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Comprehensive Report to Congress

Clean Coal Technology Program Completing the Mission

U.S. Department of Energy
Assistant Secretary for Fossil Energy
Office of Clean Coal Technology
Washington, D.C. 20585

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EXECUTIVE SUMMARY

The Clean Coal Technology Demonstration Program today stands as a model of a successful Government/industry partnership for technology development and commercialization. Since its inception in 1986, this unique, cost shared program has created 45 projects in 21 states valued at nearly \$7 billion. This joint public/private investment is helping to ensure that the U.S. can continue to use its most abundant domestic resource, coal, while protecting the environment. The program also promises significant worldwide benefit for many U.S. companies.

The Clean Coal Demonstration Program supports three substantive national objectives:

- o ensuring a sustainable environment through technology improvements,
- o enhancing energy efficiency and reliability, and
- o providing opportunities for economic growth and employment.

The commitment of industry to these goals is evidenced by its contribution of two dollars for every Government dollar invested. If the technologies are successfully replicated, the Government will share in the revenues from future commercialization.

With its roots in the acid rain debate of the 1980's, the Clean Coal Technology Demonstration Program initially emphasized acid rain abatement technologies in its early phases. With the subsequent passage of the Clean Air Act Amendments and growing concern with global climate change, the emphasis of the Program shifted in the later rounds to highly efficient technologies.

Today, the Clean Coal Technology Program stands at its mid-point. Many of the earlier projects, chiefly environmental retrofit technologies, are generating data or have completed their test programs. The larger projects, new, highly advanced power generating systems, are at the point of design completion with several now moving into construction. By the time utilities need to make

decisions about new power capacity after 2000, several prototype demonstration power systems will be operating and generating first-of-a-kind data.

Congress requested this report, in part, to determine the need for a continued federal role in clean coal technology development, including the possibility of a sixth round of competition.

In the judgment of DOE, the 45 projects that today comprise the Clean Coal Technology Program provide a sufficiently wide range of applications to meet U.S. energy needs. Therefore, an expansion of the current demonstration program in the form of an additional round of competition is not recommended.

At the same time, DOE believes that an analysis of a continued Government role in clean coal technology development will be needed. While the program has been successful at the demonstration stage, full commercial implementation may require some continued Government role.

In its role of encouraging commercial replication of the technologies in this program, DOE has undertaken an effort to better define the potential market for clean coal technologies. Since electric power generation accounts for roughly 85 percent of domestic coal use, that segment of the economy has been the focus. A DOE team has held a series of "Executive Seminars" with the CEO-level of investor owned utilities, nonutility generators, public service commissions, and the financial community. DOE has gained important insight into the decision making process that will lead to the adoption of clean coal technologies.

These discussions, along with both industry and EIA projections, strongly indicate that significant baseload electric power capacity will be needed early in the first decade of the next century. Coal continues to be a primary option for baseload capacity because of its low cost and reliability of supply. At the same time, the industry will face increasingly stringent environmental regulations. These factors will lead to a strong market for clean coal technologies. Those interviewed gave the Clean Coal Technology Program high marks for demonstrating the technologies that will be needed at that time.

The discussions also indicate that, even with clear potential benefits, some barriers to commercial acceptance of clean coal technologies remain. Commercial acceptance of clean coal technologies will require a continued, although refocused, Government role.

As requested by Congress, this report provides a comprehensive accounting of balances that remain uncommitted from the \$2,747,595,000 that has been appropriated to this program. Current contractual commitments (Project Commitments) account for \$2,396,871,000, with \$110,527,00 for program administration (Program Direction) through the end of fiscal year 1994, and \$38,176,000 for the Small Business and Innovative Research and Small Business Technology Transfer Programs. The balance of \$202,021,000 will be used to fund cost growth for the current 45 projects as well as Program Direction for the remainder of the program.

The financial situation, however, is not as straightforward as these numbers may indicate. Since Congress recognized the need for limited Government participation in cost growth, DOE faces several major funding go/no-go decisions in the next several years. These decisions will have a significant effect on the availability of uncommitted balances.

To better understand the funding implications of these future decisions, DOE has analyzed the funding requirements to complete the program as defined by the 45 projects. Uncertainties over total project costs and the possible termination of projects are incorporated into the analysis by using a statistical "risk pool" approach common to the insurance industry. From this analysis, DOE concludes that it can meet its project funding commitments, participate in a limited way in cost overruns, and have between 0 and \$300 million remaining. The assessment shows that the most probable scenario is that \$150 million would be available both to fund new initiatives and provide program direction in the out years.

With the expected balance of funds from current appropriations, DOE recommends that Congress initially establish an International Technology Transfer Program as outlined in Chapter 5. DOE will also analyze the merits of various commercial incentives (such as financial, tax, and buydown as described in Chapter 5) as means of transferring Clean Coal Technologies to the commercial

marketplace. A great deal has been, and will continue to be, learned from the 45 demonstration projects. The technical and financial risk for future commercial facilities, however, has not been completely eliminated. These programs will help to accelerate the commercial adoption of the Clean Coal Technologies, with their ensuing environmental benefits, in the U.S. and throughout the world.

The highest priority for DOE is the completion of the 45 projects currently in the program. Incremental funding, on a "funds available" basis, will allow these efforts to proceed without new appropriations. DOE does not intend to terminate any project or deny any otherwise acceptable request for cost growth to fund these initiatives. Experience to date and the nature of first-of-a-kind demonstrations, however, suggest that it is not likely that all of the 45 projects will continue to completion.

These initiatives will build on the strong foundation of the current demonstration program and help complete the mission of the Clean Coal Technology Program as outlined by Congress in 1986. By continuing this Government/industry partnership, the private sector will be in the position of meeting the challenges of stricter environmental regulations and the need for new baseload capacity.

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CHAPTER 1

INTRODUCTION

The Conference Report accompanying Public Law 102-154, "An Act Making Appropriations for the Department of Interior and Related Agencies, for the Fiscal Year Ending September 30, 1992, and for Other Purposes," requested the Department of Energy to submit a report no later than May 1, 1994, indicating the balances that would be available from the previous appropriations in the Clean Coal Technology (CCT) Program. The Conference Report is dated October 17, 1991, and states:

The managers have agreed to delete bill language regarding a sixth round of proposals, but agree that funding will be provided for a sixth round based on unobligated and unneeded amounts that may be available from the previous five rounds. The report from the Secretary on available funds, which was originally in the Senate amendment, is still a requirement and such report should be submitted to the House and Senate Committees on Appropriations not later than May 1, 1994. Based on that report, the funding, dates and conditions for the sixth round will be included in the fiscal year 1995 appropriation.

The report from the Senate Committee on Appropriations, dated July 25, 1991 states:

The Committee has also included language requiring the administration to conduct a sixth clean coal technology solicitation on February 1, 1994. Funding for the solicitation would be provided from funds appropriated for, but not used in, earlier solicitations. The Secretary is directed to submit a report to the Congress on November 1, 1993, indicating what balances would be available for this solicitation.

This report responds to the request contained in the Conference Report. In addition, this report gives a status of the entire CCT Program, the options available for continuing the program, and recommendations on the Government role in continuing the commercial development of the technologies being demonstrated in the program.

ORGANIZATION OF THIS REPORT

This report is divided into six chapters.

Chapter 1 introduces the report.

Chapter 2 provides a background of the CCT Program including the legislative history, the projects currently in the program, and the lessons that have been learned from the five rounds to date.

Chapter 3 discusses the commercial potential of the technologies represented in the program and is based on a continuing series of interviews that have been conducted by the Department of Energy to solicit the views of senior management in those companies and organizations that will be making or affecting commercial decisions on the use of these technologies.

Chapter 4 provides an accounting of the funds that have been appropriated for the CCT Program.

Chapter 5 presents the options available for the Government to further assist in the commercial implementation of these technologies.

Chapter 6 presents a discussion of these options with recommendations.

CHAPTER 2

CLEAN COAL TECHNOLOGY PROGRAM DESCRIPTION

Program Overview

The U.S. Congress laid the foundation for the Clean Coal Technology Program in the early 1980's as it sought to reconcile concerns with the Nation's air quality and the economic benefits of coal-based power production. Domestic availability, reliability of supply, low and stable costs, and a large and increasingly productive work force had made coal the fuel of choice for electric power production in the United States, providing nearly 60 percent of the total supply. As both domestic and international concerns with sulfur dioxide and nitrogen oxide emissions associated with acid deposition grew, however, coal's position was becoming increasingly vulnerable.

At the time, attempts to resolve concerns about acid rain involved extremely high costs and/or major economic dislocations to regions of the U.S which relied on high sulfur coal for power production and economic stability. Congress saw a potential solution that could achieve an improved environment without sacrificing economic growth. That solution was clean coal technology.

While these technologies were emerging from government and industry laboratories, the Nation lacked a mechanism for moving these technologies into the commercial marketplace. The role of Government in technology development at the time was limited to support of basic, high risk research. With a risk averse, regulated utility industry as the major potential customers of clean coal technologies, the Nation lacked a mechanism for moving these technologies into the commercial marketplace. To help fill that gap, Congress directed the Department of Energy to initiate a unique Government/industry partnership by providing \$400 million (from funds previously earmarked for the Synthetic Fuels Corporation) to cost share in the construction and operation of a number commercial scale clean coal technology demonstration facilities. These first-of-a-kind demonstrations were intended, when successful, to lead to widespread commercial use of the most promising technologies.

