4th Annual Clean Coal Technology Conference

Proceedings

The Global Opportunity

The emphasis of the Fourth Clean Coal Technology Conference was the marketability of clean coal projects both domestically and abroad. The success rate of clean coal projects in the U.S. for coal-fired electricity generation is a beacon to foreign governments that are working toward effectively using advanced NO_x and SO_2 technology to substantially reduce flue-gas emissions for a cleaner environment. There is a continuing dialogue between U.S. Government, North American private industry, and the electricity producing governmental ministries and the private sector abroad. The international community was well represented at this conference.

The Administration is determined to move promising, near-term technologies from the public to the private sector as well as into the international marketplace. The Fourth Clean Coal Conference assessed and evaluated many of the technologies that not only are promising, but will become the benchmark technologies in emissions control, for 1996 and into the next century.

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Global Opportunity, Meeting the Diverse Challenges

FOURTH ANNUAL CLEAN COAL TECHNOLOGY CONFERENCE

Denver, Colorado; 5-8 September 1995

"The World Energy Outlook"

John P. Ferriter
Deputy Executive Director
International Energy Agency

The World Energy Outlook

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INTRODUCTION

It is a pleasure to be here with you today to present the IEA's world energy outlook, and to discuss clean coal technology from an international perspective.

In my presentation today, I will concentrate on:

- the importance of coal in world energy;
- the policies affecting the outlook for coal;
- the environmental challenges ahead;
- the need for clean coal technologies; and
- the opportunities for international co-operation to meet those challenges.

THE IEA IN A CHANGING WORLD

First, a few words about the International Energy Agency for those of you who may not be familiar with our work.

The International Energy Agency was created as a result of the "energy shock" of 1973-74. Confronted by the serious damage to their economies caused by the oil shock, the major oil-importing countries sought to devise a credible response. The energy crisis was not just an economic challenge; it was a political challenge. How would the Western countries respond? Individually? Or collectively?

Against this background, the Washington Energy Conference of February 1974 was convened. Most OECD countries, which is to say most of the major industrial countries, attended that conference. From their efforts emerged, in November 1974, a new international organisation whose specific goal was to promote the energy security of its Members -- the International Energy Agency.

Today, 20 years later, the IEA has 23 Member countries. Six other countries (Mexico, Korea, Hungary, Poland, Slovakia, and the Czech Republic) have formally expressed interest in joining the Agency.

Although membership in the Agency has expanded over the years, its basic mission has not changed. Now, as then, the prime objective of the IEA is to assist member governments and nations in improving their energy security both individually and collectively. That means developing and promoting policies that will ensure the reliable provision of sufficient amounts of all fuels at reasonable prices.

Although oil security remains a major concern of our Members, the IEA today is pursuing its energy security mandate more broadly, recognizing the globalization of energy markets, the growing interdependence among participants in those markets, and the environmental imperatives that are shaping energy policies.

WORLD ENERGY OUTLOOK

The IEA published the 1995 edition of its *World Energy Outlook* earlier this summer. The outlook is intended to suggest the general direction and possible evolution of worldwide energy trends. The outlook is based on two scenarios regarding the response to rising world energy demand.

Growth in world energy demand to 2010 will be at such a level that either prices will rise -- in what we have called the *capacity constraints* case -- or energy intensity will improve as a result of more efficient use of energy -- leading to the *energy savings* case.

- In the *capacity constraints* case, we assume that trends in past behaviour will continue to dominate future energy consumption patterns. Growth in world energy demand in this case proves too fast for production to keep up. The oil price (in constant 1993 prices) is expected to rise from about $17 per barrel this year to $28 by 2005, and remain at that level after that.

- In the *energy savings* case, energy consumers choose to use currently available energy-efficient technologies to a greater extent than has been seen in the past. The need for additional productive capacity reduces as energy-efficiency rises. Under this scenario, the price of oil is expected to remain flat in real terms at $18 per barrel from 1996 onwards. Coal prices are assumed to remain flat after the late 1990s.

In the *capacity constraints* case -- in which historical trends continue -- world energy demand is expected to increase by about 45 percent between now and 2010, or at an average annual rate of just over 2 percent.

In the *energy savings* case -- in which energy-efficient technology penetrates energy markets -- world energy demand grows by less than 35 percent over the outlook period, or 1.7 percent per year on average.

Based on the IEA's *Outlook* to 2010 several major elements emerge with which energy policy makers must contend in the medium and long-term:

- We live in a world dominated by fossil fuels, and we project their share to remain at 90 per cent of total world energy consumption. One consequence is that energy-derived CO_2 emissions could grow by almost 50 per cent by 2010.

- World oil consumption is expected to increase by about 40 per cent by 2010, with most of the increase in consumption taking place in non-OECD countries.

- Natural gas will account for 22-24% of total energy demand by 2010.

- Coal will continue to account for about 30% of total energy demand under either scenario.

- The share of nuclear energy will decline, as hydroelectric generation increases modestly.

- The non-OECD area is taking over as the major user of energy and now accounts for about 50 per cent of the world's total energy consumption, and that share will inexorably increase.

- Environmental effects associated with the energy sector, from production to consumption, compel innovative approaches to energy policy.

World solid fuel demand is projected to grow to over 3000 Mtoe by 2010, compared with 2,300 Mtoe in 1992. This growth is concentrated in non-OECD countries. Coal, especially for power generation, will increasingly be imported. International coal trade, having doubled between 1973 and 1992, will double again by 2010. Although coal will continue to be traded mainly on a regional basis, the rise in international trade shows a movement towards trade and co-operation, and away from policies of exploiting indigenous resources whatever the cost.

- World consumption of solid fuels (essentially coal) in the period to 2010 is expected to increase at an average annual rate of 2 percent to 2010 in the *capacity constraints* case, and 1.6 percent in the *energy savings* case.

- Power generation accounted for 56 percent of demand for coal in 1992 and by 2010 this share is expected to be 58 percent in both cases.

- Coking coal consumption is expected to be stable over the period.

- In the OECD, coal consumption is expected to increase by 0.9 percent in the *capacity constraints* case, and by 0.3 percent in the *energy savings* case, but coal consumption is expected to fall in the former Soviet Union and in Central and Eastern Europe,

In the case of solid fuels, China and South Asia account for three-quarters of the incremental demand of non-OECD countries. This alone is more than three times the incremental demand of all the OECD countries combined. While clean coal technologies are likely to be first applied in OECD countries, this is not where the increase in coal consumption, and thus the increase in carbon and other emissions, is taking place.

The 1995 *World Energy Outlook* expects China and India alone to account for a larger amount of the increase in carbon dioxide emissions between 1990 and 2010 than all OECD countries combined. Moreover, these two countries will account for more than 50 percent of

Rest of the World emissions by 2010. The major fuel for power generation in these two countries is coal which, in 1992, accounted for around 75 percent of total electricity generation in China, and more than 70 percent in India.

Given the very low level of efficiency in many plants, the introduction of state-of-the-art combustion technology will result in significantly greater reductions in unit carbon dioxide emissions than in the OECD. And economic performance will be significantly enhanced as well, providing commercial justification for retrofitting investment.

Competition between developing nations for capital investment in their energy sectors can be expected to be a force for greater liberalisation. Wider international co-operation can optimise expenditures on energy technology development and deployment. IEA countries have the opportunity to reach out to industrialising countries and pass on the lessons that they have learned in the past. Because of this, the IEA seeks to improve its links with non-Member countries.

Energy policy makers need to recognise the major contribution which will come from coal:

- Coal is one of the world's most important and abundant fossil fuels; its share of many countries' energy mix and the wide distribution of reserves around the world enhances energy diversity, and thus increases energy security.

- Coal is low-cost compared with oil or gas, perhaps between a quarter and one-half the price for the same primary energy content. Many countries have economically viable domestic resources of coal to support sustainable economic development.

- There is major scope for improving the efficiency with which coal is used and for mitigating the pollution and emissions that its production and use can cause.

In general terms, the outlook for coal in the world energy scene is for strong competition with gas, weakening demand for some coal uses, but continuing demand for baseload power generation. The future trends of energy demand lead to a situation not unlike the present - energy demand will continue to be met by fossil fuels, although there will be a shift in their consumption away from the industrialised world towards newly industrialising nations.

ENVIRONMENTAL CONCERNS

Environmental issues are key concerns of OECD governments. These concerns cover traditional pollutants: sulphur dioxide (SO_2), nitrogen oxides (NO_x), and particulates. They also include water and land contamination, together with satisfactory disposal of solid wastes. These issues have had major effects on the development of the energy sector in the past two decades, and will continue to do so in future, particularly here in the United States as the Clean Air Act tightens emission limits. The driving force of the Clean Coal Technology program has been the need to improve the technologies available to meet these challenges.

More recently, a new challenge has come forward, that of a potentially enhanced greenhouse effect and global warming. The principal gases involved - carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O) - are all affected by energy production and combustion.

By 2010, world carbon emissions could be between 30 and 42 per cent higher than in 1990. At present the OECD accounts for more than one half of the world's energy related carbon emissions. By 2010, this could fall to just over 40 per cent.

India and China account for a larger amount of the increase in annual carbon emissions between 1990 and 2010 than do all the OECD countries combined. By contrast, in 1990, China and India accounted for less than one third of the level of total OECD emissions. Action in the industrialised world alone will clearly not be enough to cause a substantial change in the outlook for global carbon emissions.

The key is to develop energy policy options for sustaining economic growth while minimising environmental degradation. By ratifying the Framework Convention on Climate Change, IEA countries have pledged to identify the actions they will take to achieve their climate change commitments. Action in relation to energy will be central to the realisation of the Convention's goals. Carbon emissions per capita in IEA countries will continue to far exceed those of the developing world. Accordingly, the industrialised countries have undertaken the obligation to act first.

<u>Clean Coal Technologies</u>

A principal area of action is in the acceleration of the deployment and dissemination of those technologies that result in reduced emissions. Many technologies exist which, if deployed, would result in lower emissions than are attainable with technologies currently in use. But even these are insufficient to meet medium and long-term environmental concerns. Many new technologies will be needed.

The outlook for coal in the *World Energy Outlook* does not take account of some of the more advanced coal-fired power generation technologies since most observers would not expect them to be economically viable until well into the *Outlook* period. Advanced coal-fired plants are nevertheless an important factor since they have the potential to alleviate environmental opposition to the use of hard coal, and of recapturing ground from competing fuels.

Some of these technologies are still, however, on the horizon. What can the industry and governments do to accelerate the process?

Government policies directed to achieving energy pricing related to full economic and environmental costs, free and open energy trade and investment, environmentally sustainable energy production and use, are first order priorities. However, support for research and development, promotion of technology development and deployment, and technology cooperation are also proper roles for government.

Nevertheless, it will be private decisions which will determine if and where coal provides the fuel for the next generation of power stations. It is instructive, then, to look at the attitudes expressed by the coal producers, equipment manufacturers and utilities, to see which technologies are likely to be taken out of the laboratories and into commercial service.

The IEA's Coal Industry Advisory Board (CIAB) brings together 40 top-level representatives of the coal industry from throughout the world to advise the Agency on coal issues. The IEA has recently published for the CIAB a study on combined-cycle technologies for enhancing environmental performance of coal combustion in power generation. Important as these developments are, the report considered that their economic and technical performance are not yet fully competitive.

We have just published a second volume by the CIAB which looks at the technologies evolving from the well-established steam cycle technology. Results of an industry survey show that, in the next 10 years, the major uptake of new coal-fired steam cycle plant will be in China, South East Asia and India.

A negative tone to the findings of the report, however, is the comment that neither manufacturers nor utilities are generally willing to fund the demonstration of new generating technologies. Governments are increasingly reluctant to take on this rôle and may not, in any case, be the best agent for the task. Perhaps the industry needs to look to its own long-term interest, and companies along the length of the coal chain might see that their interests are best served in the development and deployment of new technologies.

I believe this is particularly true for the US market. In the Asian-Pacific region there is a commitment to coal and existing technology which represents a low-cost approach to environmental improvement. In the United States, the development and use of improved coal-fired power technology is the key to competing with gas, and of keeping coal economic as the requirements of the Clean Air Act tighten.

It is because of these additional cost burdens involved in meeting modern environmental standards that research and development into advanced coal-fired power technologies is seeking innovative methods to simultaneously improve economic and environmental performance.

INTERNATIONAL TECHNOLOGY CO-OPERATION

The cost of research and development, and the global nature of the issues that R&D is designed to meet, has led IEA Member countries to work together on efforts to address these technology challenges.

Our co-operation on science and technology takes a number of forms. One involves representatives of the Member Governments meeting to review and discuss their policies and experiences. Our Working Party on Fossil Fuels is chaired by Assistant Secretary of Energy, Patricia Fry Godley. A second involves conferences such as this one. A third is through direct co-operation between Governments (or participants nominated by them) to undertake specific projects.

Intensified energy technology co-operation among IEA Member countries, and with other countries, is an indispensable means to accelerate technology advances and to enhance long-term energy security and environmental protection. As part of our efforts to assist this co-operation, the IEA has established an energy technology and R&D collaboration programme. Key components in the programme are known as "Implementing Agreements" which aim to accelerate energy technology development by sharing scarce resources and broadening the prospects of market deployment. About forty such Agreements are currently underway, and those involved include government, industry and academic participants from both IEA and other countries. The US Government plays a leading role in many of these agreements, but we would also welcome greater industry involvement.

The largest and longest-running project of IEA technology collaboration is *IEA Coal Research*, originally established in 1975. With representatives of 14 countries and the European Commission participating, it undertakes research into a wide range of coal-related issues on an international scale, collating and disseminating information about coal, and carrying out technical and economic analyses. It provides easy low-cost access to the most comprehensive information about coal and coal technology available anywhere in the world. Three other IEA collaborative projects are also focused on coal, namely: *Coal Combustion Sciences*, *Coal/Liquid Mixtures*, and *Fluidised Bed Conversion*. Two others which deal with other fossil fuels as well cover: *Multiphase Flow Sciences* and *Greenhouse Gas R.& D*; the latter investigating capture, use and disposal options and related issues. A project completed last year on the *Testing of High-Temperature High-Pressure Filters*, showed that the IEA Implementing Agreements can also form the basis of industry co-operation.

<u>Climate Technology Initiative</u>

At the March-April 1995 Berlin Conference of the Parties to the United Nations Climate Change Convention (COP-1), statements by many governments and industry organisations recognised the important role of technology in reducing greenhouse gas emissions. There was general recognition that both expanded and intensified efforts are needed to speed up the otherwise lengthy technology development and deployment process so as to realise the potential contribution of technology.

As a contribution to this process of enhancing the application and development of technologies to respond to global climate change concerns, a **Climate Technology Initiative** was announced at the Berlin Conference by the Netherlands' Minister for the Environment on behalf of 23 OECD Member countries.

The **Climate Technology Initiative** is a linked set of national and international measures, practices and processes, including voluntary private sector activities, to accelerate development, application and diffusion of climate-friendly technologies in all relevant sectors. Other governments and international industry organisations have been invited to participate in the further development and implementation of the Initiative.

The Initiative includes: co-operative actions to enhance the use of voluntary emission reduction measures in non-OECD countries; support for developing countries to develop the technology aspects of their national climate change response plans and improve developing countries' access to information on technology options; efforts to build markets for emerging technologies in non-OECD countries; collaborative efforts to support technology demonstration projects in non-OECD countries; and collaboration on new technology development and joint efforts to evaluate and develop technologies to capture, dispose of, or use greenhouse gases.

There will be significant potential for the coal industry to participate in this Initiative.

"Joint Implementation"

Another important outcome of the Berlin conference was the agreement to undertake, on a pilot phase basis, an international greenhouse gas emissions reduction programme commonly known as "Joint Implementation" (now referred to as "actions implemented jointly under the pilot phase"). Under this voluntary programme, developed countries could assist other countries to reduce their emissions, leading to an overall reduction in emissions worldwide, at lower cost than if the same reduction had been undertaken in the initiating country.

Based on the results of this pilot phase, a decision will be taken before the end of the current decade on whether to establish a permanent programme that would "credit" signatory countries of the Climate Change Convention with emissions reductions elsewhere on the globe. There are numerous concerns and costs associated with the introduction and "credit counting" of such activities. It is also important in any application of the joint implementation concept that large scale investments in developing countries should not lock them into outdated and less efficient technologies for the future. Nevertheless, the least-cost principle underlying joint implementation makes it a natural response in a globally integrated economy.

The IEA plans to invite representatives of industry to a meeting, scheduled for 13-14 November in Paris, of the IEA's Ad hoc Industry Advisory Group on Energy and the Environment to discuss energy and environment issues and related developments.

POLICY ISSUES AND RESPONSES

The challenge for energy policy in the 1990s is how to best safeguard energy security and to meet environmental goals in the open and competitive markets increasingly becoming established in response to global economic integration. The energy industry has been responding to the challenges and opportunities of globalization by strategic restructuring to maximise competitiveness and internationalise activities.

Governments are increasingly withdrawing from direct involvement in the market, whether through ownership of operating companies or through direct regulation. Some IEA Member countries are experiencing political limitations even to residual Government intervention in markets. Market forces alone, however, cannot secure energy security or a clean environment. To break the link between economic growth, energy demand growth and carbon emissions growth, we need to reduce the energy intensity of our economies and the carbon intensity of our energy mix.

If one point is clear, it is that the role of government is to facilitate commercial activities, rather than replace them. Companies, not governments, produce and transport energy, and they do this more efficiently in markets where they face commercial pressures and rewards.

Governments need to set the stage and the rules of the game for energy market participants so that companies can operate competitively and efficiently, and thus produce results which are satisfactory in terms of energy, environment and economic objectives.

CONCLUSIONS

In conclusion, as economic and population growth occurs, demand for energy will rise. Fossil fuels will continue to meet a substantial part of energy demand over the medium term. The fundamentally sound economics of coal-fired power generation will ensure a strong continuing demand for coal to help meet this demand.

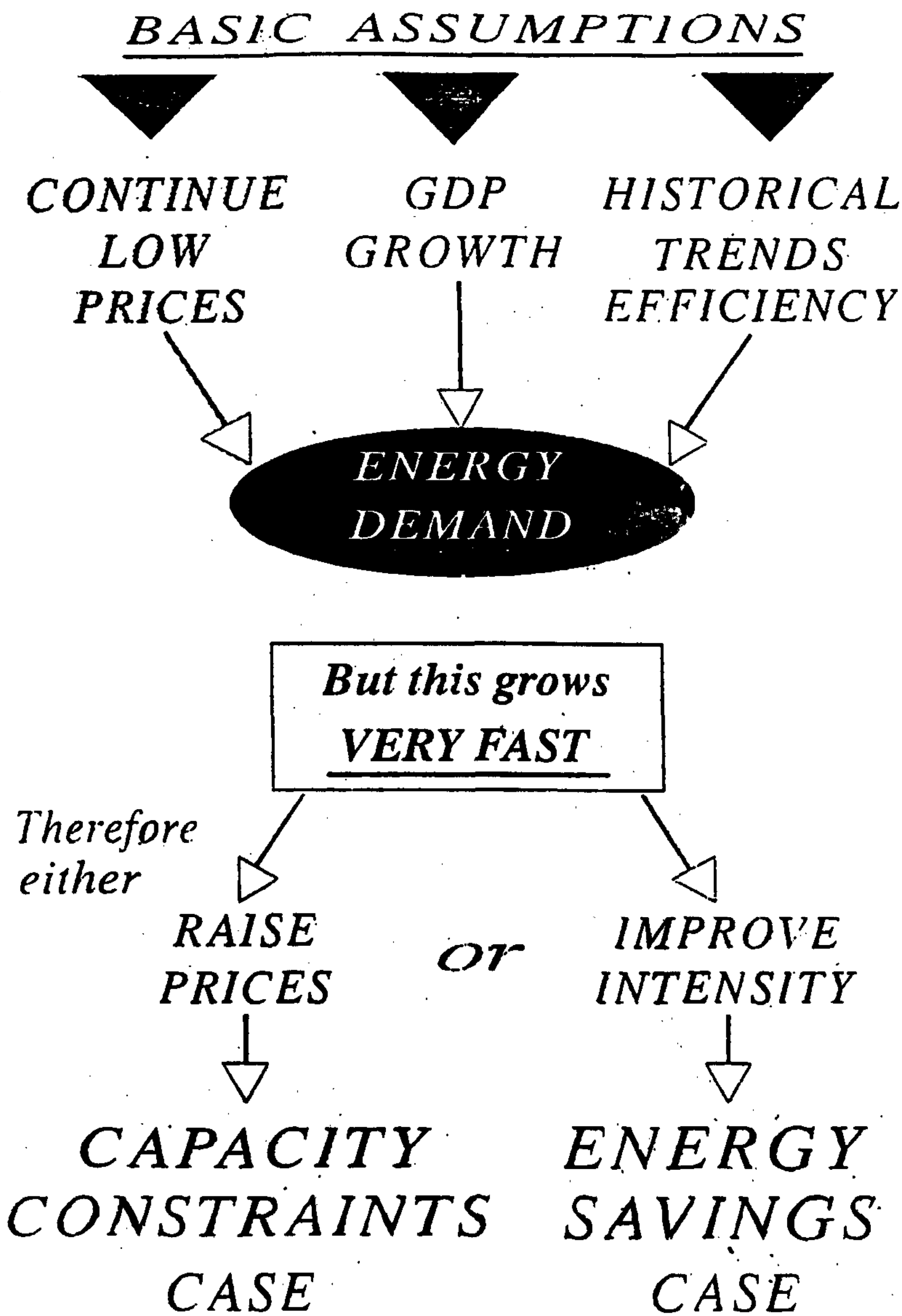
The major uncertainty regarding the outlook for coal is the environmental issue. How this will be resolved depends largely on the introduction of new techniques for cleaner and more efficient coal combustion. The IEA stands ready to assist in these efforts.

On balance, I am confident that the environmental performance of coal use can continue to be improved while costs are contained, and that the place of coal is secure. Its use can promote energy security and economic development. Producing and using coal and lignite more cleanly and more efficiently will mitigate the environmental impacts of increased energy demand, and will help lead to sustainable economic development. Deployment of new and improved clean coal technologies will play a critical part in meeting the growing world demand for energy. And that is why we are here today and why this meeting is so topical and important.

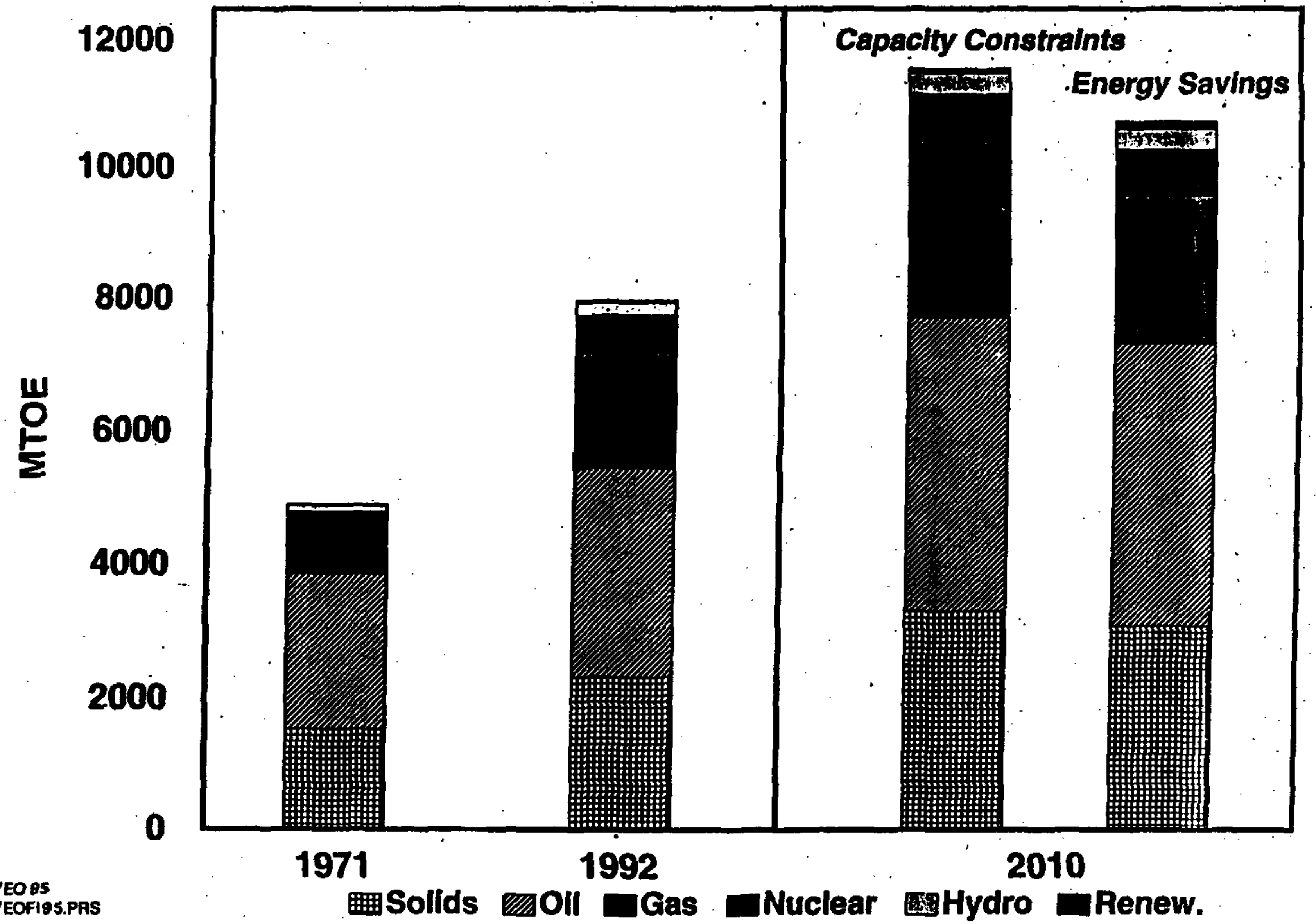
Thank you.

MAIN POINTS

- IMPORTANCE OF COAL
- POLICIES AFFECTING OUTLOOK
- ENVIRONMENTAL CHALLENGES
- CLEAN COAL TECHNOLOGIES
- OPPORTUNITIES FOR INTERNATIONAL CO-OPERATION


BASIC ASSUMPTIONS
CONTINUE LOW PRICES
GDP GROWTH
HISTORICAL TRENDS EFFICIENCY
ENERGY DEMAND
But this grows VERY FAST
Therefore either
RAISE PRICES
or
IMPROVE INTENSITY
CAPACITY CONSTRAINTS CASE
ENERGY SAVINGS CASE

WORLD PRIMARY ENERGY DEMAND



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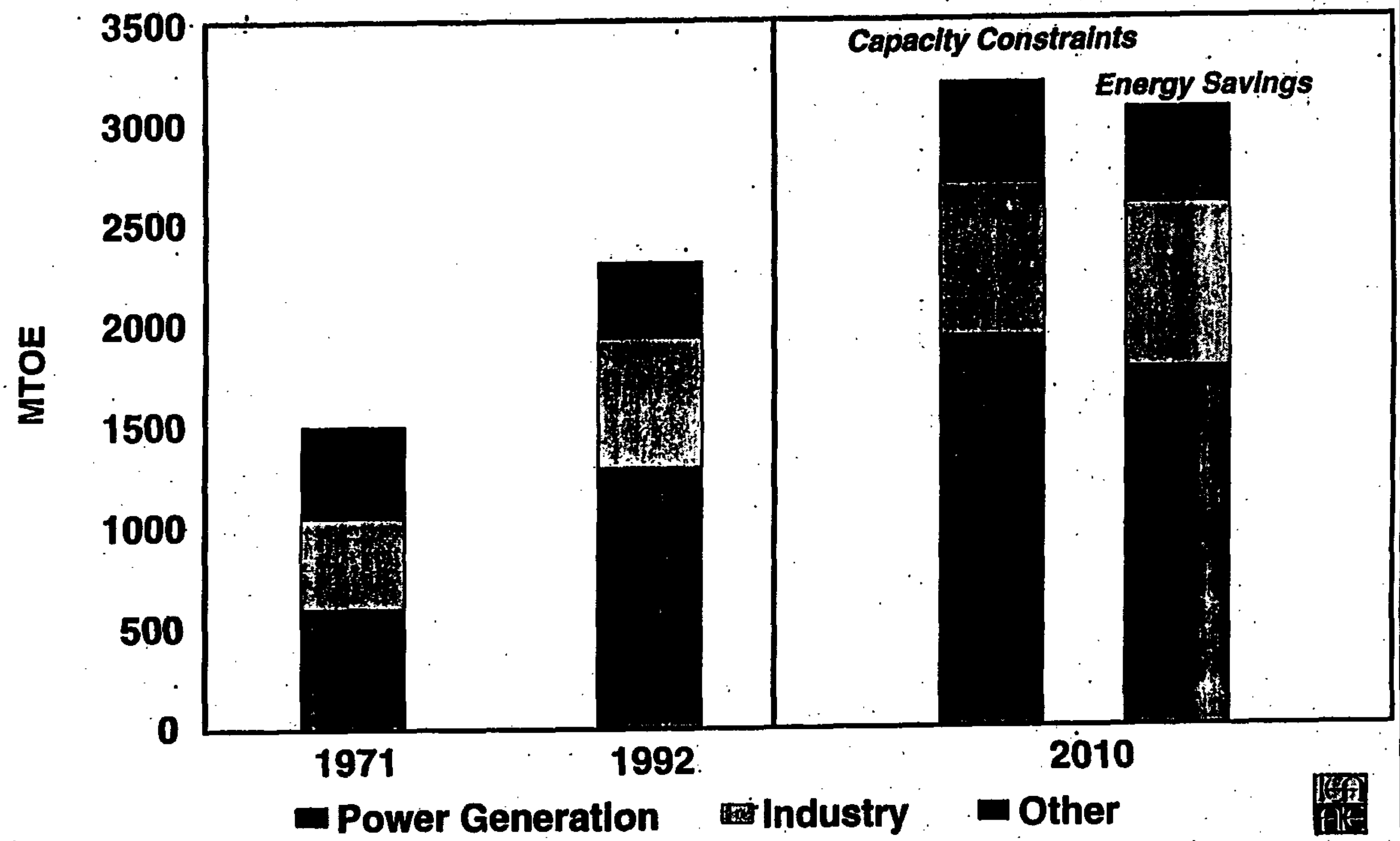
WORLD SOLID FUEL DEMAND



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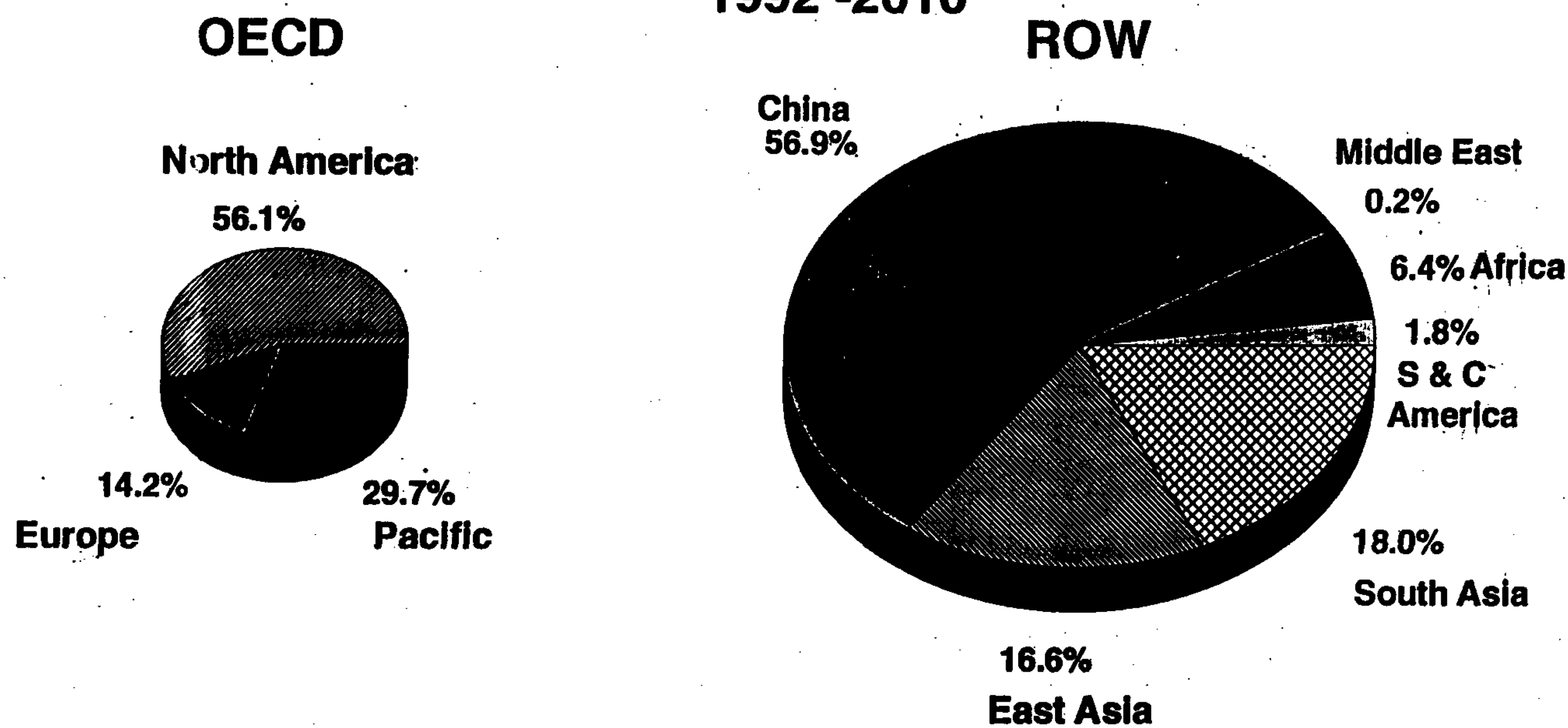
INCREASE IN ANNUAL SOLID FUEL DEMAND

