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THE ROLE OF IGCC IN U.S. DOE CLEAN COAL RESEARCH, DEVELOPMENT AND DEMONSTRATION

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INTRODUCTION

For many years, the U.S. Department of Energy (DOE) has been funding research, development, and demonstration (RD&D) projects to develop advanced power generation technologies. The goal of this RD&D is private sector commercialization of technologies that will provide reasonably priced electricity and still meet stringent environmental standards. Integrated Gasification Combined-Cycle (IGCC) systems are emerging as one of the more attractive candidate technologies to meet this goal. The Morgantown Energy Technology Center (METC) has been assigned the responsibility for implementing IGCC projects in DOE's Clean Coal RD&D program.

Factors creating the greatest opportunity for advanced coal technologies like IGCC are expectations of an increasing demand for electric power in the U.S. and continued low coal costs. Electric demand is projected to double by 2030, even with great strides in energy conservation. Coal now accounts for about 55

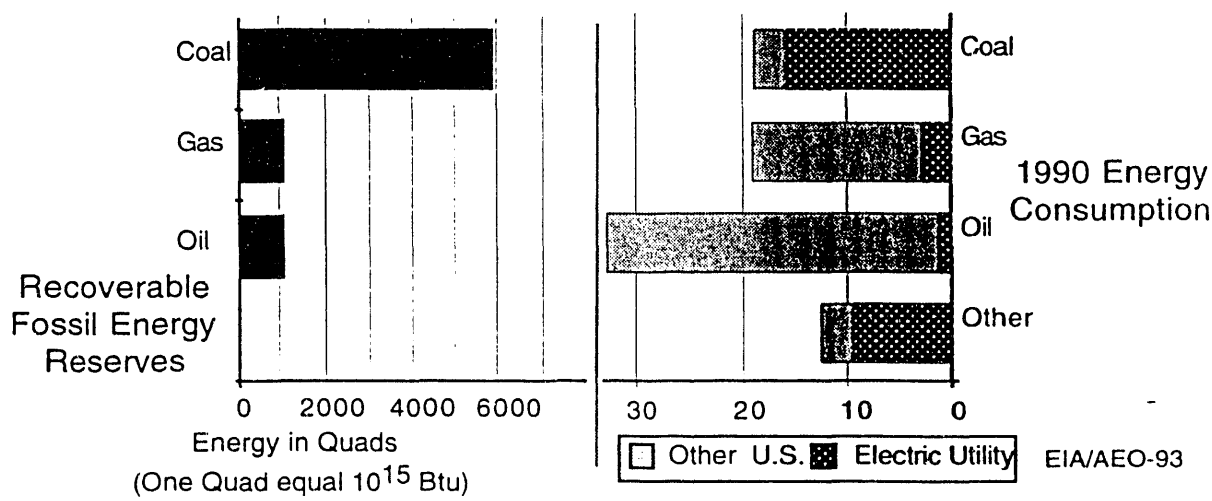

Fig. 1. Diagram showing U.S. recoverable reserves of fossil energy and energy consumption during 1990.

percent of the electricity generated in the U.S. and about 20 percent of the country's primary energy consumption. (See Fig. 1.)

The IGCC technology offers the potential for significant improvements in environmental performance compared to today's coal-fired power plants. Sulfur dioxide and nitrogen oxide emissions from IGCC systems will be less than one-tenth of existing environmental standards. Thus, the IGCC technology will make coal-based plants nearly as clean as plants that burn natural gas. (See Fig. 2.)

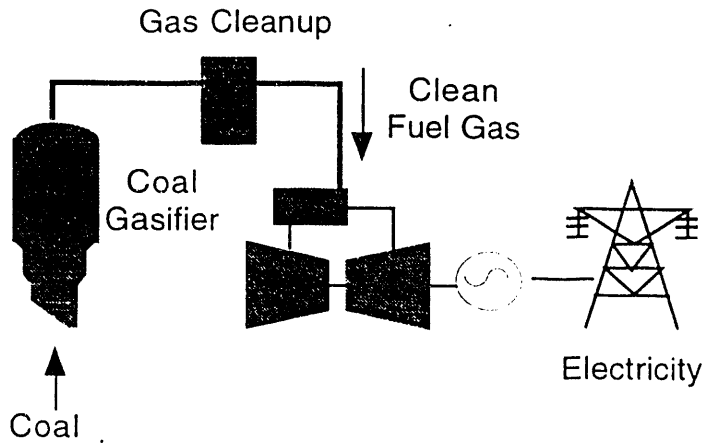

Fig. 2. IGCC schematic showing how gas from coal is cleaned before it is burned to generate electricity.