DOE implemented the Congressional directive with a competitive solicitation that focused rather broadly on projects that would demonstrate the environmental acceptability of coal. The solicitation was issued in January, 1986 and winning projects were selected in July of that year. The solicitation later became known as Round One of the Clean Coal Technology Program.

Joint Envoys Report

As the Department prepared to implement the first round, Joint Envoys appointed by the United States and Canada held a series of discussions on ways to reduce the impact of acid rain causing emissions originating in the U.S. and moving into Canada. In January, 1986, the Envoys issued their recommendations¹. In this report, the Joint Envoys affirmed the conclusion already made by the U.S. Congress that cost shared demonstrations of clean coal technologies would be the key to bringing these technologies to the marketplace and resolving acid rain concerns. In their major recommendation, the Envoys said, in part, that:

If the menu of control options was expanded, and if the new options were significantly cheaper, yet highly efficient, it would be easier to formulate an acid rain control plan that would have broader public appeal ... the U.S. government should implement a five-year, five billion dollar control technology commercial demonstration program. The federal government should provide half the funding -- 2.5 billion dollars -- for projects which industry recommends, and for which industry is prepared to contribute the other half of the funding.

The Administration subsequently endorsed the recommendation for a multibillion dollar demonstration program recommended in the report. The Congress subsequently appropriated, in advance over the next several years, an additional \$2.35 billion to complete the five round program. Table 1 presents the timing of the five solicitations in the Clean Coal Technology Program.

¹ Lewis, Drew and William Davis, Joint Report of the Special Envoys on Acid Rain, January, 1986

TABLE 1
SCHEDULE OF CCT SOLICITATIONS

	Congressional Authorization	Final PON Release	Proposal Submittals	Selection
CCT-I	Dec. 19, 1985	Feb. 17, 1986	Apr. 18, 1986	Jul. 24, 1986
CCT-II	Dec. 22, 1987	Feb. 22, 1988	May 23, 1988	Sep. 27, 1988
CCT-III	Sep. 27, 1988	May 1, 1989	Aug. 29, 1989	Dec. 19, 1989
CCT-IV	Oct. 23, 1989	Jan. 19, 1991	May 17, 1991	Sep. 12, 1991
CCT-V	Oct. 23, 1989	Jul. 6, 1992	Dec. 7, 1992	May 4, 1993

The willingness of the Congress to "advance appropriate" funds for all five rounds of the program has been critical to the attracting of the strong industry cost shared investment. Even though annual adjustments have been made, industry had strong confidence in the commitment of the Government to fund fully each Round before it made major funding commitments. Without such a commitment, it is doubtful that the high level of cost sharing or the requisite financing and regulatory approval for these projects would have been attained. Table 2 shows annual appropriations by Round.

In accordance with the recommendations of the Joint Envoys and additional Congressional guidance, Rounds Two and Three of the Clean Coal Technology Program focused on effective and economical technologies for controlling SO₂ and NO_x from existing facilities. As Rounds Two and Three were being implemented, Congress debated and enacted the 1990 Clean Air Act Amendments which set a regulatory framework around the new technologies already being demonstrated. As a result of these early demonstrations, more than 20 new technological options for reducing acid rain precursors will have been demonstrated by the time the first phase of the Clean Air Act Amendments will go into effect in 1995.

With the new Clean Air law in hand, Congress and DOE both recognized a need to provide the remaining rounds with a slightly different focus, namely, the need

TABLE 2
CCT PROGRAM FUNDING BY APPROPRIATION
(Dollars in Thousands)

Fiscal Year	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	Total
Adjusted Appropriations¹												
P.L. 99-190	99,400	149,100	149,100									397,600
P.L. 100-202			50,000	190,000	135,000	199,997						574,997
P.L. 101-446					419,000	155,998						574,998
P.L. 101-121						35,000	315,000	0	100,000	100,000	50,000	600,000
P.L. 101-121							100,000	0	125,000	275,000	100,000	600,000
Total	99,400	149,100	199,100	190,000	554,000	390,995	415,000	0	225,000	375,000	150,000	2,747,595

¹ Appropriations less amounts sequestered under the Gramm-Rudman-Hollings Deficit Reduction Act.

² P.L. 101-121 was revised by P.L. 101-512, 102-154, 102-381, and 103-138

for power generating technologies for the 21st century. At that time, sulfur dioxide emissions will be permanently capped and air toxics and global warming will replace acid rain as major environmental issues. Round Four broadened the scope of the program to place greater emphasis on technologies which could address global warming. Round Five completed this shift of focus by stressing technologies which demonstrate high efficiency (a surrogate for reducing carbon dioxide emissions) and air toxics emission reductions.

As a result, the Round Four and Round Five solicitations resulted in eight projects that will demonstrate advanced power generating technologies with improved efficiency and environmental performance.

A Unique Government Role

Today, the Clean Coal Technology Program is recognized as one of the largest, and most successful, Government sponsored technology development efforts in the Nation's history. Following five competitive rounds, 45 showcase demonstrations have either been completed or are under way in 21 states.

The level of private sector investment in new technologies leveraged by the Government through the Clean Coal Technology Program is unparalleled. U.S. industry and states have contributed two dollars for every federal dollar, for a total investment approaching \$7 billion.

After five competitive rounds, the goal of the program envisioned by the Joint Envoys has been largely met as innovative pollution control technologies begin to move into the marketplace. By the completion of the fifth round, the program will have laid the basis for new generation of advanced power generating technologies just as utility management is making decisions for new baseload capacity required in the next century.

While many factors account for the success of the program to date, much can be attributed to the unique role ascribed to the program by its initiators in Congress and as implemented by the Department of Energy. In strong contrast to previous energy demonstration efforts and other government research efforts (such as those in today's DOE Defense Programs), it is industry, not the Government, which is viewed as the developer, owner, and major customer for

the technologies. The Government role is to provide financial assistance at a critical point in technology development - between proof-of-concept and first commercial application. The broad Government goal is to accelerate the technology development to the point of commercial acceptance. Industrial sponsors of technologies have largely financed their development, maintain ownership of the technology, and directly control day-to-day project decisions.

Simply put, the Clean Coal Technology Program lets industry do what it does best -- develop and manage projects -- and Government do what it does best -- insure that the public monies are being well spent toward agreed upon goals. The successful Government and industry partnership in the Clean Coal Technology Program is one that has carefully evolved over five separate solicitations conducted over nine years. It stands as a ready model for successful industry and government cooperation.

Distinguishing Features of the CCT Program

At the initiation of the CCT Program, DOE opted to use cost shared Financial Assistance, not Acquisition, as the approach to procurement of the projects. Financial Assistance is used as the selected procurement vehicle when the Government wants to fund projects in broad programmatic areas and when the Government role in project execution will be limited. Both of these conditions applied to the Clean Coal Technology Program. The solicitation document used in Financial Assistance is a Program Opportunity Notice (PON) which differs from the more familiar Request for Proposals (RFP) in several key aspects.

- o Project Definition A basic characteristic of the Clean Coal Technology Program is that DOE does not predetermine technologies or project types (the PON's do not contain Statements of Work as is the case in an RFP). Rather, DOE seeks proposals which best meet its programmatic objectives without designating the technology to be used or any of the other key project parameters such as cost, schedule, site, etc. Projects are selected based on how they meet a variety of criteria which are presented in the PON. The criteria address factors about the project itself (e.g., technical readiness and environmental impact), the

financial aspects of the project, and the commercial potential of the technology.

- o Cost Sharing The level of cost sharing in the CCT Program not only leverages the Government funds but also helps to set the tone for the limited Government role in project execution. The manner in which cost sharing is allowed in the CCT program is among the most restrictive in Government (more restrictive than even DOE's regulations allow). The maximum Government share of any project is 50 percent of allowable project costs. Only those costs directly related to actual project expenditures are eligible for cost sharing. No credit is given for prior expenditures by the proposers. In fact, with certain limited exceptions, no expenditures are allowed for cost sharing until a cooperative agreement (the contract vehicle used in the CCT Program) has been signed. This policy is intended to attract only the serious proposers with a commitment to future commercialization of the technology.
- o Role of the Industrial Participant (IP) The IP defines the project, provides a minimum of 50 percent cost sharing, and executes the project using sound industrial practice.
- o Government Role After award of a cooperative agreement, DOE monitors the projects, evaluates the environmental impact, shares in project costs and risk, and plays a limited role at key project decision points. Importantly, the Government does not directly manage the selected projects. In fact, after selection, substantial changes, such as those affecting cost, schedule, or objectives require mutual consent. The Government shares in future revenues if the demonstrated technologies are replicated on the commercial scale.

Under this broad policy umbrella, the CCT Program has evolved a number of contract features which are, in combination, unique to the program.

- o Property The IP's receive title to all project property. This both recognizes the considerable industry cost sharing and allows the IP to

treat the project not as a "Government project" but, rather, as any other such effort within its corporate structure.