CAPACITY CONSTRAINTS CASE

1992 -2010



186 MTOE

819 MTOE

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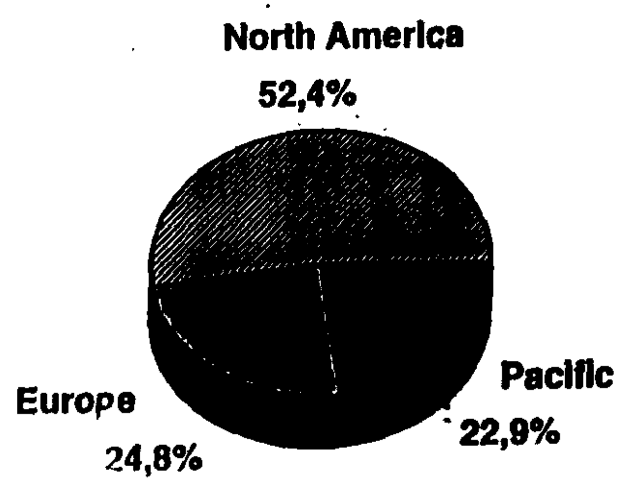
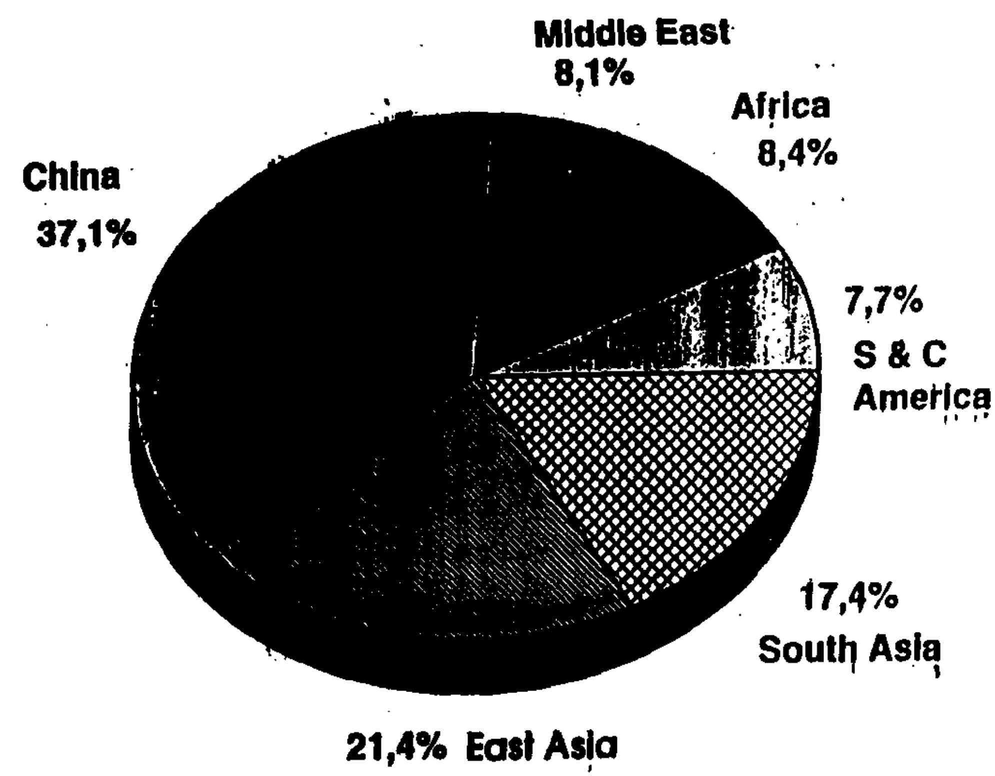
INCREASE IN ANNUAL CO_2 EMISSIONS, 1990 - 2010

CAPACITY CONSTRAINTS CASE



OECD

2482 million tonnes



ROW

7352 million tonnes

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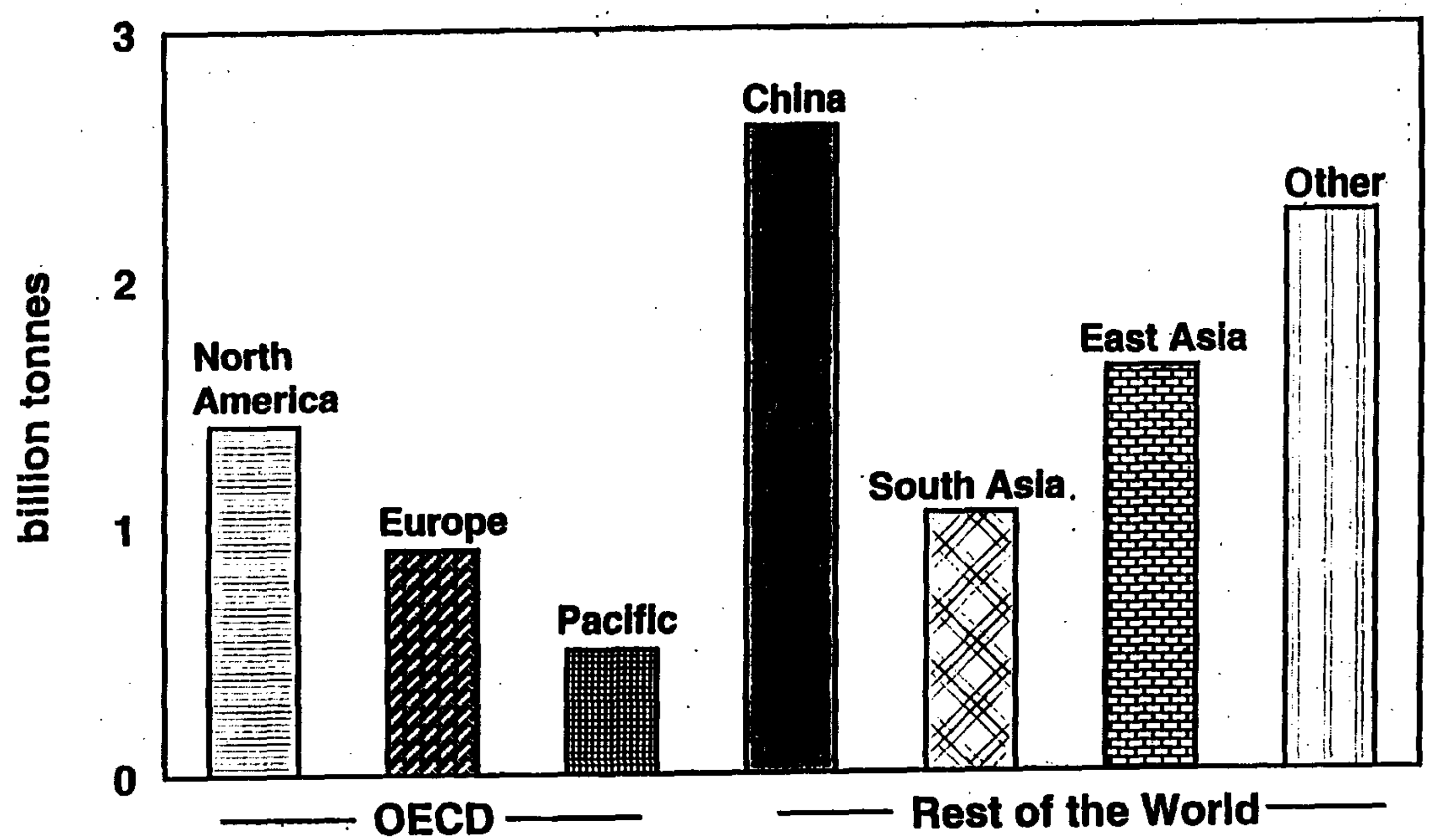
INCREASE IN ANNUAL CARBON DIOXIDE EMISSIONS
2010 vs. 1990



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COAL, TECHNOLOGY, AND THE ENVIRONMENT

- CLEAN COAL TECHNOLOGIES:
  - NOT FULLY COMPETETIVE. TIME HORIZON ?
  - ROLE OF GOVERNMENT ? OF INDUSTRY ?
  - TECHNOLOGY CO-OPERATION. IEA AS CATALYST.
- CLIMATE CHANGE CONVENTION:
  - CLIMATE TECHNOLOGY INITIATIVE
  - JOINT IMPLEMENTATION

IEA IMPLEMENTING AGREEMENTS

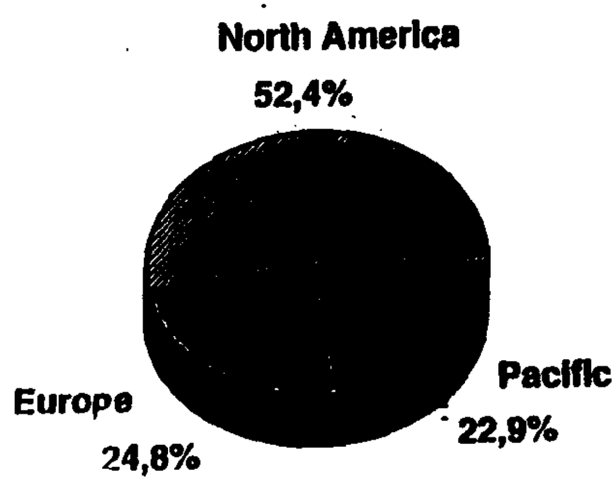
- IEA Coal Research
- Coal Combustion Sciences
- Coal-Liquid Mixtures
- Fluidised Bed Conversion
- Multiphase-Flow Sciences
- Greenhouse Gas R&D Programme

CONCLUSIONS

- STRONG DEMAND FOR COAL
- MAJOR UNCERTAINTY: ENVIRONMENT
- NEW TECHNOLOGIES CRITICAL
- IEA IMPLEMENTING AGREEMENTS

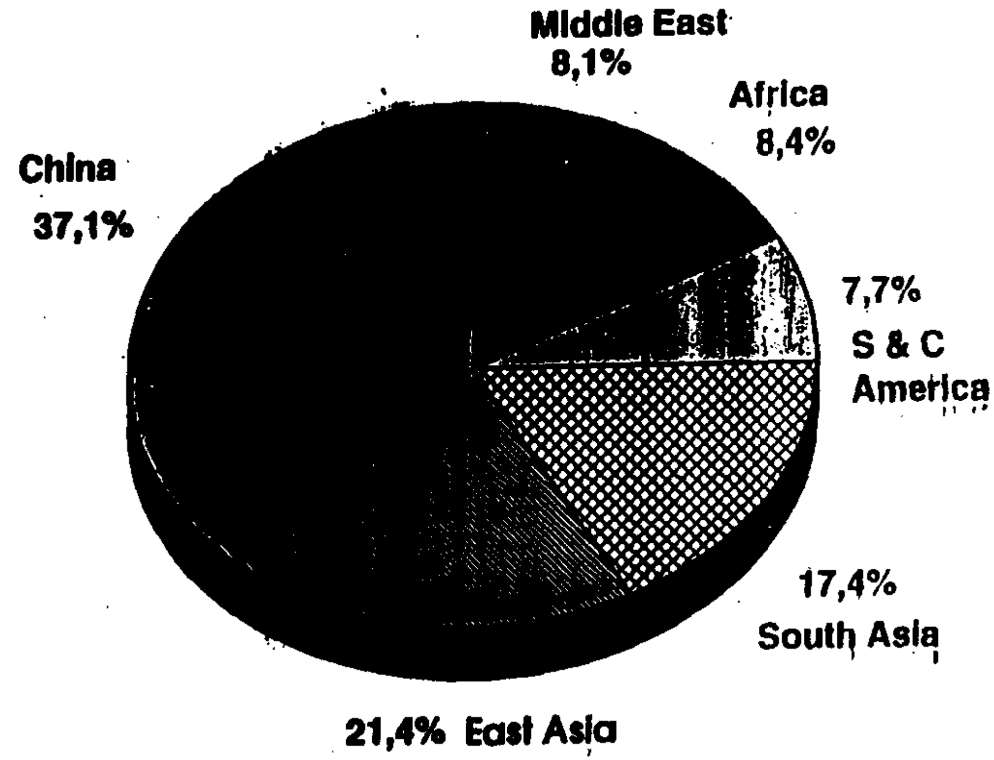
INCREASE IN ANNUAL CO_2 EMISSIONS, 1990 - 2010

CAPACITY CONSTRAINTS CASE



OECD

2482 million tonnes



ROW

7352 million tonnes

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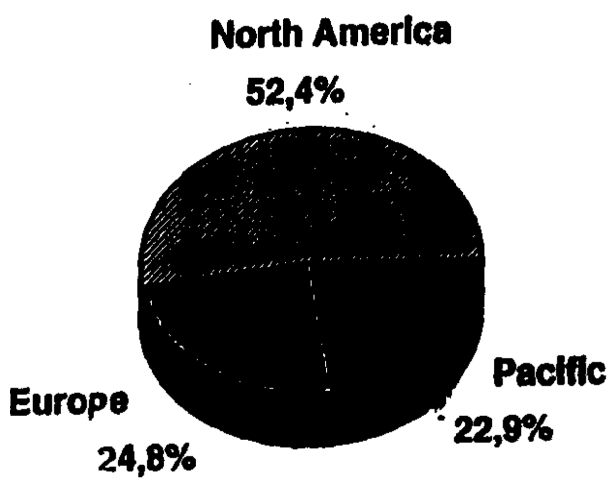
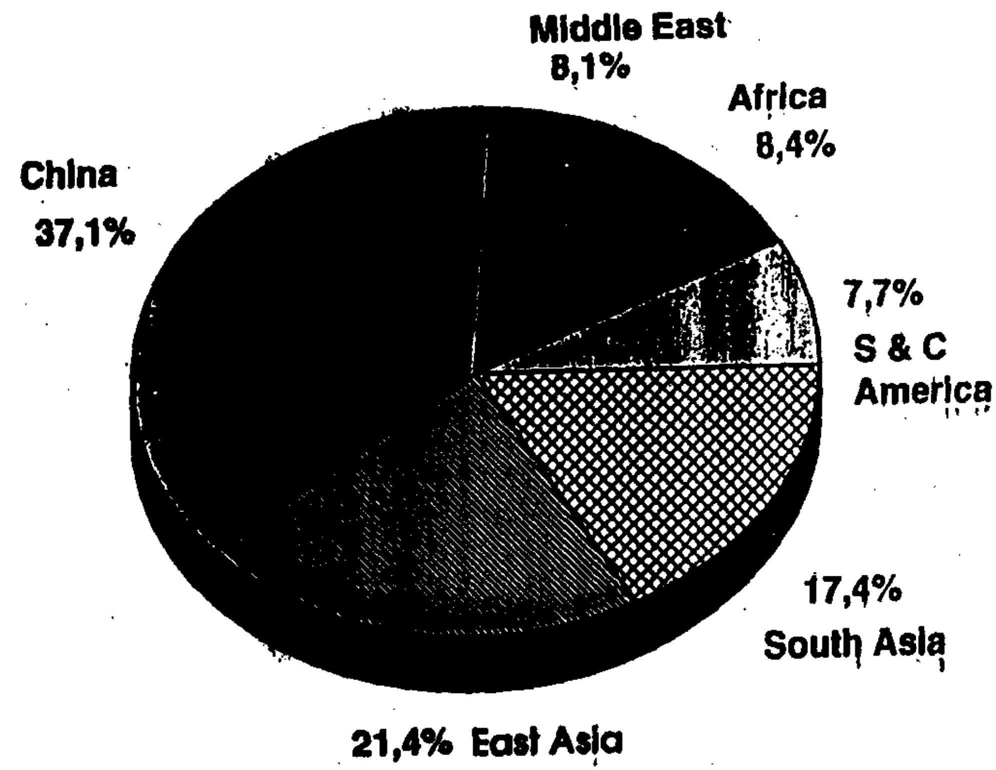
SENSFIG1.PRS

INCREASE IN ANNUAL CO2 EMISSIONS, 1990 - 2010
CAPACITY CONSTRAINTS CASE



OECD
2482 million tonnes



ROW
7352 million tonnes

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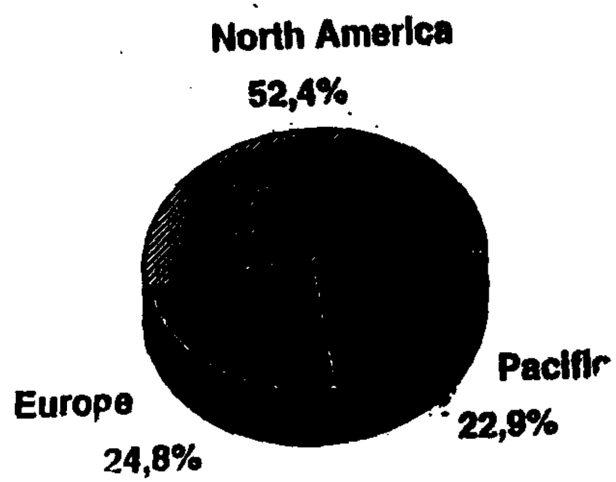
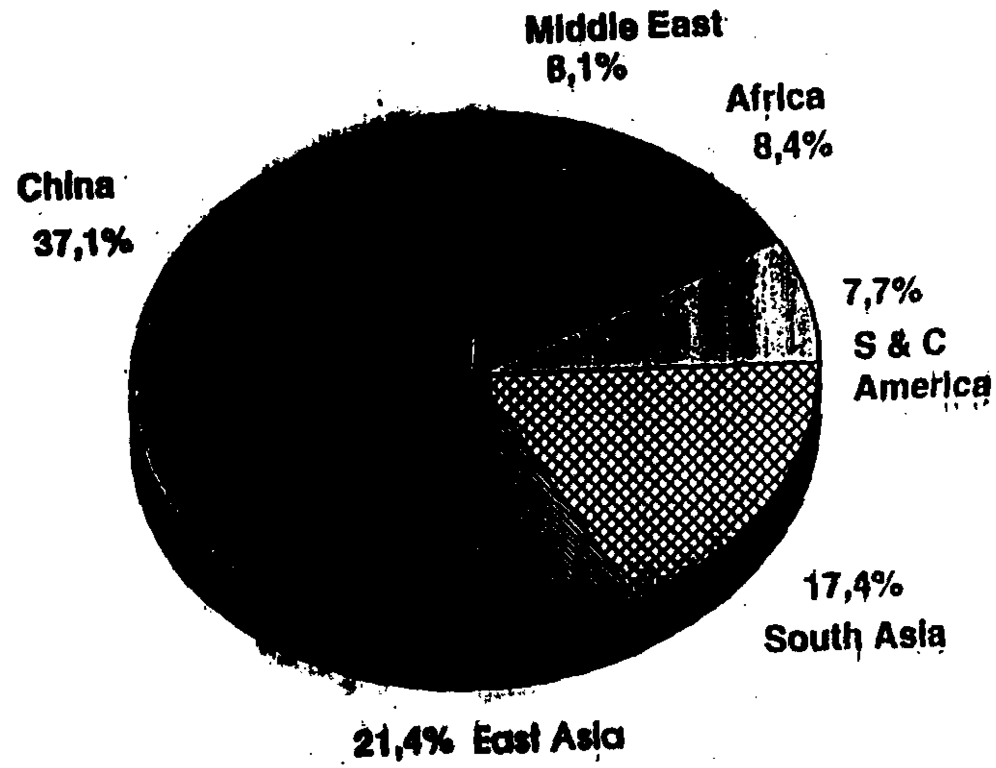
SENSFIG1.PRS

INCREASE IN ANNUAL CO2 EMISSIONS, 1990 - 2010

CAPACITY CONSTRAINTS CASE



OECD
2482 million tonnes



ROW
7352 million tonnes

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SENSFIG1.PRS

National Mining Association
Foundation For America's Future

Coal and Clean Coal Technology: Keys to an Expanding World Economy

Keynote Remarks
by
Richard L. Lawson
President
National Mining Association

To the
Fourth Annual Conference
on
Clean Coal Technology

Sponsored by the
U.S. Department of Energy
and the
Center for Energy & Economic Development

Denver, Colorado
September 6, 1995

Thank you ladies and gentlemen.

This is an important conference in the series of Clean Coal Technology conferences.

We meet in a time of transition, and of transitions within transitions -- political, social, and economic, national and international.

The world is in transition from an era of super-power confrontation to something else; the U.S. economy is in transition; the federal government is in transition; and our customer the electric power industry is in transition.

The Clean Coal Technology Program is all but complete, and we need to start thinking and talking about what happens next with these splendid technologies which you have made ready for the market.

One of our purposes here is to examine these transitions as they affect and will be affected by the clean coal technologies.

Before that, however, there is one institutional transition on which I ought to touch in detail for context.

The National Mining Association is a new entity to many here. It was formed this year by the union of the trade groups that represent the enterprises which deliver America's basic industrial resources -- the National Coal Association and the American Mining Congress.

In addition, this is my first opportunity to meet with a technology group since the merger.

Therefore, I want to make it clear for the public record at the outset that:

- First, the National Mining Association shall be no less diligent on matters relating to coal than was the National Coal Association;

- Next, the National Mining Association shall be no less vigilant on questions of energy security and national security than was the National Coal Association;

- And, most emphatically, the National Mining Association shall be no less vigorous in support of clean coal technology than was the National Coal Association.

The union of industries within the National Mining Association did not diffuse our resources and strength; it amplified and extended them.

The fitting technical metaphor for the occasion would be the generation of electric power by our newest clean-coal technologies -- more power output from available resources to meet ever-changing requirements.

The energy and economic security of the United States lead the National Mining Association's list of concerns, especially:

- The free flow of resources required to meet the social and political demands of Americans for the opportunity to earn a strong standard of living;

- And the use of these resources in ways that resolve the nation's other concerns and problems.

Coal and clean coal technology are such balancing resources.

Now to the business at hand: My assignment is to discuss the role of coal

- Recognition that economic activity joined with trade spreads and hastens the advent of higher standards and draws nations peacefully together;

- Worldwide application of these principles through the institutions of economic cooperation and development;

- The beginnings of modern economies and rising standards of living in the developing nations, especially those of Asia;

- The attraction to these principles of the former Soviet Union and the nations of Eastern Europe;

- The opportunity to even out economic progress among all nations;

- And the renunciation of conquest.

All of this was no small achievement. It grew from the ashes of World War Two, and could not have happened without the following:

- It required that the former warring nations trade freely with one another and all who would join;

- It required the energy that increases human productivity -- required it in abundance and at low cost;

- It required the technology that amplifies and increases the higher productivity that energy imparts to human activity;

- And it required American leadership.

Today the goal is to create an expanding world economy in order to create the foundations for a different kind of new century.

Because the 20th century was one of war and tension, there now is a chance the 21st century can be made one of peace marked by worldwide achievement of human potential.

This century also has been notable for the degree of human prosperity achieved and potential released by the marriage of science and technology in the last century.

In consequence, many are living much more productive, more comfortable, and longer lives than was possible in the not-far-gone days of subsistence and early death. Birth rates have fallen and population stabilized in the industrialized nations.

In these industrialized nations, the availability of wealth and the pressure of social concerns have eliminated most of the pollution that stems from economic activity. Our natural environment is cleaner.

However, huge geographic and demographic portions of the globe were left behind in this century's growth; and now they mean to catch up. Their birthrates are high and their populations are exploding. Concerns are on the rise, primarily in the industrialized nations, about what happens next.

The challenge of the half-century to come is no less than that of the half-century past. Now it is to build an enduring peace and balance the following:

- World population -- it is expected to rise from about 5.5 billion at present

World Energy Council incude the following findings on the future of imported oil:

- •Much greater production to be required;

- •Production to further concentrate in six nations -- five in the Persian Gulf, plus Venezuela, all members of the Organization of Petroleum Exporting Countries;

- •Prices must rise to stimulate additional production;

- •Increased market dominance by Persian Gulf exporters;

- •Price volatility could become severe;

- •Political and military security of source must be continually monitored;

- •The costs of security may prove unsustainable and unacceptable.

The World Energy Council's book _Energy for To-morrow's World_ makes the following points about the world's proved reserves of fossil fuel:

- •World coal proved reserves exceed the combined reserve of oil and natural gas by a factor of 2.5;

- •The coal reserve exceeds the oil reserve by a factor of 4.4;

- •The coal reserve exceeds the gas reserve by a factor of 5.6;

- •The gas reserve is 13 percent of the fossil fuel reserve, and the reserve-to-produc-tion ratio is 56 years;

- •Oil is 16 percent of the world reserve, and the ratio is 40 years;

- •And coal is 71 percent of the reserve, and the ratio is 250 years.

The U S. coal reserve is one of the world's major coal reserves -- the major reserve when other pertinent influences are factored in.

First, the U.S. coal industry is the world's most modern and efficient by any ranking. This effectively expands the reserve and the economic impact of the reserve. It is the low cost source of electric power. It is the source of nearly three-fifths of the nation's electric power.

Coal imparts a special strength to the ever-electrifying U.S. economy. It will be the low cost source in the years coming on.

Next, the U.S. coal industry is *dedicated to international free trade in coal.* America led in establishing the world trade in steam coal and we intend to compete strongly in that market in the years coming on.

Security of energy supply will not be a factor in world coal, not for America or its trading partners. Production and the dominant reserves will not concentrate in a few countries in the manner of imported oil, not with the U.S. in the market. World-dislocating price-volatility will never be a problem.

We now come to the introduction of the clean-coal technologies.

- Greater modification of carbon-release projections from efficiency gains than from proscriptive regimens;

- And that technology transfer can powerfully modify all projections -- technology from coal preparation on through advanced combustion and up to better transmission and distribution.

By introducing existing and newly emerging clean-coal technologies we can achieve the following:

- We can raise thermal efficiency in existing and future generation for economic gain;

- And at the same time reduce pressure on the coal reserve; and stem the release of carbon dioxide.

- We can improve transmission and distribution;

- And at the same time lower the amount of fuel required to deliver a given amount of power; and thereby reduce combustion emissons

In nations with very low thermal efficiencies and very high losses in transmission and distribution, the savings may well reach one ton in three for coal; and well over 30 percent in carbon dioxide release per unit of power.

Here is the means of economic development that can sustain itself. Here is sustainable use of resources.

Here is the means of peace-fostering balance for the three critical environments -- the political, the economic, the natural.

If increasing carbon dioxide release is the concern, then technology is the way to go about dealing with the concern.

Clean-coal technology will sustain economic growth and extend the life of resources -- add to the 10-fold gain.

Clean coal technology addresses the speculative concerns in constructive ways -- it resolves concerns and balances the critical environments.

This century has shown Americans to be good at some things and poor at others.

We are good at bringing about conditions for lasting peace and balance, and we are good at advancing technology.

We are sometimes not as good at introducing the advanced technology. Our competitors in Japan and Germany have been much better at capitalizing on such advances.

We have come too far to quit short of commercial deployment of our clean-coal technology advancements.

We have invested too much toil, too much sweat, too much capital to let them now languish because our policy-makers are preoccupied with matters of doctrine, philosophy and other concerns.

Let's try to do it differently this time. This time let's talk about it and think about it and then act. We must not get lost in philosophical debates.

A U.S. Perspective on Clean Coal Technologies
National Coal Council Studies 1994-1995

Jerry Oliver
Vice President and Manager of Technology
Bechtel Corporation

presented to
4th Annual Clean Coal Technology Conference
on
September 6, 1995

A U.S. Perspective on Clean Coal Technologies
National Coal Council Studies 1994-1995

Jerry Oliver
Vice President and Manager of Technology
Bechtel Corporation

Dwain Spencer
Principal
SIMTECHE

ABSTRACT

This paper provides an overview of two National Coal Council Studies on Clean Coal Technology. The studies reviewed are "Clean Coal Technologies for Sustainable Development" and "A Critical Review of Efficient and Environmentally Sound Coal Utilization Technology". The studies provide an in-depth look at and some prioritization of all coal related development activities underway from research to commercialization.

Both studies conclude that the U.S. Department of Energy plays a key role in Coal Utilization Technology development and strongly recommends that the U.S. Government continue to supply financial and technical support to the development and initial deployment of coal utilization technologies. Further the focus on new and developing technology can be reduced to three basic criteria: 1) high efficiency, 2) environmentally sound and 3) cost competitive.

INTRODUCTION

During the past two years the National Coal Council has undertaken to perform two major studies for the Secretary of Energy that are focused on Clean Coal Technologies. The first, which was completed in February 1994, was titled "Clean Coal Technologies for Sustainable Development". The second, which was completed in April 1995, is titled "A Critical Review of Efficient and Environmentally Sound Coal Utilization Technology".

The two efforts provide an in-depth look at all coal related development activities underway from research to commercialization. The National Coal Council established working committees composed of a prestigious group of experts for both efforts. These committees developed a focused, prioritization of research, development, demonstration, and commercialization needs from both the purely technical perspective and from a business and a market potential perspective.

The work that the National Coal Council has done indicates that the expanded utilization of fossil fuels will rely on development of advanced technology that improves efficiency and simultaneously reduces environmental impacts. The two reports discussed in this paper cover the specific role of competing coal technologies to meet our national and international needs for improved coal utilization systems.

NATIONAL COAL COUNCIL - BACKGROUND

To provide background perspective, a brief understanding of the National Coal Council (NCC) is appropriate. The NCC is one of 2000 Federal Advisory Committees chartered under the Federal Advisory Committee Act. It is only one of two that are totally self-funded. The other is the National Petroleum Council. The sole purpose of the NCC is to advise, inform, and make recommendations to the Secretary of Energy on national policy issues relating to coal or the coal industry. Members are appointed by the Secretary of Energy and come from a variety of industries and interests and reside in more than 30 states. The NCC was chartered in the fall of 1984 and became active in mid-1985, with the first report produced in 1986. To date the NCC has published 16 reports including the two discussed in this paper.

CLEAN COAL TECHNOLOGY FOR SUSTAINABLE DEVELOPMENT

In 1993, the Secretary of Energy requested that the National Coal Council undertake an evaluation of the U.S. Department of Energy's (DOE) Clean Coal Technology (CCT) program. This program was initiated in 1986 and represents the largest coal and environmental technology demonstration program undertaken jointly by industry and the DOE. The program was implemented through a total of five solicitations and some 45 cooperative projects. A total budget of $2.75 billion was appropriated by the United States government and was matched by $4.25 billion of industry funds. Specifically, the Secretary requested that the NCC:

1) examine the current state of U.S. industry acceptance of technologies supported to date by the CCT demonstration program;

2) identify where technology gaps may exist in the U.S. portfolio of clean coal technologies;

3) assess the need for further Federal initiatives to overcome remaining market hurdles including, for example, use of Federal "buy-back" provisions to create early market incentives or changes in tax policy to encourage the use of cleaner, more efficient technologies;

4) assess the merit of additional co-funded improvements in previously demonstrated technologies at existing facilities, and if such a need exists, offer guidance on the most effective and financially prudent means of further Federal support (e.g., different levels of cost sharing); and

5) offer advice on carrying out the international technology transfer efforts called for by section 1332 of the Energy Policy Act.

As a part of the study, a perspective on the electrical generation and application marketplace after the year 2000 was developed and was used as a basis for framing conclusions and recommendations on the questions raised by the Secretary. The year 2000 characterization follows:

- A strong emphasis on energy efficiency will be reflected in efforts to improve energy use by customers and to use more efficient conversion technologies. This will reduce the need for new base load generating capacity, but will increase the number of opportunities for replacement of older, less efficient generating plants.

- The retirement and reuse of old utility sites, which are close to customers and have coal handling and transportation infrastructure, will provide ideal locations for new capacity additions. This will be attractive to local government, will provide or maintain local jobs, and will be an ideal opportunity for new CCT projects.

- With the growth of the non-utility generating industry, pressure will increase to use smaller, lower cost and cleaner systems.

- It is anticipated that most of the new plants will be in the intermediate size range (200-400 MW) to provide flexibility in dispatching, to reduce siting impacts, and to lower capital costs per unit.

- Increasing pressure will be placed on the development of new fossil electric resources globally. Emphasis will be on new systems in the Pacific Rim and retrofits in Eastern Europe and the Commonwealth of Independent States. This should open up new markets for CCTs.

With the year 2000 perspective as a backdrop and as a framework for long term technology needs, the following conclusions were reached concerning the CCT demonstration program:

- The market for CCTs is significant with a domestic potential of up to 62 GW between 1994 and 2010 in both new and retrofit applications; however market competition with natural gas will remain strong during the period. International growth is expected to be significantly greater.

- DOE surveys conducted on the CCT program in 1992 showed limited awareness of the details of program among potential users.

- Essentially no technology gaps were found except in areas of developing regulations.

- The intent and objectives of the DOE's CCT program have been or will be met with existing projects in the program.

- The U.S. government can help to continue to move CCTs to the marketplace by overcoming barriers caused by commercial risks and associated financial hurdles. It is worthwhile to note that many of the 45 projects are composed of several technology innovations. Some of these innovations are being commercialized independent of the CCT program but the overall projects require not only component guarantees and warranties but also a "wrap" of the entire plant from a process guarantee perspective.

- The international market for environmental and clean coal technology is large and awaiting new, commercially proven technologies that decrease pollution without appreciably increasing total capital and operating costs.

Finally, based on the effort, the following recommendations were made to the Secretary of Energy:

1) No further solicitations under the Clean Coal Technology Demonstration Program are needed.

2) Clean coal technologies should be recognized broadly as environmental technologies in current and future Federal programs.

3) A new federal-level CCT incentive program to stimulate initial and sustainable commercial deployment of CCT is needed. The program is envisioned to require $1.4 billion of federal capital and performance incentives during the period 1995-2010. The program should provide commercial units in such areas as integrated coal gasification combined cycle systems, pressurized fluidized bed combustion systems, advanced pulverized coal-fired power plants, and innovative component technologies.

4) The DOE market assessment and communications program should continue and be expanded to include all stakeholders in coal.

5) The DOE should evaluate the potential of converting old existing but non-compliant plant sites to new sites employing CCT.

6) The DOE should disseminate commercial cost information as it becomes available to facilitate assessment of each technology's total economic viability.

7) Unused CCT program funds should be used to continue selected operating demonstrations to gain more experience which would facilitate commercial deployment and obtain environmental data necessary to understand air toxics and other related issues.

8) Global deployment of CCTs is a critical ingredient to both sound domestic economic development and worldwide sustainable economic and social development.

COAL UTILIZATION TECHNOLOGIES STUDY

This study was initiated in 1994 at the request of the Secretary of Energy and has been titled "A Critical Review of Efficient and Environmentally Sound Coal Utilization Technology". The Secretary asked the NCC to review the scope of coal utilization technologies and prepare "a single source document which defines state-of-the technology for coal-using systems and associated benefits". This study builds on several of the earlier NCC studies including the Clean Coal Technology Report(1986), Innovative Clean Coal Technology Deployment(1988), Export of Coal and Coal Technology(1993), and Clean Coal Technology for Sustainable Development(1994).

This study breaks and evaluates coal utilization technologies in 46 technology areas including conventional and unconventional coal cleaning, all types of combustion technology and postcombustion control technologies. Within the 46 technology areas several hundred actual specific technologies were evaluated and included in either an aggregate form when technologies could be combined or individually. In addition the report covers advanced power systems and looks at technologies involved with the conversion of coal into other useable products. The conclusions from the study include:

- All new coal utilization technologies need some form of risk sharing for first-of-a-kind commercial scale plants to accelerate the transition from demonstration to commercialization,

- Many of the promising technologies will be demonstrated under the DOE CCT projection; however further development to reduce cost is critical to market acceptance,

- As Federal and State environmental requirements are mandated, the relative importance of many of these technologies change,

- A wide range of technologies is necessary to assure both short term and long term economically viable and environmentally acceptable options.

Each technology was evaluated to identify its most important immediate needs depending on the state of the development, (i.e. research, development, demonstration, and commercial assistance). This is provided in the report identifying specific technical needs for each process or technology. Finally, the report provides a priority listing for each technology area and specifies the emphasis which should be placed on further research, development, demonstration or commercial assistance funding. An example of this prioritization is provided below for research:

1) hazardous air pollutants control with the specific emphasis on the control of mercury and other heavy metal emissions:

2) pressurized fluidized bed, advanced gas turbines, steam turbines, advanced pulverized coal-fired boilers, and recuperators with research needs in erosion, corrosion and oxidation resistant metallic and ceramic materials and coatings;

3) electrostatic precipitators, fabric filters, FGD and SCR systems with specific research efforts for the characterization of all effluent streams, the performance of ESP, fabric filter, FGD and SCR systems and the development of a topping system for fine particulate control:

4) fuel cells need continued work on cathode life improvement;

5) carbon dioxide control with research emphasis on post-combustion control and sequestration processes;

6) selective catalytic reduction with needs for advanced formulations;

7) conversion of synthesis gas with research emphasis on CO conversion, catalyst chemistry and slurry processes; and

8) biological coal cleaning with needs in reaction kinetics, selectivity and economics.