DOE'S IGCC PROGRAM

DOE's IGCC RD&D program focus on system improvements will lead to lower cost and higher efficiency without any compromise in the superior environmental performance of this technology. The efficiency of IGCC plants will also be much higher than the typical 33 to 35 percent efficiency of conventional coal-based power plants. By 2000, IGCC should achieve efficiencies of 45 percent. By incorporating high-temperature gas cleanup and advanced gas turbine systems, IGCC efficiencies will increase to 52 percent by 2010. (See Fig. 3.)

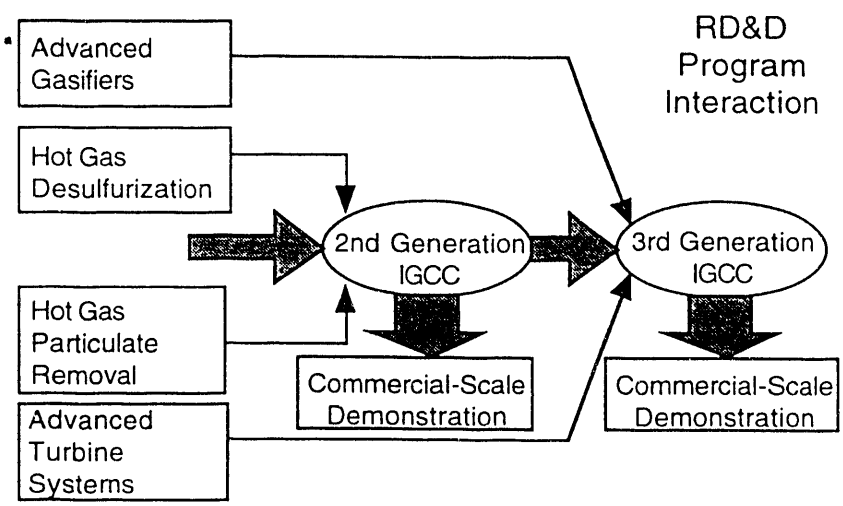

Fig. 3. RD&D program interaction of hot gas cleanup improvements and other advancements.

These increased power plant efficiencies will result in a 35 percent reduction of carbon dioxide emissions, compared with today's coal-fired power plants. Because of system improvements, capital cost will be reduced 20 percent by 2000, with an additional 15 percent by 2010. These lower capital costs and increased efficiencies will lower the cost of electricity by up to 20 percent, compared with today's state-of-the-art power plants. These RD&D goals are given in Table 1.

TABLE 1 RD&D PROGRAM GOALS

Year	2000	2010
Net Electric System Efficiency, percent (HHV)	45	52
Sulfur Dioxide Emissions* (pounds per million Btu)	0.06	0.06
NOx Emissions* (pounds per million Btu)	0.06	0.06
Air Toxic Emissions relative to 1990 CAAA law	1.0	1.0
Capital Cost ($ /kW 1990)	1,200	1,050
Cost of Electricity relative to Conventional PC Plant	0.8	0.75
*NSPS reference requirement is 0.6 pounds per million Btu		

Demonstration Projects

Seven IGCC projects are currently in DOE's Clean Coal Technology (CCT) Demonstration Program. This program was established in 1985 to support commercial-scale demonstration projects for advanced coal utilization technologies. When the 47 projects resulting from the 5 solicitations in the CCT Program are completed, the Government will have spent $2.75 billion on the program. The industry cost share will be over three times this amount. The seven IGCC projects valued at about $3 billion are listed below. (Also, see Fig. 4.)

- Combustion Engineering Lakeside Repowering Project.
- Tampa Electric Polk County Project.
- Destec/Public Service of Indiana Wabash River Repowering Project.
- Sierra Pacific Pinon Pine Project.
- TAMCO Toms Creek IGCC Project.
- Centerior IGCC/COREX Project.
- Duke Energy Camden Project.

Research and Developmer . (R&D) Projects

R&D plays a key role in the development and commercialization of the IGCC technology. Major R&D projects are discussed below. (See Fig 4.)

(i) General Electric (GE) Integrated Gasifier and Hot Gas Cleanup Operation

GE is demonstrating the operation of a hot fuel gas desulfurization process at their Corporate R&D Center in Schenectady, New York. Over 400 hours of testing has been completed in GE's 2.5-megawatt scale unit to investigate the durability of mixed metal oxide sorbents. Gas turbine components are also being tested to measure combustor performance on low-Btu gas, assess the effect of impurities in the fuel gas on deposition/corrosion in the gas turbine hot gas path, and measure level of trace impurities in the exhaust. This work directly supports the systems being designed for Tampa Electric and Combustion Engineering projects in the CCT Program.

