

# CONSOL'S PERSPECTIVE ON CCT DEPLOYMENT

F. P. Burke and R. M. Statnick  
CONSOL Inc.  
Research & Development  
4000 Brownsville Road  
Library, PA 15129

## ABSTRACT

The principal focus of government investment in Clean Coal Technology must be to serve the interests of the U.S. energy consumer. Because of its security of supply and low cost, coal will continue to be the fuel of choice in the existing domestic electricity generating market. The ability of coal to compete for new generating capacity will depend largely on natural gas prices and the efficiency of coal and gas-fired generating options. Furthermore, potential environmental regulations, coupled with utility deregulation, create a climate of economic uncertainty that may limit future investment decisions favorable to coal. Therefore, the federal government, through programs such as CCT, should promote the development of greenfield and retrofit coal use technology that improves generating efficiency and meets environmental requirements for the domestic electric market.

## INTRODUCTION

The CONSOL Coal Group, jointly owned by Rheinbraun and DuPont, produces about 72 million ton per year of steam and metallurgical coal and has reserves in most of the U.S. coal basins. Our mining operations are located in Canada, Kentucky, Illinois, Ohio, Pennsylvania, Virginia, and West Virginia. Domestically, CONSOL coal markets are east of the Mississippi River. Foreign sales include the Far East, the Middle East, and Europe. Because of the locations of our mines and our markets, we are particularly interested in environmental control technologies, including many of those being developed as CCTs.

Why is CONSOL qualified to speak about CCT deployment? CONSOL has supported coal-related research and development. We are the only U.S. coal company that supports a privately-funded coal research program. We have been active in supporting the DOE coal R&D program, including participating in four CCT projects: The Edgewater Boiler Limestone Injection and COOLSIDE Process Demonstration, The Milliken Clean Coal Project, the Micronized Coal Re-Burning Project, and the Piñon Pine IGCC Project. Our involvement includes financial contribution, direct participation to develop and evaluate process performance, and, in some cases, as a fuel supplier. As a coal-supplier, our goal in participating in the CCT program is

to increase coal's market share of the electric generating market. The development of new technology may gain increasing importance as the deregulated utility market seeks the lowest fuel cost and capital cost for its electric generating systems. In addition to uncertainties due to deregulation of the electric utility industry, the generation-capacity owner, technology developer/marketer, and fuel supplier are facing uncertain environmental regulations. These environmental issues will create the potential for development and deployment of new CCTs.

Before proceeding, I would like to define what CONSOL means by Clean Coal Technology. Our definition includes retrofit and greenfield environmental control technology (wet scrubbers, low NOx burners, Selective Catalytic Reduction, and wide-plate-spacing ESPs), retrofit technology to improve cycle efficiency at existing plants (e.g., heat pipe air heater), and new power generation systems (e.g., PFBC, IGCC, advanced supercritical boilers, and the Kalina cycle) for greenfield or repowering applications.

During the remainder of my presentation, I will cover three main topics:

- Future of the power generation Industry
- Impediments to commercialization of clean coal technologies
- Need for government-industry partnerships

## **FUTURE OF THE POWER GENERATION INDUSTRY**

The future of the power generation industry is uncertain. Utilities are buying and selling generating assets. The role of the IPP in the electricity generation market is unclear. Despite these uncertainties, one constant in any future utility scenario will be a focus on fuel price. The market will reward the low-cost producer and punish the high-cost producer. This will affect competition among coals, and particularly between coal and natural gas as the primary fuel for new electric capacity. Three issues drive the competition between natural gas and coal. They are:

- The efficiency of natural gas combined cycle units vs coal-fired systems
- The availability and price of natural gas
- Current and future environmental regulations

The natural gas combined cycle (NGCC) generating systems have significantly improved cycle thermal efficiency compared to simple cycle and first generation NGCC units. On a high heating value basis, the advanced NGCC generators have achieved 52 to 55% cycle efficiencies (at sea level and in new condition). The NGCC cycle efficiency is a function of elevation above sea level (cycle efficiency decreases by 0.3%/100 ft elevation), ambient temperature and age. The installed coal fired capacity in the United States has a cycle efficiency between 35 and 37%. CONSOL R&D developed the CONSOL Coal Quality Cost Model (CQCM) to evaluate the break-even price of coal and other fuels. The break-even price is the delivered natural gas price at which the bus bar power cost is identical for natural gas and coal. For the cost comparison, a new 500 MWe pulverized coal-fired power plant, complying with the NSPS for utility boilers

and having a thermal efficiency of 36.2%, was compared to an NGCC plant complying with the Gas Turbine NSPS and having a thermal efficiency of 45.6%. Life cycle costs were estimated for different coal and gas prices, depending on the real inflation rate for gas prices. Figure 1 depicts the relationship between the break-even natural gas price (expressed as dollars per million Btu), the real inflation rate for natural gas, and the delivered coal price. For example, at a NGCC cycle efficiency of 45.6%, a current delivered natural gas price of \$2.75 per million Btu, and a natural gas real inflation rate of 1%, the break-even coal price is \$40 per ton. The impacts of NGCC and coal-fired cycle efficiency on the break-even coal price are illustrated below.