Development technical priorities are in the following six areas; 1) integrated gasification combined cycle systems in the area of hot gas cleanup, 2) advanced gas turbines in oxidation and corrosion resistance coatings for metallic and ceramic materials and in the area of catalytic combustion, 3) hazardous air pollutant controls in mercury controls, 4) pressurized fluidized beds in hot gas cleanup and in the acceleration of topping combustor development, 5) fuel cells in the cost effective manufacturing process and in fuel cell/GT integration, and 6) wet FGD in improved mist eliminators or high velocity scrubbers.

Demonstration technical priorities are in 8 areas as follows: 1) pressurized fluidized bed CCT program should be completed, 2) integrated coal gasification combined cycle should also complete the CCT program effort, 3) advanced pulverized coal boilers should complete the low emission boiler system program, 4) hazardous air pollution system controls should be extended to include the characterization of all effluents from the ongoing CCT demonstration program, 5) indirect fired cycles CCT demonstration should be completed, 6) the molten carbonate fuel cell demonstration should be completed, 7) byproduct utilization work should concentrate on key solid streams found in the ongoing CCT program, and 8) SOx/NOx control projects under the CCT demonstration program should be completed and economics of each control system evaluated separately.

Commercial assistance priorities lie in 6 areas as follows: 1) integrated coal gasification combined cycle systems will need further government supported risk sharing, 2) advanced pressurized fluidized bed systems will need further government supported risk sharing, 3) physical coal cleaning systems need international marketing assistance 4) low rank coal benefication systems need international marketing assistance, 5) byproduct utilization technologies need to have a national utilization standard as a basis for commercialization, and 6) coal-fired diesel engines need international marketing assistance.

This report points out the fact that all coal utilization technologies have roots in basic research, and there is always a number of interacting scientific and engineering disciplines required in the progression from research to demonstration. The decline since the 1970's in the number of universities with facility expertise and graduate research programs related to coal is a problem which could threaten the future of coal utilization technology development by eliminating the basic research source of new ideas and concepts. Not only is there a current need for research, but there will be the related need for trained personnel with experience in coal technologies to design and manage the coal utilization facilities of the future. A strong concern in this area is expressed in the study as an overriding point of the review.

There are several different levels of need which may be addressed by different collaborative mechanisms. For example, advanced technologies must be evaluated by prospective users to determine how the technologies can be best integrated into their facilities and business operation, and the economic effects on their businesses must be analyzed and understood. New technologies must face the competition of existing technologies that are upgraded in performance through improvements in equipment or process operating conditions. It is important for the effective development of new technologies that industry and government collaborate to ensure that input from the user community is part of the effort surrounding basic research and development. This report also concluded, as did the 1994 effort on sustainable development, that government assistance is needed to move promising new technologies up the chain from concept to research to reality. This will involve some level of support as the new technology goes through the early phases of commercialization. The level of overall support is small during basic research and peaks during demonstration. The cost sharing by industry increased dramatically as the new technology moves from demonstration to commercialization.

Overall this report satisfies the request of the Secretary and provides one of the most complete reviews of coal utilization technologies to date.

CONCLUSION

The focus on new and developing coal technology can be reduced to three basic criteria: 1) high efficiency, 2) environmentally sound, and 3)cost competitive systems. As the global need for energy continues to increase, coal has a strong place in that growth as long as it both is and is perceived to be competitive and environmentally acceptable in relation to competing alternatives. The technology developments highlighted in the two studies reviewed, if commercialized as envisioned, will provide for the needed competitive advantages.

Of the systems being commercialized currently through the U.S. DOE CCT demonstration program, Integrated Coal Gasification Combined Cycle (IGCC) systems provide the most flexibility in achieving the primary goals addressed above. Pressurized Fluidized Bed Combustion systems and Advanced Supercritical Pulverized Coal power plants provide considerable promise of meeting all of the criteria.

Both reports recommend that the U.S. government continue to supply support to the development of coal utilization technologies. It is believed that Federal level financial support is fundamentally important and critical to all phases of developing coal utilization technologies. There are a great many uncertainties in the evolving energy market, including future economic growth, retail and wholesale wheeling, current over-capacity, increased competition, Clean Air Act Amendments continuing implementation, consumer demands for reduced electricity prices, nuclear and hydroelectric relicensing, global competition and demands, and the marginal cost of power. Overcoming these uncertainties in the development of new coal utilization technologies under a variety of cooperative government/industry programs will help to maintain coal's preeminent position in the production of electricity and provide a secure domestic resource base for meeting our nation's energy needs.

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A U.S. Perspective on Clean Coal Technology

National Coal Council Studies

1994 - 1995

4th Annual Clean Coal Technology Conference

September 6, 1995

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National Coal Council: Background

- One of 2000 Federal Advisory Committees
- One of only two self-funded committees
- Purpose is to advise, inform, recommend
- All members appointed to two-year terms
- Fifteenth report - "Clean Coal Technology for Sustainable Development"
- Sixteenth report - "A Critical Review of Efficient and Environmentally Sound Coal Utilization Technology"

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National Coal Council Studies

- 1994 - Clean Coal Technology for Sustainable Development
  - Examine Industry Acceptance of CCT Demonstration Program
  - Identify Technology Gaps
  - Assess need for further federal initiatives
  - Assess merit of co-funded technology support
  - Provide advice on international technology transfers

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National Coal Council Studies

- 1995 - A Critical Review of Efficient and Environmentally Sound Coal Utilization Technology
  - Review scope of coal utilizing technologies
  - Prepare a single source document which defines state-of-the-technology for coal using systems

Clean Coal Technology Study
CCT Program: Overview

- Started 1986
- Largest coal/environmental technology demonstration program undertaken by Industry and DOE
- Five solicitations - 45 projects
- Seven billion total capital Investment
  - $4.5 billion industry
  - $2.75 billion DOE

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Clean Coal Technology Study
Year 2000 Perspective

- Strong emphasis on energy efficiency
- Retirement and reuse of old utility sites creates new markets
- Emphasis on smaller, lower cost, cleaner generating plants
- Size range (200 - 400 MW) provides flexibility, reduces siting impacts, and lowers capital costs
- New pressure on expansion of electrical resources globally

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Clean Coal Technology Study Conclusion

- Market for CCTs significant
- DOE survey indicates limited potential user awareness of CCT program
- No technology gaps were found
- Intent and objectives of DOE CCT program met
- Key to market acceptance - overcoming commercial and financial hurdles
- International market is large and awaiting competitive, commercial CCT technologies

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Clean Coal Technology Study Recommendations

- No further demonstration project rounds
- CCTs should be recognized as environmental technologies
- A new CCT technology incentive program is needed
- DOE market assessment and communication program should continue
- Conversion of old plant sites to new sites is needed
- DOE should disseminate CCT commercial cost information
- Unused CCT funds should be used to continue selected projects
- Global deployment of CCTs is encouraged

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Coal Utilization Technologies Study
Technology Area Evaluations

- Technology area evaluations involved:
  - Technology Description
  - Development Status
  - Environmental Performance
  - Commercial Impact
  - Development Needs

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Coal Utilization Technologies Study Overview

- 46 broad technology areas evaluated in depth
- 26 have significant research needs
- 25 have significant development needs
- 20 need further demonstration support
- 9 are ready for commercialization but still need assistance

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Coal Utilization Technologies Study

Research, Development, Demonstration and Commercialization Needs of Coal Utilization Technology

Technology Related to Power Generation - Precombustion

Technology	Research	Development	Demonstration	Commercial Assist.
1. Physical Coal Cleaning:	Hazardous Air Pollutants (e.g. Cl, Hg, & Alkali Removal		Complete CCT ---Demonstration	International Marketing Assistance
2. Chemical Coal Cleaning:	---	---	---	---
3. Biological Coal Cleaning:	Kinetics; Economics; Agents Selectivity	---	---	---
4. New Fuel Forms:	---	---	---	---
Low Rank Coal Beneficiation	---	Continue the LRC Beneficiation Program	Complete Demonstration	International Marketing Assistance
Micronized Coal	---	Emphasize Development	---	---
Coal Liquid Slurries	---	---	NOx Reduction Potential: GOB Pile Utilization	---

Coal Utilization Technologies Study

Development Technical Priorities

Technology	Needs
1. Integrated Gasification Combined Cycle Systems	Hot Gas Clean Up
2. Advanced Gas Turbines	Oxidication and Corrosion Resistance Coatings for Metallic and Ceramic Materials: Catalytic Combustion
3. Hazardous Air Pollutants Controls	Mercury Control
4. Pressurized Fluidized Beds	Hot Gas Clean Up; Accelerate Topping Combustor Development
5. Fuel Cells	Cost Effective Manufacturing; Fuel Cell/GT
6. Wet FGD	Improved Mist Eliminator (High Velocity Scrubbers)

Coal Utilization Technologies Study Conclusions

- New coal utilization technologies need risk sharing support to accelerate the transition from demonstration to commercialization.
- Support beyond the CCT demonstration program is needed to ensure competitive commercialization.
- As environmental requirements are mandated, the relative importance of technologies change.
- A wide range of technology is needed to assure short- and long-term economically and environmentally acceptable options.

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Clean Coal Technology Studies Conclusions

- Coal Utilization Technology Focus Criteria:
  - High efficiency
  - Environmentally sound
  - Cost competitive

Clean Coal Technology Studies Conclusions (Cont'd)

- Of the systems being commercialized:
  - IGCC provides the most flexibility
  - PFBC and Advanced Super Critical PC have promise

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Clean Coal Technology Studies Conclusions (Cont'd)

- Continued federal funding (research through commercial assistance) is crucial for maintaining both domestic and international market positions.

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TECHNOLOGY DEPLOYMENT IN EMERGING MARKETS

David C. Crikelair
Vice President
Texaco Inc.

Fourth Annual
Clean Coal Technology Conference
September 6, 1995
Denver, Colorado

I would suggest that very few of the original authors of the DOE's Clean Coal Technology Program would have envisioned that the real beneficiaries of the program would be non-U.S. markets. But that is where we are headed.

The U.S. marketplace is relatively mature and subject to uncertainty due to regulatory reform. Emerging markets on the other hand happen to be where there are abundant reserves of coal and other hydrocarbons, robust economic growth <u>and</u> a pressing need for sound environmental stewardship.

But with these emerging markets and opportunities comes an entirely different set of challenges and risks. Let's now focus on the requisite competencies necessary to develop and deploy technology in these emerging markets, with particular attention on the Pac Rim and Asian markets.

Elsewhere in the world, we speak of economic growth in single digits or even fractions of single digits. In much of Asia, though, we speak in terms of double-digit annual growth. So it is no wonder that energy companies, technology vendors and the like look upon this market with great enthusiasm.

As you may know, Texaco has a long history of involvement in this market; both in our traditional oil and gas activities and in the area of gasification for syngas and power. Worldwide, there are now more than 50 distinct gasification facilities operating or in advanced stages of development, with a total syngas capacity in excess of three billion standard cubic feet per day. Some facilities are licensed, some are Texaco-owned. Some are coal-fed, others use heavy oil, or resid, or petroleum coke, or natural gas, or wastes. Some manufacture chemicals, others produce fertilizer, fuels or power.

And -- in the course of these activities -- we have learned some valuable lessons.

First, recognize there are risks: from radical currency devaluations and rampant inflation to political unrest and outright expropriation of property. From inconsistencies in laws and regulations to favoritism involving local companies. From lack of infrastructure to often perplexing customs and traditions. Take steps to minimize these risks.

Second, be aggressive in demonstrating the value to your host country in working with your company and your people. Emphasize and be sensitive to the human aspects of your relationship with the host country.

In China, where we have been actively deploying our gasification technology for close to 20 years, our Chinese customers value our relationship as much as they value our gasification technology.

Third, be flexible, resourceful and creative. Just as important, make sure your technology, product or service is designed to meet your customers' needs.

Texaco's gasification technology has certainly advanced since the early days when it was used simply to produce synthetic fuels. It is not just a coal technology; and it's not just a power technology. Worldwide, the most common application has been for chemicals. But now we are producing power, supporting the IGCC market and consuming a full array of feedstocks.

As we move forward in our key markets, we try to tailor the technology to meet our customers needs, not vice versa. This has been a fundamental element of our success.

Here's an example:

Several years back we did a little "out-of-box" thinking on ways to make our technology more valuable to our customers and to expand the market for gasification. Their answer: wastes. Our gasification technology appreciates all forms of hydrocarbons. So whether it was coal, or oil, or waste plastics or sewage sludge; it was still a feedstock. Why not, then, try to recycle wastes and at the same time produce chemicals or power? If it makes the system more economical without impacting reliability and performance, our attitude was "go for it." Today, we see a wide range of wastes destined for gasification.

Fourth, I urge you to listen to your customers. This sounds rather basic, but you'd be surprised how often deals collapse because of a breakdown in two-way communication.

A representative of one of the leading U.S. environmental organizations recently visited China, and it seemed that his sole purpose in Beijing was to encourage the Chinese to adopt reformulated or alternate fuels.

For the most part, I imagine his message fell on deaf ears, because he didn't understand the market or his customers. He should have understood that utilizing clean, efficient technologies for industry and power generation would have a much larger impact on environmental quality in China than would using cleaner gasoline.

Hence, he left China with little to show for his effort, and the Chinese lost an opportunity to gain any insight on practical ways to improve environmental quality. He would have been better off encouraging the Chinese to employ clean coal technologies.

Fifth, understand where your customers are coming from. For instance, while we speak of "Clean Coal Technology," I would place the emphasis on the word "Technology." To many in this country, "coal" is a four-letter word. But elsewhere in the world, it is the lifeblood of economic strength.

In some markets, the driver is not always and ultimately environmental performance -- although it is certainly not a negative. In these markets, it is just as important to be economic, to be efficient, to be proven and reliable. While our gasification technology's calling card may be its environmental performance, it isn't our only strength. For countries that are merely seeking to feed their people and fuel their economies without breaking the bank, the conversion of indigenous hydrocarbons to produce chemicals and power is the pressing objective. Protecting the environment is just an added benefit.

Sixth, appreciate the pressures your customers are facing internally. Accept the reality that they will make a decision based on their schedule, not yours. Be ready to help them answer all the questions that are likely to arise from their government or regulatory body.

At Texaco, we don't view ourselves as merely a technology supplier. Rather, we see ourselves in the role of a strategic partner. We work with our customers through the entire decision-making process.

How do you secure feedstock?
How do you pay for the project?
How do you permit the project?
How do you integrate the technology with existing infrastructure?
How do you plan for future growth?
How do you operate the technology?
How do you select related vendors?

Lastly, understand the value of working with our government agencies in Washington to move projects over the goal line. When working in markets where a government ministry or official with have the final say on a project, endorsement or other more formal support from a U.S. agency or official can be a crucial.

This is particularly true when the competition is non-U.S. companies who have political and financial support from their respective governments.

As an aside to this point, I would suggest to our friends with the Department of Energy and other agencies here that the best way for them to be helpful is to stay focused on the ultimate objective -- securing a project that means more U.S. jobs, American leadership in technology, and a return on the money the stakeholders have invested to establish America's leadership in these technologies.

As the presentations at this week's conference will demonstrate, many of these Clean Coal Technologies are ready for the marketplace. We're beyond R&D. At some point, further study is counterproductive. Our job now is to deploy these technologies into the market.

In this complex world, that often requires a partnership of several agencies: D-O-E, Ex-Im Bank, the Commerce Department, State Department and E-P-A. By keeping both the private and public sectors focused and in agreement on the mutual objective, the partnership can be successful and the deal secured.

I hope I have been able to share with you some of the lessons we have learned, and continue to apply, in these emerging markets. And I will be happy to answer any questions.

Thank you.

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Luncheon Address

WRITTEN REMARKS OF BEN YAMAGATA[1]
EXECUTIVE DIRECTOR
CLEAN COAL TECHNOLOGY COALITION

TITLE:

"CAN WE ACHIEVE SUCCESS FOR CLEAN COAL TECHNOLOGIES IN THE GROWING INTERNATIONAL MARKETPLACE?"

BEFORE THE FOURTH ANNUAL
CLEAN COAL TECHNOLOGY CONFERENCE

DENVER, COLORADO
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[1] Ben Yamagata is Executive Director for the Clean Coal Technology Coalition (CCTC), a public/private organization of electric utilities, technology developers, state governments and others who advocate the development and deployment of CCTs. The comments contained in this paper are the speaker's only and should not be attributed to the CCTC.

I. THE DOMESTIC MARKET FOR CCTs IS NOT LIKELY TO MATERIALIZE SOON:

The benefits associated with clean coal technologies (CCTs) are well documented. Many promise greater energy efficiency, reduced costs and less emissions, or more effective, less costly emission control, when compared with currently-available, conventional coal utilization and emissions control technologies. CCTs also offer indirect benefits, including stimulation of U.S. exports, high-value jobs creation, fuel security and fuel diversity.

Despite these benefits, CCTs have not, and cannot, escape the challenge that confronts the commercialization of any new technology. Whether referred to as the "valley of death" or the "commercialization bubble" many products never reach the marketplace as they move from research and development, prototyping, small scale and then full scale demonstrations, early commercialization and initial deployment, and then national and international marketing. At any stage of technology development insurmountable barriers may materialize and the technology dies.

Generally speaking, the path to the marketplace is ultimately predicated upon demand, cost-competitiveness, proven reliability and commercially acceptable degrees of risk. Once risk and cost are commercially acceptable, and depending upon the levels of demand, commercialization is achieved and the associated economic benefits are enjoyed. That is the theory we learned in "Economics 101" – demand will create the market for the product and supply will be priced accordingly. All too often, however, products are never commercialized and never successfully maneuver the "valley of death". At the risk of over simplification, demand for the product, any new product, exists once the risk and costs are reduced; yet, the risk and costs cannot be reduced until adequate demand is present. In essence, in this chicken and egg scenario both factors are co-dependent and each relies on the other to lead the way. Products remain in the "valley of death" because this co-dependency cannot be broken.

The barriers to commercialization as they relate to the market entry of clean coal technologies, in my judgment, include:

- a regulated, risk-averse electric utility industry in rapid and dynamic change moving towards open competition, likely to be without benefit of a regulated return on investment may have little interest in CCTs;

- suppliers with gloomy market forecasts, unable to assume great risks or absorb the costs of development and early, first-of-a-kind use, cannot provide an acceptable, or attractive price, with appropriate guarantees, to potential customers to create demand;

  and finally overriding these problems,

- citizen activists who doggedly seek to prevent the use of coal under any circumstances.

Faced with these near term realities, our government – in the past – would have encouraged development to create a "market push" where the market had not matured but the need is clear or the promise great. The potential for government assistance is decidedly not the case today.

Washington and the Congress are intent upon cutting R&D budgets to the "bare bones" and you can be sure that no one is interested in supporting projects (e.g. clean coal technologies) beyond the "demonstration" stage, let alone the demonstration itself. The debate has been how much of agency-supported R&D activities should be cut not whether funds should be provided for demonstrations and beyond. The long-knives are cutting near the front-end of the technology development cycle – research; the back end of the development cycle – demonstrations and early commercial deployment – already have been abandoned.

Many, including importantly, the Republican-controlled Congress, claim that a good product will be developed by industry because of the profit motive. Conversely, they claim that a product that fails to be commercialized never retained adequate market demand and thus should not be artificially supported for commercialization. Such a "subsidy," they believe, only leads to economic inefficiencies and hinders growth and development.

As we know with respect to clean coal projects the pioneer, commercial-sized plants generally are more costly to build than subsequent plants and provide only partial information about operating, maintenance, and cost issues. The electric utility industry that principally will use these technologies is not likely to assume the risk of pioneering a commercial-sized plant alone and more importantly, as already noted, the advent of major changes in the industry has negated demand, at least for now. As a result, the Clean Coal Technology Coalition, as well as the National Coal Council and numerous other organizations, have urged government to assist in a commercial deployment program so that assistance is provided beyond the demonstration stage. In this way, even with a weak market and uncertain customers the technologies will be available for commercial use in a timeframe when it is estimated we will have need for additional and/or repowered capacity.

There are those who would argue that lack of demand is proof positive further assistance should not be provided. Admittedly, little demand is a difficult argument to refute.

But we have a looming energy crisis. When we import 44 percent of our domestic oil needs today, and DOE projects that will rise to nearly 60% by 2010, we have a crisis. Worse yet, it is creeping and all the more insidious because the issue never reaches a crescendo until we react in a crisis mode.

Further, most estimates predict that the fuel price structures for oil and natural gas will not maintain their current low levels by the 2005/2010, within the next ten to fifteen years. At that point coal may again be the economical fuel of choice. In addition, domestic base load capacity is predicted to be required during this same time frame. Coal again will be the likely, most economic choice for this new power. It is not expected that environmental regulations will be relaxed drastically. If anything, restrictions on stack emissions are likely to increase. It is, therefore, in the best interest of the nation to have available clean, efficient technology for coal utilization when the demand grows.

To simply give up on CCTs because current market forces alone will not pull the technologies through the "valley of death" is, I believe, short-sighted. It is also unwise, and perhaps even a foolish waste of taxpayer's investment given the billions of private and public dollars already invested in CCT development, not to assist to insure that the technologies are commercialized.

Given current federal budgetary constraints, the Clean Coal Technology Coalition has spent the majority of this year reviewing revenue-neutral CCTs incentive proposals. Providing incentives for CCTs through a tax package is a possible solution towards introducing CCTs into utility planning today so that the plants will be on-line in time to meet expected demand growth in the next century. Others at this conference, including the Chairman of the Clean Coal Technology Coalition, Dr. James Markowsky of American Electric Power will describe these tax-related incentives in greater detail and provide the rationale for their adoption.

If we agree on the uncertainty of the short term domestic market, then we might also agree that the international market is "where it's at" for CCTs today. While the international market may offer an interim, and important market, I want to emphasize that the domestic market ultimately ought to be the principal focus for CCTs. These technologies, and the clean coal program were, and are, intended to primarily benefit the U.S. coal industry, U.S. equipment suppliers and U.S. consumers and taxpayers. These potential beneficiaries will be advantaged most if the technologies are widely used in this country.

II. IS THERE AN INTERNATIONAL MARKET FOR COAL-BASED TECHNOLOGIES?

The fact that we must look overseas for CCT deployment is certainly far from the worst case scenario because tremendous opportunities do exist in the international market. The potential energy market abroad is huge. First, economies of the developing world are growing at twice the rate of economies in developed nations and much of this growth is in the area of infrastructure development. According to the International Finance Corporation, over $200 billion per year will be spent on privately financed infrastructure projects in the developing world over the next decade. More than one-half of this amount, $100 billion per year, will be spent on energy projects. As a result, developing countries represent one of the most important export opportunities for the U.S. economy.

Coal will be a primary source for energy especially in the developing countries, and this means opportunities exist for CCT deployment and commercialization. The Energy Information Administration predicts world coal consumption will increase by 27 percent from 1990 to 2010. During this same period coal is projected to remain one of the leading energy sources in terms of primary energy consumption, second only to oil.

The Department of Energy estimates that worldwide capital requirements for new coal-fired plants outside the U.S. between 1993 and 2010 range between $412 and $708 billion. A large portion of this investment in coal-fired plants has the potential to utilize CCTs. Retrofits with CCTs may add an additional $162 billion of capital requirement during this time period.

Both the United States and the project host countries stand to gain if we successfully market and deploy abroad emerging CCTs.

The U.S. benefits in terms of an improved balance of trade, and jobs creation (the Commerce Department estimates $1 billion of U.S. exports sustains 20,000 American jobs). Export-related jobs also pay approximately 13 percent higher wages than non-export jobs.

Importers of CCTs gain the benefits of energy infrastructure, job training and skilled labor, a higher standard of living derived from economic growth sustained by energy, and sustainable development – that is to say cleaner, environmentally sound development that allows for affordable growth with reliable domestic fuel resource utilization.

In an ideal world, all production, including energy production, would be pollution free and we could afford to develop economies today without any environmental cost for future generations. Yet, reality dictates that economic growth relies on ample and cheap supplies of energy. Countries desperately trying to grow and obtain higher standards of living will utilize fuel sources that offer ample and cheap energy. In large part, developing countries, like China and India, will be using coal which may be used in a manner that is neither clean nor efficient. Without proper emissions control measures, serious harm to the environment could occur. Yet, with CCTs we have the opportunity to mitigate harmful environmental effects from energy production and still promote economic development.

III. THE INTERNATIONAL MARKET FOR CCTs – MYTH OR REALITY?

While tremendous opportunities reside overseas for power development and CCT deployment, and in fact millions of dollars in sales of CCTs already have occurred, significant barriers exist. Unless addressed and overcome, the barriers will hinder our ability to seize the huge rewards from CCT commercialization.

First, as with the domestic case, internationally, conventional technologies are favored over new technologies because of the higher costs and risks associated with first-of-a-kind technologies. Again the "chicken and the egg" scenario develops where no one will purchase CCTs until the price and risk decline, yet these factors will not change until the CCTs are deployed and subsequently commercialized. Further, it should be remembered that what is conventional technology in this country may be highly advanced in a developing country or a country with an economy in transition. In other words, the market may be enormous, but the basic ability to use new CCTs, let alone the interest and ability to afford such technologies likely are seriously lacking.

Second, despite the market opportunities noted before, in reality developing countries, in their efforts to obtain basic infrastructure, cannot afford to develop in the most environmentally sound manner. This is not to say that they do not care about the environment, rather that they cannot afford to be environmentalists. Once all citizens have the ability to turn lights on and off, then a country will consider more efficient light bulbs. Given the great need and significant costs associated with infrastructure development, developing countries may not seek out CCTs without incentives.

And finally, adequate project financing, in this age of reduced federal assistance and foreign privatization (where the foreign governments have little capital to absorb the bills for new infrastructure projects), poses perhaps the most significant problem.

Due to the enormous cost associated with the development of an electric power plant (a large energy project can cost more than one billion dollars) most private power deals require "project financing" – a financial arrangement which relies upon the revenue stream from the sale of power to repay the debt to lenders and the equity and returns to investors. The risk involved with the political and regulatory environment of a foreign country makes obtaining necessary private capital difficult. Just witness Enron Corporation's multi-billion dollar power project in India – a country judged to be among the most advanced democracies in the third world.

Until privatization gains a better foothold, public funds derived from multilateral and bi-lateral development banks (MDBs) and developed country's export promotion agencies such as the U.S. Export-Import Bank and the Overseas Private Investment Corporation (OPIC), must shoulder a large percent of the financing for these projects.

Developing countries alone will average $40 billion per year of external financing needs for electric power through 2010. Yet, international lending institutions currently have the capacity to provide only $8 to 9 billion (including co-financing). An additional $2 to 3 billion in direct loans and grants will also be provided each year. The result is a funding gap of approximately $28 billion per year.

Where do these financing, technological and political realities leave CCTs?

The international market is too large to ignore. To do so would only harm our own opportunities for economic growth, competitiveness and leadership. Of the questions that confront us as we try to enter foreign markets with new, not-yet-commercialized CCTs, I would suggest that we need to re-examine how we determine goals, define missions and implement policies.

Perhaps it is timely to think more boldly if we are to capture a portion of the potential international market for clean coal technologies.

1. We must re-think and change our concept of foreign aid. Given the budgetary constraints facing this country, we cannot afford to continue to provide foreign aid in the traditional manner. The current system of simply cutting a check for an international development project has proven inefficient and ineffective. Sustainable development and economic growth is more than just the construction of a bridge or a road or a power plant. It is the integration of these projects within a system that maintains the structure and political climate to create and uphold regulations and policies, such as property rights for private entities and market-driven pricing, that support continued development. In other words, a project alone will not yield economic growth. Rather, it is the effective and efficient operation or use of that project which encourages and sustains prosperity.

I am not suggesting that we cease current humanitarian aid for projects such as immunization or emergency disaster assistance. I am suggesting that we develop a successful "win/win" plan for international aid as it relates to development projects. We can, and should, promote international sustainable development which rewards both the host country and the U.S. (and U.S. commercial interests) with returns on investments made.

Currently, the U.S. funds institutions like EXIM and OPIC to provide loans and guarantees for private sector projects in countries that the private sector considers too great of a risk to fund alone. EXIM and OPIC programs have proven successful in the development of necessary infrastructure projects. These federal lending institutions have leveraged between 20 and 40 dollars for each federal tax dollar. U.S. Agency for International Development (U.S.AID) projects only fund at a one-for-one ratio in the form of grants. In addition, institutions such as OPIC and EXIM administer each dollar of their programs for about one-tenth the cost of AID-funded programs.

In short, through our support of EXIM and OPIC, in partial substitution of direct foreign assistance the U.S. saves federal tax dollars and we gain the benefits of exportation and long-term private investment in developing nations. The host country gains from the development of an efficient infrastructure project. In addition, often when private sector projects are constructed, roads, schools, bridges, hospitals and other development projects also are constructed. Most importantly, many of these projects are paid for by the private firm, not the U.S. taxpayer or the host country. In addition, the negotiation of private development projects facilitates beneficial changes in laws and policies that resolve some of the other barriers to entry into foreign market, such as political and regulatory risk.

This concept, while it may be innovative from the U.S. perspective, is not new. Our competitors are already employing this "help yourself and the recipient country" concept and utilizing credit assistance to ensure technology commercialization and to seize export opportunities. Japan, for example, spends official development assistance primarily on infrastructure projects (as concessionary loans, not grants) and project-related technical assistance (such as feasibility studies). General policy and sector reform work is left to the multilateral institutions.

2. Alas, we must continue to search for, and support, low-cost activities that offer high returns. Again, given federal budgetary constraints, we must expand our view of federal assistance beyond traditional thought which demands direct federal funding assistance. There are many opportunities for the federal government to assist exports without significant drains on the federal coffer. For example, we should encourage efforts to complete the CCT program and to advertize the program's results overseas. The CCT Program has been a remarkably successful venture. We need to ensure that foreign entities are aware of the program and its results. We must also continue to facilitate government to government interaction to promote opportunities for U.S. industry in the international market.

3. We ought to review opportunities that exist in current programs. The Global Environment Facility (GEF) was created as a result of the Rio conference on global climate change. The goal of the program is to provide funding assistance for environmentally sustainable projects in developing countries. We contribute heavily to the GEF, we ought to tap these funds for sustainable fossil energy projects. As the Energy Information Administration and others have projected, developing countries are intending to achieve economic development powered by indigenous fossil fuels. We should not attempt to bully these countries into utilizing other, perhaps less efficient, energy supplies. Rather, we should encourage developing countries to utilize their resources in an environmentally sound, sustainable manner and this can be accomplished with advanced coal-based technologies. Staying focused on renewable energy technologies and resources, funding energy efficiency projects are all commendable and should be encouraged, but we cannot get there from here. We cannot assist in the generation of the energy needed to sustain and build economies by relying on renewable resources alone.

4. We must think creatively to incentivize international projects. For example, we need to aggressively examine tax and/or regulatory incentives. Perhaps, if a CCT project is built abroad, a U.S. company should receive a tax break here as long as the international project retains American services and parts, and the domestic project does not increase emissions.

5. We need to consider global climate change and innovative programs such as Joint Implementation (JI) as a potential source of incentives. As a result of the Berlin conference on global climate change, a JI pilot program has been adopted. At the end of the pilot phase, the conference parties will determine whether JI should be institutionalized. We need to ensure that JI becomes permanent policy and that it develops teeth.

An *effective* JI program may be developed once the entire international community views itself as part of the global environment and recognizes the economic benefits associated with least cost emissions reductions. We must consider offering incentives to U.S. based developers through emissions credits and off-sets.

In short, the way that we will overcome barriers to the international market is through a creative re-evaluation of our own global efforts. We must place importance on this process and on international activities – it is outside of the borders of the U.S., after all, where the markets lie and where the future of U.S. competitiveness and economic leadership exist.

Our competitors understand this reality all too well and we must too.

The underlying theme of this concept is that the federal government will, and must, maintain a significant and important role in export promotion and technology development. This is not an independent role, but one that acts in concert with industry. But, it is the federal government that will need to lead the creative thought and policy changes and to ensure implementation of incentive programs.

With respect to coal and the use of CCTs, we should encourage first the use of conventional technologies that may be better than what is now contemplated or used in a particular developing nation. Then we should look for opportunities to use more advanced clean coal technologies.

IV. CONSEQUENCES – STOPPING OR STOPPING TOO SOON:

If we do not overcome the barriers to the international marketplace for advance coal based technologies and if we stop support of clean coal technology development too soon we will have squandered a wonderful opportunity.

As I mentioned earlier, the Republican Congress asserts that we must balance the budget by cutting federal expenditures, including advanced research, otherwise known as "corporate welfare." Their argument follows the line that if you cut government spending, the government borrows less from the private sector. More credit is then available for private sector investments; industry borrows more and invests more and growth proceeds. However, for this argument to be successful, you cannot cut from the base of economic growth – R&D. Federally supported R&D has led to innovation and economic growth. In addition, given the climate of corporate scale backs and reduced private sector spending on R&D, it is wrong to assume that the private sector will pick up the slack from the federal cuts.

The proposed cuts to technology R&D are significant. The Republicans claim that they will only cut corporate welfare and not touch "basic research." The truth is that research is a continuum that cannot be subdivided and the truth is that the numbers do not correspond with the rhetoric. The Budget Resolution approved by Congress last June calls for cuts in federal spending to achieve a balanced federal budget within seven years. Under this resolution, non-defense R&D spending would be slashed by 32.5 percent by 2002 – $11.1 billion less than the $32 billion spending in FY 1995. This amount will extend far beyond the elimination of "corporate welfare."

It is worth noting that while we seem intent upon slashing R&D budgets and refusing to join with industry to assure that technologies are navigated though the "valley of death" our foreign competitors are taking a different tack. Ironically, and tragically, while we cut our competitors are adding. Japan currently invests 35% more in R&D than the U.S. on a per capita basis in civilian-technology; and Germany invests 30% more. And, Japan plans to double the country's R&D spending by 2000.

Let me re-emphasize that the private sector will not fill in this gap because it cannot do so and remain competitive. Corporations have been forced to downsize and cut back on expenditures. In 1990 IBM spent just under $5 billion in R&D in 1990 and in 1994 that number was only $3 billion. GE spent $1.5 billion in 1990 and in 1994, approximately $1 billion. Texaco spent $230 million 1990 and reduced that amount to $150 million in 1994. The list of corporations scaling back R&D budgets is long and there are no indications that this trend will change anytime soon. As I mentioned earlier, during this time of accelerating pace of technical change, ever shorter product cycles, rapid diffusion of technological information – what individual company would want to risk billions of dollars on R&D when the profits may be short lived and/or minimal? Add to this the fact that the principal user industry – electric utilities – face an uncertain future and we have a dangerous prescription for gridlock and failure when it comes to the commercialization of CCTs.

This is not a pretty picture or a bright future.

We are considering cuts at a time when our competitors are increasing funding, industry is reducing R&D budgets and the importance of technology to global competitiveness grows. Given the fact that companies that utilize advanced technologies have been found to be more productive and profitable, pay higher wages, offer more secure jobs, increase employment, grow more rapidly and are more likely to export, the current policy direction of government seems to me to be illogical and detrimental to the health of our economy's future.

We must realize that the international market is markedly different. To stay competitive, and maintain economic leadership, a country's industry must provide the better-yet-cheaper product. Given the fact that our foreign competitors recognize and support this path to economic dominance, if the U.S. eliminates, or drastically reduces, federal assistance for industry efforts to develop product from the concept phase to commercialization, we will have a balanced budget, but we will be a poorer country.

We need, rather desperately, to challenge the theory that dissects technology development and rather arbitrarily stops government assistance at certain early stages. Does not it make more sense to look at the technology, the market potential, U.S. competitiveness and economic benefit and act with assistance – only when necessary – but without regard to the stages of technology development? We can avoid the government picking "winners" or "losers" by assisting those that come forward with their own dollars – a hallmark, by the way, of the clean coal program.