- o Repayment For those projects which are successful and achieve commercial status, the Government share of the demonstration project is to be repaid from future commercial use of the technology.
- o Data In keeping with its role of fostering future commercialization, DOE can protect certain project data for limited periods after the demonstration project is complete. Involvement in the CCT program will not jeopardize the proprietary position of a privately funded development effort.
- o Commercialization For its participation in the program, a technology owner must agree to make its technology available on a nondiscriminatory basis to satisfy the market in the United States. A technology owner is not forced to divulge its proprietary know-how (if developed solely on private industry funds) to a competitor, but it cannot withhold it from a potential domestic user either. If a technology owner does not meet these conditions, the Government reserves the right to "march-in" and insure that the commercial market is being satisfied.

A Critical Juncture

Today, the Clean Coal Technology Program stands at a critical juncture. Having completed all five planned solicitations, the program can best be described as being at its mid-point.

Many of the technologies demonstrated in the early rounds of the program are well on their way to meeting the original goal of the Clean Coal Technology Program as envisioned by the Special Envoys. A new suite of technologies is emerging that can more effectively and more economically reduce acid rain-causing emissions from existing coal-fired power plants. By the time the first phase of the new Clean Air law goes into effect in 1995, more than 20

new technological options for reducing acid rain will have been demonstrated².

These technologies are already working their way into the commercial marketplace in the U.S. They have even attracted interest overseas. This is particularly true for developing nations looking for low-cost technology to bring older power facilities up to modern environmental standards.

At the same time, the Clean Coal Technology Demonstration Program has laid the foundation for a new generation of clean and efficient coal-fired power production. The integrated gasification combined cycle and pressurized fluid bed combustion projects under way through the Clean Coal Technology Demonstration Program offer the potential to reduce air emissions while supplying affordable electric power. Most of these projects will be in operation in the latter 1990s, in time to provide the data needed for utility decisions in the 2000-2010 time frame.

² Clean Coal Technology: The Investment Pays Off, DOE/FE-0291, January, 1994

CHAPTER 3

COMMERCIAL POTENTIAL FOR CLEAN COAL TECHNOLOGIES

The success of the Clean Coal Technology Program will ultimately be judged not on technical achievements of the projects alone but, rather, the extent to which those achievements are replicated in the commercial market. To better understand the dynamics of the decision making process for new power facilities, DOE has been conducting a series of Executive Seminars with the Clean Coal Technology Program's key stakeholders. These seminars focus on the power generation market and include discussions with leaders in the utility, independent power, regulatory, and financial communities. In these meetings, DOE seeks insights not from the technical community with which it deals on a day-to-day basis, but the management and planners whose views will decide the fate of clean coal technologies in power generation.

In conducting these discussions, DOE selected the most likely market for CCT's, targeting, for example, those investor-owned utilities that currently use a significant amount of coal, project some load growth, and have facilities 30 years or older. For non-utility generators, DOE chose companies with at least 300 MW of capacity and more than 25 percent of their capacity being coal-based. Similarly, utility commissions were in areas where coal was a major resource, some near-term growth was expected, or advanced regulatory issues were actively being discussed.

To date, discussions have been held with 20 investor-owned utilities, seven nonutility generators, one municipal utility, four regulatory agencies, three investment bankers, and two insurance carriers. The effort is on-going. The specific objectives of these discussions are to determine:

- o the level of senior management awareness of the CCT Program;
- o projections of power generation needs both near term and into the next century;

- o potential changes to the industry and how these changes will affect decisions to adopt CCT's;
- o what it will take for the CCTs to be given serious consideration in meeting future energy needs.

The perspectives gained from these seminars have been extremely helpful in formulating and evaluating possible future directions for commercializing technologies developed through the Clean Coal Technology Program.

Load Growth

There was general agreement by those interviewed that coal was not likely to be an option for new power generation in the 1990's. The relatively low short-term load growth, a negative public image, and the difficulties in siting new facilities combine to make a strong case against coal for the near term. At the same time, these utility executives universally saw coal as playing a major role in the future generation of power in the U.S., particularly after the year 2000. Along those lines, the Clean Coal Technology Program was widely known and recognized as being critical in keeping the coal option alive as a way to address the nation's power needs into the next century.

Both investor owned utilities and nonutility generator executives foresee low load growth, at least by historic standards, through the year 2000. The projected growth rate is between 1 percent and 2 percent per year. This is true across the country with the possible exceptions of the southeastern U.S., primarily Florida, and Texas. As a result, the expectation for baseload capacity is even lower with few, if any, new facilities needed until after the year 2000. Most of the capacity additions for the remainder of the decade will be in the 100-200 MW size range and used for peaking duty. These units will fire natural gas (or will be dual fuel capable with fuel oil) and have planned capacity factors (percent of the year that these facilities will operate) as low as 10 percent.

Overall, the load growth will be met by, in order of preference: demand side management, life extension or repowering of existing facilities, simple cycle gas turbines, combined cycle gas turbines, and coal.

Another factor affecting short-term decisions is the requirement by more and more state regulators for competitive bidding for any power generation needs. This is the case whether these needs are for new baseload, retrofit, or repowering. This competitive bidding process makes it more difficult for utility decision makers to consider capital-intensive CCT's now.

Integrated Resource Planning (IRP) has received wide acceptability in the U.S. utility industry. Although this planning tool is widely practiced, it is not the only method used by the investor owned utilities use to forecast their power needs. Our discussions revealed a layer of concern that is not apparent from reading IRP's.

While there are limited short term opportunities for coal, the Executive Seminars revealed three largely independent factors which will start to have a measurable effect on the power industry after the turn of the century.

- o Considerable uncertainty was expressed about projected savings from demand side management and whether these savings will have a significant impact on reduction of power generation needs. There is little experience with these varied measures to conserve power.
- o The economy may grow at a faster rate than currently projected. While there may be a lessening of the relationship between economic activity and electric power usage, a relationship still exists. If efforts to stimulate the economy are successful, the current IRP assumptions and load growth projections may need to be revised upward.
- o The existing inventory of nuclear units, which account for roughly 20 percent of electric power generation in the U.S., starts to come up for relicensing in about ten years. The executives that we talked with expressed doubt whether life extension for all these nuclear units will take place. Additionally, a recent study by DOE indicated that several nuclear units may retire before their licenses come up for renewal.

Together, these factors lead to the conclusion that a significant need for baseload power will exist early in the first decade of the next century. For those utilities that now use a significant amount of coal (i.e., typical of the companies interviewed in this study) the baseload fuel of choice for supplying that power will continue to be coal. Significantly, the advanced power systems being demonstrated in the CCT Program are the technologies most being considered for meeting this need.

The Energy Information Administration³ supports this view. It estimates that coal usage for power generation will maintain its market share of roughly 54 percent of all power generated with an additional 42 GW of new coal capacity projected to be on line by 2010.

These selected executives felt that while natural gas is a valuable fuel for peaking applications, availability, deliverability, and future pricing may limit its use as a baseload fuel. There is also uncertainty about obtaining long term reliable contracts for supply and a preference for fuel supply diversity for security purposes.

In this context, the potential for commercial replication of CCT's, especially among utilities which have traditionally relied on coal, is very substantial.

Environmental

Another major topic for these Executive Seminars was the plans for utility compliance with the Clean Air Act Amendments of 1990. Most of the companies interviewed expressed little concern with the Phase 1 limits for SO₂ control. The dominant option is not technology but switching to lower sulfur coal. Similarly, there was little concern expressed for Phase 2 compliance. It is not clear from the discussions if this lack of concern is caused by the relatively long time horizon or whether the current approach being used by most companies (fuel switching and some scrubbing, possibly combined with allowance purchases) will also be sufficient for Phase 2 compliance.

³ Energy Information Administration, Annual Energy Outlook 1994 with Projections to 2010, DOE/EIA-0383(94), January, 1994.

There is quite a different story for NO_x. Here, the Clean Coal Technologies have already made valuable contributions and inroads into the commercial market. Although the regulatory levels are not as well defined as for SO₂ control, NO_x is a serious concern particularly for the eastern U.S. companies. As supported by the number of commercial sales that have already taken place, the NO_x control projects have demonstrated a number of effective ways to control emissions on the full range of coal fired boilers that would not have been available without the Clean Coal Technology Program.

The area of most concern to executives interviewed was the potential for future regulations, especially for carbon dioxide and air toxic emissions. For many companies, CO₂ regulations would cause a far more severe problem than Clean Air Act compliance. The Advanced Power Generation projects in the CCT Program were recognized as demonstrating new approaches for high efficiency power generation with coal which could be used to lower carbon dioxide emissions. Executives, however, voiced concern about the financial impact on their companies of replacing significant existing capacity with these new facilities.

Technical Preferences

The discussions uncovered a surprisingly high level of awareness of the CCT Program overall and, in particular, the Advanced Power Systems projects. Executives were particularly interested in integrated gasification combined cycle (IGCC), although the pressurized fluid bed combustion (PFBC) and conventional boiler projects were also discussed. Most executives viewed high efficiency systems such as IGCC as the most promising for meeting the potentially new environmental regulations discussed above. Several executives stated a preference for PFBC since the configuration for this application is similar to current facilities.

