECTS,
SPONSORS, AND ESTIMATED COSTS AS OF MARCH 15, 1989

<u>Project</u>	<u>Sponsor</u>	<u>Estimated project costs</u>	
		<u>DOE</u>	<u>Sponsor</u>
		(millions)	
Advanced cyclone combustor ^a	Coal Tech Corp.	\$ 0.4	\$ 0.4
Underground coal gasification	Energy International, Inc.	11.8	101.4
Limestone injection multistage burner	The Babcock and Wilcox Co.	7.6	11.8
Gas reburning/sorbent injection ^a	Energy and Environmental Research Corp.	15.0	15.0
Tidd pressurized fluidized-bed combustor ^a	Ohio Power Co. ^b	60.2	109.8
Advanced coal gasification combined cycle power generation project ^a	The M.W. Kellogg Co. and Bechtel Development Co.	87.5	156.3
Prototype commercial coal/oil coprocessing project ^a	Ohio Ontario Clean Fuels, Inc.	45.0	180.7
Circulating fluidized-bed combustor ^c	Colorado-Ute Electric Association, Inc.	19.9	34.2

<u>Project</u>	<u>Sponsor</u>	<u>Estimated project costs</u>	
		<u>DOE</u>	<u>Sponsor</u>
		(millions)	
Advanced slagging combustor ^c	TRW, Inc.	<u>23.5</u>	<u>25.5</u>
Total		<u>\$270.9</u>	<u>\$635.1</u>

^aEstimated costs likely to change because of projected cost increases or project restructuring.

^bOhio Power Company is a subsidiary of American Electric Power.

^cReplacement project.

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