We are at a crossroad. We have invested significant amounts of money in a very successful clean coal technology program. Industry and government have proven through the Clean Coal Technology Program that the two entities can work together in an effective manner. Rather than hide the relatively high federal expenditures associated with the CCT program, we should advertize the dollars leveraged and the success of the program's management, and encourage similar programs. Again, given the current climate on Capitol hill, some may claim that the odds of Congress approving another clean coal program are less than none. Yet, we should, and in fact we have an obligation to, support good programs and policies. As a country, we cannot afford to gut the good programs especially when our continued economic leadership and prosperity are at stake.

We must think and act creatively and we must put our money with our words. The Administration has voiced the benefits of technology development, yet backed away from this commitment by cutting program dollars (albeit by a lesser amount than the Republican Congress). We must break this trend. We also must continue to work hard and work together. Opportunities exist for CCT commercialization. If they did not, few if any of us would be in this room.

Panel Session 1

International Business

GLOBAL OPPORTUNITIES FOR CLEAN COAL TECHNOLOGY - UNDERSTANDING INTERNATIONAL MARKETS

FOURTH ANNUAL CLEAN COAL TECHNOLOGY CONFERENCE

DENVER, CO

SEPTEMBER 5-8, 1995

Thomas E. Rappold
Assistant Vice President -
International Coal Marketing
Norfolk Southern Corporation
Roanoke, VA 24042-0026

I'm not an expert on clean coal technology, but Norfolk Southern has been exporting coal for over one hundred years. So, we are familiar with international markets - and we have a keen interest in supporting efforts to improve the attractiveness of coal to help meet the world's energy needs into the 21st century.

My comments today will include general thoughts on international coal markets, pertinent facts and projections on energy use, comments on energy choices and clean-coal technology, and finally how obstacles to spreading the use of clean-coal technology might be overcome.

International coal markets are quite different from the domestic market in the U.S. Typically local governments are more involved, and countries frequently will want to use their indigenous coal reserves. For security and political reasons subsidies often are involved.

Significant differences exist between energy policy in the developed world versus that in undeveloped countries. In Western Europe environmentalists are very influential, so adoption of new technology is more pronounced. Third-world, undeveloped countries generally do not have funds available for higher tech means of energy production, including use of clean coal technology.

Outlook for Coal-fired Electricity Demand

Last year world coal production amounted to 3.5 billion tons while seaborne coal trade totaled 383 million tons. With expected world population growth and the size of coal reserves versus other fossil fuels, it is important for the transfer of efficient and environmentally acceptable technologies for producing, transporting and utilizing coal.

Among regions of the world Asia has the most rapid growth in energy, electricity and coal demand. The region consumes almost half of all world hard coal production and over half of all internationally traded coal. According to a recent Arthur D. Little study, to meet the rising demand for electricity from 1990 to 2010 Asia may need 720 GW of new capacity requiring $1.1 trillion of investment. About 55% of the area's new power plants will be coal fired.

The People's Republic of China is adding 10,000 - 12,000 MW annually of new coal-fired capacity using conventional steam cycle powerplants. This trend is expected to continue for the next decade or so. Similarly, Indonesia is planning to add 31,000 MW of new coal capacity in the next ten years, and India intends to construct at least 10,000 MW of coal-fired or lignite-fired capacity during the same period. Serious environmental problems are expected in the medium term if China and India do not invest in new, more technologically advanced coal plants. Hence the potential for clean coal technology in these countries is very great.

The International Energy Agency (IEA) states the need also exists for improved technologies for power generation in central and eastern Europe as well as in the former USSR. There will be markets for coal-related technologies in Latin America and in some developing countries of Africa as well.

Energy Choices

As countries consider the means to meet their energy needs, fuel selection comes first. The primary factor influencing fuel choice is availability. Therefore, historically indigenous supplies have been first choice. Decisions are not always made on a strictly economic basis, and many instances exist of countries producing their own fuel at prices well in excess of the world norm in order to preserve domestic industries and jobs.

However, purchase price usually is a key factor, both near term and longer. The future cost of coal, oil and gas is a key input to choice, and there is no consensus on future relative costs. Gas prices likely will rise relative to coal, but when and how much?

Other important factors are:

- security of supply source and availability of alternatives
- fuel quality
- length of available fuel purchase contracts, and
- cost of transport

Fuel flexibility is also important. In many parts of the world choice of coal is fixed by geography. It may be physically, politically or economically impossible to import coal and so coal choice is limited to that produced locally.

Clean-Coal Burning Technology

Where coal is the fuel of choice, various technologies exist with clean coal technology. Most are capable of high efficiencies with values up to 50% achievable with further development. In developing countries advanced Pulverized Fuel (PF) systems are especially suitable. That technology is mature and readily available with low technical risk. Many manufacturers are available hence supply is competitive. Wide use of PF means people are available for training. Finally, improved environmental performance through sulfur and nitrogen oxide abatement can be included using proven technology.

Over most of the world PF is the predominant coal technology. It has good all-around performance and high availability. But low thermal efficiency and poor environmental performance are concerns. PF has fallen out of favor in countries which put high premium on efficiency and on reduced emissions. Scandanavian countries and Japan are examples.

Within the next decade construction of most coal-fired plants will be in China, Southeast Asia and India. The majority will likely be PF units because of the conservatism of utilities and their funding agencies. High efficiency clean-coal technology still gives the perception that it is more costly as well as complex to build and operate.

Circulating fluidized bed combustion (CFBC) is another clean coal technology which has over 200 units either in place or on order worldwide. These units can burn low and variable quality coal with multi-fuel capability. They have good environmental performance without added capital cost, are commercially established , and already have been successfully deployed in some less developed countries.

The industry view is that developed countries are increasingly being influenced by stringent environmental legislation which often results in choosing a natural gas combined cycle gas turbine (CCGT) plant. In the rest of the world the most important factors are perceived to be the plant's capital cost and reliability, with environmnental and thermal pervormance being lesser considerations.

Barriers to Clean-Coal Technology

Throughout the world barriers to the adoption of Clean Coal Technologies exist. The following must be considered:

- Competition from gas: often little can be done where gas is preferred. Further, combined cycle gas turbine (CCGT) plants are much cheaper than any of the coal-fired technologies.

- Conservatism of utilities: incentives are needed, probably with governmental or other assistance.

- Non-proven nature of new technologies: This is particularly important in Southeast Asia and South Asia (China and India) since most new coal-fired plants will be built there. High plant availability is needed, so technology must be proven.

- Financing is a very big issue. It's estimated that the energy finance market will need some $40 billion per year throughout the current decade.

- Little information has been published of successful and efficicient technology transfer projects. So it's hard for others to learn about the best methods, except by trial and error. That's costly and time-consuming to all. Collaboration between utilities at the demonstration phase would help increase hands-on experience of new technology.

Solutions to Adoption of Clean-Coal Technology

Here are possible solutions to increase the adoption of Clean-Coal Technology:

1. Support from private sector. British Coal's Coal Research Establishment (CRE) is actively providing technical assistance and know-how transfer in developing countries.

2. Government/industry collaboration. The U.S. DOE Clean Coal Technology program is an outstanding and successful example of government -industry collaboration. Fourteen demonstation projects are now underway.

Last fall the DOE's Office of Fossil Energy held public meetings with the business community to get input on what should be done to support U.S. exports of fossil fuels, equipment, technology and services.

3. Flexible approach. Governments, funding agencies, and technology providers and recipients need to be open-minded and flexible.

4. National Coal Council recommends that incentives be established
   - to shorten the time required for commercial deployment
   - to improve prospects for exporting U.S. technology, and
   - to ensure continued benefits of environmental protection and energy efficiency.

5. Financial incentives and/or legislation is needed to increase the adoption of developing technologies. Demonstration of new technology should take place in developed countries first.

Conclusions

In conclusion, the path to expanding CCT has been summarized quite well by the National Coal Council:

- All new technologies need some form of risk sharing for first-of-a-kind plants in order to progress quickly from demonstration to commercial use.

- Many of the most promising technologies still require demonstation at full commercial scale.

- Many promising technologies still require fundamental research and development, as well as related significant investments

- As federal and state environmental requirements are mandated, the relative importance of many of these technologies changes.

- A wide range of technologies is necessary to assure economically viable and environmentally acceptable coal options.

Finally, with the burgeoning world coal utilization market, high technology coal systems from the U.S. can fill an extremely important need. The opportunity for U.S. technology to play a major role in these markets is strongly dependent on successful domestic development, demonstration, and deployment.

Worldwide demand for capital for infrastructure projects is $27 trillion. Seventy percent of this need is for electrification, of which 50% can be supplied by coal-fired plants. Consequently, the demand for Clean-Coal Technology can reach $500 billion annually over the next 20 years. So, the U.S. investment in Clean-Coal Technology provides a significant potential for future sales and income.

Tackling the challenge of increased demand for energy has to be a team effort by all involved. Coal can and I think should play the key role. Without cooperation among coal producers, transporters, governments, end users, the financial community and increasingly those entities working to promote clean coal technology these efforts could well fall short.

As I mentioned to this group last year, the export of CCT may have little benefit to U.S. coal producers. Improved technology in developing countries can increase the attractiveness of indigenous coals versus imports. Nevertheless, the spread of CCT can mean a more suitable climate for coal, both environmentally and economically on a world-wide basis.

Utilities around the world can count on the excellent coal reserves in the U.S. Appalachian coal fields and Norfolk Southern's multi-year investment in export capability to help them get the coal needed to produce energy in the years ahead.

Thank you very much for the opportunity to be with you.

The following manuscript was unavailable at time of publication.

MECHANISMS FOR INTERNATIONAL COMMERCIALIZATION

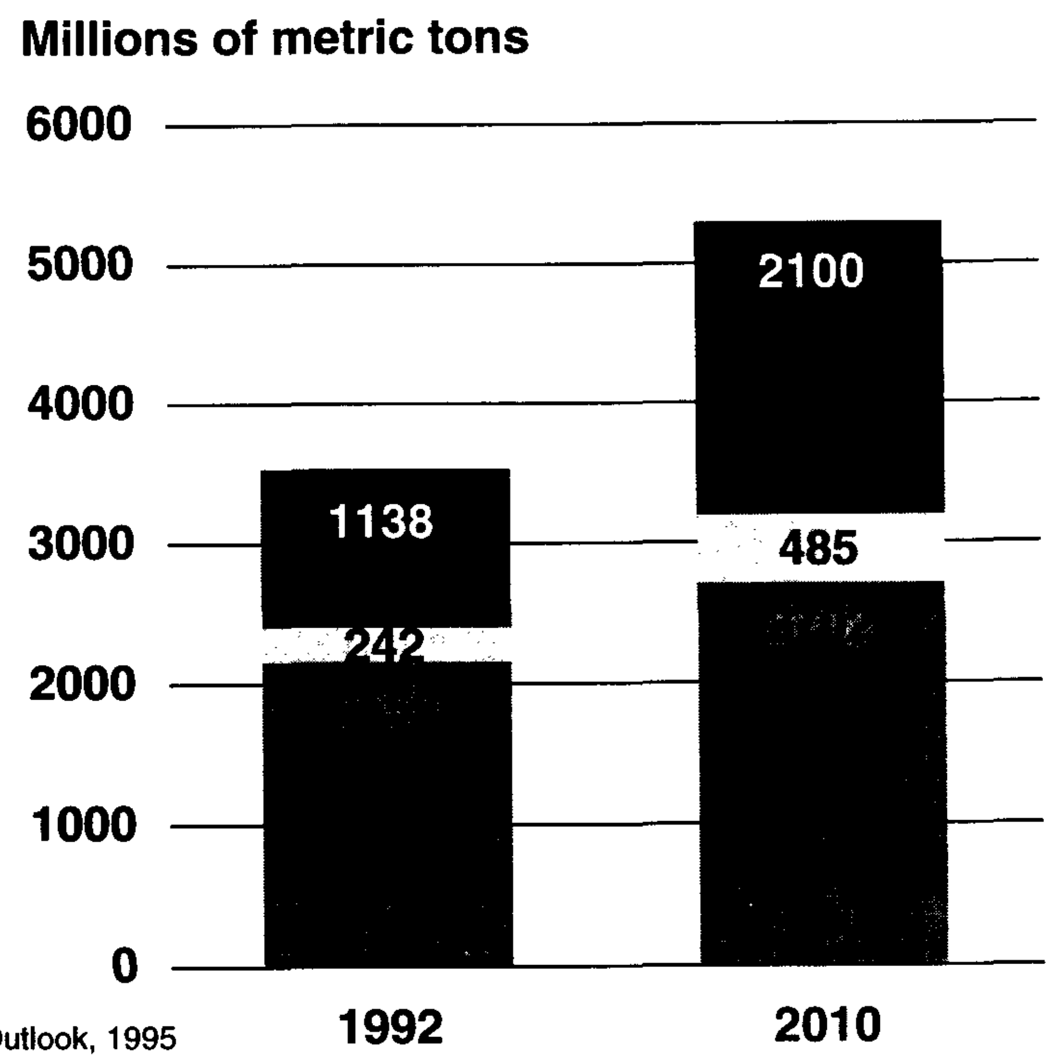
Anthony J. Drexel Biddle, III
The Chase Manhatten Bank, N.A.
1 Chase Plaza
New York, NY 10081
(212) 552-3956

Please contact author for a copy of this paper.

Why is it important?

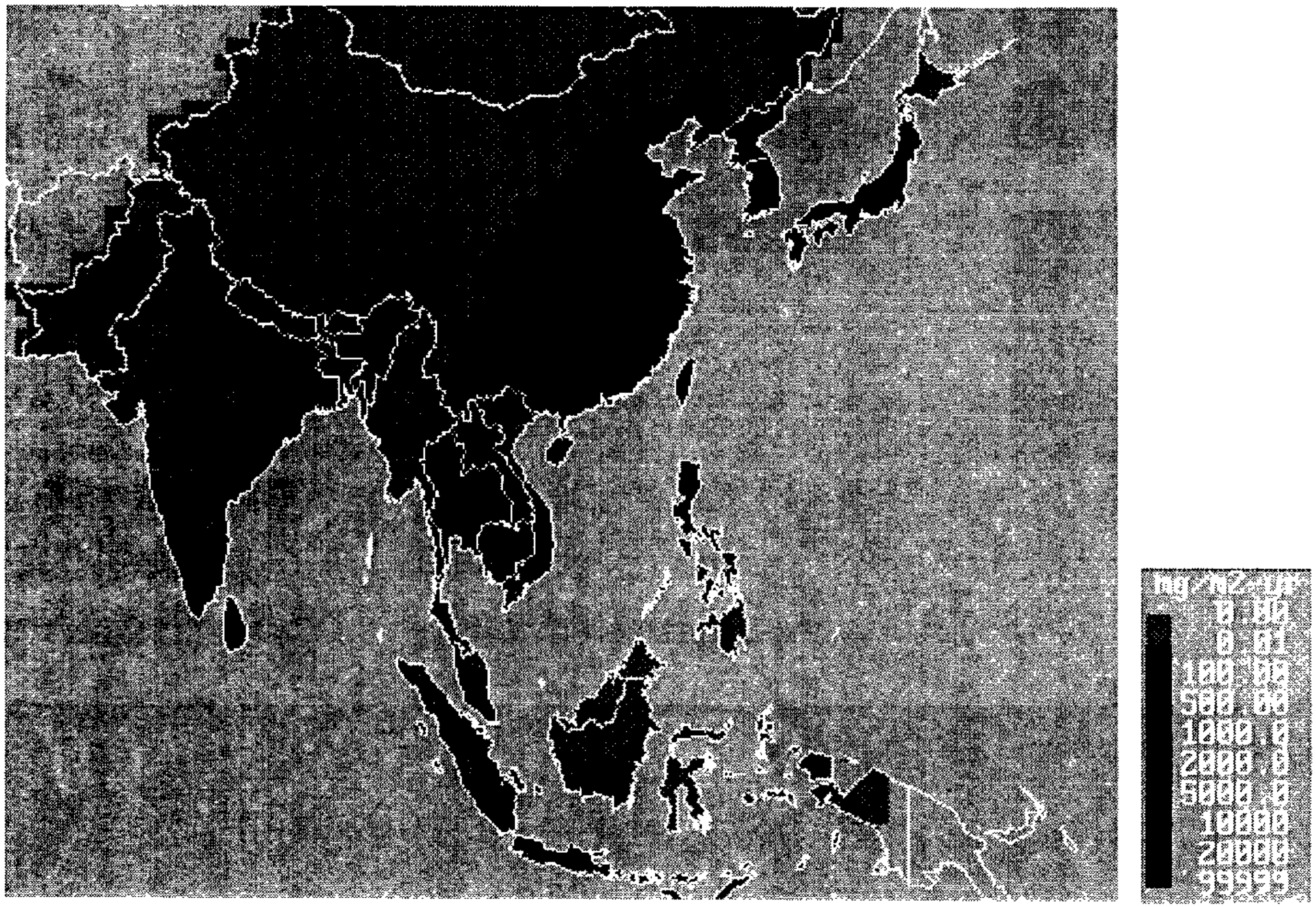
Current and projected coal usage

China
India
Others



Source: IEA, World Energy Outlook, 1995

Excedance of sulfur with no controls, 2020



Bringing CCTs into the picture

- Reform/restructure the coal sector and the power sector
- Market pricing of coal and other fuels
- Open traditional monopolies to competition
- Encourage private investors
- Eliminate distortions that block efficiency in mining, transport, and power use
- Seek incentives to scale up market for new technologies
- Improve environmental standards

Objectives of clean coal initiative

- Assist developing countries to create the "enabling environment" and to deploy appropriate CCTs for a more efficient integrated coal chain (least cost energy) and lower environmental impacts
- Seek opportunities and means to finance CCT projects by the Bank or to facilitate financing by the private sector

The World Bank's Clean Coal Initiative

- Improve enabling environment
- Develop environmental standards
- Accelerate deployment of clean coal technologies

Throughout the coal chain

- Mining
- Transport
- Power and industry

Enabling environment

Upstream

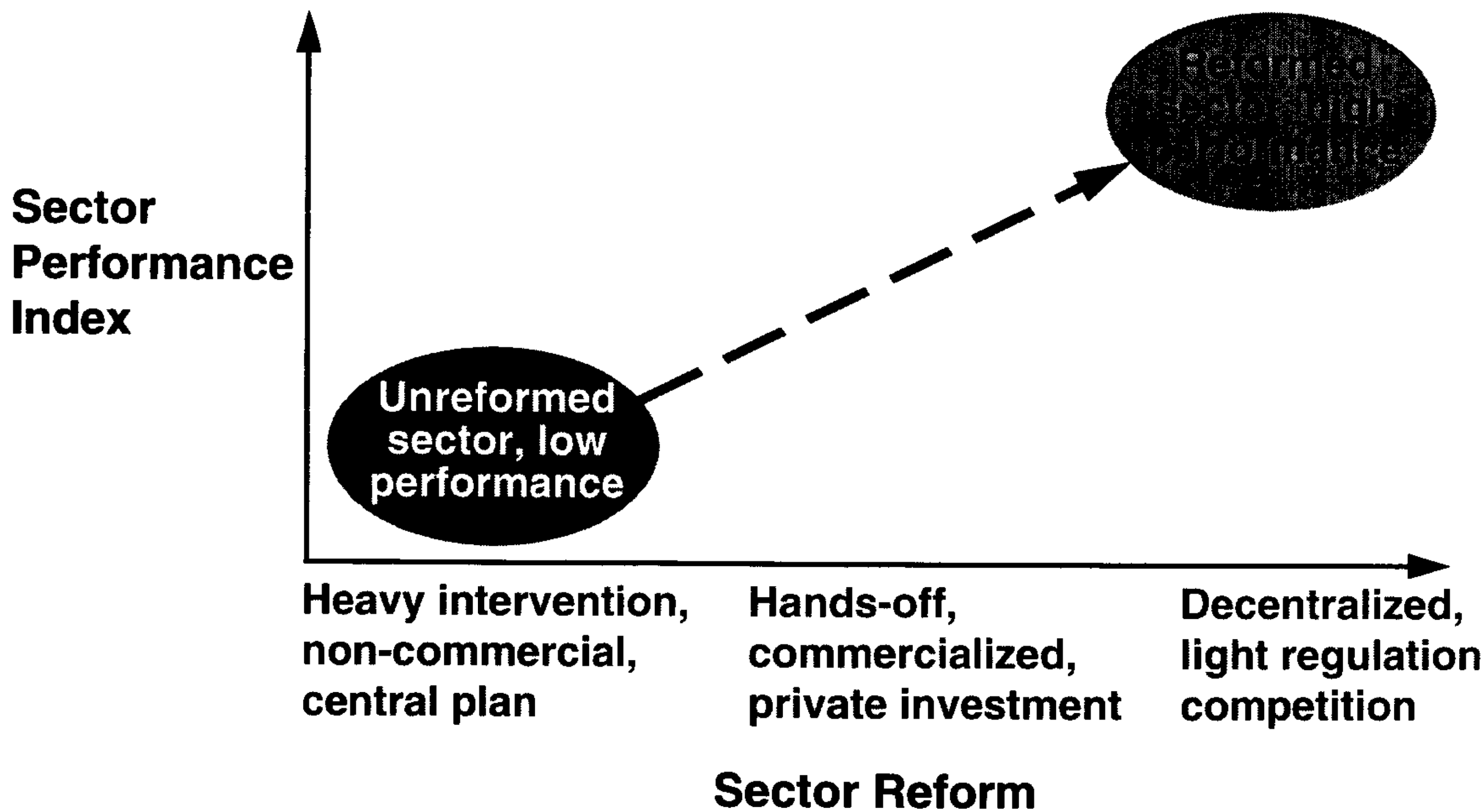
- **Deregulate coal pricing and allocation systems**
- **Unbundle coal mining and rail transport monopolies**
- **Eliminate cross-subsidies between mines and between users**
- **Open mining to private investors**

Enabling environment

Downstream

- Unbundle power monopolies
- Open power sector to private investors
- Remove electricity pricing from political constraints

Energy sector reform and efficiency



Deployment of CCTs

- Work with technology developers and private power investors to find mechanisms to reduce the cost and reduce or manage the risks of these technologies
- Seek opportunities and means to finance or facilitate private sector financing of new technologies in developing countries, where economically and environmentally sound

Deployment of CCTs

Step 1 Getting started—homework

Step 2 Looking for partners

Step 3 Identifying and preparing projects
- Commercially viable projects
- RD&D needs, demonstration projects

Step 4 Financing or facilitating projects

Step 5 Continuing assessment and monitoring of technology developments

Getting started

- Perform technology assessment (in partnership with EPRI)
- Formulate role of the Bank
- Define instruments for project financing
- Examine procurement issues

Looking for partners

- Developing country enterprises and government
- Technology developers
- Private sector developers and financiers
- Utilities and associated organizations (EPRI)
- Bilateral and multilateral agencies

Through

- Direct contacts
- Roundtables
- Internet

For More Information on:

The World Bank's
Clean Coal Initiative

Contacts:

Mr. Peter van der Veen, Division Chief
Industry and Mining Division
Tel (202) 473-4242
Fax: (202) 477-6619

Dr. Karl Jechoutek, Division Chief
Power Development, Efficiency, and Household Fuels Division
Tel (202) 458-2872
Fax: (202) 477-0542

Mr. Joseph Gilling, Senior Energy Economist
Power Development, Efficiency, and Household Fuels Division
Tel: (202) 473-3230
Fax: (202) 477-0558

Industry and Energy Department
World Bank
1818 H Str., NW
Washington, DC 20433
USA

Paul Gottlieb
Assistant General Counsel
for *Technology Transfer*
and Intellectual Property
U.S. Department of Energy

International Intellectual Property: Impacts on Transferring Technology

Recognition of a property right in technology through patents, copyrights, trade secrets, know how, etc. (intellectual property) is a tool facilitating extra national transfer of technology. Ideally, intellectual property provides the party controlling the intellectual property the legally recognized exclusive right to make, use or sell a technology, to transfer rights in a technology by contracts and licenses, and to prevent unauthorized use of a technology. The more the competitive advantage in the technology being transferred lies in the knowledge of how to do something or in the uniqueness of a product or service, the more important intellectual property protection becomes. Let us examine three "equal" worlds: (1) nations with established intellectual property laws, (2) nations seeking to establish internationally respected intellectual property laws, and (3) the United States Government and its interplay with the other two "equal" worlds.

1. Nations with Established Intellectual Property Institutions

- Western Europe, Canada, and the United States are the preeminent examples.

-Characterized by the availability of legally recognized mechanism to establish a claim to intellectual property rights.

-Mechanisms may vary but available protection is predictable and reliable. First to file a patent application entitled to patent everywhere but the U.S., where first to invent is entitled to patent. Clean Coal program is an international technology transfer. German, Japanese, and Danish technologies for example were brought to the U.S. The foreign companies were willing to rely on written agreements which protected their property rights.

-Enforcement mechanism is available.

-Established reliable legal advise is available.

-Business decisions on whether to pursue obtaining intellectual property or on the structure of contracts and licenses can be made with greater confidence about the value of decisions.

-Current system of international protection of intellectual property is high cost.

-Even in the established countries, accusations of unfair treatment against U.S. companies are made.

2. Nations seeking to establish Intellectual Property Institutions

-Eastern Europe, the Peoples Republic of China and the countries from the former Soviet Union are examples.

-U.S. Government has taken an active role in promoting establishment through bilateral negotiations- China and Russia

-Laws are being passed.

-DOE is developing a survey of some of these countries. The ABA is about to publish their survey by Richard Beam of Fitch, Even and Tabin and Flannery of Chicago.

-Eastern Europe seems to be headed towards joining the European Convention.

-The states of the former Soviet Union may organize their own convention.

-Enforcement of these laws is not yet reliable (CDS in China). Reliable legal advise being developed. Enforcement problematical.

-Business decisions in obtaining intellectual property protection must weigh the cost versus risk that rights will not be respected versus long term potential of new markets.

-DOE experience with the New Independent States (Russia, Ukraine, Kazakstan and Belorus: (a) We have toured to explain intellectual property laws, (b) scientists don't appreciate non disclosure agreements, (c)preexisting arrangements may exist (d) sensitivity about fair treatment (class waiver issued by DOE).

-No money available to protect intellectual property coming from these countries.

3. The U.S. Government

-Contract restrictions on the transfer of intellectual property through Bayh- Dole or waiver conditions.

-Conflict between promoting U.S. benefits versus environmental benefits of clean up in foreign country.

-Bad publicity for U.S. institutions that transfer without benefitting the U.S. economy.

-Eligibility requirements to receive new awards will focus on intellectual property laws of foreign countries (CRADA law, Section 2306 of EPACT). Office of Technology Assessment report now available.

-It is claimed that Japan discriminates against U.S. companies.

-We work with USAR in dealing with these issues.

Panel Session 2

Transitions in the International Power Sector

Roman ŁUCZKIEWICZ
Minister's Adviser for Energy
Ministry of Industry and Trade
Poland

POLISH ENERGY
YESTERDAY, TO-DAY, TOMORROW

Introduction.

In the mid of the nineties, Poland has got 39 million inhabitants. Situated in central Europe, its acreage takes 312,667 km^2. After the former Soviet Union it was the biggest member country of CMEA, having then three neighbours: the Soviet Union, Czechoslovakia and GDR. During the period of centrally planned economy the consumption of primary energy per capita was relatively high; it amounted to 3,48[illegible] toe per capita (in 1980). The reason of it was first of all a much greater that to-day, demand of heavy industry as well as general waste of all the energy carriers, and especially coal, whose prices were created below the costs of their production due to large subsidies from the state budget.

In 1990 there was observed a deep decline in energy consumption connected with the collapse of the economy.

Presently Poland consumes about 30% less of primary energy per capita as compared with average consumption in the countries of European Union. Due to the changes occurred in Europe there was shaped a new political map around Poland. Its neighbours nowadays are: Russia, LITWENIA Belorussia, Ukraine, Slovakia, Czechs and Federal German Republic.

Production capacity of the Polish electro-energy, that is the sum of the capacities installed in all the power and CHP plants, equals 33 thousand MW.

Maximum energy demand in 1994 was	23 thousand MW
Electrical energy production in 1994 was	135 thousand GWh
Hard coal output was	133 million tons
Brown coal output was	67 million tons
Natural gas production from domestic sources was	4 billion m^3
Import from Russia was	6 billion m^3
Crude oil production from domestic sources was	0,2 million tons
Crude oil import was	12 million tons

Structural and ownership changes.
Electro–energy.

Before 1990, the Polish energy sector was centrally managed by the then existing Ministry of Mining and Energy. Within the responsibility of that Ministry there was the management of coal mining, electro–energy, gas industry and crude oil extraction. To the Minister there were also subjected all the enterprises of machine building industry, producing machinery and equipment for hard and brown coal mines, as well as those producing boilers, turbines, generators, transformers, and also the production units of drilling machinery and equipment, specialised construction enterprises for mining and energy sectors, and many other enterprises serving to that large branch of the national economy.

In the last period of the centrally planned economy there was established Energy and Brown Coal Authority. The above listed enterprises of machine building industry were already then placed beyond that Authority. Similarly, in hard coal mining sector the created Authority grouped only coal mines, without the enterprises of mining machines' industry.

The proper beginning of decentralisation process started in February 1990, when on the basis of the Parliament law the Authority of Energy and Brown Coal was liquidated. According to the intention of the law, electro–energy sector was divided into three subsectors:

generation	all professional power and CHP power plants as independent, autonomous state enterprises,
transmission	all high voltage transmission lines of 220, 400 and 750 kV, power dispatching in the country electro–energy system, wholesale turnover of electric energy and power in between generation and distribution, and exchange of power and electric energy with abroad – as the first in the energy sector joint stock company of the National Treasury: Polish Power Grid S.A.
distribution	33 distribution units, local dispatching network of 110 kV and of lower voltage, as state enterprises.

As a result of the performed transformations, all enterprises found themselves in a completely new situation. Without experience and in many cases also without satisfactory knowledge on independent managing, management teams simultaneously faced on one hand – full organisational, economic and financial autonomy, and on the other – enormous personal responsibility for availing themselves of independence.

The process of decentralisation during the last five years showed however efficient functioning of majority of enterprises as well as positive liberalisation of many valuable organisational and economic initiatives. In lots of enterprises, resourcefulness and innovation decisions of management teams were conducive to overcoming difficulties, numerous in transition period. Those decisions shaped *also rational, already own ambitious perspective programmes for the coming* years. It enabled the continuation of energy restructuring process.

By the end of 1994, in generation subsector all the CHP plants were transformed into single joint stock companies of the National Treasury, that is, into operating on the basis of Commercial Code, commercial companies whose 100% shares are owned by the National Treasury.

A year before that, there took place such transformation of all distribution enterprises. The process of power plants' transformation into single companies has already begun. It is estimated that the process will be completed by the end of this year. Thus, starting in 1996 all the enterprises of energy sector should become single joint stock companies of the National Treasury.

The already transformed companies undertook reorganisation and structural changes on their own. Out of joint stock companies there are separated daughter companies, established as limited liability companies or as employees` companies that overtook a part of assets from their mother companies, on the basis of lease, rent or purchase agreements. In majority of companies, thorough analysis of quarterly and annual financial results made by the Management and Supervisory Councils, lead to undertaking effective solutions in favour of costs` reduction, modernisation and expansion in order to increase profits and rationally divide them.

A succeeding, provided in the energy policy of the country, stage of structural changes in electro-energy sector is privatisation of single joint stock companies of the National Treasury and introduction of companies` shares to the turnover in stock exchange of securities. However, it is presumed that some energy enterprises, being strategically important for the energy security of the country, shall not be privatised or their privatisation shall be limited. The State will retain full or controlling block of shares with regard to:

= brown coal mines,

= Polish Power Grid S.A.,

= some huge system power plants

Hard coal mining.

After 1990, individual mines, factories of mining machinery, specialised mining construction enterprises led autonomous, mutually independent economic activities. The decrease in demand for hard coal with the simultaneous retaining, due to continued subsidies, of production capacities of the mines led to overproduction. The difficulties were deepened by maintaining official coal prices. With the quickly increasing extraction costs, the mining sector found itself at the point of bankruptcy.

At the turn of 1992 and 1993 in the mining sector there were undertaken structural and ownership transformations resulting in the establishment of coal companies. Reduction of yield and stabilisation of prices were brought about. There were also started extraction costs` decreases and financial restructuring. As a result of those activities, 56 mines were grouped into single joint stock companies of the National Treasury. Beyond organisational structures there stay 12 mines, out of which 4 are independent single joint stock companies of the National Treasury, 3 are limited liability companies and remaining 5 are being liquidated and they have retained the status of state companies.

The goal of such shape of mining industry was to create strong, autonomous economic entities able to face growing competition on the market and to self-finance modernisation, expansion and to a still greater extent, the costs of mines` liquidation.

Presently, the second stage of mining industry restructuring is being implemented, comprising the years 1994–95. The implementation of this programme concerns liquidation of mines that do not promise to achieve appropriate level of economic effectiveness, with simultaneous ensuring the minimisation of social and ecological damages. Restructuring programme is financially supported by the state budget in the form of allocations to cover the costs of mines` liquidation. Under preparation there is the strategy for the years 1996–2000, with regard to the adjustment of mining industry to the being implemented on a still larger scale conditions and mechanisms of market economy in Poland.

Energy policy of the country assumes that privatisation in hard coal sector will comprise separated factories, enterprises and mining institutions operating presently in favour of mines, on the surface. The underground parts of coal mines will, as before, remain the exclusive ownership of the National Treasury.

Brown coal mining.

Open pit brown coal mines, similarly to the co–operating with them power plants of large capacities, remain state companies until now. Preliminary concept of 1994 to merge individual power plants with open pit mines into bigger organisations of holding or concern type – has not succeeded because of suggested forms and ways of merging. At the turn of 1994 and 1995 the first system power plant of 2700 MW, fired with brown coal (but without a mine) was transformed into a joint stock company of the National Treasury. Presently, there is being prepared a privatisation project of that company, through the emission of its shares into the market of securities.

Heating.

Dominating role of hard coal, as formerly cheap fuel to produce heat for the needs of industry and heating resulted in the fact, that in Poland centralised sources of heat can be found in every urban agglomeration and in majority of smaller towns and housing estates.

Besides 35 CHP plants, the so-called professional ones, which produce heat in combination with electrical energy, heat in Poland is produced in over 200 CHP industrial plants, that is, built on the area or in a direct neighbourhood of industrial works that hitherto are their owners. In many cases those CHP plants supply also municipal or housing estates heating network. Out of the total heat production from centralised sources, about 32% comes from professional energy, and 68% – from industrial CHP and heating plants. The total capacity installed in CHP plants in Poland constitutes till 25% share in the total capacity of electro-energy sector.

Obligatory in Poland new law on self-governments, charged local authorities with the task to provide heat for inhabitants. In this situation all so far state enterprises of heat distribution, operating within 49 voyevodships in the country, have been transformed into about 500 local heating enterprises. Among them there are commercial law companies, local heating companies, state heating enterprises, co-operatives and private entities.

Gas industry.

The whole economy of natural and coking gas in Poland is so far concentrated in practically one, country-wide state enterprise – that is, the Polish Power Grid (PPG). The elaborated restructuring programme for this enterprise includes in its assumptions the decision of Antimonopoly Office of 1993.