(ii) Power Systems Development Facility (PSDF)

Conceptual designs are currently being developed for a facility to test the integration of advanced power system components. The PSDF will contain five separate modules: An advanced pressurized fluidized system, a transport reactor gasifier, several hot gas filter units, a combustion gas turbine, and a fuel cell with associated gas treatment equipment. The modular design maximizes the flexibility of the facility. Testing of various technologies will be able to be conducted in stand-alone and integrated test configurations.

The PSDF facility is located at the Southern Company Clean Coal Research Center near Wilsonville, Alabama. Participants in this cost-shared R&D project include DOE, Southern Company Services, Foster Wheeler, American Electric Power, M.W. Kellogg, Westinghouse, Southern Research Institute, GM-Allison, Alabama Power Company, Southern Electric International, and the Electric Power Research Institute. Startup is scheduled for January 1996.

The Wilsonville PSDF will be a focal point of DOE's R&D program in the coming decade. The PSDF will be used to solve systems integration issues and to develop product improvements in several of DOE's power systems. The facility will also be an invaluable support for CCT demonstration projects as they enter the operational phase in the latter part of this decade. A final role for the facility will be as a host site for collaborative and cost-shared R&D partnerships with developers and users of power systems equipment. This R&D could be conducted through Cooperative Research and Development Agreements or through participation in the existing consortium.

(iii) Gasification Product Improvement Facility (GPIF)

CRS Sirrine is currently developing conceptual designs of a Gasification Product Improvement Facility to be built at

Monongahela Power's Fort Martin station near Morgantown, West Virginia. The overall goal of the GPIF is to improve the IGCC technology by developing the optimum gasifier for IGCC. The proposed gasifier is a hybrid concept which is air blown. The hybrid design combines an entrained-bed pyrolyzer within a fixed-bed of char, which gasifies the carbon. The gasifier will be capable of operating with highly caking eastern coals. The modest off-gas temperature from the gasifier (1500°F), together with contaminant removal within the gasifier are projected to lead to a significant cost reduction and efficiency improvement for IGCC systems. Startup is anticipated in mid-1995.

(iv) Advanced Gas Turbine Systems Program

DOE's Offices of Fossil Energy and Energy Conservation recently initiated a program to develop ultra-high efficiency, environmentally superior, and cost-competitive gas turbine systems for application in the utility, non-utility generators, and industrial markets. The primary focus of the program is on natural gas-fired Advanced Turbine Systems (ATS). However, the ATS resulting from this program will also be applicable to coal-based power generation systems utilizing turbines. The efficiency boost from the ATS plays a major role in enabling the IGCC to meet an efficiency goal of 52 percent by the year 2010.

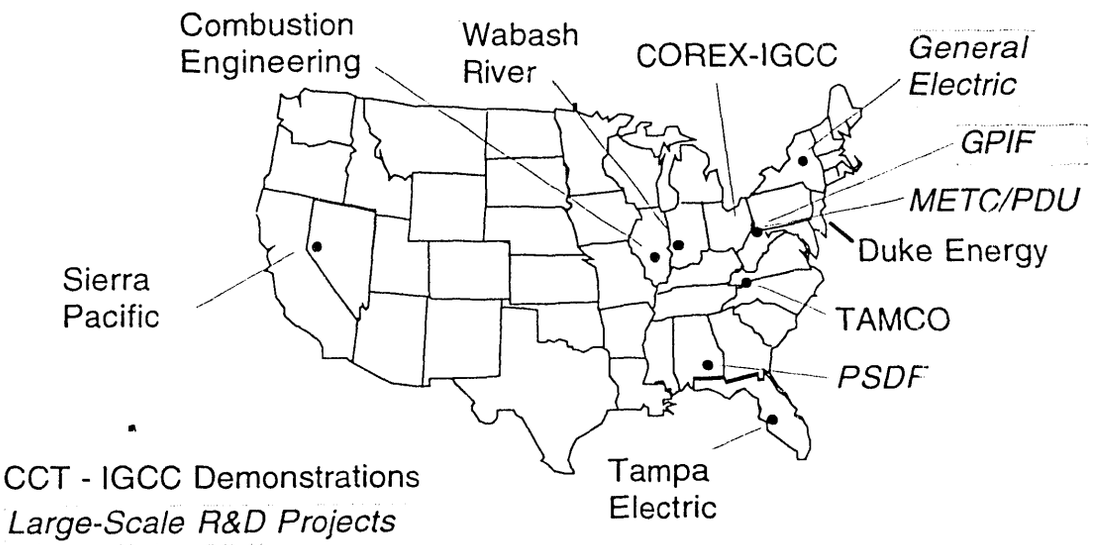

Fig. 4. Diagram showing the locations of IGCC clean coal demonstration projects and major IGCC related R&D projects.