Institutional

There is no question that the electric power industry is on the brink of major change. The institutional changes facing the electric utility industry will have a major impact on the potential acceptance of clean coal technologies.

Planning for this uncertain future is a foremost concern to all those interviewed.

For investor owned utilities, the conventional form of asset based regulation is clearly undergoing change. Capacity additions are increasingly driven by short term considerations, with competitive bidding often required by regulators for all additions. While this typically leads to lower near term rates for customers, it also makes it more difficult for investor owned utilities to plan for future needs. The executives interviewed were concerned about system reliability since the investor owned utility still has the "obligation to serve" should the nonutility generator fail to perform.

As noted earlier, if bid evaluations do not consider life cycle costs, this requirement puts clean coal technologies, which have higher initial capital costs, at an initial disadvantage. CCT's typically have higher capital costs than conventional plants but, in the later years of operation, operating costs are lower and the benefits of improved environmental performance are higher.

A second disturbing trend to the investor owned utility executives is the potential unbundling of the generation segment of the power industry. Such concepts as wholesale and retail wheeling of power, loss of large customers, and tiered rate structures were discussed in some detail. If large users go off line due to self-generation or other arrangements, the utility would need to spread its fixed costs over a smaller base. This would result in higher rates for the remaining customers or lower profits for shareholders.

While timing is uncertain, it is clear that these executives foresee major change in the industry. Planning and making large capital commitments in this environment are difficult which works against the near term deployment of CCT's.

The perspective in the independent power market is quite different. In the short term, domestic growth has abated and siting new plants is becoming increasingly difficult. Additionally, the investor owned utilities which purchase power from nonutility generators are increasingly requiring stricter operating procedures from IPP facilities. While this is not a major concern to nonutility generator owners, it is an added factor as this segment of the

industry matures. Most nonutility generator executives explained that their near term opportunities lie outside of the U.S.

At first glance, the structure of the nonutility generator industry may seem inhospitable to clean coal technologies. The typical independent power arrangement includes a power purchase contract price and a guaranteed fuel delivery price, both of which are indexed to some financial parameter such as Gross Domestic Product Deflator. Project developers generally purchase the generating facility itself on a fixed price, turn key basis. As a result these units are normally highly leveraged and financed on a nonrecourse basis. There may be little room for technical innovation or risk taking in this arrangement. Financial institutions confirmed these observations although some examples exist of nonutility generators building facilities that use clean coal technologies.

Other factors in the independent power market work to encourage deployment of advanced technologies. Since asset based regulation does not constrain the risk/reward equation for IPP's, the potential for using new technologies does exist. The key is that project developers want new facilities to be offered on the same basis as more conventional technologies: fixed price construction with ensuing performance guarantees.

The current CCT demonstration projects are a major step toward achieving these goals, and technology developers are working to their full realization. As an example, one company was set up to commercialize a leading gasification technology along just such lines.

While nonutility generators operate on a different business arrangement than investor owned utilities, both are potential users of CCT's. The key for both sectors to adopting CCT's will be the maturing of technologies to the point that commercial offerings will be made on the same basis as the competitive technologies (i.e., conventional technologies). With all their promise, CCT's at the moment have capital cost structures that are too high. Both investor owned utilities and nonutility generator executives expect that this situation will change as the current CCT demonstration facilities reach the operating phase and the technology developers are able to make commercial offerings.

International

Most nonutility generators interviewed, as well as many of the investor owned utilities with affiliated, unregulated subsidiaries, are pursuing projects outside of the U.S. While project development potential still exists in the U.S., the export market is very large.

Southeast Asia, China in particular, has very large electric power needs that will continue to grow as the economies in this region grow. The use of U.S. technology and expertise is much sought after. One drawback to the potential use of CCT's, however, is the lack of environmental regulations that would give U.S. firms a marketing advantage. Host countries would clearly prefer to use indigenous resources for their power needs. Most of these countries have domestic coal deposits (although coal quality varies considerably).

A second major area for possible export of technology is Eastern Europe, whose needs provide a mirror image of those in Southeast Asia. Existing facilities are able to meet current power needs but the emissions problems are grave and well documented. While there is not a current need for new power, many of the existing facilities may either have to be replaced or extensively modified. Retrofit projects of existing facilities will be much more complex than in the U.S. due to the state of these facilities. From the view of a project developer, however, Eastern Europe is not as promising as Asia. Political stability and currency problems force many of the companies that we talked with to focus on the Pacific rim and India.

Several of the public utility commissions expressed concern about the possibility that investor owned utilities would raid their parent corporations for both financial and personnel resources. One state is considering a ruling to clarify the need to keep operations within their jurisdiction at high levels of availability and reliability when the parent is involved in projects outside of their franchise territory.

Findings

Even with all the uncertainty clouding the future of electric power generation, the commercial potential for CCT's is very high, for both investor

owned utilities and nonregulated generators. Current projections for domestic power generation indicate that, by the middle of the first decade of the 21st century, a significant amount of new baseload capacity will be needed. The timing of this additional capacity fits well with the schedules for the Advanced Power Systems projects in the CCT Program. These projects will be in full operation starting in 1996. The technology decisions for the new capacity will be made late in this decade to allow time for construction of new facilities. Thus, the CCT's will be able to demonstrate their operational advantages over conventional technologies in sufficient time to be serious contenders for the wave of capacity additions.

In addition, the Emission Control Systems projects have demonstrated a suite of technology options that are available now for retrofit and repowering applications. This is particularly true for the NO_x abatement projects. Although compliance strategies for Phase 2 have yet to be determined, the demonstrated CCT's can be expected to continue their market penetration.

The Executive Seminars uncovered several major areas of uncertainty which cloud projections. The structural changes now being discussed for asset based regulation are potentially quite traumatic for the electric power industry. Unbundling of generation capability, competitive bidding systems, retail and wholesale wheeling, and tiered rate structures are all being discussed. Given relatively low load growth, with such significant issues on the table, it is not hard to understand why little new capacity additions are being contemplated at this time.

Significant interest was expressed, however, in projects outside of the U.S. The U.S. still has the most advanced, environmentally sensitive, and reliable electric system in the world. This expertise is in demand in many areas of the world. The potential export of the technologies being demonstrated in the CCT Program with an ensuing increase in domestic employment is very promising. There is significant interest in new power generation facilities in Southeast Asia, particularly China. While there are not the same environmental drivers as in the U.S., considerable demand exists for U.S. technology. While Eastern Europe has serious cleanup needs, the potential for new projects is less inviting than in Asia. Political stability and financial risk are drawbacks

for project developers. Still a significant need exists as does the potential for changing circumstances which could make these markets more attractive.

CHAPTER 4

ACCOUNTING OF APPROPRIATED FUNDS

Status of Funds

Since the start of the Clean Coal Technology Program, Congress has appropriated a total of \$2,747,595,000 in Budget Authority. These funds have been appropriated in five legislative actions spanning 11 years, as indicated in Table 2. From this total appropriation amount, DOE covers its administrative cost (\$110,527,000 through the end of fiscal year 1994) and its commitment to the Small Business and Innovative Research Program and the Small Business Technology Transfer Program (\$38,176,000). The remainder (\$2,598,892,000) is available for DOE to meet its contractual commitments for the 45 projects which constitute the program.

Table 4 presents the status of funds in the CCT Program as of February 28, 1994. The Project Commitments entry in this table, \$2,396,871,000, represents the current contractual commitments for the 45 projects in the program. The Uncommitted Balance as of February 28, 1994, is \$202,021,000.

Table 5 presents the 45 projects, currently in the program, by technology group with the estimated total project cost, the Government share of that cost, and the scheduled completion date. Current status and other pertinent project information is detailed in the Program Update⁴.

Cost Share Analysis

At the start of the CCT Program, Congress set a maximum cost share for DOE at 50 percent of actual project costs. DOE has been able to leverage this Government share to a higher degree than was originally projected. As shown in Table 6, DOE has negotiated cooperative agreements that provide more than 66 percent of total funding from non-DOE sources. Due to this leveraging of Government funds, the total value of the 45 projects, which was projected by

⁴ Clean Coal Technology Program Update, DOE/FE-0299P, April, 1994

TABLE 3**BUDGET AUTHORITY BY APPROPRIATION**

(DOLLARS IN THOUSANDS)