### **Effect Of NGCC Cycle Efficiency On Break-even Coal Price**

<b>NGCC Cycle Efficiency, %</b>	<b>Coal-Fired Cycle Efficiency, %</b>	<b>Break-Even Coal Price, per ton</b>
45.6	36.2	\$40.00
52	36	\$34.00
52	42	\$37.50

Assuming a 1% real inflation rate for the natural gas price and natural gas base price of \$2.75 per million Btu, increasing the NGCC cycle efficiency by about 6% absolute reduces the break-even coal price by \$6.00 per ton. Increasing the coal plant cycle efficiency from 36% to 42% at 52% NGCC cycle efficiency will increase the break-even coal price to \$37.50/ton. The current average delivered coal price is about \$33/ton.

This short discussion illustrates how NGCC and coal-fired boiler cycle efficiency, and the natural gas and coal prices will affect generation fuel selection.

Another topic that is being discussed is the rate of growth of utility generation. Many experts predict the future...most are wrong. That said, we will provide some estimates of future electrical load growth. Based on EPA telephone contacts with boiler owners and state regulatory offices, the projected 1996-2000 planned capacity addition is 5189 MWE<sup>1</sup>. The Energy Information Agency<sup>2</sup> estimates that electrical load will expand by 50,000 to 60,000 MWe through 2010. The increased demand for electricity will be filled by increased utilization of existing capacity purchase of electricity from Canada and Mexico, repowering of existing units, and construction of new power plants. Repowered and new power plants could provide the markets to deploy CCT demonstrated generating systems (PFBC, IGCC, etc.).

### **IMPEDIMENTS TO DEPLOYMENT OF CCT TECHNOLOGIES**

As I mentioned earlier, CONSOL markets coal worldwide. While our primary interest is the domestic market, CONSOL supports the worldwide deployment of CCTs to expand foreign markets. Expanding domestic and foreign markets will stabilize coal prices, increase the volume

of coal exported, increase the volume of U.S. industrial exports, and help to maintain U.S. technological leadership.

I will now focus on domestic CCT installations and impediments to deploying CCT technology. As a coal producer, we are interested in retrofit CCT's which will be deployed beyond 2000 and in new, greenfield power installations for the post-2005 period. CONSOL believes that there will be three main impediments to deploying CCT technology. They are:

- Uncertainty concerning environmental regulations
- Uncertainty concerning power industry
- Coal-supply implications of new technology.

The U.S. power industry is facing a period of high uncertainty concerning the future of environmental regulations. EPA is considering the following environmental regulations:

### **Pending Environmental Regulations**

National Ambient Air Standard for SO <sub>2</sub>
National Ambient Air Standard for Ozone
Revised New Source Performance Standard for Utility Boiler NOx Emissions
NOx Emission Limits Due to the Ozone Transport Assessment Group
NOx Emission Limits Due to OTC Regulations
Nation Ambient Air Standard for PM <sub>2.5</sub> (2.5 μm Particulate Matter)
Utility Air Toxics Regulations

The three ambient air standards could require utilities to reduce NOx and SO<sub>2</sub> emissions from existing utility boilers through the State Implementation Plans. If the cost of compliance is not excessive, these regulations could create a market for the retrofit CCTs. For example, the CCT program demonstrated the performance and economics of the Pure Air, Chiyoda, and SHU FGD processes for SO<sub>2</sub> control; of the NOxOUT, Selective Catalytic Reduction, and low NOx burners for nitrogen oxide control; and wide-plate spacing ESPs for particulate control. The OTC and OTAG processes could create a market for NOx control technologies capable of achieving emissions of 0.15 pounds-per-million-Btu. Clearly, EPA's actions will either expand the market for CCTs or, if the environmental regulations are too severe, they could reduce coal-fired generation and the demand for CCTs.