The programme provides transformation of the whole enterprise into a single joint stock company of the National Treasury by the end of 1995. At the same time there are conducted works on elimination from the structure of the existing enterprise, independent companies comprising separately: technical background, auxiliary production, geophysical services, and drilling.

At the further stage of restructuring, privatisation of PPG company is assumed, through the establishment of joint stock companies: Polish Oil Mining S.A. and Polish Gas Industry S.A.

Liquid fuels industry.

The programme of transformations of liquid fuels` sector in Poland has been being elaborated for four years. Since 1990 distribution and liquid fuels` import have been demonopolised. Besides still existing, state-owned Commercial Centre of Oil Industry ("CPN") there have been established about 40 private
and foreign companies that created or overtook over 2500 fuel stations.

In order to co-ordinate activities as well as to strengthen the position of domestic enterprises on competitive market of liquid fuels shared by still growing number of foreign companies, a single joint stock company of the National Treasury: the Polish Oil Company will be established. The company will comprise independent enterprises of the branch. There will be continued the transformation of those state refineries that have not been so far changed into single joint stock companies of the National Treasury.

The progressing process aiming at full privatisation of the enterprises of liquid fuels` sector will not include – in accordance with the assumptions of energy policy of the country – the Enterprise for Oil Pipelines Exploitation ("PERN"), as a strategic enterprise for ensuring energy security of the country.

Demand and energy supply structure.

Contrary to the eighties, when in the period of peak load in Poland there occurred energy and fuel deficit, from the beginning of the current decade the balance of energy demand and supply is equalised due to a lower consumption of primary and final energy and to disappearance of import limitations. The hard coal demand is totally covered from domestic sources. During the last four years coal exports oscillated from 28,4 mln t in 1993 to 27,1 mln t in 1994.

Gas demand is only in 42% covered by domestic supplies of high methane and high nitrogen content as well as coking gas, whose production in 1993 was 4,2 bln of re-counted m^3. The remaining quantity to cover the demand for natural gas comes solely from Russia.

The Polish gas transmission system has been recently connected with the German gas transmission system near the town of Zgorzelec. The connection, having about 1 bln m^3 of flow capacity does not presently perform transmission function, but it ensures a possibility of effective trans-boundary co-operation in this region.

In 1993 the import of gas amounted to 5,5 bln m^3, and last year – 6 bln m^3.

The demand for crude oil is presently covered with import from Russia (about 40–50% of the demand in last years) and through the Northern Port from the deposits of the Northern Sea and from Arabian countries.

Domestic balance of final energy is presently equalised due to a lower demand. In all the energy sectors there occurs the surplus of power. The installed power of generation subsector in electro-energy exceeds currently the peak demand by over one third. As it was mentioned before, this is due to the demand decrease of the industry as well as to more and more rational energy use, and also due to the prices, gradually increased to the economically justified level. For several years, an additional reason for such situation are mild winters

Technical infrastructure of energy.

During the last decades of centrally planned economy in Poland there was created a substantial industrial potential in electro-energy, in coal mining and in crude oil and gas production. In electro-energy there were constructed power plants of large capacities, equipped with energy blocks of domestic production, having the capacities of 200 MW (Soviet documentation) and 360 MW (license from BBC-Switzerland). In hard coal mining sector, beside the construction of new mines, the investment effort was focused on the extension of the industry of mining machines and equipment. Within petrochemical industry, beside previously existing, in the centre of Poland, the biggest refinery of 12 mln t processing capacity – a new relatively modern refinery was constructed near Gdańsk, with the processing capacity of 3 mln t and a possibility to expand by the next 3 mln t.

According to the then assumed trend to first of all develop heavy industry basing on the own deposits of natural raw–materials, hard coal mining together with the industry of mining machinery and equipment became a priority branch of the national economy in Poland. Similarly, electro–energy production potential was created on the basis of the own design and construction forces and the production of domestic engineering industry. Inasmuch as technological solutions applied in electro–energy and mining sectors, especially starting from the seventies, were comparable to the then average world level, the impact of energy entities upon the natural environment was drastically neglected and underestimated. Energy consumption was irrational and devoid of real economic circumstances. As a result, the Polish energy at the threshold of system and structural changes bore the ballast in a form of record–breaking on European scale emission of SO_2, NO_x, dusts and also abundant drop of saline mine waters, mainly to the drainage–basin of the Vistula river.

Taking into consideration that an average age of presently used energy equipment (boilers, turbines, generators) amounts to 25 years, and in 15% is past 30, it becomes obvious, that the key problem for the Polish electro–energy is a rational modernisation. By that it is understood a complex address, on the basis of a thorough analysis, of the issues of generation capacities` reproduction, implementation of modern technologies ensuring a proper level of environmental standards, and economic effectiveness including sharpened competition on still more open and aggressive market of energy carriers. In coal mining sector there appears an urgent need of mines` modernisation from the point of view of implementation of modern and highly effective technologies of coal mining and enrichment.

Opportunities and chances of co–operation with foreign investors.

The above mentioned substantial surplus of production capacities as compared with the real demand, creates presently a specifically favourable situation for undertaking modernisation investments, the more that in Poland before the year 2010 no start–up of any new thermal power plant fired with hard coal is provided. Some consulting companies, co–operating with energy sector, estimate the total investment expenditures to be borne by the year 2010 for the modernisation of fuel and energy sector in Poland, to reach the amount of about 50 bln USD. Even if this sum may be considered to be overestimated, the scale of needs speaks for itself.

The realisation of such programme obviously exceeds financial possibilities of the sector itself. As is well known, the process of transformation from a centrally planned into a free market economy deprived enterprises of previous central subsidies to finance investment expenditures.

That is why, among others, the implemented reform of managing structures in Poland created legal and financial conditions for the management of autonomous enterprises and commercial law companies (power plants, CHP plants, distribution units) to enter into commercial, economic and investment arrangements with representatives of western companies, on the same basis that are applied in the countries of free market economy. Presently many western companies are conducting negotiations in Poland with regard to establishment of joint ventures in order to jointly, with capital share, undertake modernisation of power plants, CHP plants or to install, for instance, desulfurisation equipment. Representatives of foreign investors, coming to Poland, are often surprised to learn that the directors of energy units are fully competent to conclude long-term agreements on a large scale, without waiting for any acceptance or decision of a ministry or other central administration authorities. One of serious obstacles still occurring in Poland while concluding economic agreements, and especially when obtaining credits, is the matter of guarantee from the side of the owner, that is, from the National Treasury. It concerns single joint stock companies of the National Treasury and state-owned enterprises not yet transformed. Overcoming this obstacle will soon be facilitated by issuing a new law on state performance and indemnity guarantees. Advanced works on that law are being performed in the Ministry of Finance. Another fundamental legal act that will introduce transparency and make legislative order within the whole energy economy in Poland, will be Energy Law. That modern document has been elaborated on the basis of detailed estimate of energy situation and economic conditions of the country, including also legal regulations and experience existing in western countries. During its preparation, the law was consulted with many domestic and foreign renowned experts in the fields of law, economy and energy. The draft of the law has been approved by the Ministers' Council and in the 4th quarter of this year is to be submitted to the Parliament.

Poland, as a signatory of Association Agreement with the European Union, signed in December 1991 and of the Treaty of European Energy Charter, signed in December 1994 practically meets all the indispensable formal, legal, banking and financial conditions to perform wide, open investment and commercial co-operation on international scene. Energy policy of the Polish government univocally aims at the establishment of conditions encouraging foreign investors to long lasting engagement of their technological and capital potential into investments in energy sector. This kind of co-operation is also favoured by international and foreign economic and financial institutions, such as the World Bank, European Bank of Restructure and Development, European Investment Bank, commercial banks and others whose representatives carefully follow the progress in economic transformation in Poland.

Environmental protection.

Fast economic development of Poland in the post–war period led, like in many other countries, to surpassing regeneration capabilities of natural environment. Especially in the seventies, dynamic industrialisation brought *an enormous increase of pollution of surface waters and the air.* In 1991 in Poland there were elaborated new, strict standards of permissible pollution, in many cases even more severe than in the countries of western Europe. In 1991 the Polish Parliament approved the resolution on "Ecological policy". Poland has also increased its engagement in international activities in favour of environmental protection and started implementation of Convention on Long–range Trans–boundary Air Pollution (Geneva, 1979) and of the Second Sulfur Protocol (1994). which requires bearing high financial costs. Similar effects, although spread over a longer period of time, are the consequences of signing U.N. Convention on Climate Change (1992).

The share of energy sector in environmental pollution in Poland, especially with regard to the air, is exceptionally high due to the fact that almost 100% of electrical energy production are based on hard and brown coal. In the process of domestic ecological policy implementation, the following activities have been considered as priorities:

<u>for a medium term perspective</u>

= reducing emissions of: SO_2 by 30% as compared with 1980, of NO_x by 10%, and of dust by increasing the effectiveness of exhaust gases de–dusting up to 96%;

= reducing by 50% the amount of salt carried away from hard coal mines to rivers;

= reducing damages connected with the extraction of hard and brown coal;

= increasing the use of raw–materials occurring in fuels` deposits;

= improving the quality of fuels.

<u>for a long term perspective</u>

= introducing the obligation to equip all the cars with catalysts;

= reducing emissions of SO_2, NO_x, CO_2 and dust – at least to the level resulting from international obligations.

In this situation the activities within the Polish energy in favour of environmental protection are focused on:

= increasing the effectiveness of energy consumption and conservation,

= radical improvement of hard coal quality,

= increasing economic utilisation of furnace wastes and their storage, to a larger degree, in mine excavations,

= modernisation of combustion techniques in order to diminish strenuous impact on environment

= changing the structure of applied energy carriers, by the increase of the share of less harmful ones,

= introducing the equipment for the reduction of dust and gaseous contamination

= increasing the share of renewable energy sources.

The effects of those activities in spite of their preliminary phase, are presently evident and perceptible, both with regard to the scale and to the range. Among others, there was the start-up of the first of four plants of wet desulfurisation of combustion gases in the biggest power plant in Poland, Bełchatów (4320 MW). The next one will soon be completed in Jaworzno III power plant. A good beginning of the adjustment of combustion technologies to environmental requirements is the construction of fluidized bed boiler in being presently modernised power plant Turów and CHP plants: Bielsko-Biała in Bielsko and Żerań in Warsaw. There are also conducted works on the analysis of effectiveness to introduce the technology of gasification of coal with high sulfur content, to be combined with the construction of steam-gaseous blocks. Works are also advanced on substitution of coal with gaseous fuel, especially originating from local sources, in several CHP plants situated in the neighbourhood of natural gas deposits. An effective economic incentive forcing the decrease of negative impact on environment is the introduction of more severe payments and fines. The caesura in this respect in Poland will be the beginning of 1998, since when there are put into force very severe regulations issued by the Minister of Environmental Protection, with regard to the punishment for transgressing the fixed standards.

Development prognosis.

In order to ensure in Poland a stabilised, high rate of economic growth, there are required reliable energy supplies in a long term perspective. To meet that requirement it is necessary, first of all to ensure obtaining primary energy from domestic sources to the extent possible as well as justified by economic and political and social respects, and secondly – to ensure conditions for a long lasting participation in international energy markets. It requires also a creation of terms and mechanisms to maintain good economic and technical conditions of energy enterprises to enable them to meet growing needs of consumers, including open competition on domestic and foreign markets.

The perspective of energy sector development is closely connected with the development of the national economy. Experts estimate that the growth of demand for electrical energy at the end of the next decade could even reach 40%. Nevertheless making any forecasts for energy demand in the conditions of deep transformation of political system, is very difficult. Taking this into account, the forecasts prepared in Poland are treated very cautiously. Recently in Poland more and more attention is paid to the prognosis based on the recognition of the market made by energy enterprises that due to direct contacts with energy consumers can learn their expectations, future intentions and behaviour towards changeable price relations on domestic market. Credibility and usability of those prognostic data for the elaboration of synthetic domestic forecasts depend however upon the development of basis for strategic planning and marketing within enterprises themselves, as well as upon the quality of business plans prepared by them.

A positive phenomenon at the present stage of transformation in the Polish energy sector is undertaking of strategic planning and marketing by still growing number of distribution enterprises and achieving a satisfactory quality level of those elaborations in a relatively short period

In the present situation of the country, when GDP growth reaches the level of 5–6%, the increase of demand for electrical energy is slower and remains at the level of about 1–2%. This is a symptom of a desired process of spontaneous initiatives to diminish energy consumption indices in industry through the application of more modern technologies, generally occurring right choice and rationalisation of use of different kinds of energy carriers, as well as evoked by the growth of energy prices – a necessity of energy conservation.

As mentioned before, in the perspective of the next decade, in the Polish energy sector there are not provided new generation capacities to be installed, either in coal mining or in electro-energy. The only exception is the being continued construction of Opole power plant with 360 MW blocks, fired with hard coal.

The main effort will be directed to the modernisation of fuel and energy sector and to the elimination of units which due to their technical and economic conditions do not promise to achieve satisfactory economic effectiveness.

Warszawa, August 1995

USAID/USEA
Utility Partnership Program

FOURTH ANNUAL CLEAN COAL TECHNOLOGY CONFERENCE

Panel Session 2: Transitions in the International Power Sector

PRIVATIZATION
A CHANCE FOR POLISH ELECTRICITY SECTOR

Zbigniew BICKI
President
Polish Power Grid Company

Denver, Colorado
September 5 - 8, 1995

1. Introductior

The beginning of tr
industrial branches. '
of electricity sectors
to changes in the poli

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The choice for European power sectors is very dramatic. The common electricity market will certainly reduce prices for electricity. This will have an impact on the competitiveness of European economy. More competitive economy will influence the possible level of finance for the economy restructuring. Restructured economy in turn will consume less energy and the industry will produce more efficient appliances.

On the other hand, if the common electricity market is not established and electricity prices not reduced the Europe economy will face both less competitiveness and capital running out, according to the global financial market rules. And power industry will lose. After 100 years of rather simple life of power industry in Europe, the coming years will provide the most difficult test for this sector. And there is no doubt, that test will be successful. The sector will realise in near future the value of the liberalisation. And Europe will not be isolated from the development going through the world.

Lesson for Poland

For Poland the lesson from foreign experiences is that nothing is more important than further radical changes. Especially, the share of long-term power purchase contracts on wholesale market is still controversial problem and open one. When in Poland the prices are below an economic level these contracts, being future revenue guarantees, are necessary in order to attract a foreign capital and to develop the Project Finance structure. On the other hand, long-term power purchase contracts must be limited because they are against the necessary increase of effectiveness. It is conclusion from USA and UK experiences. For example, under PURPA regulation utilities were forced to contract the power at prices resulting from analytical avoided costs. The problem is that real, market based avoided costs are much below the analytical avoided costs. As a result large number of utilities is purchasing power under long-term power purchase contracts at 2 USc/kWh higher price than the regional market prices. It is the reason for which the next step of market development has been undertaken in USA and Energy Act of 1992 has been passed. In Poland, just recently we have a unique opportunity to introduce harder competition into generation as a result of Polish zloty appreciation after extending its exchangeability in May 1995. This appreciation speeds up the economic prices level achievement and thus the limitation of long-term contracts is more realistic.

Investments and Privatisation: After 1995

Transformation of the power industries in Poland and generally in Central Europe and coming unification of the region with the European Union are creating a unique investment market. For foreign investors the following opportunities are important:

Firstly, market for the investments is huge. The Polish power industry alone needs over USD 1 billion every year to finance necessary projects, mainly in the power generation subsector.

Secondly, special investments market in Poland is created with regard to environmental standards which must be met from the beginning of 1998. The appropriate SO_2 emission reduction program in Poland will cost in 1996 and 1997 about USD 500 million; the program resulting from the II Sulphur Protocol will cost additionally about USD 1.3 billion by year 2005.

Thirdly, the region is very large laboratory to demonstrate how to take advantage of modern technologies and new trends. The rapid development of the telecommunications businesses based on fibre-optic technologies integrated into power transmission and distribution is an excellent example.

Fourthly, the power industries in the region are the most open to foreign capital in Europe and they are already able to cooperate on the provision of the capital. This is an opportunity for both the Central European region and foreign investors and suppliers to take advantage of international markets.

Fifthly, the power industry privatisation, although with difficulties, is going on through the region. In Poland the privatisation in near future is more realistic than it was whenever. The main reason of it is the impact of Polish złoty appreciation on the fast reachment the economic level by electricity prices.

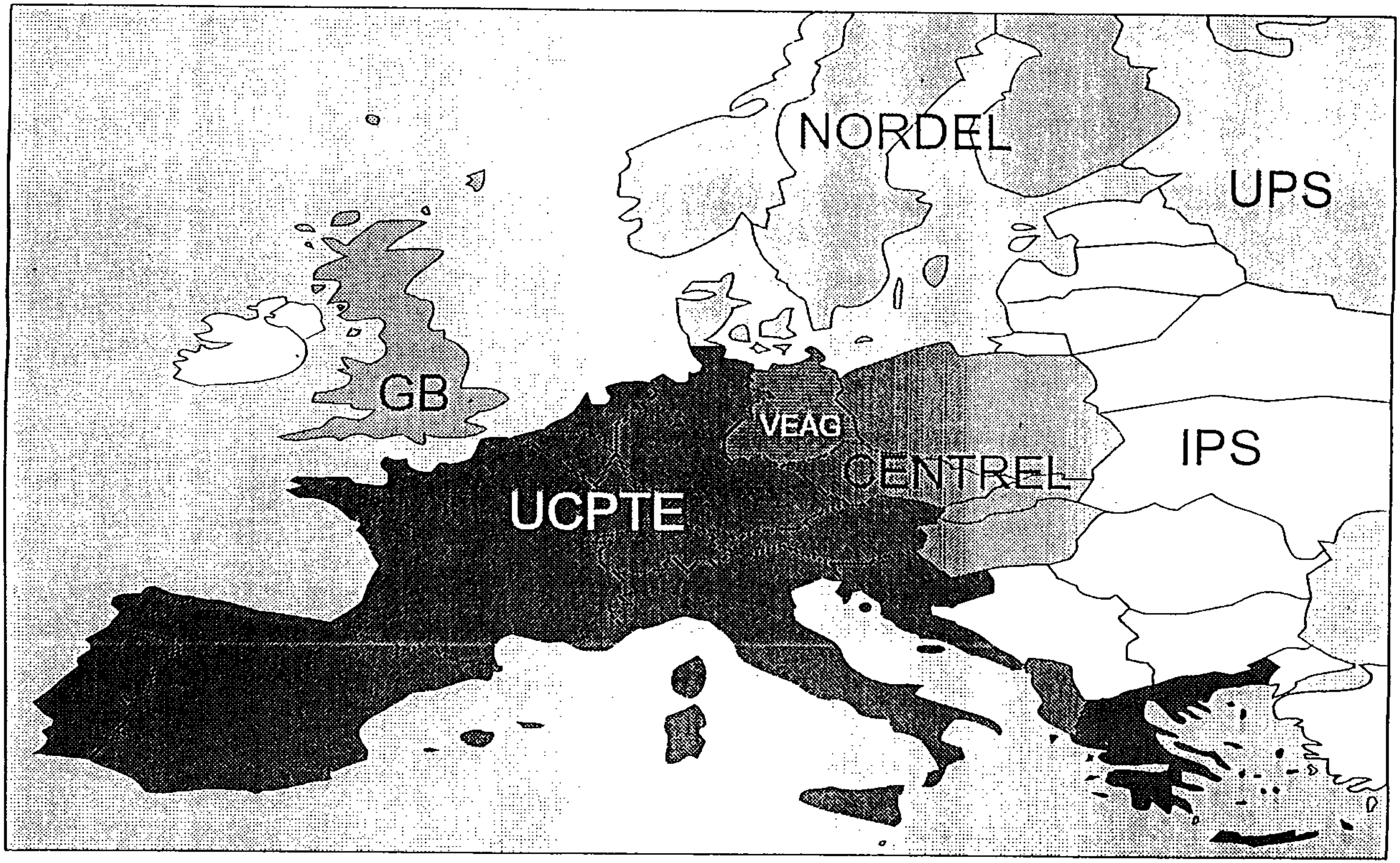
Sixthly, political risk of Poland has been reduced significantly what has been proven by very successful placement of governmental Eurobond beginning this year.

An additional remark on power industry privatisation in Poland is as follows. If, because of Polish zloty appreciation, the growing of electricity prices in coming years is much less problem than it was expected in the past, the new approach to the power industry privatisation is necessary. Generally, there is opportunity to speed up this privatisation. Especially, with regard to generation from economic point of view there are possible both joint-venture approach to separate projects and capital privatisation of companies with participation of strategic investors. With regard to distribution the capital privatisation open to the mass-investors is very likely in coming 2-3 years. And some distribution companies involved in the regional integrated resource planning are even at present interested in attracting of the private capital on local electricity markets for supporting financing of local generation projects (mainly CHP projects). With regard to the transmission, according to the general outline of power industry restructuring formulated in 1990, privatisation of this subsector was not intended. After 5 years, taking into account the strengthening of new trends over the world, the problem is open from both economic and electricity supply security point of view. But, the political sensitivity of it is very high. Therefore, an uncertainty of transmission privatisation is high too.

Of course, the market value of power industry assets is very controversial issue even in stable economics because of its sensitivity on regulation. In Poland, and in other countries in transition, the issue is more difficult because the investors want to enter on the new markets and they are ready to pay high price. On the other hand the state should achieve the good balance between two big contradictions: high selling price of power assets now (to supply the poor budget or/and mass - privatisation found) and low electricity prices supporting the competitiveness of economy in future.

According to the author of this paper in Poland well balanced market value of power assets in the middle of 1995 is about 21 billion new Polish zloty (USD 8.5 billion). The market / book (after full revaluation) ratio is about 0.55. On base of Polish privatisation low in the middle of 1995 the employees would have right to obtain about 1.5 billion new Polish zloty assets (it is about 7% of shares in case of market value equal 21 billion new Polish zloty).

Presented market value was calculated on base of cash flow for Polish power industry during years 1996-2005. It was assumed that discount rate will be 12% in years 1996-2000 and 10% after year 2000. The cash flow was constructed on result of executed IRP and developed contractual policy on wholesale market and took into account the expected dynamic of both internal inflation and external appreciation of Polish zloty. The increase of electricity prices resulted from this cash flow in years 1996-2005 is as follows: 0, +4, 0, -1, -2, -2, -2, -2, -2, -2 percentage above (+) or under (-) internal Polish zloty inflation. In year 2000, when the economic level equal about 8 USc/ kWh in an average will be achieved, the exchange ratio will be 2.8 Polish zloty/USD.



Interconnected Power Systems in Europe (first half of 1995)

- ⇒ IN THE COUNTRIES IN TRANSITION SOCIETY IS MOVING TOWARD A WESTERN MODEL. IS THE POWER INDUSTRY ALSO?

- ⇒ WESTERN POWER SECTOR WAS CONSOLIDATED IN INDUSTRIAL SOCIETY

- ⇒ HOW WILL THE SECTOR CHANGE IN THE NEW INFORMATION SOCIETY?

- ⇒ CAN THE CENTRAL AND EASTERN EUROPEAN EXPERIENCE BE FRUITFUL FOR THE WEST?

WHITE PAPER FOR POLAND, HUNGARY, SLOVAKIA, THE CZECH REPUBLIC, BULGARIA AND ROMANIA

STANDARDS FOR ADAPTATION - HOW HIGH THEY SHOULD BE ?

POWER SECTORS IN CENTRAL EUROPE IN BETWEEN *EUROPEAN COMMISSION* AND *EURELECTRIC*

THE UNITED STATES SEPTEMBER, 1995

1990 - BEGINNING

FIRST STAGE OF REFORM

1995 - EXTREMELY INTERESTING YEAR

AFTER 1995 : GROWING INVESTMENT MARKET

- 1990: SPLIT INTO GENERATION (OVER 30 ENTERPRISES), TRANSMISSION (PPGC ESTABLISHMENT) AND DISTRIBUTION (33 ENTERPRISES)

- 1991:
  * SUBSIDIES ELIMINATION
  * COSTS STANDARDIZATION
  * COST TRANSPARENCY INTRODUCTION

- 1992-1993: OWNERSHIP CHANGES WITHIN DISTRIBUTION, TRANSMISSION, HYDRO PUMPED-STORAGE AND CHP SUBSECTORS

- 1994:
  * INTEGRATED RESOURCE PLANNING AT THE NATIONAL LEVEL
  * LONG-TERM POWER PURCHASE CONTRACTS SIGNING

- ACCELERATION OF PREPARATORY WORKS ON *EU* JOINING BEING EXPECTED ON TURN OF THE DECADE

- INTEGRATION OF **CENTREL** SYSTEMS INTO *UCPTE* ON TURN OF THE YEAR

- WHOLESALE MARKET INTRODUCTION FROM THE BEGINNING OF THE YEAR

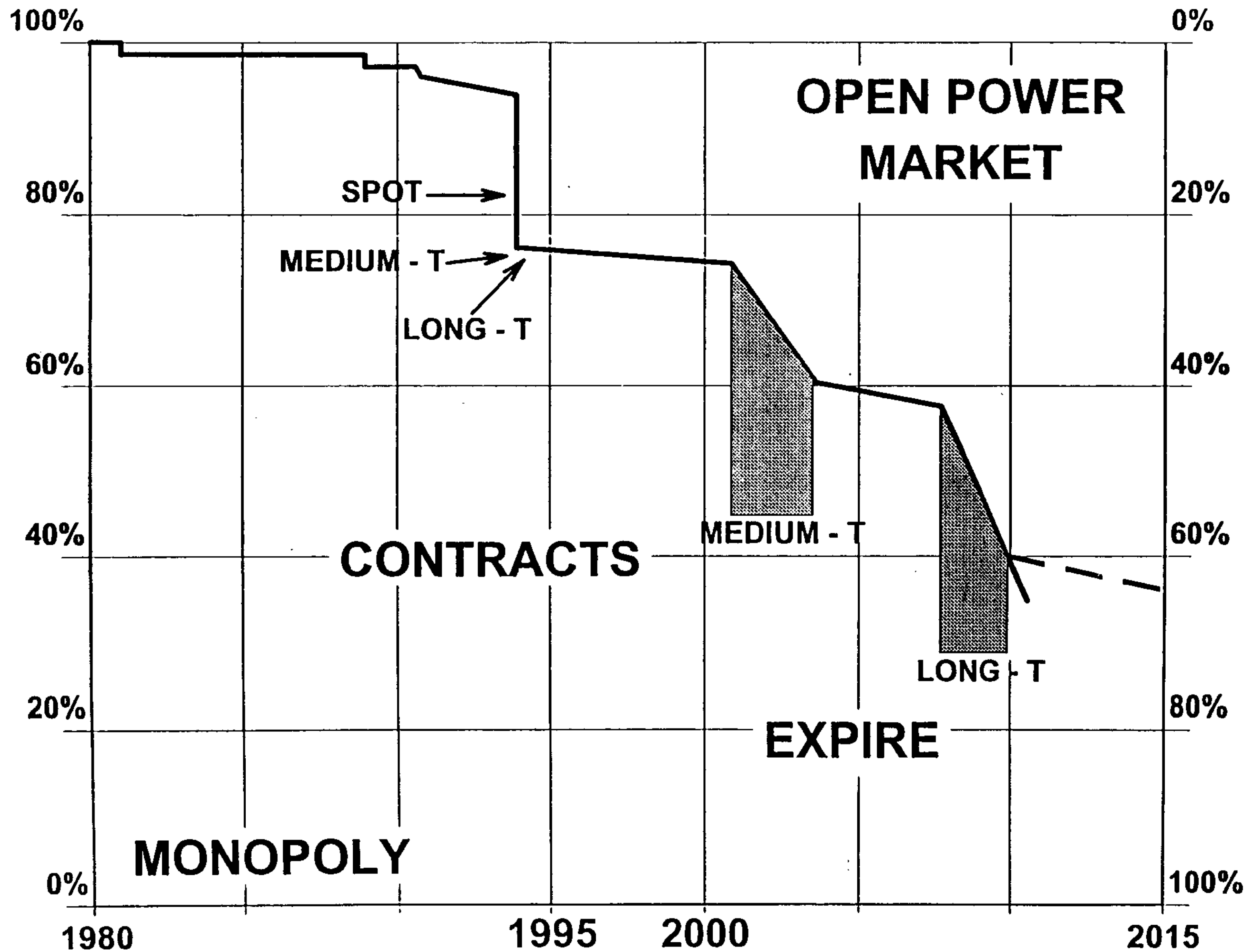
- MINISTRY OF FINANCE DECISION ON ASSET REVALUATION FROM THE BEGINNING OF THE YEAR

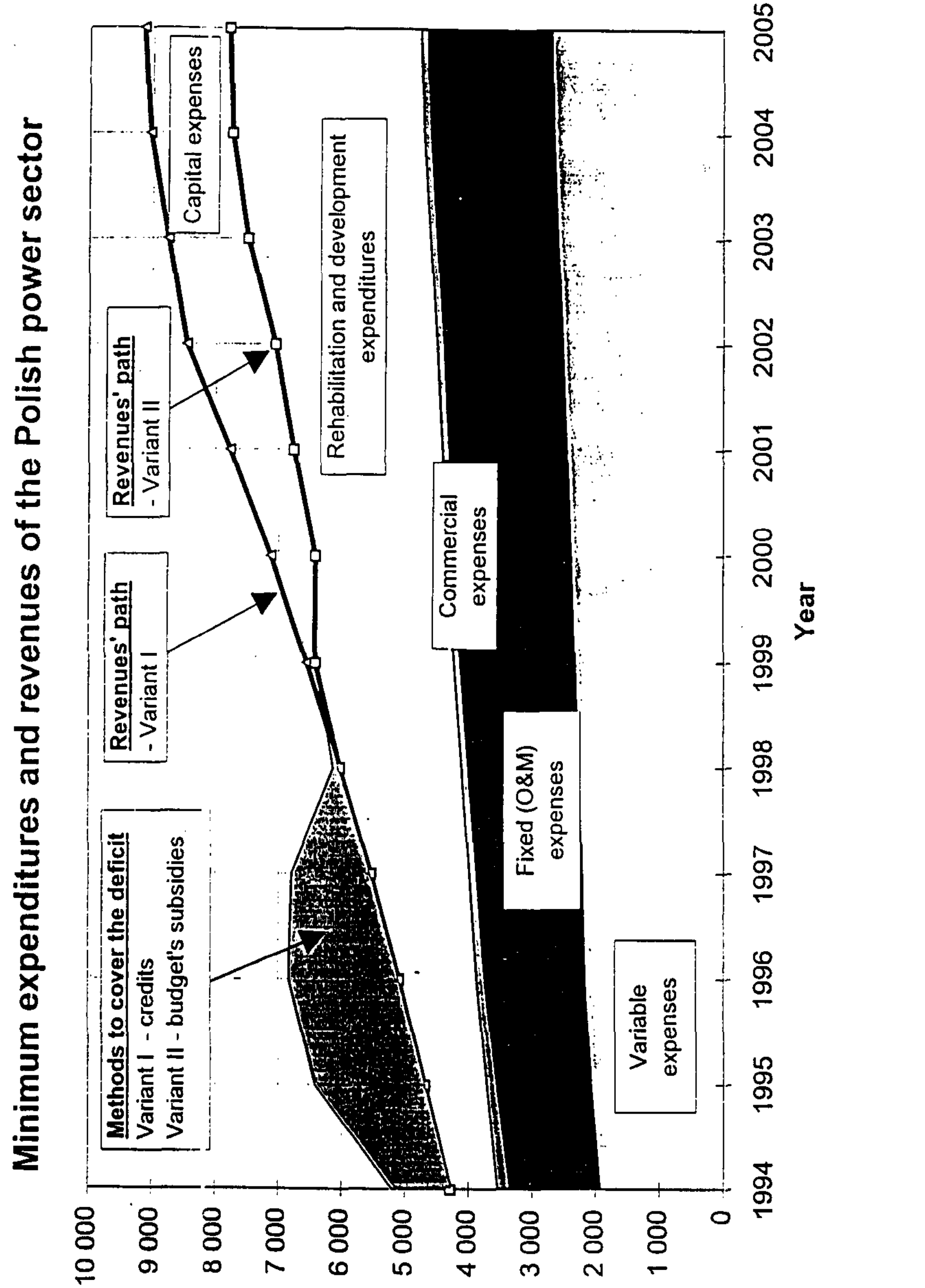
- REGIONAL INTEGRATED RESOURCE PLANNING COMMENCEMENT

- COOPERATION WITH THE WORLD BANK - FIRST LOAN TO PPGC BEING EFFECTIVE MIDDLE 1995

- BULK TARIFF FOR DISTRIBUTORS
- TRANSMISSION CHARGES
- COMPETITIVE NEGOTIATION ON LONG-TERM POWER PURCHASE CONTRACTS AS A BASE FOR THE PROJECT FINANCE STRUCTURE
- MEDIUM-TERM POWER PURCHASE CONTRACTS AS A FUEL SUPPLY STABILISATION
- AVOIDED COST FORMULA FOR COMBINED HEAT AND POWER PLANTS
- ELECTRICITY MARKET - SETTLEMENT AGREEMENTS