ACCOUNT	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	TOTAL
OCT-1 PROJECTS	96,685	145,273	145,273									387,231
SBIR*	1,224	1,839	1,839									4,902
PROG DIR	1,491	1,988	1,988									5,467
OCT-1 TOTAL	99,400	149,100	149,100									397,600
OCT-2 PROJECTS			31,094	173,800	133,313	197,497						535,704
SBIR*			394	2,200	1,687	2,500						6,781
PROG DIR			18,512	14,000								32,512
OCT-2 TOTAL			50,000	190,000	135,000	199,997						574,997
OCT-3 PROJECTS					391,496	154,048						545,544
SBIR*					4,956	1,950						6,906
PROG DIR					22,548							22,548
OCT-3 TOTAL					419,000	155,998						574,998
OCT-4 PROJECTS						9,875	311,063		98,450	97,900	48,925	566,213
SBIR*						125	3,937		1,500	2,000	1,000	8,562
STTR**									50	100	75	225
PROG DIR						25,000						25,000
OCT-4 TOTAL						35,000	315,000		100,000	100,000	50,000	600,000
OCT-5 PROJECTS							74,062		123,063	261,225	97,850	564,200
SBIR*							938		1,875	1,500	2,000	10,313
STTR**									62	275	150	487
PROG DIR							25,000					25,000
OCT-5 TOTAL							100,000		125,000	275,000	100,000	600,000
PROJECTS	96,685	145,273	176,367	173,800	524,809	361,420	385,125		221,513	367,125	146,775	2,598,892
PROG DIR	1,491	1,988	20,500	14,000	22,548	25,000	25,000					110,527
TOTAL FE	98,176	147,261	196,867	187,800	547,357	386,420	410,125	0	221,513	367,125	146,775	2,709,419
SBIR*	1,224	1,839	2,233	2,200	6,643	4,575	4,875		3,375	7,500	3,000	37,464
STTR**									112	375	225	712
TOTAL DOE	99,400	149,100	199,100	190,000	554,000	390,995	415,000	0	225,000	375,000	150,000	2,747,595
CUM APPORTIONED	99,400	248,500	447,600	637,600	1,191,600	1,582,595	1,997,595	1,997,595	2,222,595	2,597,595	2,747,595	

* Small Business Innovative Research Program

** Small Business Technology Transfer (Pilot) Program

TABLE 4

CLEAN COAL TECHNOLOGY FUNDING PROFILE

According to current law and the status of projects as of Feb. 28, 1994
(1000 \$):

Project Commitments ¹		
Current Obligations ²	897,154	
Remaining Obligations	1,499,717	2,396,871
Uncommitted Balances		202,021
Program Direction ³		110,527
SBIR/STTR ⁴		38,176
TOTAL APPROPRIATIONS		\$2,747,595

Definitions:

- (1) Project Commitments. The amount equal to DOE's share of the total project cost contained in signed cooperative agreements or, for those CCT V projects which have not yet signed cooperative agreements, DOE's share of the total project cost at the time of selection.
- (2) Obligations. Each negotiated cooperative agreement establishes funding increments referred to as budget periods. The cooperative agreement defines the work to be performed in each budget period. An obligation occurs in the beginning of each budget period and establishes the incremental amount of Federal funds available to the Industrial Participant for use in performing tasks as defined in the cooperative agreement.
- (3) Program Direction. Funds for DOE to administer the program through the end of the current fiscal year.
- (4) SBIR. Small Business and Innovative Research Program
STTR. Small Business Technology Transfer Program

the Special Envoys Report to be \$5 billion, today approaches \$7 billion.

The almost \$4.6 billion of non-DOE cost sharing comes from a variety of sources, as shown in Table 7. The wide range of financial partners reflects both the complexity of these projects and the broad base of support that the CCT Program has been able to attract. Both the scope and level of funding from the private sector show its commitment to the commercialization of technologies, and this will, in large part, be the driver by which commercialization occurs.

TABLE 5

PROJECTS IN THE CLEAN COAL TECHNOLOGY DEMONSTRATION PROGRAM

PROJECT	CURRENT TOTAL COST in \$1000s	CURRENT DOE SHARE in \$1000s	CURRENT SCHEDULED COMPLETION
ADVANCED ELECTRIC POWER GENERATION SYSTEMS	4,691,290	1,655,197	
Tidd PFBC Demonstration Project	189,886	66,957	2/95
Nucla CFB Demonstration Project	54,087	19,920	Completed
York County Energy Partners CFB Cogeneration Project	379,645	74,734	9/97
Combustion Engineering IGCC Repowering Project	270,700	129,357	5/02
PFBC Utility Demonstration Project	917,944	184,800	2/04
Nealy Clean Coal Project	227,000	109,513	6/98
Tampa Electric Company Integrated Gasification Combined-Cycle Project	260,706	130,353	6/98
PCFB Demonstration Project	202,959	93,253	5/99
Toma Creek IGCC Demonstration Project	196,570	95,000	4/00
Pinon Pine IGCC Power Project	269,993	134,997	7/00
Wabash River Coal Gasification Repowering Project	396,000	198,000	10/98
Warren Station EFCC Demonstration Project	146,832	73,416	In Negotiation
Demonstration of Clean Coal Diesel Technology at Easton Utilities	38,310	19,155	In Negotiation
Camden Clean Energy Demonstration Project	779,950	183,282	In Negotiation
Four Rivers Energy Modernization Project	360,708	142,460	In Negotiation
ENVIRONMENTAL CONTROL DEVICES	686,616	288,376	
LIME Demonstration Project Extension and Coolside Demonstration	19,404	7,596	Completed
Enhancing the Use of Coals by Gas Reburning and Sorbent Injection	37,498	18,747	12/94
SNOW Flue Gas Cleaning Demonstration Project	31,438	15,719	3/95
SOX-NOX-ROX Box Flue Gas Cleanup Demonstration Project	13,272	6,078	4/94
Demonstration of Innovative Applications of Technology for the CT-121 FGD Process	44,389	21,728	1/97
Advanced Flue Gas Desulfurization Demonstration Project	151,708	63,913	9/95
Demonstration of Advanced Combustion Techniques for a Wall-Fired Boiler	14,711	6,554	12/94
Demonstration of Selective Catalytic Reduction Technology for the Control of NOx Emissions from High-Sulfur-Coal-Fired Boilers	23,230	9,407	7/95
180 MWe Demonstration of Advanced Tangentially Fired Combustion Techniques for the Reduction of NOx Emissions for Coal-Fired Boilers	9,153	4,440	Completed
Demonstration of Coal Reburning for Cyclone Boiler NOx Control	13,647	6,341	4/94
10 MWe Demonstration of Gas Suspension Absorption	7,717	2,315	7/94
Full-Scale Demonstration of Low-NOx Cell Burner Retrofit	11,233	5,443	4/94
Confined Zone Dispersion Flue Gas Desulfurization Demonstration	10,412	5,206	5/94
Evaluation of Gas Reburning and Low-NOx Burners on a Wall-Fired Boiler	17,811	8,906	6/95
LIFAC Sorbent Injection Desulfurization Demonstration Project	21,394	10,637	8/94
Commercial Demonstration of the NOXSO SO2/NOx Removal Flue Gas Cleanup System	66,250	33,125	12/98
Integrated Dry NOx/SO2 Emission Control System	27,411	13,706	11/94
Milliken Clean Coal Technology Demonstration Project	158,608	45,000	6/98
Micronized Coal Reburning Demonstration for NOx Control on a 175 MWe Wall-fired Unit	7,330	3,515	8/96

TABLE 5 (cont'd)

PROJECTS IN THE CLEAN COAL TECHNOLOGY DEMONSTRATION PROGRAM

PROJECT	CURRENT TOTAL COST in \$1000s	CURRENT DOE SHARE in \$1000	CURRENT SCHEDULED COMPLETION
COAL PROCESSING FOR CLEAN FUELS	466,726	212,393	
Advanced Coal Conversion Process Demonstration	69,000	34,500	3/96
Development of the Coal Quality Expert	21,746	10,864	7/94
Commercial-Scale Demonstration of the Liquid-Phase Methanol Process	213,700	92,708	9/00
ENCOAL Mild Coal Gasification Project	72,564	36,282	9/94
Self-Scrubbing Coal: An Integrated Approach to Clean Air	89,716	38,039	3/96
INDUSTRIAL APPLICATIONS	1,118,150	219,399	
Advanced Cyclone Combustor with Internal Sulfur, Nitrogen, and Ash Control	983	490	Completed
Cement Kiln Flue Gas Recovery Scrubber	17,800	5,982	4/94
Innovative Coke Oven Gas Cleaning System for Retrofit Applications	45,240	13,500	11/95
Blast Furnace Granulated-Coal Injection System	191,700	31,260	1/98
Demonstration of Pulse Combustion in an Application for Steam Gasification of Coal	37,333	18,667	6/98
Clean Power From Integrated Coal/Ore Reduction (COREX)-CPICOR	825,092	149,500	In Negotiation
TOTAL	6,962,782	2,375,365*	

* DOE share from terminated projects is \$21,506.

Financial Controls

In fulfilling its monitoring role, DOE uses a phased funding approach centered around predefined budget periods to control Government funding. Each negotiated cooperative agreement includes a number of decision points where both DOE and the Industrial Participant review the project and decide on proceeding. The time between these go/no-go decision points is labelled a budget period. DOE obligates money to each project by budget period.

At the end of each budget period, progress on the project is evaluated against established criteria. If the Industrial Participant commits to continuing the project by submitting a continuation application, DOE decides on whether or not to proceed to the next budget period based on satisfying how these criteria were met.