I have been informed that the utility deregulation legislation being drafted by DOE may include an environmental compliance title. It was reported that EPA is seeking significant SO<sub>2</sub> and NOx emission reductions beyond Title IV Acid Rain Control levels. DOE and EPA are discussing a concept termed "environmental comparability". While the definition of "environmental comparability" is not clear at this time, it could mean that existing SIP-regulated boilers become subject

to the New Source Performance Standard after a certain operating life. There is much economic uncertainty due to deregulation. Adding an uncertain environmental burden only increases this uncertainty.

Not on the list of pending regulations is greenhouse gas control. A program to limit greenhouse gas emissions without including the entire community of nations is doomed to failure. Several countries have already stated that they will not participate in greenhouse gas emission control. Many third world countries are purchasing the standard 2400 psi, 1000 °F/1000 ° F boiler. The third world is where the growth in greenhouse gas emissions will occur. China is currently the world's leading coal consumer. The Chinese are purchasing the standard boiler package and have stated that they will not agree to greenhouse gas limitations. Reducing CO<sub>2</sub> emissions will limit coal and, for that matter, any fossil fuel usage. Increasing power plant efficiency will reduce CO<sub>2</sub> emissions per kilowatt generated, but may not reduce the total CO<sub>2</sub> emissions if there is compensating growth in generating capacity.

Regardless of the post-deregulation future of the power generation industry, there will be a shakeout period. As stated above, the low-cost power producer will be the winner. The role of CCTs in this market is not clear. The uncertainty in the nature of the generation business will limit capital expenditures over the short term. The initial impact of deregulation is to minimize capital investment. Only absolutely needed generation will be purchased. The initial choice will focus on low capital cost systems with short payback periods. As the future becomes clearer, the generation owners will begin to focus on least-cost, life-cycle processes. In this market, coal will continue to be an important player. CCTs can capture a portion of the new generation capacity market (2005 to 2015) if they can demonstrate cost-effectiveness, reliability, and generating capacity flexibility.

The impact of coal quality specifications on CCTs has not been clearly defined. Will all coals perform equally well with a given CCT? What are the impacts of ash fusion temperature, coal chlorine content, ash content, volatile matter, etc., on CCT process performance? These issues have not been resolved for all economically attractive coal basins.

## **NEED FOR CONTINUED FEDERAL ASSISTANCE**

CONSOL believes that government involvement in the development of technology should be minimized. However, the combination of regulatory and environmental uncertainty caused by past and potential future federal actions has changed the private sector risk analysis. Typically, when a company evaluates a development project, it evaluates the market size and the cost and performance of current technology. For example, Intel knows the cost and performance of both its current generation and the competitors' microprocessors. Developing a new microprocessor has risk, but the market size and new performance requirements can be estimated with some accuracy. Compare this to developing power systems. What is the performance requirement? The EPA can alter the performance specification by imposing additional requirements that are out of the control of the process developer. If the developing design includes a 90% NO<sub>x</sub> removal but EPA regulations require 95%, then the development effort may be in vain. A

significant uncertainty is greenhouse gas emission reduction. What is a minimum acceptable boiler efficiency that might satisfy EPA requirements? No one can answer that question.