CONCLUSION

Throughout the industrial world, the availability of reliable, low-cost energy supplies is a major determinant of economic competitiveness and quality of life. Relatively low energy costs enable a nation to produce goods and services that compete favorably in both the domestic and international marketplace. Strength in the global market, in turn, fosters growth across all sectors of the nation's economy, increasing employment opportunities and standards of living.

In the U.S., fossil fuels--coal, petroleum, and natural gas--have been central in filling the need for reliable, low-cost energy for more than a century. Today, fossil fuels remain the energy mainstays of the U.S., supplying more than 90 percent of the nation's primary energy.

Ensuring reliable supplies of low-cost energy in the future has been the focus of numerous legislative and policy initiatives of the U.S. Government. These initiatives encourage more effective use of domestic energy resources and reduced dependence on imported oil. In particular, key initiatives target more effective conservation of energy; accelerated use of renewable energy sources; expanded utilization of natural gas; and optimum use of coal, our largest domestic fossil energy reserves.

At the same time, significant efforts are being made at the Federal, State, and local levels to enact increasingly stringent environmental protection measures. Strategies for utilizing all forms of energy must support this national commitment to achieving a cleaner environment. Coal-based power generation, specifically, is subject to the provisions of the Clean Air Act Amendments of 1990 and other regulations.

The U.S. DOE, Office of Fossil Energy, has structured an integrated program for RD&D of clean coal technologies that will enable the nation to use its plentiful domestic coal resources while meeting environmental quality requirements. The program provides the basis for making coal a low-cost, environmentally sound energy choice. IGCC will play a major role ir helping the U.S. meet future power generation needs. (See Fig. 5.)

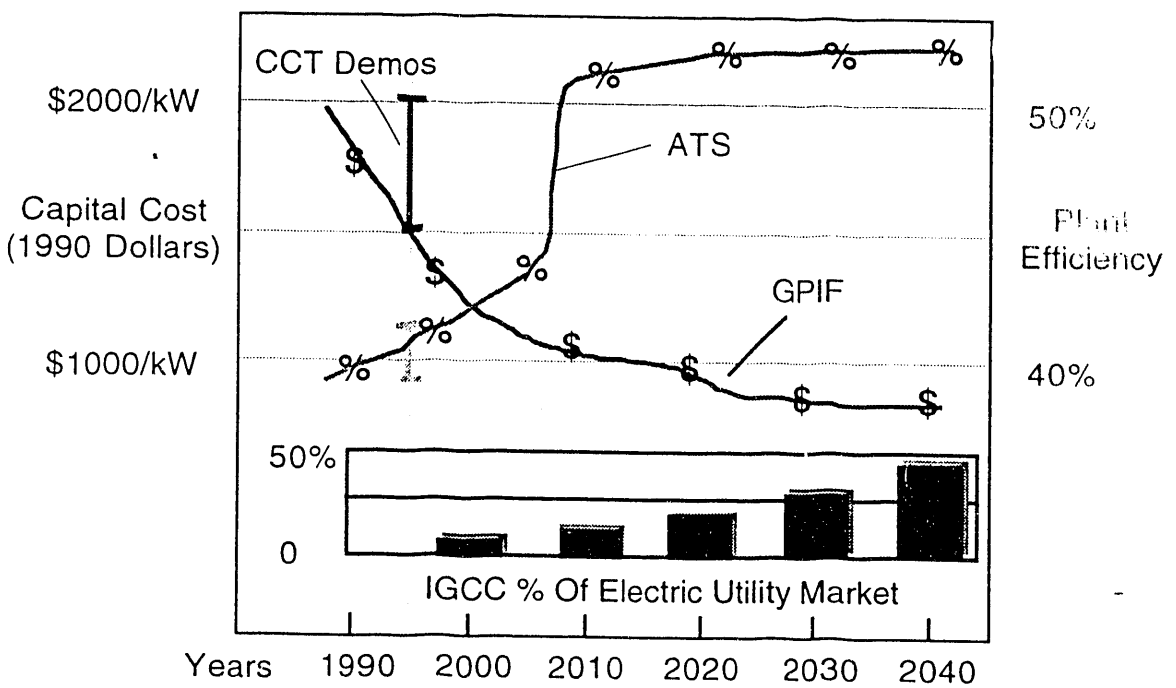

Fig. 5. Vision of IGCC capital cost and efficiency improvements, increasing market share resulting in potential of over $250 billion investment.

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