TABLE 6

CLEAN COAL TECHNOLOGY DEMONSTRATION PROGRAM
GOVERNMENT/INDUSTRY COST SHARING
(thousand dollars)

<u>Solicitation</u>	<u>Total Cost of Projects</u>	<u>IP Cost</u>	<u>DOE Cost</u>	<u>Percent IP Share</u>
CCT-I	772,252	538,442	233,810	70%
CCT-II	1,553,231	1,085,411	467,820	70%
CCT-III	1,330,858	758,152	572,706	57%
CCT-IV	1,155,550	622,334	533,216	54%
CCT-V	2,150,891	1,583,078	567,813	74%
	6,962,782	4,587,417	2,375,365	66%
<u>Technology Category</u>				
Advanced Electric Power Generation	4,691,290	3,036,093	1,655,197	65%
Environmental Control Devices	686,616	398,240	288,376	58%
Coal Processing for Clean Fuels	466,726	254,333	212,393	54%
Industrial Applications	1,118,150	898,751	219,399	80%
	6,962,782	4,587,417	2,375,365	66%

Project Cost Growth

The extent to which funds will be available after completing projects from the five rounds of competition will depend largely on a series of upcoming project decisions. In setting up the CCT program, Congress permitted the Government, in a limited way, to share in cost increases that occur as a project proceeds. This additional Government funding, however, was capped at 25 percent of the Government share of the total project cost at the time of the original award (i.e., signing of the cooperative agreement).

TABLE 7
ANALYSIS OF COST SHARE SOURCES

SOURCE	CONTRIBUTION AMOUNT FROM INDUSTRIAL PARTNER (THOUSAND \$)	PERCENT
INVESTOR OWNED UTILITY	2,774,756	61%
NONUTILITY GENERATORS	603,501	13%
TECHNOLOGY OWNERS	443,139	10%
INDUSTRIAL	292,758	6%
RESEARCH AND DEVELOPMENT ORGANIZATION	231,988	5%
MUNICIPAL UTILITY	108,955	2%
EQUIPMENT VENDORS	84,274	2%
COOPERATIVE UTILITY	34,167	1%
PROJECT DEVELOPERS	7,317	< 1%
FEDERAL UTILITY	6,562	< 1%
TOTAL	4,587,417	100%

In addition to this overall cap, two other mechanisms have been effective in encouraging the Industrial Participants to carefully monitor and control costs.

- o At the proposal selection stage, the quality of the estimate of project cost is an important evaluation criterion. DOE can limit its share of any project to the amount requested in the proposal. Since the Cost and Finance criteria count for 25 percent of the total evaluation score (in CCT V), each proposer has an incentive to put forward its best estimate of project cost. In this way, a "low ball" bid is strongly discouraged.
- o After project award, any increase in project cost may be cost shared with the Industrial Participant. If the Government decides to participate in the overrun it can be at no higher a cost share ratio for the Government than its ratio in the overall project (and then only up

to 25 percent of the Government share of the original award amount). This "shared risk" for project cost increases serves as a strong incentive for the Industrial Participant to control costs effectively.

Even with these protections, however, Congress recognized the inherent difficulty of estimating project cost at the early stages of a large scale, first-of-a-kind demonstration project. Estimates become more defined as actual bids are received on equipment and the project moves through construction and operation.

Industrial practice deals with these uncertainties by including contingencies in the cost estimate. Since managing these contingency pools is a key to effective project management, DOE reviews these procedures for each prospective Industrial Participants during proposal evaluation. Not all uncertainties, however, are easily controlled or managed. Congress recognized this situation and, in keeping with its partnership role with industry, allowed DOE to share in these cost increases.

Although Congress permitted limited Government cost sharing, no separate "overrun pool" was directly funded by appropriation money. Rather, these increases have been decided on a case-by-case basis and are only granted subject to the availability of funds. Such funds become available from (i) projects that were selected but failed to obtain an award, (ii) projects that were terminated before completion, or (iii) projects where the actual expenditure of funds was lower than anticipated at the time of the award.

Overrun Analysis

As described above, DOE project monitoring is based on project decision points built into each cooperative agreement. At these decision points both the Industrial Participant and DOE review project progress and plan the detailed activities for the next budget period. DOE's process for approval of continuation applications and for approving any additional Government funding is described in Appendix A of this report.

As the schedule in Figure 1 indicates, several major project decision points will be reached in the next seven years. The outcome of these go/no-go

decisions will largely determine the availability of additional uncommitted Government funds for the Clean Coal Technology Program.

DOE uses an insurance risk pool approach to manage its out-year funding needs. For this analysis, DOE estimated a range of total cost for each of the 45 current projects. This range is based on the collective judgment of those DOE personnel most familiar with each project and accounts for the status of each project as well as its schedule for completion. The closer a project is to completion, the narrower is the range of likely costs. Also factored into this analysis is DOE's estimate of the likelihood that each project will go to completion as planned.

The results of these estimates are then pooled, using standard statistical techniques common to the insurance industry. The result is an estimate of overall program funding needs that includes the potential for cost overruns and project withdrawals. In using this planning tool, DOE is not providing any a priori approval to participate in any specific project overrun. Rather, this approach allows DOE to most effectively use available appropriated funds in this unique Government/industry partnership. The assessments which are the basis of these analyses are derived from the experience in the CCT Program to date and the intrinsic uncertainty of demonstration projects.

Based on these analyses, DOE now estimates that there will be between 0 and \$300 million remaining after meeting its funding needs for the 45 current projects. The "most likely" remaining balance is \$150 million. Program direction funds beyond fiscal year 1994 and any new programmatic initiatives would come from this balance. Based on these analyses, DOE concludes that, even though major project go/no-go decisions will be made over the next seven years, the CCT Program can be completed with currently appropriated funds.

It should be emphasized that the "risk pool" analysis described above is a planning tool that helps the Government to gauge the out-year funding needs for the CCT program. DOE is under no contractual obligation to fund any project overruns. Thus, even in the unlikely event that all projects proceed to completion under the terms of the cooperative agreements, DOE could still meet its funding commitments. In such a case, however, not all projects may

be able to receive cost sharing in overruns. DOE will update this assessment on a semiannual basis.

CHAPTER 5

OPTIONS FOR NEXT STEPS IN THE CCT PROGRAM

DOE has assessed the potential options available for the CCT Program. This chapter presents these options with a brief discussion of programmatic impact for each option.

OPTION 1: Conduct a Sixth Round

Description

In this option, a sixth round of competition would focus on broadening the use of coal to solve environmental problems. Along with projects which would demonstrate higher efficiency and improved environmental performance over currently practiced technologies (the CCT V objectives), DOE would seek projects which demonstrate co-processing of coal with waste materials and other uses of coal which ameliorate environmental problems beyond acid rain emissions.

Discussion

Some interest has been expressed for a continuation of the current progression of solicitations. In CCT V, DOE received 24 proposals with a total project value of \$6.9 billion, the largest amount for any of the five rounds. Only five projects were selected. The emphasis in CCT V was on improved efficiency and environmental performance which are the major areas of concern for the use of coal in the post-2000 time frame. This suggests considerable private sector interest in new project development.

Such a solicitation could seek technologies that can solve environmental problems beyond those in the electric power industry and the industrial applications thus far demonstrated in the CCT Program. For example, there is significant interest in coprocessing coal with waste material to generate a variety of products from electricity to chemicals and fuels. This approach

can treat not only solid waste but also industrial sludge and other waste materials. Such technologies reduce the volume of solids for disposal and create value from an otherwise environmental problem.

OPTION 2: Commercial Enhancements Program

Description

Establish a technology enhancements program that would improve the commercial potential of the technologies currently in the program by demonstrating selected improvements at existing project sites. A competitive solicitation would determine those demonstrations with the highest potential payback for accelerating those technologies toward commercial replication.

Discussion

U.S. Government and industry will have invested almost \$7 billion in demonstration projects through the five round Clean Coal Technology Program, with the Government contributing more than \$2.7 billion. Such an investment offers an opportunity to further the commercial potential of the demonstrated technologies without making unnecessarily large new capital investments. Most of the 17 projects which will be completed during the current fiscal year (FY 1994) are in the Emission Control Devices part of the program. Some of these facilities will be shut down upon completion of the operating phase. Cost shared continued operation of selected projects demonstrating improvements learned in the initial operation phase could offer the potential to:

- o speed penetration of the technologies into commercial markets,
- o improve the economics, performance, operability, and environmental aspects of the technologies,
- o expand the applicability of the technologies to new and larger markets, and
- o improve the ability to market CCTs abroad.

Many of the original CCT proposals were "bare-bones" efforts aimed at demonstrating basic feasibility at commercial scale. As is the nature of first-time demonstrations, significant opportunities have been identified that can further improve the technologies beyond initial operating phases. Such advances result both from lessons-learned at the demonstration facility as well as other facilities both inside and outside of the CCT Program. An enhancements program would invest cost-shared funds to demonstrate these advances at existing facilities. With experience from operating demonstrations in hand, the Industrial Participants have a chance of attracting additional funds for testing technology enhancements.

An Enhancements Program could include testing of foreign coals (an option not permitted in the current program) and help open new opportunities to export U.S. technology. This is particularly true for the attractive world market for pollution control devices. There is no question that actual commercial data from operating facilities are a powerful marketing tool.

Using existing facilities would represent significant savings in monies as well as time. This leveraging of Government moneys would further commercialization goals at a small fraction of the total original investment.

OPTION 3: Commercialization Incentives Program

Description

Promote the commercialization of CCT's in the United States by "buying down" the cost of the initial commercial facilities for deployment in the U.S.