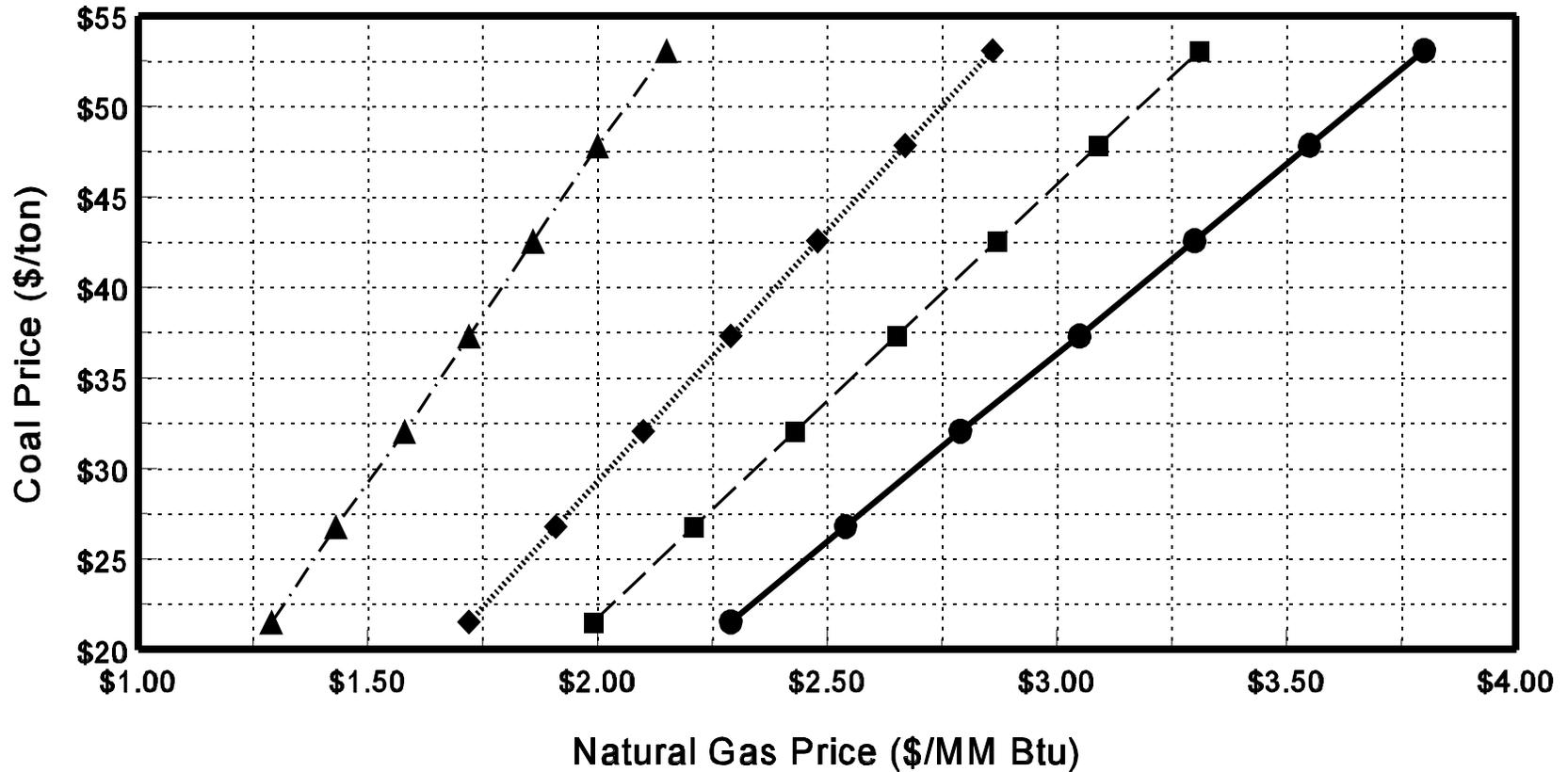
When regulatory uncertainty introduced by the federal government has such significant impacts on technology development, then the government has a responsibility to assume a portion of the development risk. The Clean Coal Technology Program was an example of a private sector federal program which achieved some success. Some have complained that this was a welfare program for industry. This is far from the truth. For example, CONSOL, Babcock & Wilcox, DOE, and EPA developed low capital cost, moderate SO<sub>2</sub> removal processes. When the Clean Air Act Amendments of 1990 were passed, Title IV ( Acid Rain Control) did not favor these technologies because of the utility-wide emission allowance and trading programs. The private sector and federal investments were made obsolete by the Congress and EPA's implementation of the Act. This situation continues to exist today and probably will continue to exist in the foreseeable future. If the United States is to remain a leader in power systems development continued federal assistance will be required to domestically deploy CCT-demonstrated NO<sub>x</sub> and SO<sub>2</sub> controls and more efficient coal-based power systems such as PFBC, IGCC, the advanced supercritical boiler, the Kalina cycle, and others.

One final point. Ultimately, the decision about federal investment in energy technology should reflect the goal of providing power to the domestic consumer at lowest cost consistent with environmental objectives. In this sense, the success of the CCT program should be judged by how well it speaks for the energy consumer. The objective of the CCT program is to demonstrate lower cost, environmentally-compliant technologies to increase the use of inexpensive, abundant coal, and to leverage the government investment through private-sector cost sharing. A successful CCT program keeps the cost of electricity low, which benefits industrial, commercial, and residential users. I believe the CCT program can stand on its record in addressing the two demands of the energy consumer: low-cost electricity and environmental protection.

## REFERENCES

1. J. Eddinger, EPA personal communication
2. Energy Information Agency, *Electric Power Monthly*, March 1996, and *Short Term Energy Outlook*, April 1996.

**Break-Even Fuel Prices**  
**New 500 MW Power Plant (Today's Efficiencies)**  
**Coal @ 36.2% HHV -- Natural Gas @ 45.6% HHV**



—●— No Real Inflation      —■— 1% Real Inflation  
 .....◆..... 2% Real Inflation      -·-▲-·- 3% Real Inflation