POLAND: MARKET





Minimum expenditures and revenues of the Polish power sector
mill. USD
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Variant I - credits
Variant II - budget's subsidies
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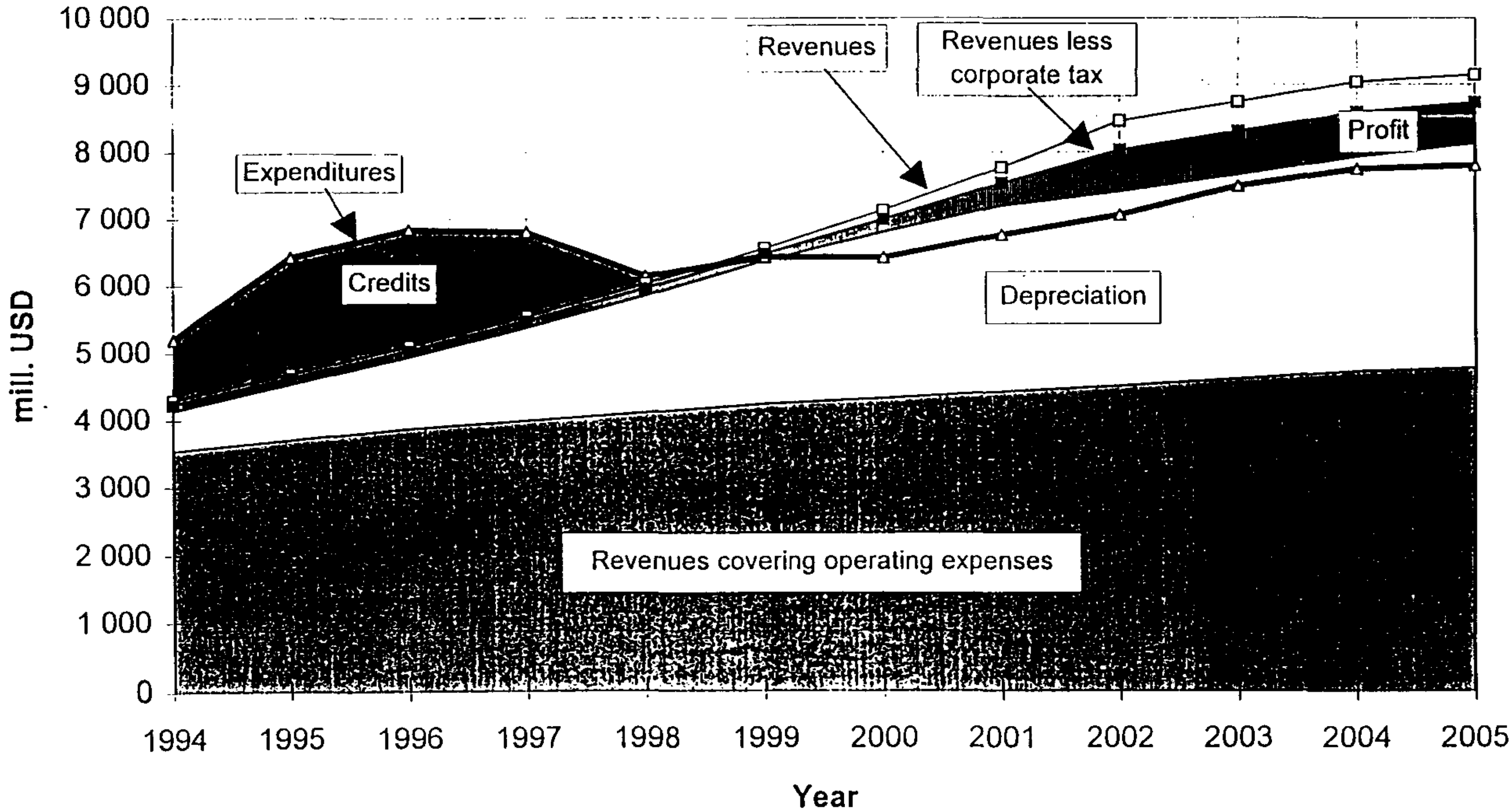
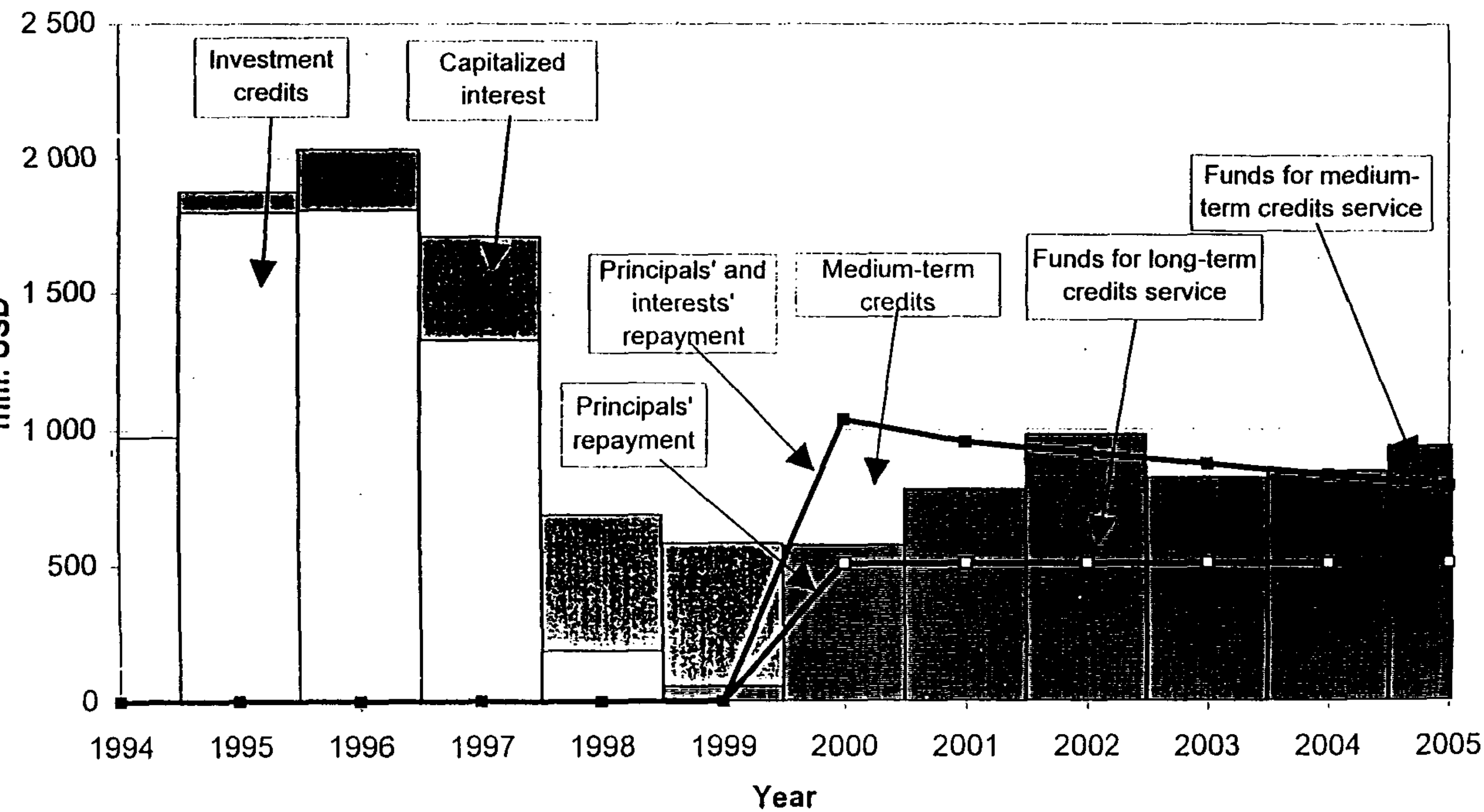
Rehabilitation and development expenditures
Commercial expenses
Fixed (O&M) expenses
Variable expenses

Sources of financing of the Polish power sector's expenditures



Investment credits' service



PRICES US¢/kWh (VAT not included)

	1994	1997	2000
FUEL	1,8* (import level)		
TRANSMISSION	3,5	5* (UCPTE)	
END-USERS (in average)	5,0	7	8*

* MEANS: STABLE (ECONOMIC) LEVEL

BASE:
- ☞ IRP - MINIMUM COSTS STRATEGY
- ☞ COMPETITIVE MARKET
- ☞ BALANCE SHEET AND PROJECT FINANCING

- GLOBAL MARKET: EXPENSIVE ELECTRICITY VERSUS COMPETITIVENESS OF ECONOMIES

- POWER INDUSTRIES IN USA, PACIFIC RIM, LATIN AMERICA, ... - MOVE TO HIGHER EFFECTIVENESS

- FUTURE OF EUROPEAN POWER INDUSTRY - DRAMATIC CHOICE

NOTHING IS MORE IMPORTANT THAN FURTHER RADICAL CHANGES:

- LONG-TERM POWER PURCHASE CONTRACTS ARE NECESSARY FOR PROJECT FINANCE DEVELOPMENT WHEN PRICES ARE BELOW ECONOMIC LEVEL

- LONG-TERM POWER PURCHASE CONTRACTS MUST BE LIMITED BECAUSE THEY ARE AGAINST TO THE NECESSARY INCREASE OF EFFECTIVENESS

- POLISH ZLOTY APPRECIATION SPEEDS UP THE ECONOMIC PRICES LEVEL ACHIEVEMENT

⇒ **OVER USD 1 BL EVERY YEAR - POLISH POWER INVESTMENT NEEDS, MAINLY IN GENERATION**

⇒ **USD 500 M - INVESTMENT NEEDS IN 1996 - 1997 TO MEET ENVIRONMENTAL STANDARDS REQUIRED AFTER 1997**

⇒ **USD 1.3 BL - INVESTMENT NEEDS BY YEAR 2005 TO MEET THE II SULPHUR PROTOCOL REQUIREMENTS**

⇒ **USD 8.5 BL - WELL BALANCED MARKET VALUE OF POLISH POWER ASSETS**

⇒ **ELECTRICITY PRICES REGULATION IN 1996 - 2005: 0, +4, 0, -1, -2, -2, -2, -2, -2, -2 %**

Bernard BŁASZCZYK

Undersecretary of State

in Ministry of Environmental Protection, Natural Resources and Forestry

The Republic of Poland

CLEAN COAL TECHNOLOGIES IN ECOLOGICAL POLICY OF POLAND

Denver - September 1995

Poland is a country of great traditions in the utilization of solid fuels, mainly of hard coal. The production of heat and electricity is based to the large extent on the coal. This has a very significant influence on the quality of environment, because of emissions of the large amount of air pollutants (carbon dioxide, particulate matters, sulphur dioxide, nitrogen oxides), as well as of waste materials (fly-ashes, slams).

Intensive and not sustainable development of Polish economy after the Second World War, similarly as in many other countries, has created a significant pollution of the environment. In the centrally planned economy and all natural resources and industrial plants state-owned, an ecological law has been rather on the paper than it was directed into concrete actions and investments. In addition, a high cost of reduction emission of pollution into the environment had created a situation, that during economic crises - particularly in the 1980s, economic and budget cuts were imposed on this category of investments.

The transformation of political and economic systems in Poland, which occurs since the late 1980s, and the introduction of principles of a market economy and of an international competition, forces the restructurization of industry and much better effectiveness of energy's productions and consumption. The result of this is the reduction of the amount of pollutants discharged into air, water and land, and the lower stress on the environment as the consequence of the above.

Our country undertakes also legal and organizational activities directed into the intensified action in environmental protection. In 1990, the Minister of Environmental Protection, Natural Resources and Forestry introduced regulations concerning emissions of pollutants (sulphur dioxide, nitrogen dioxide, dusts) from the processes of fuels combustion. In 1991, the Parliament accepted a governmental document, entitled "State Ecological Policy". This document contains the principles of the state ecological policy, the main directions of activities in the economy and its particular sectors, as well as the priorities in environmental protection.

Poland has also intensified activities on international forum. The country signed and started-up the realization of the Convention on Long-range Transboundary Air Pollution with the existing protocols, including the Second Sulphur Protocol (signed in Oslo, 1994). Poland also signed and ratified the United Nations Framework Convention on Climate Change.

The basis of the state ecological policy of our country is a principle of sustainable development. This principle assumes that the future growth of civilization of our society will have a character of permanent maintenance of qualities and environmental resources.

The following principles for this development should be fulfilled:

- the principle of law - a bidigness, it means the necessity of reconstruction of our legal system in such a way that the environment will be protected and every regulation will be strictly abode,
- the principle of "polluter pays" -it means placing full responsibility, including material liability, for the effects of pollution, upon the polluter,
- the principle of market mechanism utilization - it means the greatest possible utilization of this mechanism in order to increase the effectiveness of activities in environmental protection,
- the principle of regionalization - it means the increase of a role and rights of local self-government and regional governmental administration towards commercial entities which impacts on the environment are local or regional,
- the principle of common good, realized though the establishment institutional and legal conditions for participation of social groups and non-governmental organizations in the process of environmental protection.

The particular significance has also the application of a principle that European and global problems of environmental protection should be solved jointly due to transboundary effects of pollution.

Because of the long term neglect of environmental protection and the necessity of large investment costs in environmental protection, there is a need to schedule activities and to prioritize goals.

Priorities in the Polish ecological policy are, among other, as follows:

- in short-term perspective (until 1995):

- improvement of the quality of utilized fuels by implementation of the coal quality improvement and coal desulfurization programme,

- noticeable reduction in dust and gaseous emissions, particularly in Upper Silesia, this refers especially to the reduction of low emissions;

- in medium-term perspective (until 2000):

- reducing SO_2 emission by 30 per cent in relation to 1980, NO_x by 10 per cent in relation to 1987, and dust emission by 50 per cent in relation to 1990,
- taking up activities, adequate to the action taken by international community against global climate change, in particular reducing CO_2 emissions and other gases causing green-house effects, and protection of the ozone layer.
- decreasing by 50 per cent of a total load of salt waters discharged to rivers from coal mines of the Upper Silesia,
- reduction of the amount of produced waste materials and increasing the degree of their utilization,
- recultivation of degraded lands due to the mining of bituminous and brown coal;

-in long-term perspective (after 2000):

- introduction of proecological modernization of technologies in country's economy mainly through clean production technologies,
- reducing emission of pollutants, mainly SO_2,NO_x and CO_2 to level that results from international obligations.

The realization of the above tasks creates a challenge for our country and will required a great financial effort.

Regardless the greater supply of liquid fuels and gas to our market, the Polish power, heating and communal sector, considered in this case as individual heating and for food preparation, is based on the use of bituminous coal. The different quality of the coal in many regions of our country creates emission of pollution to the air.

During the last years the yearly utilization of bituminous coal in the total economy is about 110 millions tons. About a half of this amount is used in large power and heating plants. However, these plants equipped with tall chimneys, and discharging pollution substances to air, do not create local extreme air pollution problems. Instead they are create problems for representatives of industry and of environmental protection due to our international obligations. The power plants, constructed in the past, were not equipped with installations for flue gas desulfurization. After changes in our economy, introduced after 1989, activities were directed into the following:

- construction of installations for enrichment of energetic fine coal,
- construction of installations of wet flue gas desulfuarization with 90 per cent efficiency,
- construction of installations of dry flue gas desulfuarization with 30-40 per cent efficiency,
- construction of boilers with fluidized beds in heat and power stations.

It should be stated that until now the above activities have not solved local problems related to very high pollution concentrations released from low sources of municipal sector and individual heating. The annual utilization of bituminous coal in the above group of users has been estimated as about 27 millions tons, including about 9,5 millions tons used in households boilers and about 8,5 million tons in local boiler houses.

Pollutions originated from old and not effective boilers are discharged from low sources, giving as the result very high concentrations in the air. Annual emissions in this group of sources have been estimated as:

- about 170 thousand tons of particulate matter,
- about 60 thousand tons of sulphur dioxide,
- about 70 thousand tons of benzoalphapirene.

Such large amounts of pollutants are the reason for about 60 per cent of participation of these sources in average annual concentrations. During "cold" half-year, called a heating season, this amount reaches even 90 per cent participation in concentrations.

In Poland, the highest concentration of activities directed into reducing the amount of released air pollution is in a southern part of the country. Since the year 1990, joint-activities of Polish and American specialists have been carried out, which should, in the future, permit to lower the influence of air pollution on cultural heritage and people in Cracow - the city considered by UNESCO as the world cultural heritage.

In the country the biggest problems are in Katowice Province, where mainly heavy and mining industry has been concentrated. In this area lives 5 million people from the total 38 million population of our country. About 62 per cent of flats are heated by coal, and one-third are not equipped in gas installations. The consumption of coal by individual users and small heating systems reaches almost 3 million tons.

The activities related to reducing the amount of air pollution have to go into multi-directions and take into consideration specific conditions of regions. In Katowice Province, a programme of low emission elimination is being created now.

In Polish conditions, as until now, the most often activities are related to the change of fuel from coal to gas. However, in many cases the above change has shown to be too expensive. The main reason for this situation is related to only partial solution to the problem, since the change of fuels has not been performed together with optimalization and automation of heating systems of the total system. In addition, due to external sources of gas fuels our price conditions are not completely stable. Therefore, the complete coal to gas conversion in households is not justified from the economic point of view. Similar situation is in the case of liquid fuels.

Taking the above into consideration, Poland for many nearest years to come will utilize solid fuels, particularly bituminous coal. Therefore, it is necessary to start-up the investments allowing the realization of energetic -ecological effects by two ways.

The first way is start-up the production of a ecological fuel for residential heating (called in Poland as smokeless fuel) from bituminous coal. The greatest experience in this respect has our Institute for Chemical Processing of Coal in Zabrze. Smokeless fuel has been produced at pilot plants and is about 30 to 40 per cent more effective from raw fuel. In addition it is much better ecologically. Control measurement have indicated that a total amount of air pollution, created during ecological fuel's combustion, is lower that from the raw fuel, as follows:

- 50 times, for small boiler houses,
- 150 times for bakeries,
- 1,5 times for ceramic oven,
- 1 to 2 times for oven with fixed grate.

This good results of measurements create an argument for starting-up the industrial installations. At present, a barrier is the price of ecological fuel, which is difficult barrier to overcome due to financial and social (unemployment) problems.

Another way, forced by economic conditions, is constantly growing interest of Polish industry and craft to start-up the production of small boilers for coal with high efficiency. These boilers have reached a heating efficiency exceeding 80 per cent, and it is a success in Poland for such small constructions. In these furnaces, it will be possible to burn ever worst quality fuels with the lower emission of pollutants to the air.

The presented above information shows activities undertaken in our country, and areas where co-operation would be possible with institutions dealing with the rationalization of energetic and ecological utilization of bituminous coal for heating and domestic purposes in Poland.

INVESTMENTS IN ENERGY SECTOR SUPPORTED BY ECOLOGICAL FUNDS

Prof. Maciej Nowicki
President of the ECOFUND

Well known is fact, that Poland has an unique structure of the energy consumption. Almost 80 % of the primary energy comes from coal. Deposits of hard coal are still huge and are assessed as 35 bln of tonnes. Also resources of brown coal are big - about 8 bln tonnes. In the opposite to this Poland has rather limited resources of natural gas and almost doas not any oil deposits. It means that also in XXI century coal will mantain as a major source of the electric power and heat. Thus, the main problem in Poland is very similar to the task of the US -Programme "Clean Coal Technology"- how to make process of energy generation from coal more clean.

Coal burning is presntly the main source of air pollution. Almost 90 % of SO2 emission, and 60 % of NOx and dust emission comes from energy sector. Now emission of SO2 from Poland amounts 3,2 mln tonnes a year, giving us the third place in Europe, after Russia and Germany. The emission of NOx is about 1,5 mln tonnes a year, and emission of particulates - 2 mln tonnes a year.

But not only coal as a fuel is responsable for so high air pollution in Poland. District heating systems in many towns are old, outdated and consuming to much energy, in power plants boilers for at least 15 000 MW are more than 20 years old and should be renovated in near future, and there are about 9 mln ceramic stoves in old hauses and 1,5 mln small boilers burning coal. These low sources of emission are responsible for strong smog in centres of cities. Such outdated, ineffective heating systems ought to be improved as quickly as possible.

It is clear, that modernization of the energy sector is also the most effective and the cheapest action serving air protection. Nevertheless the majority of money for this aim should spend owners of the power plants and district heating systems from own resources according to the "Polluter Pays Principle". But the dimension and importance of the problem is so huge, that the support from additional financial sources is really necessary. Ecological funds can support these efforts substantially.

In the last five years Poland implemented in full scale very innovative system of financing the most important pro-ecological investments. Each enterprise emitting pollutants into the air, water or soil must pay fees or even penalties. For example the emission of one tonne of SO2 or NOx costs 80 dollars, emission one tonne of particulates costs 40 dollars, and carbon monoxide 20 dollars. Even there is the price for emission of carbon dioxide and methane. One tonne of these gases emitted into the air costs 4 cents. Every year the Council of Ministres decides about prices for the next year. It is also worth to mention, that the penalties for excess of emission standards cost 10 times higher than fees. About 50 % of this money is collected by National Fund for Environmental Protection and the second half - by regional ecological funds. This money is spent for supporting the crucial investments for environmental protection at the regional or even national level. So, it is a kind of optimization of the spending additional financial means, which play often very important role for smouth implementation of the most important investment projects in environmental protection area.

In 1993 and 1994 ecological funds had to their disposal about 500 mln dollars a year. About 40 % of this amount they spent for air protection in the energy sector. So far the biggest contract National Fund signed with Turow Power Plant. The contract concerns complete renovation of the plant with the building up 6 new blocks 200 MW each equiped with fluidized bed boilers produced by ABB - Pyropower.The cost of the contract is 1,2 bln dollars. In the first stage, in 1995 - 97 first two blocs will be renovated for the price 350 mln dollars.National Fund for Environmental Protection gave the soft loan with really preferential terms for 50 mln dollars.

The second very innovative mechanism used in Poland for supporting efforts in environmental protection area is so called "debt-for-environment swap".

Poland was heavily indebted in times of rules of communist regime. In 1991 the official Polish debt amounted 32 bln dollars. In this situation 16 creditor countries creating so called „Paris Club" decided to reduce the debt by 50 % with the condition, that the second part of the debt will be re-paid in yearly rates up to 2010. Polish government made a proposal to assign additional 10 % of the debt for environmental protection using mechanism "debt-for-environment swap". It was the first such initiative on the world scale.

Government of the United States approved this proposal in June 1991. It made it possible to establish the ECOFUND as a special institution aimed at managing the financial resources coming from this source. In 1993 Switzerland and France also accepted debt-for-envirnment swap idea and joined ECOFUND.

Among four priority areas of the ECOFUND ~~activity~~ two sectors are conected with energy sector and air protection, namely:

- reduction of emission of greenhouse gases,
- reduction of the transboundary transport of SO2 and NOx from Polish territory.

ECOFUND supports only investments projects in these areas giving dotations, which can cover 10 - 30 % of the cost of project. The rest of money must come from own financial resources of the investor and from ecological funds as soft loans and from comercial credits.

It is worth to stress, that one of the main tasks of the ECOFUND is promotion of the transfer of the best pro-ecological technologies from donor countries onto Polish market. In this respect it can be really interesting mechanism for many American firms, which would like to export their products in Poland. In the last two years several very good US-firms received financial support from ECOFUND. Among them are:

- Roberts and Schaefer - building the installation for deep cleaning of hard coal in the Staszic coal mine - dotation from ECOFUND 5 mln dollars;
- Nalco Fuel Tech - for desulphurisation plant in Legnica power plant - dotation 2,4 mln $
- AirPol - also for desulphurisation plant in Skawina near Cracow - dotation 1,5 mln $
- Pyropower and ABB - for fluidized bed boilers in Turow power plant - dotation 12 mln $

Altogether the US-firms in the energy sector active in Poland have recived from ECOFUND more than 21 mln dollars for the building up full scale demonstration plants for their excellent technologies born in the framework of the Programme „Clean Coal Technology". We believe, that this is ~~only~~ the good start for much closer cooperation in near future. ECOFUND can spend for projects in energy sector each year about 5 mln dollars. We are waiting for good ideas, modern technologies and courageous firms which want to expand their activity also in Poland, because in our both countries coal is seen as an promissing energy souce also in the future, but it must be used clean coal technologies for energy generation. You are cordially invited as ~~really~~ good our partners for many, many years.

Panel Session 3

Transition to Competition in the Electric Power Generation Industry and its Impact on CCT Markets

TRANSITION TO COMPETITION IN ELECTRIC POWER GENERATION AND ITS IMPACT ON CCT MARKETS

A Utility Perspective

J. J. Markowsky

Fourth Annual CCT Conference
Denver, CO
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INTRODUCTION

This morning, I would like to provide the perspective of an investor-owned utility on how we see competition in the electric power generation industry impacting Clean Coal Technologies, and what must be done to sustain and advance this important technology *for the future.*

As I have said already, the transition toward competition is already having a dramatic impact on the electric generation market. This move will also have a dramatic impact on the market for CCTs, and could prevent us from ever realizing the potential benefits they offer.

As Chairman of the Clean Coal Technology Coalition, I have been closely involved in a number of studies looking at the hurdles which face the commercialization of CCTs, and the need for incentives to assist CCTs in overcoming those hurdles. This coalition is a broad-based, ad-hoc organization supporting the commercialization of CCTs, and includes utilities, equipment suppliers, architect/engineering firms, coal companies, academia, and governmental agencies in its membership.

While great strides have been made towards the commercialization of CCTs, they still must overcome several hurdles before they are able to fully serve the marketplace. Like any technology, CCTs must undergo a maturation process in which both the costs and risks are higher for the first several units sold. That is why incentive programs -- such as the Clean Coal Technology Program -- have been vitally important to support the development and demonstration of these new technologies. A number of them are now developed to the point where they are ready to be commercialized. These technologies still face higher initial costs and possible performance risks since no manufacturing infrastructure exists, nor is there any operational experience to use in optimizing their design. In addition to these higher initial costs and possible risks, these technologies face significant market-related hurdles as a result of the transition to a competitive structure in electric generation in the U.S.

The major points I would like to make associated with this transition are:

- Currently, very few new power plants are being constructed due to uncertainties associated with existing utility load. Under deregulation, utilities can no longer be assured of having a customer base, let alone knowing what their future capacity requirements will be, and therefore are deferring the addition of most new base-load coal-fired capacity until well into the next century. This will also defer opportunities for significant domestic market penetration of CCTs in the near term.

- At the same time, competition will create a demand for lower cost and more efficient technologies in the future. CCTs can meet that demand, but need to be further developed between now and then so the technology is ready when it is needed.

- Incentives will be required to assist in the continued commercialization of CCTs in order to prepare them to serve this marketplace when the need arises.

COMPETITION

Since the 1930's, electricity has been an energy source which was generated and delivered to the "rate payers" -- a term used for many years by utilities to refer to "customers"-- under a regulatory pact. Utilities were granted exclusive franchises in a given service territory. The price of electricity was set by regulatory commissions to earn a certain rate of return on equity, provided the utility demonstrated reliable service under an "obligation to serve", and "prudency" in its expenditures. In other words, electricity was an energy source whose price to the customer was determined by the cost to produce the power, rather than a price set by the market itself.

One way utilities could keep their costs down was to vertically integrate, combining the production (power plant), shipping (transmission), and retail sale (distribution) of electricity into a single company. Often, as was the case with AEP, the fuel source -- the coal mines -- were also owned and operated by affiliated companies. This system has been in place for the past century, but is now coming to an end.

The electric utility industry is entering a new era: one of market-driven competition with retail wheeling, open transmission access, and deregulated generation. This competition is expected to lead to market-based pricing for electric energy and services, instead of cost-based pricing. In other words, the price of electric power will be determined by the law of supply and demand in the market. There are significant unknowns concerning competition. We do know that competition is increasing. However, we do not know exactly how soon competition will be here, how low electricity prices may go, what portions of the utility industry will remain regulated, and how the balance will be achieved between competition and regulation. These are complex issues, and we could spend many days discussing them. Essentially, we can characterize the coming of competition as creating a total and fundamental restructuring of this industry.

This restructuring is happening as we speak. At this point in time, not only do we not know all the rules of the game, we are not even sure what the game is! Furthermore, we probably will not fully understand this game for some time to come. Nevertheless, there are certain trends which warrant mentioning.

The momentum towards competition has become so strong that it is irreversible.

- At least thirty-four states are at various stages of looking at the issues and effects of competition. Eleven states are actively considering some form of retail wheeling. Michigan and California have both approved retail wheeling experiments, and Nevada law currently allows for retail wheeling.

- Major industrial users are pushing extremely hard for retail wheeling, and it is expected that retail wheeling for smaller customers will not be far behind.

- The domino effect will likely occur once the first state opens the door for retail wheeling. The pressure to be competitive from an economic development standpoint is expected to cause many other states to rapidly implement retail wheeling as soon as one state does.

Competition will most likely result in reducing -- if not eliminating -- the current vertical integration between the generation, transmission and distribution of electricity.

- In March, the Federal Energy Regulatory Commission issued its "Mega NOPR" concerning comparability of service and equal access to transmission systems. This proposed rule strongly encourages the functional "unbundling" of electric utility services in order to separate generation from transmission.

- Many utilities, including American Electric Power, are restructuring into separate generation, transmission and distribution entities in order to position themselves for the new market structure.

Market conditions will drive the price of electricity down, at least for some customers.

- If the history of deregulation in the transportation and telecommunication industries can be used as an indicator of what might happen to the price of electricity, competition and open access are expected to drive down prices -- at least in the early stages. Some projections indicate that the market price for power could drop by as much as 25% during this transition. This is already happening. Current prices under new power contracts to industrial customers are significantly less than similar agreements five years ago, as utilities scramble to retain their existing load and attract new load.

- As prices fall, utilities are feeling significant pressure to reduce costs in order to remain profitable. Examples of actions taken to reduce costs are throughout the industry today, and include restructuring, mergers, staffing reduction programs, cutting inventories, seeking innovative partnering relationships with suppliers and outsourcing functions.

- Some people estimate the price of electricity in the near future will be so low that new capacity cannot be competitively built and operated.

<u>Competition and open transmission access are expected to cause the delay or cancellation of base-load capacity additions by taking advantage of the excess capacity of other utilities, and installing peaking units (gas turbines) to meet short-term peak requirements.</u>

- Mergers and consolidation of utilities are occurring at an unprecedented pace. In the last two weeks, a number of mergers and consolidations have been proposed, including PECO (Philadelphia Electric) and PP&L (Pennsylvania Power & Light), Union Electric and Central Illinois Public Service, and Public Service of Colorado and Southwestern Public Service. Many of these mergers are being proposed because they offer cost savings through greater economies of scale, and allow for the deferral of capacity additions by improving the match between generating capabilities and load demand for the resulting company.

- Historically, utilities have maintained capacity reserve margins of at least 20%. Generation deregulation, open transmission access, and uncertainty regarding the future are expected to force these utilities to operate with effective reserve margins of 10% or less by the year 2005. This decline in reserve margin will result in a deferral of between 60 and 70 GW of new capacity which otherwise would have been required in the next ten years.

- There will be more long-distance, bulk power transfers as utilities depend on others to help meet their capacity and energy requirements.

- The current market for electric utility construction is soft, with limited investment being made in new facilities. Concerns about the competitiveness of new facilities, retention of existing loads, and regulatory treatment of assets in the future have all but stopped the construction of new base-load facilities. Construction of new transmission lines is also being delayed or deferred, and public and regulatory challenges abound whenever a utility does try to site a line.

- What little construction activity exists today is being dominated by IPPs rather than utilities. IPPs accounted for 61% of the new generating capacity additions last year. Of that capacity, 53% is natural gas, 34% is renewable energy, and only 13% is coal.

IMPACTS ON CLEAN COAL TECHNOLOGIES

As I mentioned previously, under a regulated structure, electric utilities were -- in principle -- promised a rate of return on prudent capital investments, provided requirements set forth by the regulatory commissions were met. Life-cycle cost analyses and least-cost option planning were important; however, the commissions were often willing to allow for higher electric rates to achieve certain agendas. One such example is the funding of the Tidd PFBC Demonstration Plant. A portion of the funding of Tidd was provided by direct rate recovery of capital expenditures from Ohio Power rate payers. This recovery mechanism was developed in Ohio for CCT demonstration projects based on the fact that Ohio would benefit in the long term from the commercialization of CCTs and the continued use of Ohio coal.

In a competitive environment, the "rate base" mechanism of cost recovery goes away, and in its place, the law of supply and demand will set the market price of electricity. The projected market price of electricity generated by a new facility must assure a reasonable return on investment for the developer of that facility.

Given all of this uncertainty, a developer of a new facility today -- be it a utility or an Independent Power Producer -- would not be likely to choose a Clean Coal Technology.

Let's explore why this is the case.

The developer would likely look at a matrix of capacity types (base load vs. peaking) and fuel options (i.e. coal vs. natural gas). If the decision were made to use coal, then the developer would need to decide whether to use a conventional combustion technology or a Clean Coal Technology. As the developer conducted this analysis, the following factors would come into play:

- New base-load coal-fired generation facilities are capital intensive.

- NGCC facilities currently require about 60% of the capital investment compared to conventional technologies.

- At the current cost spread between coal and natural gas (where the cost of natural gas is less than twice the cost of coal), coal is often not competitive with natural gas for new generation, even for base-load capacity.

- The technologies associated with clean coal combustion generation plants are not yet mature. Therefore, they are currently faced with higher capital costs and risks than conventional coal-fired technologies. These higher costs and potential risks will exist until the first few CCT plants have been built and these technologies have reached maturity.

Therefore, such an analysis does not bode well for Clean Coal Technologies in the current transitional marketplace. But at the same time, virtually every one of the credible studies conducted on the economics of CCTs have indicated that they are expected to have lower capital and operating costs compared to conventional technologies, <u>when fully mature</u>.

INCENTIVES

This leads us to a contradiction: Competition in the electric utility industry will result in the need for power generation technologies which have low capital and production costs. Such plants would provide the highest profit to a power producer. Clean Coal Technologies -- with their projected lower capital and operating costs -- as compared to conventional technologies are well suited to meet that need. But, the current soft market for any base-load coal-fired plants coupled with the remaining hurdles for CCTs make it difficult to justify erecting plants using not-yet-mature CCTs at this time.

What is needed to overcome these concerns is a set of appropriate incentives to sustain the development and commercialization of CCTs. Recognizing this need, and facing a political climate in Washington that is unreceptive to traditional cost-sharing incentives, the Clean Coal Technology Coalition created a task force to identify and quantify credible and revenue-neutral incentives which could be applied to support the commercialization of CCTs. Several such incentives were identified in the areas of permitting, export initiatives, and tax incentives along with an expanded educational program to communicate the potential benefits of CCTs.

The permitting incentives identified for CCTs included finding ways to streamline the permitting process for CCTs such as allowing use of Environmental Assessments in lieu of Environmental Impact Statements, presumptive designation of CCTs as Best Available Control Technology (BACT) and Lowest Achievable Emission Reduction (LAER), and grandfathering of existing permits for plants which are repowered with CCTs.

In light of the soft domestic market, export initiatives could offer significant opportunities to support the commercialization of CCTs. Unlike the domestic marketplace, portions of the global energy market are very strong, and offer significant possibilities for application of CCTs. Therefore, it is believed that the government should take a more proactive role in encouraging the export of CCTs. This could be done by programs such as facilitating export financing, supporting trade missions with information on CCTs, and including CCTs as part of foreign aid packages.

The educational initiatives would focus on better partnering between the DOE, EPA, State, and Commerce Departments in articulating the merits of CCTs and their importance to our nation.

Several tax incentives were also proposed, including extension of the synfuels production credit, investment tax credits and accelerated depreciation for CCTs. In cooperation with the DOE, the Clean Coal Technology Coalition worked with Argonne National Laboratories to quantify the benefits of these various incentives. Some of the preliminary results of that study are:

1. Although the initial CCT generating plants are not expected to be cost competitive with NGCC Plants, due to their higher costs, as CCTs mature they can be competitive with NGCC Plants. The time frame in which maturity is reached depends on the difference in future prices between coal and natural gas. As mentioned previously, the price of natural gas today is less than two times the price of coal on a cost per million BTU basis. This is significantly lower than the historical ratio of over 2.5. It is projected that as the demand for natural gas increases, the cost spread will once again achieve historic levels. As that happens, CCTs are expected to be able to effectively compete with NGCC plants.

2. Permitting incentives, while important, do not have enough impact on the life cycle cost of a plant to overcome the higher initial costs of the immature technologies.

3. A combination of structured tax incentives have the potential of bringing the life cycle cost of initial CCT plants to the same level as the life cycle cost of a NGCC plant, even at the current price differential between natural gas and coal.

4. Even with tax incentives, a CCT plant will bring more tax dollars to the federal treasury over its lifetime than an NGCC Plant, because of the more capital-intense nature of a CCT plant compared to the NGCC plant.

In other words, properly structured tax incentives have the potential to level the playing field between not-yet mature CCTs and NGCC Plants <u>and</u> enhance revenue to the federal treasury in the long run.

> [If anyone would like to learn more about the details of this study, feel free to contact Ben Yamagata or any of the Clean Coal Technology Coalition members during this conference.]

CONCLUSION

In conclusion, the transition of the electric utility industry from one of the most highly regulated industries today to a market-based competitive industry, I believe, will impede the commercialization opportunities for Clean Coal Technologies until they are mature and perceived to be of no higher risk than currently available technologies.

CCTs are strategically important to our nation. They have a greater potential to provide lower-cost base-load generation than any other available technology category, while ensuring that coal remains an important element of our nation's energy mix. Virtually any credible analysis of the power generation needs for the future must recognize that coal will remain the primary energy source for both our nation and the world. Of the 725 GW of installed capacity in the United States, approximately 43% is coal-based and generated 56% of the electricity in our country last year.