Discussion

When the Clean Coal Technology Program was first established, its founders expected that the one time, cost shared demonstrations would be sufficient to move promising new clean coal technologies into the commercial marketplace. In some cases, such as several of the Environmental Control Devices that have an extra "market push" from the Clean Air Act, that has proven to be correct.

This may or may not, however, be true for the Advanced Power Generation systems that will be demonstrated in the later rounds of the program.

The public interest can often require a government role in helping to shape the commercialization of new technology. Since the private sector responds to market signals, and not necessarily to broader societal priorities, it cannot always be expected to ensure the goals of improving environmental performance and improved system efficiency except through government incentive.

Successful demonstration projects, as have occurred in the CCT Program, significantly reduce both the technical and financial risk of follow on commercial applications. Inherently, these demonstration facilities include redundancy and overdesign to offset uncertainties associated with novel equipment and to deal with the challenge of first time scale up to the demonstration size. Even the most successful demonstration plants typically have only a few years of operating experience before commercial replication occurs. Though a great deal would have been learned from the demonstration facility, the risk for subsequent commercial facilities would not be completely eliminated.

The demonstration project, therefore, is a significant step along the learning curve but not in itself the jump to full commercial status. The risk premium, although greatly reduced, still exists for the first commercial plant. This translates into added cost which hinders the wide commercial acceptance. As described in Chapter 3, competition for financing and regulatory (i.e., least cost) oversight does not, at the moment, allow for new technologies to reach commercial acceptance until this risk premium has been eliminated. Until the newer clean coal technologies can be offered on the same basis as competing commercial options, full deployment will be hindered.

A commercial incentives program option assumes that some assistance may be necessary before CCT's can fulfill the potential demonstrated in the program to date. The Government would cost share, on a limited basis, in the risk premium for commercial facilities. This incentive would address only the incremental cost of a new facility over currently available technologies (i.e., the least cost option). Conceptually, industry investment would cover the cost of the base facility while the Government incentive would apply only to the increment over available technology. This approach would allow the

technology selection to be made on a cost neutral basis while encouraging the use of innovation in newer and more efficient systems.

With this approach, the Government cost share would be considerably less than the 50 percent allowed in the current program. The Government share in this new initiative would not exceed 25 percent of the cost of these new facilities.

The advantage of this approach is that the Government assistance would not mandate specific technology selections. It would allow the CCTs to compete on a basis where their inherent environmental and performance advantages could become a significant factor in new facility construction while the Government covers the burden of project risk premium. It is anticipated that this incentive would be needed for only a few facilities and thus the cost of the new program could be within the currently available uncommitted funds.

The cost of this initiative can be estimated using the experience of two of the current Clean Coal projects. Both the Wabash River project in Indiana⁵ and the Polk County project in Florida⁶ received regulatory approval after having gone through the Integrated Resource Plan (IRP) process in the respective states. In each case the Government cost share reduced costs enough to make the CCT project the least cost option. The added risk of a demonstration plant, even though operating in commercial mode, made it necessary for the demonstration plant to have a cost advantage over its competition in the IRP process.

In a Commercial Incentives Option, which would fund projects beyond the demonstration phase, this added increment would not be required. Rather, the DOE cost share would be aimed at "buying down" the cost of the facility only to the point that the project would be at cost parity with its competition. It is also anticipated that the first commercial facilities will be less expensive than the demonstration plant. This learning curve effect is an important element of the overall plan to reach commercial acceptance. Based

⁵ Cause No. 39312, Indiana Utility Regulatory Commission, May, 26, 1993

⁶ Docket No. 910883-EI before the Florida Public Service Commission, Polk Unit One Need Determination Study, September, 1991

on the experiences of the Wabash River and Polk County projects, roughly \$50 million of Government cost share would be sufficient to reach the goal of parity.

Such cost share would need to come at the right time in the cash flow of a developing project. This would allow the Government investment to have maximum effect on the analyses performed by the financial community. Many of the features of the current CCT Program, including the Government role in the project, would be retained.

This option could be carried out in an incremental fashion using funds that have already been appropriated for the Clean Coal Program if they are not needed to complete the current 45 projects. Emission Control facilities, with lower capital costs, would not require the same level of incentive as Advanced Power Generation projects.

OPTION 4: International Clean Coal Technology Transfer Program

Description

This option involves three elements. The first step would be to provide education and technical support to U.S. industry and export credit agencies, multilateral banks, and government agencies and industry in potential market countries. The second step would be to provide limited Government financial assistance for a few "showcase" demonstrations of U.S. technologies overseas. The third step would be to develop a fund for cost sharing with U.S. industry certain definition activities required for obtaining financing for foreign clean coal projects using U.S. technology.

Discussion

The potential market for the export of clean coal equipment and services for new power generation facilities and for retrofit installations outside the U.S. for 1993-2010 is projected to be between \$180 to \$260 billion (or an

average of \$12 billion per year in constant 1993 dollars)⁷. Such a level of exports could create 90,000 person-years of employment in the nations with capabilities to export. If the U.S. maintains the 25 percent share it currently has in this market, 22,000 person-years of employment could be created.

A Clean Coal International Technology Transfer program would:

- o Improve the U.S. balance of trade. The potential to increase exports is greater with developing countries than developed countries,
- o Contribute to the Administration goal of economic security,
- o Increase employment in relatively high skilled, well paying jobs,
- o Reduce pollution in developing countries,
- o Contribute to the Administration Program of Joint Implementation and reduce global emissions for greenhouse gases,
- o Contribute to political stability in developing nations through providing efficient, economical power,
- o Provide support to countries or regions that are of strategic interest and need the benefits of Clean Coal technologies.

An advantage of the three phased program, as outlined above, is that it would offer built-in effectiveness. The first step is to provide education and technical support to U.S. industry, export credit agencies, multilateral banks, as well as governments agencies and industries in potential market countries. This would serve to inform potential users of the technologies of the economic and technical performance benefits of U.S. clean coal technologies. U.S. industrial representatives would have opportunities to meet the decision makers in the foreign markets. Clean coal trade missions, already conducted, have been well received by both the foreign markets and

⁷ Market Potential for Clean Coal Technology Exports Updated Estimates, Office of Fossil Energy, October 1993.

U.S. industry as providing a cost effective mechanism to acquaint the seller with the buyer. U.S. export credit agencies, now increasing support for power and environmental projects in developing countries, could greatly benefit from technical support offered by the DOE Clean Coal Program Office. The Clean Coal Office is currently providing technical support to the Trade Development Agency, Export - Import Bank, Agency for International Development and the World Bank.

The second step in the program would be to provide limited financial assistance for a few "showcase" demonstrations of U.S. technology. With China facing the need to increase power generating capacity by 200 GW over the next 15 years, and coal as the main fuel for these facilities, there is a large market for environmentally acceptable, high efficiency power generation technology. Eastern Europe represents a large market (170 GW) for technologies to upgrade the environmental performance of existing coal fired facilities. A demonstration project in each of these markets would accelerate the acceptance of U.S. technology and provide a competitive edge for U.S. equipment and services.

For this initiative, advanced technologies would be defined as those demonstrated in the U.S., not yet replicated commercially in the U.S., and believed by both U.S. industry and the industrial sector of the host countries to have considerable future replication potential abroad. Commercial financing may not be readily available for such projects because the technologies are early in their commercial phase, raising questions about cost and performance risk. Financing for these initial projects will also be difficult due to the uncertainty of the economic projections. Factors affecting these projections are the uncertainty of enforcement of environmental legislation in the host countries, the lack of understanding of economic evaluation as practiced by financial institutions, and the fact that regulated power prices in these countries do not realistically represent the cost to produce power. In addition, questions of political stability and currency convertibility cloud normal business relationships.

An important determinant would be selection of candidate technologies for demonstration that have a good potential to achieve economic success in subsequent projects in the host country or region. Assistance would be

structured to reduce the incremental cost of the demonstration technologies over the cost of what has been conventional practice in these countries. Projects would be selected so that the learning experience would reduce or eliminate cost differentials for future facilities. By reducing private capital investment in the demonstration project, U.S. government financial assistance would help achieve an acceptable rate of return and could be leveraged to raise debt in the capital markets.

The attractive features of this approach for marketing U.S. technologies to developing countries include providing a source of financing not obtainable through commercial markets, spreading of financial risk among multiple funding sources, developing a foundation overseas for market acceptance of future U.S. technologies through participation in the demonstration, and generating goodwill through mutual investment in the development of technologies to satisfy the future needs of the host country.

The funding needed for this phase of the program would be \$75 million which would be returned to the U.S. market through equipment sales to the demonstration projects well in excess of the U.S. government funding. Over the long term the investment would be returned many times over through the future sale of U.S. goods and services.

The third phase of an international program would cost share with U.S. industry those definition activities required for obtaining financing for foreign clean coal projects using U.S. technology. Many of the U.S. firms that market clean coal technologies do not have the capitalization to invest in overseas marketing and project formation activities. With the increased use of project financing more front end definition and development costs are required, which is costly even for well capitalized organizations. Such assistance is not available currently from any of the export credit agencies and none is available for feasibility studies for projects in China. If the results of the definition activities prove attractive, then financing can be sought through the Export-Import Bank, multilateral banks, or commercial institutions. The funding for this step of the program would be \$25 million.

This three step approach to assisting U.S. industry with marketing U.S. goods and services for clean coal projects overseas is widely supported by industry and represents a prudent leveraging of government funds.

OPTION 5: Commercialization Incentives Using Financial Vehicles

Description

Assist in commercialization efforts by using strictly financial mechanisms to promote the construction of CCT's.

Discussion

As Option 3 discussed, the need for a Government presence is necessary to help overcome the remaining barriers to commercialization of CCT's. In this option, the objective is the same, reduce the risk premium for initial commercial facilities. The Government role would be more arm's length, however, relying on financial mechanisms such as partial loan guarantees, partial loans, and price supports. By spreading the risk, it is expected that the financial community will be more willing to finance new ventures. To further overcome the reluctance of the financial community, any obligation to the Government (e.g., loan repayment) incurred by the project promoter would be subordinate to other lenders. This is in line with the Government objective of promoting commercialization and not generating investment income.

OPTION 6: No Further Government Activity

Description

Complete the CCT Program within the bounds of the 45 current projects and return any unused funding to the Treasury.

Discussion

This option would restrict program activity to the completion of the currently defined program. There would be no continuing Government expanded effort to promote the benefits of clean coal technologies.

CHAPTER 6

RECOMMENDATIONS

1. DOE agrees with the recommendation by the National Coal Council^o that there is no need for a Round VI along the lines of the first five rounds.

Discussion

The National Coal Council has performed an analysis of the existing program as part of its study on the future direction for the Clean Coal Program. The Council has determined that the 45 projects currently in the program represent a broad diversity of applications and coal types which it believes have or will satisfy the original intent of this demonstration program. DOE agrees with this conclusion.

2. The new Outreach/Technology Transfer initiative will be immediately implemented.

Discussion

The ongoing Executive Seminar series, as discussed in Chapter 3, will be broadened to include a wider number of organizations which will affect the future decisions to use the technologies demonstrated in the program. The program has matured to the point where more projects are being completed and approaching commercial status. Activities will be initiated to disseminate more effectively the results of the 45 projects currently in the program as well as promote the use of clean coal technologies to improve the environment. Funding for this activity would continue to be derived from the Program Direction account.

^o The National Coal Council, Clean Coal Technology for Sustainable Development, March, 1994.

3. On a funds available basis, implement the International Technology Transfer Initiative (Option 4).

Discussion

This initiative would greatly enhance the Government role in fostering the Congressional and Administration objective of commercial acceptance of CCTs. It would also have a direct effect on improving the environment, providing for U.S. jobs, and improving U.S. competitiveness in the global economy.

The initiative, as discussed in Chapter 5, would permit the United States to maintain its current market share in the growing international market for clean coal technologies, while continuing the development of these technologies on a commercial scale.

No new appropriation amounts would be necessary to fund the initiative. As presented in Chapter 4, DOE feels that there are sufficient funds to complete the current demonstration program. In the event that current funding is more than enough to cover current commitments, this effort could be initiated on an incremental basis, since it has a number of separate steps. Depending on the upcoming funding decisions, if the available funds are close to the upper limit of what is currently projected, then it could be fully funded from amounts within existing appropriations.

The highest priority for DOE is the completion of the current 45 projects in the program. The DOE will not cancel any of the current projects to fund new initiatives. The program will continue to be managed as described in Chapter 2.

4. Within the context of guidance received from program participants and stakeholders analyze the merits of commercial incentives (e.g., financial, tax, buydown) as means for transferring Clean Coal Technology to the commercial marketplace.

Discussion

Demonstration projects are significant steps along the learning curve in the development and commercialization of a new technology. The risk premium associated with implementing the technology in a subsequent first commercial plant, however, is believed by many to be too high to allow these projects to compete on a favorable basis for funding. Until the newer technologies can be offered on the same basis as competing commercial option, full deployment will be hindered.

The proposed review of incentives analyzes the position taken by many in the private sector that further assistance in commercialization of technology is necessary. It also introduces an incentive concept that addresses the reduction of remaining risk to an acceptable level at a reduced cost without interfering with normal, market driven commercial project development. The analysis will include, but not be limited to, the incentive concept discussed in Chapter 5 along with regulatory reforms and tax incentives. A fundamental criterion of the review will be the policy of reducing government involvement as a technology approaches commercial status.

APPENDIX A

CONTINUATION APPLICATIONS

Introduction

In establishing the Clean Coal Technology Program, Congress recognized that DOE should be in a position to help fund cost overruns in these first-of-a-kind demonstration projects. The stipulation was that these added funds (beyond the original selection amount) must be cost shared at a ratio not to exceed the original ratio at the time of award. These added funds are matched, on average, by two dollars of non-Government money for every dollar of Government money. This section explains the philosophy that DOE has used in managing these funds.

Overruns: The Decision Philosophy

In making decisions regarding overruns, the following principles are being followed by DOE:

- o No project overrun will be considered for funding (I) in the event that the Industrial Participant made definitive statements in its prior representations to DOE that it would unequivocally provide additional funds in the event of a shortfall and (II) such representations were material to the DOE selection decision.
- o DOE will consider cost sharing an overrun involving the demonstration of a technology that has a positive potential for marketing penetration.
- o DOE will consider cost growths as they occur and fund them to the extent that funds are currently available in the management reserve pool, that they are consistent with PON requirements (i.e., no more than 25 percent of the original DOE funding for the project), and to the degree that they meet the criteria presented below.

Criteria for Sharing Overrun Costs

Subject to the criterion that any overrun will be no costlier than necessary, as determined by process and operational factors, the application of the following criteria will be used as the basis for recommending whether the Assistant Secretary for Fossil Energy shall commit to share the cost of an overrun:

- a) Extent to which the technical and economic performance of the mature unit still (i.e., as opposed to the time of selection) promises significant commercialization potential, including:
 - Potential to be more cost effective than currently commercially available alternatives.
 - Potential to offer technical and/or performance superiority which would likely lead to significant market penetration for retrofit, repowering, replacement, and new application.
- b) Degree of commitment and incentive of the Industrial Participant to complete the project as originally proposed, or as modified in agreement with DOE, even if further cost growth occurs.

Relevant Information for Overrun Decision

As part of any Continuation Application submittal, which includes a request for DOE cost sharing of overruns, information shall be provided to the Assistant Secretary for Fossil Energy by the Program Office relative to the above criteria, as well as an analysis of other considerations, which might be pertinent to the decision by the Assistant Secretary. Examples of such considerations are presented below:

I. Programmatic Considerations

- Does the project still satisfy the PON objective germane to the original selection?

- Does the change represent an addition to the Statement of Work agreed to in the original Cooperative Agreement?
- Will the proposed change increase the likelihood that commercial scale facilities using the demonstrated technology will be designed, built, and operated successfully in the U.S.?

II. Contract Considerations

- Would the proposed change violate any statute or regulation or otherwise be materially inconsistent with terms negotiated and agreed to in the Cooperative Agreement?
- Is the change envisaged within the "technical envelope" that represents the novel aspects of the Demonstration? If so, have adequate provisions been made to include the addition under the terms of the repayment provisions agreed to between the parties?

III. Technical Considerations

- If the change includes innovative process change or includes first-of-a-kind technology, is there sufficient data available to support the "readiness" for inclusion in this particular Demonstration?
- Would inclusion of the proposed change into the Demonstration Project increase the technical risk and, therefore, adversely affect the probability of success of the Demonstration?
- Does the change improve the prospect of gaining information which will mitigate technical barriers to commercialization?
- Does the change include a system, sub-system equipment piece, or components which are being demonstrated in another project within the CCT Program? If so, is there adequate rationale for support of inclusion in this Demonstration Project?

- Is the rationale for the size of the element of change consistent with the size of the Demonstration and is justified vis-a-vis expected commercial applications?

IV. Environmental Considerations

- Does the proposed change (if implemented) alter emissions of SO₂, NO_x, particulate matter, and any hazardous air pollutants currently subject to State or Federal regulation?
- Does the proposed change (if implemented) cause a net change in (a) water discharge, (b) water consumption, or (c) solid waste volumes or characteristics?
- Does the proposed change require any change to any applicable permitting requirement for the Demonstration Project?

V. Commercial, Financial, Cost and Market Considerations

- Is the change merely an updated estimate to correct an identified estimating error or omission or to provide funds for a construction overrun?
- Does the proposed change affect the efficiency of conversion of coal to electricity or to other useful products?
- Does the proposed change improve the control of noxious emissions associated with coal use or minimize the amount and adverse environmental impact of solid and liquid waste compared to other technologies commercially practiced in the U.S. or currently within the CCT Program?
- How does the proposed change affect both this Demonstration Project and the proposed "commercial embodiment" of the technology, inclusive of the change, in terms of:

- capital cost (in units of \$/ton of product or \$/KW)
 - annual fixed O&M costs
 - variable costs
 - life cycle cost (\$/kwh, \$/bbl, or \$/ton of pollutant removed)
- Does the change improve the commercial potential of the technology by other factors from those identified above?
- Does the Industrial Participant have a specific plan for financing its portion of the proposed change?
- Will the proposed change affect the Industrial Participant's ability to generate project income from the Demonstration Project?

DATE
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7/25/94

END