It is in the national interest to maintain a multi-fuel energy mix for the generation of electricity. It makes sense to develop technologies which enhance the viability of coal -- our nation's most abundant indigenous energy resource. It is simply not feasible to project that this important element of our nation's energy resources will be cast away. As we enter the second decade of the twenty-first century, new power plants will need to be built, both to meet new demand and to replace the aging fleet of existing generation. CCTs allow coal to remain an important component of our future generation mix, despite the hurdles which I have discussed today.

As the electric utility industry begins its transition to a competitive market, short-term strategies which ensure survival in these turbulent times dominate the decision-making process. However, long-term survival mandates that utilities also develop strategic plans geared towards long-term success. Likewise, this approach must be taken by the government and industry concerning CCTs. We must work together to protect the gains made with CCTs to date in the short term, so that they will be positioned to serve the marketplace in the long term when their advantages can benefit our nation and our energy security.

INDEPENDENT POWER PRODUCERS

JOSEPH P. KEARNEY
U.S. GENERATING COMPANY

Clean Coal Technology Conference
Denver, CO
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I. Introduction

I would first like to thank DoE's Center for Energy and Economic Development for providing me the opportunity to speak to this audience regarding Clean Coal Technology. I especially want to thank Jim Markowsky from American Electric Power for asking me to participate.

Today, I would like to briefly discuss the change in the market for electricity, long anticipated, and now a rapidly evolving fact. In this context I wish to cover the following items:

1. The characteristics of Competition.
2. Timing of increasing competition.
3. The implications for Clean Coal Technology of a competitive market.

I would like to also touch on the economic implications of Clean Coal Technology for US competitiveness in a global market.

II. Introduction of USGen

First, however, let me introduce my company, US Generating Company

- USGen is a company with a diversified fuel portfolio. We have to be because we have $5.5 billion in assets. Coal - both regular and waste - is used in approximately $3 billion of these assets. We use pulverized coal and fluidized bed converters. USGen also has the largest Bio-Mass plant in the country.

- We have competed in all major RFPs for new electric capacity over the last six years and have won a large number of these. USGen was born in a competitive market, one which we could not avoid. We hope to make use of this experience as we enter into a new phase of competition.

- I am on this panel, supposedly representing the Independent Power Producers. I firmly believe that this designation is meaningless in today's market. We are a Generating Company, just as many of what we call "utilities" are, in part, generating companies. As we go further in this discussion you will see more clearly what I mean by this.

III. Characteristics of Competition

It is important to note where the state of the market for electricity is in the United States. When contemplating this I try to reflect on *what I see happening*, not what I might want or desire to happen. I would love to continue wholesale competition for new 20 to 30 year capacity blocks. Unfortunately, that World is over!

Here is how I view the immediate future of the electricity market:

- First, electricity will be traded as a commodity. The rules for this commodity market are currently being developed, although they are currently unclear.

  - This will be the case for both the short and long term market.
  - Only the aggressive, imaginative players will win in such a market.
  - Whining about the market will not help one win, it must be accepted.

- Second, the way in which new capacity is introduced is totally unclear but will occur in ways different than we have experienced.

  - Pools will be one part of the capacity picture and, as such, will function with lower margins. The introduction of new capacity in this environment may be a function of an individual generator's assumptions about the competitiveness of new capacity in this market.
  - Bi-lateral contracts between generators and transmission/distribution companies are clearer. Such an environment will make sorting out need for new capacity easier.
  - Nevertheless, either of these market environments will be different depending on what regional market we are discussing.

- Third, I believe we can expect to see effluent or allowance trading market transactions being conducted separate from the electricity trading markets. Trading in allowances is probably not imbedded in electricity trading at the point of electricity sale. For Clean Coal, this is important. There will be no implied environmental surcharges either.

- Finally, we are in a transition period that will probably last 5-7 years. The latter timeframe is perhaps when we will see a transition to a fully competitive commodity market.

IV. *Implications for New Technologies*

- The three most important items to bear in mind in contemplating a commodity market is ; 1) price, 2) price, 3) price. Therefore, any new technology or fuel must compete on the basis of price.

- If it is unclear or complex as to how any new capacity is added and/or priced, introducing a new technology will be doubly confusing. The market is now telling us to take more risks than ever when adding new capacity or new investments and then one must add more risks on top of that when introducing a new technology.

- Finally, to complete this rosy picture for Clean Coal Technology, the government's reduction in R&D funding is a reality that will not go away.

- The trend toward smaller government R&D *is not new*. The first two years of the Clinton Administration were a brief interruption of what has been a general decline in non-Defense government R&D over at least fifteen years.

- We should not, therefore, allow ourselves to believe that the move toward reduced R&D is a passing thing. There has always been a debate as to what is the Federal government's role in energy R&D. I remember the debate in the 1970s when I was at the Office of Management and Budget. However, now this pressure is combined with the enormous pressure to reduce expenditures across the board.

- Clean coal, as is the case with other DoE R&D efforts, is vulnerable. Funding for CCT represents a cost when the government is trying to reduce cost. Additionally, as a result of de-regulation, funding for CCT represents both a cost and additional risks.

V. Should Anyone Care? If so, Who?

- The first question we should ask ourselves is; Should anyone, other than coal suppliers, care whether clean coal can be successful?

- After all, natural gas is plentiful, clean and cheap. Given the direction of the market, towards cost and environmental sensitivity, it is understandable if one might ask if we should continue to look to coal as a viable fuel.

- I believe that such a view is decidedly short-sighted for a number of reasons

  - Gas could supply all of the "new" generation market new capacity, repowering, etc. if current circumstances continue. Although the United States has so far avoided fuel catastrophes of the kind envisioned in the 1970s - and which I suspect we will continue to avoid - it is clearly ill-advised to have the nation's electric generation dominated by one type of fuel.

  - Coal is the "American fuel". Many nations have natural gas, oil, and other fossil fuels in abundance. As we all know, the United States is the "Persian Gulf" of coal. It only makes sense that we find a way to take advantage of this abundance in a manner that is cost effective and environmentally sound.

- Late last month, the American Association for the Advancement of Science issued a report concerning the long-term effect of reduced, government sponsored R&D on the US economy. Its conclusions were that reductions of the kind currently being discussed would have a "marked" effect on American competitiveness shortly after the year 2000.

- Energy is the basis for many products produced for global consumption. If, after 2000, U.S. electricity prices increase due to oil/gas price hikes, we put our ability to move U.S. products in jeopardy!

- Therefore, the answer to the question as to whether we should care about coal's viability as a clean alternative fuel is - *yes, we should care.*

- While I believe that clean coal technology needs to be perfected and brought to market - and there is a Federal R&D role to be played - I do not believe in seeking to "keep the waves off the beach with a broom". In other words, the need to reduce government size and the deficit is greater than the capability of all of us in this room to fight.

- It is, therefore, up to all of us who benefit from clean coal technology to decide how to act.

- It is obvious that coal suppliers and coal technology suppliers are the most directly affected by the success or failure of clean coal technology to reach the market. Boiler manufacturers also have a direct interest in the success of this effort, especially if other nations capture the technology market as a result of their government's help.

  - We can not just fall back and rely on Federal money. I want to note the dramatic improvements in gas technology which occurred without ***much***, if any, government help. As an example of this improvement, the heat rate for gas combustion turbines or combined cycle plants went from around 9000 BTU/Kwh in the late 1970s to approximately 7000 BTU/Kwh currently. The next generation is likely to go lower.
  - This represents a 22% reduction in total cost/Kwh; coal is fighting an uphill battle to be and stay competitive. It is not only improvements in price but also technology improvements in CCT that are necessary to drive the market towards CCT.

- Furthermore, there are others also who have an interest in seeing clean coal technology reach the market:

  - Industrial customers (and all customers, for that matter) have an interest in long-term competitive fuel prices that can only be achieved by fuel diversity.
  - Likewise, electricity generators do have an interest, for the same reason. But we are in an industry transition and it is, therefore, unclear who a generator is at this point.

VI. What Then?

- If we accept that clean coal technology should be pursued and we know who the beneficiaries are, what then is the course of action that these interest groups should pursue.

- As I said, we can not stand in the middle of the Congressional appropriations road and yell "Stop!" We must accept that DoE will have limited funds.

- First, I believe that DoE will, and must, prioritize what programs should receive funding. It will not do any interest group any good to merely evenly spread around a decreasing pool of funds. If R&D is to have any practical benefit it must be to bring the most promising technology to market - and *fast*.

- We in industry have an obligation to assist DoE in determining where funding priorities should be. As we have the knowledge to ascertain what clean coal technology has the most market potential we should agree as an interest group and share this with DoE.

- Industry should also be willing to take risks if we are going to be beneficiaries. USGen has committed to pursuing Pressurized Fluidized Bed (PFB) as a technology and is willing to take some initial risks in order to bring a PFB plant to market.

    - Are the Coal Suppliers?
    - Are the equipment/boiler manufacturers?

- Industry also must be clear on what the characteristics of successful clean coal technology should be. Since we have recognized that the industry will be market driven, any clean coal must:

    - Match gas on price. Today's electricity price from natural gas is between 2 and 3 cents per Kwh. Coal is 4 cents or higher. If that continues, no one will have an incentive to buy coal power until prices for gas go up or coal comes down.
    - It must be nearly as clean as gas.

- Finally, generators - as they become better defined - should commit to assisting the suppliers and manufacturers in CCT efforts. However, the present lack of a clearly defined generation community now is the best rationale for Federal R&D funding for CCT. The transition to a more defined generation community could take the 5-7 years that it will take the market to evolve. In that time, we could lose CCT.

IV. Conclusion

- For any of this to actually occur, some one has to take the lead in organizing the interest groups' efforts and its interaction with DoE. The Clean Coal Coalition has been and is a step in this direction As the coal suppliers have the most direct interest, perhaps they should take a more significant position in this effort.

for all prices above 3.5¢. Clearly, base load unit B is in the driver's seat. It runs almost as much as unit A and makes money for its owners for all electricity prices above 3.0¢ per kilowatt-hour. From this simple illustration, it should be clear that generating units with lower fixed costs may be preferred by a generating company, even when there is a considerable difference in variable cost of production.

The consideration of societal benefits and associated monetization of environmental externalities in selection of new electricity supply technologies will cease (or certainly be minimized). Also, utilities will be willing to invest in demand side or customer initiatives only where cost-effective. In the past, traditional rate making and cost recovery allowed--even required--consideration of these externalities and demand side initiatives in utility resource planning. With electricity prices established by market conditions that extend beyond one regulatory jurisdiction, investors in new electricity supply options will not be willing to overcomply with environmental regulations unless there are market-based incentives to do so.

However, these environmental market incentives will become more prevalent. In addition to the SO_2 allowance market created under Title IV of the 1990 Clean Air Act Amendments, several local markets dealing in multiple pollutants have developed. Additionally, the current Ozone Transport Assessment Group and the Environmental Protection Agency's recently proposed open-market emissions trading program are indications that other pollutants, principally NO_x, will be included in national or super-regional markets soon.

The continuing uncertainty as to what will constitute minimal compliance for electricity generators will, however, make it difficult for utility decision makers to focus only on the regulatory world at the time of the decision.

At this time there are at least nine environmental initiatives that have significant potential to tighten emissions limits for electricity generators. These are: redefinition of ambient standards for ozone, particulate matter, acid deposition and SO_2; regional ozone transport; regional haze; visibility; hazardous air pollutants; and greenhouse gases. When the potential financial liability associated with all these initiatives is considered, some decision makers may be willing to invest in more expensive but "cleaner" technologies. In this case, the prudence of the decision will be determined by the market, not the state regulator.

Finally, let's focus on profitability. As discussed in my previous example, a generating asset will be profitable if, on balance, its total cost--variable plus fixed--is below the market price of electricity. In the competitive world, other means of ensuring profitability, such as revenue enhancement, may become important considerations. Sales of marketable by-products such as fly ash and gypsum or co-products such as steam or chemicals can enhance the profitability of a generating asset. This will be especially true if synergism can be found that simultaneously improves the market position of both electricity and the co-product.

A more traditional approach to maximizing the potential for profitability will be to take actions that preserve fuel flexibility. Reducing dependence on the fortunes of one fuel source can greatly improve a generating source's competitive position.

Now, with this scenario, what will be the impact of the emerging competitive electricity supply market on the Clean Coal Technology market? Some things are relatively certain.

High capital cost technologies will be at a disadvantage, even if lower heat rates and fuel flexibilities give them lower variable operating costs. Total cost must stay below market to stay profitable.

Disaggregation and the probable recapitalization of old plants will tend to make new technologies more competitive as the fixed cost of old plants also increases.

Pollutant trading markets and uncertainty of future regulation will establish the value of very low emissions technologies. It will, however, require a very gutsy decision for a utility to invest based on anticipation of future regulation. Remember, guaranteed recovery through rate making is a thing of the past.

Technologies that offer revenue enhancement opportunities and synergism among multiple products may be able to overcome a high investment or fixed cost hurdle. Additionally, commercial approaches that reduce the requirement for capital investment by the generating company will improve the competitiveness of the offered technology.

Many of the projects being presented at this meeting have taken the right steps to be viable in a competitive electricity generation world. Some projects have been developed with investment partnerships that effectively eliminate the capital burden on the host utility (and I'm not talking about the DOE investment). Other projects focus on reducing fixed costs while also achieving performance improvements. Still other projects involve cogeneration, waste utilization, or methanol from coal. All these are examples of steps in the right direction. However, the pace of these steps needs to increase and the focus on the bottom line needs to become even more intense if Clean Coal Technologies are to fulfill their promise and enable us to continue using our most abundant native energy resource.

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Working Together:
A Regulator's View of The Transition to Competition in the Electric Power Market and its Impact on Clean Coal Technology

a presentation by

Dr. Bil Tucker
Wyoming Public Service Commission

to the

Fourth Annual Clean Coal Technology Conference

Denver, Colorado
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Note: The views expressed in this presentation by Commissioner Tucker are his own and do not necessarily reflect the views of the other members of the Wyoming Public Service Commission or the Commission's staff.

By way of introduction, I intend to confine my remarks to comments on today's electric utility industry, followed by observations about Wyoming's coal and regulatory experience, and then concluding with remarks about the importance and future of clean coal in the world's rapidly developing economies.

There is an obvious commonality among the players in the electric industry in that we are all in transition. The transition to competition in the nation's electric market is coming, and it is coming soon. The competitive model will drive the evolution of all phases of the electric power industry for the foreseeable future. My reference to all components of the market includes all of the jurisdictional components as well. I do not believe that there will be -- or should be -- a developmental discontinuity between the federal level and state level markets as the transition matures.

We have learned much from the experience in fostering competition undertaken by the Federal Energy Regulatory Commission in the interstate natural gas industry. Perhaps the most important things that we have learned are that the development should be evolutionary rather than revolutionary, that local interests and local realities must be considered and seriously addressed and that a national "one size fits all" solution for the transition, in reality, would probably end up fitting nobody. In the natural gas market transition, there were mistakes and rough spots that can be avoided and should be avoided in the competitive development of electric markets. I hope that we have all learned from the natural gas experience. At least we have been given that chance. We must make the most of it.

I am pleased that there is a growing understanding that the most promising model for the future development of competition in the electric industry in the United States is cooperative and collaborative. "Collaborative competition" is neither internally contradictory nor tautological. The experience of the West in working together to guide the evolution of the western integrated power grid, and the positive organizational interaction that has taken place as the grid has grown, show that this model is a good one that is worthy of serious consideration. The western integrated grid is one of the best examples in the United States of workable, regionally cohesive efforts which provide the basis for the development of vigorously competitive markets which, by their very nature, must have a strong interstate and, in the case of the West, international, character.

At this point questions regarding regulation arise. Does it even have a role to play? Can it be a positive force in a competitive environment? Or, should it just get out of the way and let the competitors compete?

The answer to these questions is that regulation -- federal and state -- does have a role to play and it can be overwhelmingly positive. If regulation exists as a surrogate for competition, one might ask, what business does it have dealing within a competitive environment? There are two answers to this question. First, evolving electric markets are not likely to be perfectly competitive. There are strong elements of natural monopoly in several parts of the industry which may vary in intensity from region to region but which are present throughout the nation. We are not done with monopoly services yet. It may make considerable sense in some cases, such as local distribution, to retain the benefits of a single monopoly physical system, while granting the benefits of competitive open access common carriage on that system. Second, no matter what the level of competition, electric utility service will always be imbued with the public interest. It will retain its character as an essential component of modern life. Competition will not make electric utility service optional for the average citizen or the business community. Even if pricing is controlled by market forces, customer service questions will retain their vitality and will require a regulatory forum in which to be addressed.

Regulators must remain engaged in the current issues, but they must be willing to adapt and change. The Federal Energy Regulatory Commission is doing this by going forward with the *Noporus giganticus* ("Giga-NOPR") which will address some of the interstate components of the electricity market. The FERC also actively supports regional transmission groups -- RTGs -- which hold great promise in their ability to bring all of the regional players together to develop regional solutions to regional challenges in transmission access, pricing, and dispute resolution.

It does not stop there, however. The states are also doing their part to assist in the development of healthy competition. For example, the Wyoming Public Service Commission has joined the Western Regional Transmission Association, "WRTA". WRTA is the logical extension of the fine record of cooperation that has been built in the West, and it offers a chance for those unfamiliar with the challenges of operating an integrated grid to become intimately involved in finding solutions to competitive and operational problems.

Also, Wyoming's 1995 legislature passed a bill which gives electric and gas utilities great flexibility in proposing innovative and competitive market rates and service offerings. The first cases under this new law are expected soon and represent a positive step toward the development of competitive abilities and mindsets among the local distribution utilities. In fact, KN Energy, Inc., a Wyoming retail gas utility, filed an unbundling application on September 8, 1995. The application "...seeks to initiate a program for unbundling KN's natural gas supply services at the retail level in order to allow customers the opportunity to select among competing gas suppliers." It proposes commercial and irrigation service unbundling and direct access for commodity purchase starting in April 1996, with residential unbundling to follow in 1997. **IMPORTANTLY,** the law under which this direct access application is being make is the same for both gas and electricity. I am pleased to have been an integral part of the development of that law from the concept stage through its passage and, now, its implementation. I am pleased that this piece of legislation came to be known as the "energy consensus law" because it represented a meeting of the minds of all players in the Wyoming energy industry.

These transitional competitive developments are promising in that they illustrate a deliberate and serious commitment to make the system work to serve the people. Simple laissez-faire competition, also called cut throat competition, is not the answer just as clinging to the monopolistic model is not. I am gratified to see that the attempts to accommodate and foster healthy competition have been, so far, deliberate steps which take into account the responsibilities of the industry to the public it serves. Marketers starting from scratch with entrepreneurial zeal and a desire to maximize their profits are contributing. Established utilities, starting from a strong customer base, are contributing. They are beginning to develop an awareness of their customers' unique needs and a desire to understand and improve their customer relations. This will also help in developing strongly competitive abilities which will provide the needed survival skills for these entities in the coming competitive times.

The philosophical underpinnings of the competitive model are that the price for service should be controlled, and hopefully lowered, by market forces and that competition should hasten the introduction of new technologies and innovative services. It should stimulate the introduction of new sources of energy and should stimulate existing sources to find ways to become more efficient. It is at this point that clean coal technology assumes a critically important role in the new competitive electricity markets. There simply is no market unless you have two conditions -- something to sell and at a price that is right. I believe that competition will come to all aspects and levels of the industry in one form or another. However, clean reliable generation will be a critical factor in the success of a competitive industry because the new markets cannot develop to any significant degree without stable and increasing supplies of electricity which combine reliability and low cost with popular acceptance.

In Wyoming we have witnessed first hand the effects of recent competition in the electric generation industry through our largest electric utility PacifiCorp. While this utility is blessed with numerous efficient coal-fired generators located in Wyoming and other states, in addition to hydroelectric resources, it is now wind resources and gas-fired combustion turbines which appear in the company's integrated resource plan as the avoided cost to beat in the forseeable future. One of the reasons, of course, is that combustion turbines and renewable resources can be added to the generation mix in small increments as needed. However, the most important attraction for these generation resources is a very competitive cost of produced electricity stemming from recent technological developments and efficiency gains.

This is not to say, however, that clean coal technology has been out-done by the competition. What may be the newest coal-fired thermoelectric generation plant built in the United States is in Wyoming and just came on line. It is the Neil Simpson Unit No. 2, near Gillette, Wyoming. Built by Black Hills Corporation, this relatively small (80MW) coal-fired air-cooled facility was supported in Black Hills' integrated resource plan as the most cost effective alternative, beating out natural gas combustion turbines and other generation resources. The lesson here is that generation siting, natural gas availability and cost as well as environmental and other factors must be considered. When all is said and done, efficient clean, even moderately sized, coal-fired plants may still be winners for power producers as well as end-use customers.

Coal-fired thermoelectric generation provides a strong basis upon which to build a competitive electric industry. It offers proven technology which is reliable, readily dispatchable and clean, despite its undeserved reputation to the contrary among those who have not examined the progress that the industry has made in clean coal technology.

Consider these important points:

- clean coal projects offer ways to add value to coal for export -- Clean burning coal in Wyoming and elsewhere allow states to not only have abundant, cheap, clean and reliable electricity locally, but also to export electrons, to widen the use of this dependable resource.

- coal is a clean resource -- Wyoming has proven that with its long standing responsible emissions laws that exceed Clean Air Act Amendments standards, and its reasonable utility regulation, which allows for the recovery of pollution control facilities costs. New clean coal technology makes this an even cleaner, more efficient, and more economically appealing fact.

- environmentally responsible clean coal generation should go forward -- Electricity can be produced in and exported from airsheds like Wyoming that are not overstressed with other pollution problems. This allows "electrification" for problem airsheds like the Los Angeles basin. Environmentally sound clean coal producers can compete vigorously as exporters across state lines.

- "glamour" fuels also have their problems -- Nuclear generation is a political bomb at the present time which no one is willing to defuse. Wind isn't dispatchable and there are only a few premier wind sites in the nation. Hydro is clean but there are lean times when snow pack is low and it has increasing environmental concerns such as impacts on wildlife and fisheries, dam silting and erosion. Natural gas combustion, although perhaps less controversial than coal, produces by-products which may need to be dealt with. Also, the siting of needed large gas transmission lines is becoming more problematic.

Shifting focus from the domestic shorter term picture to the longer term global scene, one can foresee vast and critical roles and markets for clean coal technologies. The World Bank, a credible and critical global financial source, is very focused on clean coal technologies from the mine through generation. They are particularly sensitive to the situations in China and India with their great coal resources, staggering population statistics, rapid economic growth, and policy to industrialize and increase their standards of living as rapidily as possible. Understandably, rapid electrification, not environmental protection, is their goal. These facts are a receipe for strident confrontation over economic development and environmental issues or a tremendous opportunity for the industrialized nations and for clean coal technologies.

Don Hodel, former Secretary of Interior and Secretary of Energy, recently summed up my concerns relative to global electrification with the following statements: "I believe that for environmental,...ethical/moral and security reasons the United States...should seek to...expand access to electricity." Hodel went on to develop this thesis citing some interesting economic thresholds over which all developing nations progress. "Around $1400 per capita income it [a developing nation] seeks to get rid of sewage in the water people drink. ...smoke and particulates...when...income reaches about $3300. ...sulfur dioxide begins to decline when per capita income approaches $3700." You don't clean up the environment first and then increase the standard of living. You must significantly improve the nation's economy first and only then will it clean up its own environment, and thus the global environment.

Improved economies will come about through increased productivity. Increased productivity will come about through increased electrification. Countries will naturally use the most abundant domestic fuel to provide electrification. That fuel is quite often some form of coal. Not always the cleanest or highest grade of coal. The challenge, then, is to get the most bang for the coal electrification buck in developing economies. To me this means we should be doing all we can to encourage the utilization of clean coal technologies worldwide. This means reducing existing regulatory barriers to the exporting and foreign implementation of clean coal technologies. It also means that we should not interfere with fuel choice when developing economies understandably opt to use their abundant native coal resources.

In our own country one of the most important impediments to the continued use of coal may come from governmental agencies and well meaning but under-informed regulators. Regulators and policy developers who use the "one size fits all" mentality to fix pollution problems, both real and imagined. For instance, we should not impose a domestic interstate "customs duty" on coal fired electricity from states which have done their homework and responsibly produce electricity using clean coal technologies in order to make it the environmentally friendly resource that it can be, as we have proven in Wyoming. These types of punitive policy have no economic justification. They are wrong for the electricity industry and they are wrong for the nation.

We are proud in Wyoming of our reputation for world class coal production, our clean air and water, and our clean coal-fired thermoelectric generation resources. Having lived through an era of dramatic change in the regulation of the natural gas industry, I know from experience that the transition to competition in the electric industry will hold challenges and obstacles to overcome for all of us. Nevertheless, we are committed to meet these challenges head-on and encourage the development and continued use of clean coal as a modern energy resource.

When properly engineered and utilized, clean coal technologies will continue to make coal an effective and competitive domestic and global fuel now and well into the future. A clean fuel that will hasten efficient low cost global electrification. Rapid global electrification will significantly improve productivity and per capita income and hence the standard of living of billions of the world's population. A population which will be aware of its environment and will have both the desire and the resources to keep the environment as unspoiled as possible. This is the challenge and the future of clean coal technologies.

Remarks of Bruce C. Driver

Principal, Sustainability Initiatives and

Special Counsel to the Energy Project of the

Land and Water Fund of the Rockies

on the Impact of the Transition to Competition in

Electric Power Generation on Clean Power Technologies

"Are We In This Together?"

Good morning.

I am most pleased to appear before the Clean Coal Technology Conference on the effect of competition in the electric industry on clean power technologies. I was charged with speaking about the impact of competition on clean coal technologies, but I have expanded the topic to include any clean power generation technology. I think that the general implications of competition are largely the same for most so-called "clean power" technologies, whether it be IGCC, fluidized bed, solar thermal, photovoltaic or geothermal. Thus, I have titled my remarks: "Are We In This Together?"

In my remarks I hope to cover 3 topics. First, I want to lay out for you my impression of clean coal technology, its attributes and its problems, so you can see where I am coming from. Second, I'll discuss what I think the threat of competition is doing to utilities' investment portfolios and what the effect is on clean power technologies generally. Third, I'll share with you some thoughts I have regarding the continuing battles between the coal industry and the Land and Water Fund in this time of transition in the electric industry.

Impressions of Clean Coal Technology

I am no technical expert on clean coal technologies. Some of what I know about them is gleaned from representing an independent power producer before the Nevada Public Service Commission in the late 1980s in its attempt to get Nevada Power Company to acquire from it a couple hundred megawatts of fluidized bed combustion capacity from a cogeneration unit. We failed in our attempt with Nevada Power, an experience shared by some other clean power advocates in recent years, especially those promoting Demand-Side-Management and certain kinds of renewable resources. Another way I have learned about clean coal technology is in the preparation of the Land and Water Fund's energy "Vision Piece," a book-length document in which we propose the reworking of this region's electric system to make it cleaner over a 20-40 year period. We have considered the role that clean coal technologies might play in a cleaner electric industry and conclude that there could be a large role for them.

Our principal concern with clean coal technologies is that, while they are predictably cleaner than conventional pulverized coal-burning powerplants, they may still be "dirty" when compared with other clean power technologies, in particular renewable resources. Thus, while fluidized bed technologies remove much of the incremental NOx and SOx from emissions before they go up the stack, they still emit more SOx than gas-fired combined cycle plants and, of course, renewable resources. And they still emit substantially more CO2 than gas plants and, of course, renewables. IGCC processes also have to deal with the incremental carbon found in coal vis a vis gas. And there are solid waste and other issues surrounding IGCC.

Of course, it may be possible technically to make clean coal as clean as natural gas combustion, although not as clean, in terms of air emissions, as renewable resources. But the cost of doing so appears daunting at this time. Clean coal technologies appear relatively expensive compared to combined cycle natural gas-fired plants, not to mention conventional coal-fired powerplants. Removing the incremental carbon (relative to natural gas) prior to or after combustion may add significant costs to clean coal technologies and also may reduce plant efficiencies, according to studies we have reviewed. In sum, it seems that the issue for clean coal technology proponents is whether any clean coal technology that is as clean as its nearest competitor, namely natural gas, will be economically competitive with it. Gas prices being what they are, the outlook for clean coal is not promising in the immediate future. But the same problems of competition with natural gas apply to renewables technologies, too. Are we in this together?

I should share with you another impression I have of clean coal technology and that, more than renewable energy resources, it has been subsidized by the federal government. In 1993 the Alliance To Save Energy estimated that in 1989 the coal industry had received nearly $8 billion in federal subsidies and tax relief. My understanding is that the feds have poured over $3 billion into the Clean Coal Program alone since 1986. These figures compare with a total of $500,000,000 in federal help to the entire renewables industry in a recent year, according to the Solar Energy Industries Association. My impression is that the feds have given clean coal a head start over its clean power competitors.

The Impact of Competition on Utility Investment Portfolios

Electric utilities are under financial pressure. The pressure results from the possibility that competition in the electric industry, especially at the retail level, will cause loss of business, creating "stranded costs."

As a result of the financial stress occasioned by competition, utilities we encounter in the West are increasingly unwilling to acquire resources that could entail long-term obligations or possibly put upward pressure on rates. Two examples of this come to mind:

1. Nevada Power Company's present 20-year Integrated Resource Plan ("IRP") consists almost entirely of 20 annual increments of short-term power purchases. There's a little DSM, a little renewables, but beyond that no commitment to new resources other than short-term purchases. This is on a system that is growing at 6%/annum in terms of peak load in a region in which the present surplus will likely dry up within 3-5 years absent new resource investments.

2. At the announcement of the merger between Southwestern Public Service Company and Public Service Company of Colorado, PSCO Chief Executive Del Hock was quoted in the Denver Post as saying:

> "Our industry is in the midst of tremendous change, driven by demands in the marketplace for lower costs, more services," said Del Hock, PSC Chairman and chief

executive.

"In light of these changes, we've concluded that price is everything...."[1]

Simply put, when it comes to considering commitments to new power or DSM resources in which capital is risked for some period of years, utilities are acting like deer frozen in the headlights, in fear of what the future holds for them. They want to travel light for the time-being.

While the behavior of utilities in this time of transition is understandable from the corporate financial perspective of a vertically integrated monopoly, in our view it falls short of appropriate resource acquisition policy. In the main it falls short because utilities--or someone--should be considering policy objectives beyond maintaining the financial integrity of the monopolies. For example, what about the need to reduce costs of service over the long-run? What about resource diversification as a hedge against price run-ups in natural gas? What about environmental protection? What about "sustainability," a topic of increased public interest in the West as our population grows strongly? It is not necessarily the case that utility resource acquisitions to avoid future stranded costs are consistent with any of these objectives. As a result, these objectives are increasingly given short shrift by utilities. The result of utilities ignoring these interests and objectives is unbalanced resource planning.

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1 "Public Service to Merge," Denver Post, August 24, 1995, p. 11A.

It is also to disadvantage resources, like renewable resources and clean coal technologies, that are relatively capital intensive but have no or relatively low expected fuel costs over the long-run. It also disadvantages DSM, too, because, while DSM is often cheap, it can raise rates because of the need to recover fixed costs from sales that are lower than those used to calculate rates in the last rate case. As a result, I suggest that environmental interests and clean coal proponents should have somewhat the same concerns with the transition to competition. Note that I did not say with competition, but with the transition to it.

The real challenge in 1995 is to find a model of regulation that restores balance to resource planning while accounting for the financial pressures under which today's utilities operate in this transitional time. This is not an easy task. There are three such models. The first is what the utilities propose, which is tantamount to unregulated monopoly status, in which utilities use their market power over their monopoly functions--transmission and distribution--to force their mainly captive customers to pay for uneconomic generation resources that are now being cast into a competitive market by federal energy policy under EPAct.

This model--unregulated monopoly--should be unacceptable to environmental interests and clean coal proponents because few investments are made under it in resources which imply a commitment of capital beyond the short-run. It is also unacceptable because resources that may cost more than the cheapest resources but have other values, like solarpower or clean coal, are ignored.

The second model is competition, first at the wholesale level and, later, at retail. The third is IRP with meaningful public and PUC involvement in the selection of utility resource portfolios to counterbalance utilities' present tendency to ignore the long-run and other objectives.

Either of the other two models should work for us--wholesale competition leading to retail competition or IRP. In Colorado we promote IRP. In Nevada we promote vertical disaggregation of Nevada Power Company. Ultimately, I suspect that the West will, in most states, slowly, move towards retail wheeling. Our position is that, if this is where we are going, let's get there with due, deliberate speed. Let's get over this transitional period so that our interests--yours and ours--are not set back by the very short-term focus of utilities during the transition.

CEED/WFA vs. the LAW Fund: From clean coal's perspective, does this fight make sense?

For the past couple of years, PUCs in the West have been treated to episodes in a continuing battle between CEED and Western Fuels Association on one side and the Land and Water Fund of the Rockies on the other regarding utility integrated resource planning policy. I want to talk about these battles a bit to make two points: (1) That it is possible our position on the issues may be closer to the interests of clean coal than CEED's and WFA's but (2) that these battles may largely be a waste of effort.

Recently, we joined battle again before the Colorado PUC. The PUC is seeking to determine whether to amend its existing IRP regulations. The LAW Fund, along with nearly all other Colorado-based intervenors, believes that the IRP rule should be amended to encourage wholesale competition to meet utility resource needs as well as to streamline the existing rule. Our group also believes that, while we still have vertically-integrated monopolies who can and do use their market power to impose their narrow view of resource acquisitions on captive customers--the Colorado PUC should reserve the right to exercise its authority under Colorado law to direct utilities to acquire specific types of resources for the purpose of meeting objectives beyond the financial health of the utilities.

CEED/WFA challenged us on both policy and legal grounds. On policy grounds they argued that implementing such authority would create stranded costs. Our answer to this is that this is possible but not likely if the PUC acts with care. On legal grounds CEED/WFA told the Colorado PUC that any attempt to try to direct utilities to acquire resources that they do not want to acquire in this time of transition would be preempted by the Federal Power Act and would violate the Commerce Clause of the U.S. Constitution. CEED/WFA recommends reliance on utilities's judgment and the evolving competitive wholesale market to make resource choices.

I wonder whether our position may be more in tune with the interests of clean coal than CEED's and WFA's because utility judgment and the market will not likely give us any clean coal for the foreseeable future but a PUC order might.

Another stage on which our battle with CEED and WFA is being waged is in the context of dueling studies. CEED has its study, "Energy Choices in a Competitive Era." We have ours: "How the West Can Win: A Vision for a Sustainable Energy Future." CEED's study was prepared by Resource Data International, apparently without any comments, after it had been prepared in draft, by anyone but CEED. At least it was finished without our comments. The result, in our view, is a biased study that concludes that open and direct competition would reduce the share of renewables of the electric market to 1% by 2010 and that, if renewables were to attain a 4% of market, the cost to the national economy would be $52 billion. The study trumpets the marketplace advantages of coal vs. renewables.

The LAW Fund's study is being carried out differently. First, we are writing it. (From a staff perspective, I'm not sure that this is an advantage.) Second, we held fifteen meetings around the West to hear what people cared about in terms of electric resource policy. These meetings were attended by a wide range of people, including CEED and CEED members. Third, we published a draft and asked 70 people to comment on it, including CEED. In fact, CEED's comments, authored by Terry Ross, were among the very best we got. Our final report will be different because of Terry's comments as well as the other comments we received. There will be a place for clean coal in our report.

A final point on our battles with CEED/WFA: CEED/WFA seem to think that we are out to shut down coal. That has never been our aim. While coal burned conventionally is not the cleanest fuel around, it is a safe, reliable and relatively low-cost baseload powerplant fuel. It will continue to enjoy a prominent role in meet the need for power in the West for years to come under all circumstances that are likely now.

What we are interested in is encouraging the development of all clean power resources, subject to limits related to the impact on electric rates. This does not mean an end to coal, although it may mean phasing out conventional coal-burning technologies over the long-run in favor of clean coal and other cleaner resources.

In short, we just do not think that we present the threat to coal use that CEED and WFA apparently fear. However, as long as they continue to fear us, we're willing to do battle with them. It's fun. I get to think about interesting legal theories, testify and make legal arguments before state PUCs and other bodies. But it's probably also a waste of our time, not to mention of the time of the poor PUC commissioners who have to read our briefs and listen to us go on at hearings.

It may also be nonsensical, given that, after all, when it comes to clean coal, renewables and other clean power options, aren't we all in this together?

Changes in the UK Generating Industry since Privatisation

By Dr. Derek Cheetham. National Power UK

UK Privatisation Working Well

In my view the UK privatisation is working well. It has its critics but most would agree that it is successful. We have seen massive changes driven by the need to serve customers and shareholders in an industry which was previously engineering led often under a cost plus philosophy.

Security of supply has never been in jeopardy and contrary to the impression given by a vociferous minority wholesale prices have come down and customers are actively exploring the opportunities afforded by the enfranchisement. The industry's five million investors have done well but not at the expense of customers.

Despite earlier concerns that safety and the environment would suffer through the drive for profit - this has not happened. In my company time lost through accidents is 10% of historic levels and spending on the environment has never been higher.

Losers as well as Winners

Whilst it is clear that customers and shareholders have benefited from privatisation it would be wrong to pretend that there have not been losers.

First, employees - The drive for efficiency, low costs and the elimination of uneconomic and redundant plant has meant that the two major private generators formed from the CEGB have eliminated many thousands of jobs.

The second major loser has been the British Coal Industry. When both electricity and coal were owned by the government electricity was forced to take preferentially the output of the coal industry - this protection was lost with privatisation.

A third group who would regard themselves as losers are the very large industrial customers (in the chemical, paper and similar industries). Their subsidies have been withdrawn though their prices are no higher than they were before privatisation.

Structure of the Industry

The structure of the industry was and is complex. In England and Wales as part of the privatisation process the industry was unbundled into its constituent parts of generation, transmission, distribution and energy sales (supply). It is now composed of 12 Regional Electricity Companies (RECS) (distribution), three major generators, National Power, PowerGen and the still state owned Nuclear Electric, (although likely to be floated next year) plus many smaller generators and the transmission company National Grid (owned by RECs, but likely to be floated off).

All, except National Grid are involved in the supply to the ultimate customer.

Prior to privatisation generators were dispatched on merit order based on efficiency rate and fuel cost. Now power is sold by the many generators into the wholesale market called the Pool where we bid daily prices and the cheapest bids get business for their generating units. The price changes every half hour based on the supply demand relationship. Generally, there is today little or no income for capacity and if a plant is in surplus, the price is low. If the plant is in shortage the price is high. The customer and the generator therefore see some very clear cost messages.

On a typical day (as shown) the price will vary from £9 to £33 per MWhr across the day with virtually no capacity payment.

In a period of exceptional supply shortage the price can peak up to several hundred pounds per MWhr for a small number of half hour periods. In this case the capacity element has become significant. Generators and consumers will have regard for market signals such as these and take the appropriate commercial action.

Principles of Privatisation

Privatisation has produced reductions of monopolies, customer enfranchisement and promotion of competition in both

Cost Cutting - Fuel

A priority in reducing generating costs has been to unshackle the chain tying the generating industry to British Coal as a captive customer.

Prior to privatisation British Coal supplied 80% of the fuel for power stations much of it from very high cost pits. The average delivered price of coal was some 50% above world levels. This protection was lost with privatisation of the electricity supply industry. Since we were privatised, and notwithstanding the transitional protection given to coal, the inevitable rationalisation of that industry has now taken place.

Its annual output has been reduced from some 90 million tonnes in 1990/91 to about 55 million tonnes in 1993/94 and employees from 74,000 to 19,000 over the same period.

An important step in the process of establishing a more normal commercial customer/supplier relationship between the two industries was investment by the generators in new coal import facilities.

Coincidentally in the late 1980's large volumes of natural gas from the North Sea became available for power generation for the first time at competitive prices. Highly efficient and environmentally cleaner combined Cycle Gas turbine power stations, which could generate competitively and be built quickly and in modular units thereby reducing the construction and commercial risk became the favoured technology.

Even without privatisation the move into gas would no doubt have come to pass as a consequence of pressures to minimise environmental impacts and to reduce the demands made on public sector borrowing by large coal and nuclear projects.

However competition not only opened up the market to independent power producers who were naturally attracted to the relative simplicity of Combined Cycle Gas Turbine projects but forced existing generators to look closely at production costs and switch to Combined Cycle Gas Turbines as well. These Combined Cycle Gas Turbines are also helping to meet the higher emission reduction standards required by the Pollution Inspectorate and make an important contribution to national emission reduction targets.

Last year 17 Combined Cycle Gas Turbine stations were operating or under construction with a combined capacity of 12,000 MW. Transmission contracts have been signed with National Grid which would double this by the end of the decade if all the projects were to go ahead - although experience in the UK indicates that this is not a likely outcome. National Power has four such stations operating or under construction with a capacity of about 3.5 GW together with planning consent for a further 1500 MW.

To secure supplies of gas National Power has the biggest portfolio in the UK other than British Gas. We have purchased direct from producers in the UK and Norwegian sectors of the North Sea and from British Gas. We also have invested in gas exploration and production as a hedge against future increases in gas prices.

Redundant Plant

Since 1990 some 5,400 MW of new Combined Cycle Gas Turbines have entered the system and, as nuclear output and the contribution from the interconnectors with Scotland and France have grown so excess capacity has emerged on the system making older coal-fired and oil fired plant redundant and uneconomic

Accordingly the existing generating companies have reduced existing fossil fuelled capacity substantially by closing or mothballing old coal and not so old oil fired plant. National Power has withdrawn 9 GW from service since privatisation.

Reducing Generation Costs

Other areas of activity that have been significant in driving costs down are improving the performance of our older power stations, focusing on the most efficient to increase thermal efficiency, and flexibility of operating regimes including management of some power stations remotely from others.

Achieving dramatically better productivity through devolution of responsibilities to local management to encourage local initiatives, flexibility in working practices and motivational devices such as performance-related pay. Most of our power stations are reflecting the drive to achieve world best practice standards.

National Power Experience

Thus in National Power since we were established in 1990 we have:

- closed or mothballed 9,000 MW of capacity
- reduced staff numbers from 17,000 to 6,000
- increased turnover per employee by nearly 100%
- improved productivity by 84%

Customer Enfranchisement

Customer choice is now real and extending all the time by:

- Third party access to the transmission and distribution networks.
- Progressive deregulation of the market.
- The willingness of customers to take advantage of the competitive market through shopping around for supply contracts.
- The development of demand side bidding in the Pool.
- Greater transparency and awareness of the time/cost differentials. With intelligent metering and advances in communications, this will, in time, give even domestic customers better purchasing choice.

Participants in the electricity market are taking advantage of the opportunities of deregulation. With open access to the transmission system geography is no impediment to the customer's choice of supplier.

Customers have exercised their rights to shop around with 50% of large users changing suppliers over the last four years.

Co-Generation

One area of added value which does provide good returns is co-generation which also has Government support. It has a target of increasing capacity to 5000 MW by the year 2000. A number of the electricity generating companies are involved in projects ranging from a 1,875 MW plant to projects down to 1KW. My company has set up National Power Cogen which is involved in schemes for the paper, chemical, pharmaceutical industries and a university.

Moving into International Markets

Moving overseas into the green fields of an unregulated environment has strong attractions.

The Regional Electricity Companies and National Grid Company are studying or involved in projects in several countries.

National Power has also adopted a strategy to become a leading global power company. We have already made substantial investments and expect to own £5 billion of overseas assets by the end of the decade.

Regulation

One important aspect of privatisation in Britain has been the role of the industry regulators.

Their primary duties are to promote competition and to regulate the prices where monopolies persist. They are seen as the customers' friend though in law they also have a duty to have regard to the health of the industry being regulated.

Following a recent review of the generation market in England and Wales the Regulator reported in February last year that [illegible] found no evidence of any abuse by National Power with regard to its behaviour in the market pricing or profitability. How[illegible] we were asked to give undertakings with regard to a two year temporary cap on prices bid into the Electricity Pool and to [illegible] reasonable endeavours to sell or dispose of up to 4000 MW of plant to increase competition in the market. PowerGen w[illegible] was similarly cleared by the Regulator also gave undertakings on plant disposal and prices.

The Future

During the past four years there have been enormous changes under the twin drivers of competition and price regulation.

The Government sold their remaining 40% share of National Power and PowerGen earlier this year. Nuclear Electric is pushing for privatisation and the Government has set in train arrangements for this to take place during 1996.

There will inevitably be political and regulatory sensitivities when the cap on Pool prices agreed with the Regulator ends next year. But it is an inescapable fact that over time prices will have to reflect the full costs of electricity generation including environmental costs. Looking further ahead the retail market becomes fully competitive in 1998 and all the players in it are now studying the implications. It's realistic to think that with smart metering and developments in communications individual householders will be able to exercise choice as easily as some telephone users can in the United States. Already there is a convergence between electricity and gas with British Gas moving into electricity generation and electricity companies moving into gas supply.

Summary

The British system may well remain unique to the UK. Whilst it is by no means perfect it is serving the customer well satisfying the investor and as a more efficient system will serve the economy and I believe the environment better. No-one now yearns for a return to the good old days!

Panel Session 4

Domestic Challenges

REMARKS OF COMMISSIONER JOHN HANGER

PENNSYLVANIA PUBLIC UTILITY COMMISSION

FOURTH ANNUAL CLEAN COAL TECHNOLOGY CONFERENCE

MARRIOTT CITY CENTER

DENVER

SEPTEMBER 7, 1995

First, I want to thank the Conference organizers for asking me to share with you some observations about the ongoing restructuring of the electric industry and how that will impact power generation markets and clean coal technology. As a state official from Pennsylvania who has responsibility for insuring that the supply of electricity to Pennsylvania's businesses and families are both reliable and reasonably priced, I can say your subject this afternoon is of great importance to the future of those attending this conference as well as the future of Pennsylvania and the nation.

In Pennsylvania, approximately 60% of the state's electric supply comes from coal. A little more than 30% of Pennsylvania's electricity supply comes from nuclear plants. Coal generation has proven itself to be both the most reliable and lowest cost generation in Pennsylvania over the last 20 years. Indeed, utilities in our state and around the country have typically encountered major cost and rate problems when they abandoned coal generation and embraced nuclear generation. It is not a coincidence that the utilities in Pennsylvania that have the lowest rates are those that are predominantly coal utilities and that the utilities with the highest rates are those that made major investments in nuclear power. Pennsylvania's coal-based utilities have maintained their cost advantages even after spending hundreds of millions of dollars in order to comply with the Clean Air Act.

In addition to generating most of its electricity from coal, Pennsylvania has a long history of mining coal and today ranks fourth among the states in coal production. While Pennsylvania continues to have a bountiful supply of coal, much of that supply has medium to high levels of sulfur. Consequently, clean coal technology is of great interest to me.

The title of this session, U.S. Power Generation Markets--Evolution or Revolution under EPACT 1992, implicitly assumes and correctly so that the market structure for building generation is undergoing fundamental change in the United States. The question posed by this session's title is, will that change be evolutionary or revolutionary in nature? My answer to this question is that the destination to which the electric industry is plainly headed is revolutionary but the process and means by which we will all get to this new revolutionary point will be evolutionary. From the observation post that Pennsylvania gives me, I will describe how this revolution looks from Harrisburg.

The 1992 Energy Policy Act gave the states the task of largely deciding how the retail electric sector will be structured and gave the Federal Energy Regulatory Commission (FERC) the job of creating a competitive wholesale electric market. Over the last two years, FERC has aggressively moved to create a competitive wholesale electric market by opening the nation's transmission system to all buyers and sellers of electricity on terms and conditions that are comparable to those terms and conditions that owners of transmission assign to the movement of electricity that they produce.

As a proponent of competition and customer choice, I applaud FERC's efforts to create in an orderly, expeditious manner a competitive wholesale electric market. Indeed what FERC has already done strikes many of those who have spent their entire professional lives in the electric industry as being revolutionary. But plainly this revolution has only just begun. Mergers, downsizing, corporate reorganizations, and declining rates in real terms are a few of the indicators that the customer choice revolution is just now gathering steam.

Even though EPACT reserves the issues of retail wheeling or retail customer choice to the states, the Federal Energy Regulatory Commission is making noises indicating that it might not agree that the states are the principal decision-makers about the future of the retail electric sector. FERC in its April 1995 Open Access and Stranded Investment Notice of Proposed Rulemaking establishes a 7 part test for deciding whether particular transactions are within the jurisdiction of FERC or the state public utility commissions. This jurisdictional test is anything but clear and will give market participants little guidance as to whether particular transactions must meet state or federal requirements.

Additionally, FERC explicitly states in the NOPR that something called "retail transmission" transactions are FERC jurisdictional. Now to FERC apparently a retail transmission transaction is one where an end user of electricity takes electricity directly from the transmission system as distinguished from a utility's distribution system. If FERC persists in this interpretation, FERC effectively is claiming the power to mandate retail wheeling.

Notwithstanding these noises from FERC, states should have the first chance to make decisions about restructuring the electric industry at the retail level. Since the states presently have the retail ball, the states must run with it. Indeed, if one or more states decide to act like protectionists and try to destroy retail customer choice and the benefits of competition, the national interest in insuring free markets within and between the states will have been sufficiently attacked to warrant federal preemption.

A few states do have initiatives to restructure the retail sector. That was not the case just two years ago. Michigan, California, Massachusetts, Rhode Island, and New Hampshire have seized this opportunity by coming forward with proposals that would partially or dramatically increase customer choice at the retail level. Other state public utility commissions, including Pennsylvania's, are in the process of making recommendations to their Governors and Legislature about if and how their states should promote competition within the electric industry. These proposals are the beginning of a true retail competitive market for electricity. That is the revolutionary destination where the electric industry is headed.

Once a competitive retail market is established, customers, not regulators, nor utility managers, will be in the driver's seat. The generation plants of the future will be those that best meet customers demand. In my experience most customers whether they are residential, commercial, or industrial want primarily two things from an electric plant: low as possible prices and reliable service. There, however, will be market niches within the retail electric market. One such niche may be for generation that is deemed by consumers to be environmentally benign, even if it is not lowest cost. In the competitive retail electric market of the future, this market niche and other niches will exist only if consumers through their buying power voluntarily create demand for a particular service or form of generation.

The central issue of the restructuring debates raging in many states is customer choice. Will states allow electric customers to choose from which producers of electricity that they will purchase electricity? If so, on what terms and conditions will customers now captive to monopolies be allowed to shop for electricity? And how will the electric industry make the transition to an industry where customers, not regulators, are king? In my judgment these questions are revolutionary, and a major reason why most states are now asking them is the huge impetus for competition that EPACT provided.

Fortunately for the future of coal, advances in clean coal technology offers coal a way of dealing with the environmental costs and problems that could threaten to erode coal's competitive position. Maintaining coal as the best way for a utility to produce the lowest rates becomes ever more important as electric generation becomes ever more competitive. Make no mistake the old days of something like cost plus regulation that once characterized the electric industry are long gone.

Pennsylvania is a particularly interesting state in which to be part of the debate about bringing choice to retail electric customers. Pennsylvania has 8 major electric utilities. Our utilities operate 9 nuclear units within the Commonwealth, though 10 units have been built in Pennsylvania. One of those had a little problem in 1979 that some of you may remember. Pennsylvania's utilities also have an ownership share in 3 more nuclear units located outside of Pennsylvania.

As a result of primarily this heavy investment in nuclear plants, some recent studies not surprisingly found that Pennsylvania may have as much as $10 billion of potentially stranded investment, making Pennsylvania one of the states with the biggest stranded investment problems. For example, a Resource Data International study that was summarized in the January 15, 1995 edition of Public Utilities Fortnightly concluded that "45 percent of the stranded generating assets were concentrated in Texas, Illinois, Pennsylvania, and Ohio." The study also said that the generation stranded investment problem was also concentrated among a few companies with 10 investor owned utilities accounting for 46% of the electric industry's total stranded investment problem.

Listening to this tale of nuclear financial woes, I am sure some of you in this audience are thinking: "we told them to buy coal generation but they just would not listen."

At this point, we should remember that all stranded investment estimates are very dependent on the accuracy of key assumptions such as the market price of electricity if retail customers were allowed to shop. Moreover that price if it is a real market price is a moving target. Another key assumption is the date on which customers would be given the power of choice. Enough time and accelerated depreciation can turn even a multi-billion dollar mistake that is now projected as stranded investment into a possibly competitive asset or least into an investment that will not cause bankruptcy.

With possibly a large amount of stranded investment, it is also not surprising that Pennsylvania's average electric rates are approximately 20% higher than the national average. For example, in 1993 Pennsylvania's average price of electricity was about 7.9 cents per kwh when the national average price was 6.6 cents per kwh. In Pennsylvania the 1993 average industrial rate was 5.7 cents per kwh as compared to the national average of 4.7 cents per kwh.

Though Pennsylvania's average rates are above the national average rates, Pennsylvania's rates are the lowest in the Northeast region which tells you a little about the problems some of our neighbors have. To some extent Pennsylvania's low cost coal generation has counterbalanced its high cost nuclear generation. As a result if competition develops regionally, Pennsylvania's utilities may not be badly positioned.

Though I philosophically support competition and customer choice, ill-considered reforms that compromise reliability, unfairly shift costs, or make more difficult achieving universal service must be rejected. It is especially alarming that some in the restructuring debates are lulled by today's excess capacity and operational success and assume that reliability will continue into a restructured industry automatically and without thought.

Before jumping blindly into the world of poolcos, bilateral contracts, transcos, and discos, we all should resolve some key reliability questions. Would companies battling for customer allegiance and market share quickly drop the competitive cudgels and return to the cooperative, sharing ways of the old industry in order to stabilize regional electric systems at times of operational stress or emergency? Or would their new competitive instincts tempt them to view the operational problems of other utilities as an opportunity to give a competitor a black eye? Who will have the responsibility and authority for insuring that regional electric systems are reliable each minute of each day?

Here are a few more reliability questions. Which competitor would build the plant that provides the last increment of necessary reserve margin? After all, that plant may operate only once every ten years or so. Which of those customers, newly empowered with choice, would pay for that last increment of reserve margin which may never be needed or needed once every ten years.

As a Commissioner who informed his Governor on January 19th, 1994 that the PJM and APS electric systems that are central to the survival of millions of businesses and families in Pennsylvania were in an unstable, emergency condition that morning and who advised the Governor to declare a state of emergency, take it from me that these questions are not academic or hypothetical. They are central to public health and safety. They also are not at the center of the restructuring debates.

We cannot brush off these questions by saying discussion of reliability is a underhanded way of resisting customer choice. Though some opponents of competition raise concerns about reliability in just that spirit, reliability issues are real and cannot be dismissed because some have ulterior motives.

Many in this debate correctly warn that costs could be shifted to small users unless steps are taken to prevent this result. To prevent cost shifting to smaller consumers, must small users have the same ability to shop as large industrial customers? If so, how do you do that? Or will various combinations of exit fees, wire charges, and other levies billed to customers that shop be enough to prevent cost shifting to other ratepayers or utility shareholders?

Opponents of competition also correctly raise concerns about whether the transition to an industry driven by customer choice can be fairly accomplished. Some high cost utilities fear that they will be brought to the starting line of the new competitive race after having one leg amputated by the transition. At the heart of this concern of course is the problem of stranded investment.

Legitimate concerns also exist about how low-income families will do in a less regulated industry. Electricity is not cotton candy. It is a necessity of life. No decent society will structure its electric industry in a way that throws millions of poor families back more than 100 years to the times of candles and wood fires and oil lamps.

Answers have been suggested to the issues of stranded investment, reliability, cost shifting, and universal service. Before any jurisdiction expands customer choice, the sufficiency of such answers must be judged in a way that recognizes the legitimate interests of all stakeholders.

As these debates progress, I believe that my role is not to save the public or the industry from competition. I became a Commissioner to make infrastructure services more efficient and better. Customer choice is the most powerful tool available for achieving those goals. My first responsibility is to make sure that the public secures the benefits of competition and that the transition to customer choice is fair. Making sure that the transition to customer choice that is already well underway serves the public interest should be the focus.

Some foolishly believe that the revolution of customer choice can be stopped at the border of the wholesale market. This belief is foolish, because the dichotomy between a wholesale electric sector where electricity is priced by market forces and a retail sector where electricity is still substantially priced by regulators on a cost basis is unsustainable. The wholesale electric sector is awash with electricity that is being sold for relatively uniform and very low prices.

Consequently, retail customers have strong financial incentive to access the cheap electricity offered in the competitive wholesale market. They also have a way to get to the wholesale market's cheap power. That way is municipalization. The electric industry has the choice of making an orderly transition to customer choice or confronting a wave of municipalization efforts and of attempts to shift costs to captive ratepayers in order to pay for ever larger discounts to the lucky few customers that do now have some choice. The same issues of stranded investment, cost shifting, reliability, and more will drop into policymakers laps if policymakers resist change or if they comprehensively fashion a competitive transition. Market forces are loose. There is no dodging this bullet.

Now for a statement that many of my fellow state regulators would reject. In many but not all states, traditional regulation has failed to produce reasonable rates. The surest indication of this failure is the incredibly wide rate disparities for electricity.

In Pennsylvania, the rates of one utility that borders another utility are 100% higher. Business and residential consumers regularly ask me, how could the Commission have approved their electric rates when their friends or competitors who are lucky enough to be customers of another utility pay just half what they do? How could both rates be just and reasonable? Good questions. While differences in service territories do produce some legitimate rate differences, rate disparities that are seen in today's industry are indefensible.

The retail customer choice revolution cannot be aborted for one fundamental reason. There is no more important industry than the electric industry in

Pennsylvania and throughout America. Virtually nothing works without electricity. A lot of money is spent to buy it. It, therefore, must be structured to operate much more efficiently.

Some of Pennsylvania's energy intensive businesses like PPG Industries and Bethlehem Steel tell me energy can be 20% or more of the total cost of production. It is not unusual in energy intensive businesses for energy to equal or exceed the cost of labor.

Families with average incomes in Pennsylvania work from January 1st to the middle of February to pay just the annual cost of all utility services. Families scratching out an existence on incomes below the poverty level may spend 40% of their income for utilities, with the electric bill by itself consuming 10% or 15% of total income. I ask, who needs cheap electricity more than a family living in poverty? I ask, if as a society we continue to underfund or possibly eliminate the Low-Income Home Energy Assistance Program, should we not do all that is possible to produce cheaper electricity?

When the businesses and families throughout this land finish paying their electric bills for a year, they have spent close to $200 billion. Of that total, Pennsylvanians spent about $10 billion. Spending on electricity dwarfs the amount spent on any commodity. In 1991, $70 billion was spent on natural gas, and $115 billion was spent on unleaded gasoline, heating oil, and crude oil. When the price of a barrel of oil moves in one direction or another, financial markets pay close attention, interest rates can move and expectations for economic growth and inflation change. Since 60% more was spent in 1991 on electricity than on crude oil, unleaded gasoline, and heating oil combined, there is no doubt that the price of electricity is vital to economic development. So the 1994 Forbes Magazine survey that found 11 of the 12 states that had the worst job prospects were among the 12 states with the highest electric rates should not surprise anyone.

This brings me to my concluding point. Unless America gets every possible competitive advantage from its electric and other infrastructure services, the downward pressure on wages will only worsen. We must not compete by driving more Americans into poverty or depriving more and more people of health insurance. I do not want Pennsylvania's average wage to be equal to China's average wage fifty years from now.

The historic changes in the world's economy with the creation of a real, global economy demand that the United States extracts every advantage it can from the things in which it has a comparative advantage. Coal production and clean coal technology is an area in which this nation does or can have a comparative advantage. Capital moves today not only within Pennsylvania, or from Pennsylvania to Maryland but also from Pennsylvania to China. Capital seeks to maximize return and is increasingly not restrained by a sense of duty to any one country. Consequently, America needs the most efficient electric industry possible to retain and to attract investment dollars. Clean coal technology may well be the key to insuring that coal plays a central role in the competitive electric industry of the future. The creation of a competitive, customer-choice driven electric industry represents revolutionary change that can and should be achieved by an evolutionary period of transition.

Thank you.

Fourth Annual
Clean Coal Technology Conference
"The Global Opportunity"

Domestic Challenges: U.S. Power Generation Markets Evolution or Revolution Under EPACT 1992

Marriott City Center
Denver, Colorado
September 5-8, 1995

Edward J. Brady
American Electric Power
Service Corporation
1 Riverside Plaza
Columbus, Ohio 43215

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Discussion Outline

I. INTRODUCTION

This paper[1] discusses the topic: U.S. power generation markets, evolution or revolution under the Energy Policy Act of 1992.[2]

If posed as a question, the answer would be: Yes!

Electricity markets are important for those interested in coal and new coal technology because just over 80% of domestic coal production is consumed in generating electricity.[3] The outlook for coal and coal technology thus is linked closely to the electricity business and the direction in which that business seems to be headed.

The major trends affecting the industry are:

(1) Competition;

(2) Independent Power;

(3) Restructuring; and

(4) Transmission Access.

Within these trends, the electricity industry is experiencing both revolutionary and evolutionary forces. The specific revolutionary part of these trends are:

(1) Competitive contracting for wholesale power;

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[1] The views presented in this paper are the author's own and are not intended to represent the policy or views of the American Electric Power Company, Inc.

[2] Pub. L. No. 102-486, 106 Stat. 2776 (1992).

[3] See Coal Industry/Wall Street Transcript, Industry Report, April 17, 1995, Paine Webber, Inc.

(2) Restructuring for retail competition;

(3) Subsidized Energy Conservation Programs or "DSM"; and

(4) Comparability and Transmission Access.

The evolutionary part comes into play with the implementation of these ideas by the laws of the two sovereigns involved, the Federal and state governments.

This paper will provide an overview of these revolutionary and evolutionary forces and their relationship to the Energy Policy Act of 1992. It also will discuss the initiatives of the Federal Energy Regulatory Commission or FERC to foster a more competitive wholesale electricity market and the responses to FERC's initiatives.

II. THE FIRST REVOLUTIONARY IDEA: COMPETITIVE CONTRACTING FOR WHOLESALE POWER

A. The PURPA Experience.

The first revolutionary change in the electric utility industry is the movement toward competitive contracting for wholesale power.[4] It originated with section 210 of the Public Utility Regulatory Policies Act of 1978 (PURPA), which established a federal program to encourage cogeneration and small power production. The program was to be implemented jointly by FERC and the state commissions and required utilities to buy power from Qualified Facilities ("QFs") at a price based on the utilities' "avoided

[4]See, Bernard S. Black and Richard J. Pierce, Jr., "The Choice Between Markets and Central Planning in Regulating the U.S. Electricity Industry," 93 *Colum. L. Rev.* 1339, 1350. The authors identify four revolutionary changes effecting electric utilities: (1) competitive contracting for electric power; (2) negawatt acquisition programs; (3) market-based environmental regulation; and (4) environmental adders.

cost."[5] Cogeneration is defined as the production of electric energy plus steam, heat or some other useful form of energy. A qualifying cogeneration facility is one that complies with FERC rules and is not owned by someone principally engaged in the generation and sale of electricity. In implementing PURPA, FERC mandated that QFs receive the purchasing utility's full "avoided costs" for power. Under PURPA, the utilities pay QFs what the utilities would otherwise spend to generate or procure the power in the absence of the QFs.[6]

Implementation of PURPA and the determination of "avoided costs" by state commissions varied widely. To jump-start the development of Independent Power Producers ("IPPs") many state commissions and legislatures greatly over-estimated long run "avoided costs" and thus compelled utilities to buy huge amounts of what has turned out to be overpriced power. New York state, for example, adopted a law that prescribed the minimum avoided-cost figure to be 6 cents/kilowatthour. As a result, one New York utility, Niagara Mohawk Power, now contends that it must pay $7.3 billion more to third-party generators under long term contracts than the current cost of its own generated power. California also embraced the idea of encouraging alternate power supplies, and issued a standard offer requiring its utilities to buy from IPPs. Pacific Gas & Electric has argued that its PURPA obligations will cost ratepayers over

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[5]See, 16 U.S.C. § 824a-3 (1988); 18 C.F.R. § 292 (1993). FERC's "avoided cost" rule was challenged by AEP but upheld in American Paper Inst., Inc. v. American Elec. Power Serv. Corp., 461 U.S. 402 (1983).

[6]18 C.F.R. § 292.304. See Jerry R. Bloom and Joseph M. Karp, "The Folly of PURPA Repeal," page 52, *Fortnightly*, July 1, 1995.

$1 billion over use of its own more-efficient generation. Southern California Edison has estimated that its PURPA contracts will require it to pay $750 million per year above market prices for power. In Texas and Maine, utilities have also claimed they have been swamped with excess capacity from PURPA machines. In short, these PURPA contracts have continued to spawn litigation among utilities, QFs and state regulatory commissions as utilities attempt to avoid or modify these often high-cost contracts. That's the bad part. The good part is that PURPA did in fact foster the growth of an alternative, independent power production industry.

B. Competitive Contracting

Another dimension of the revolution in the competitive procurement of power occurred when Virginia Power Company undertook to add new generation by competitive bidding, and received bids for far more capacity at lower cost than expected.[7] These important developments predated the Energy Policy Act.

There are some other important lessons here. First, we learned that the administratively determined avoided cost that utilities were required to pay under PURPA far exceeded what would result from a competitive bidding process. Second, we learned that the bidding process can cause power producers to bear business risks such as construction cost overruns that were formerly borne by the utilities'

[7]Virginia Power's first competitive bidding process produced firm offers for nearly eight times the capacity it was seeking. Bids totaling nearly 14,000 MW from 43 potential suppliers were received on the company's solicitation for 1,750 MW. "Competitive Bidding Results Unveiled," *Public Utilities Fortnightly*, page 43, July 21, 1988.

consumers. Finally, as occurred in New York and California, we also learned that government can make very costly mistakes in implementing new energy policies.

In sum, competitive contracting for wholesale power has revolutionized the electricity industry. Instead of building a new plant, a utility today will likely issue a request for proposals and seek bids from potential suppliers. A current example taken from the *Wall Street Journal* of September 1, 1995 is included as Attachment A. The request seeks 300 MW by an all-source bidding process including Demand Side Management, Interruptible Load, Supply Side Resources, Renewable Resources and off-system power purchases.

III. THE SECOND REVOLUTIONARY IDEA: INDUSTRY RESTRUCTURING FOR RETAIL COMPETITION

A. Adjacent Utility Rate Differences.

In many parts of the country, neighboring electric utilities within the same state charge very different rates for the same service. An example is the rate differences for industrial service that exist within the state of Ohio. The data shown on Attachment B were copied from an investor report and indicate that within Ohio there are seven electric utility systems exclusively serving state certified service territories.[8]

The rates for industrial customers in Ohio ranges from a low of 3.19 cents to a high of 6.63 cents per kWhr. This price differential puts pressure on the higher priced

[8]TED, stands for Toledo Edison, OEC, stands for Ohio Edison, CEI, stands for Cleveland Electric Illuminating Company, DP&L, stands for the Dayton Power & Light Company, OP stands for Ohio Power Company, CSP stands for Columbus Southern Power Company, and CG&E stands for Cincinnati Gas & Electric Company, now a member of the CINergy system.

utilities to lower their rates. The result of this pressure is a constant stream of filings at the state commission by the higher cost utilities providing significant rate discounts to their larger customers. In effect, this is a real example of retail competition.

In our political and economic system, when there are large price differences, we expect that customers will act in their own interest to obtain lower prices. In Ohio, as elsewhere,[9] industrial customers must compete in the international marketplace and are under pressure to reduce all their costs. Consequently, they constantly lobby government and their host utility for reduced rates so that they can be competitive. These pressures, which result from these rate differences, are an inherent part of our economic system and an electric utility has no option but to respond to them.

B. Market Forces.

When we consider the issue of retail competition and market prices, and the question of whether there will be evolutionary or revolutionary change, we must recognize the role of government -- both Federal and state. How a business, particularly a regulated business, responds to the forces of competition clearly depends on government.

The real issue in dealing with retail competition and market forces that we need to focus on is whether the electric utility industry -- which has both high cost and low cost producers -- is facing an evolutionary change that will be managed in a thoughtful and careful way by federal and state regulators or whether the industry is facing a

[9] See Illinois re: Commonwealth Edison Co., 153 Pub. Util. Rep. (PUR) 4th 151 (1994); New York re: Competitive Opportunities Available to Customers of Elec. and Gen. Serv., 154 Pub. Util. Rep. (PUR) 4th 19 (1994).

revolutionary change in which some electric utilities are going to wind up being dismembered with their customers', managers' and owners' blood all over the floor.

Let us identify some of the factors that will help shape the answer. First, when we use the word competition, it would be helpful to be sure that we are all talking about the same thing. For an economist, competition is the situation in which the prices of goods fall to their lowest competitive level. Buyers are assumed to have an endless supply of willing suppliers and the market excludes no one who is willing to participate in it. Obviously, when we are talking about competition in the electric utility industry, this textbook definition is not going to work. The classroom economic model is important because economic theory tells us that as competition moves prices down, we can expect that electric consumption will increase. However, this effect is at odds with another part of our nation's energy strategy -- the encouragement of conservation.

But getting back to defining competition at the retail level, are we speaking of utility-to-utility competition? Competition from new technology? Competition from new suppliers such as IPPs or EWGs? Competition from new fuel sources? Perhaps all of these.

For electric utilities, the simplest definition of competition is that it is anything that can take your customer and your customer's money away from you. This definition is important because it requires that we recognize not only what competitive market forces can do, but also what the Federal and state governments can do. It recognizes that in our political, economic system, business and government are tied together. On the economic or market side, the focus is on having market forces act to lower rates. Both utilities and commissions have been responding to these pressures with write-offs and the development of special contracts offering discounted rates, and the pace to date has been evolutionary rather than revolutionary.

C. State Restructuring Efforts.

Since the beginning of this year, bills addressing retail wheeling, electric competition and industry restructuring have been introduced in 13 states: Arizona, California, Connecticut, Florida, Illinois, Indiana, Louisiana, Maine, Massachusetts, New Hampshire, New Mexico, Texas and Vermont. While no state has passed a bill requiring retail wheeling or restructuring, bills authorizing studies of electric competition were approved in Illinois, Indiana, New Mexico and Texas. Study bills also are expected to pass in Connecticut and Maine.

At last count, regulators in 23 states have initiated discussions on retail wheeling: Arizona, California, Connecticut, Illinois, Indiana, Iowa, Louisiana (New Orleans City Council), Maine, Maryland, Massachusetts, Michigan, Minnesota, Nevada, New Hampshire, New York, North Carolina, Ohio, Pennsylvania, Rhode Island, Utah, Vermont, Washington and Wisconsin.[10]

However, while some states appear to be eager to implement retail competition, others are not so eager. For example, last week the Maryland Public Service Commission nixed the idea of retail wheeling[11] calling for sensible and progressive

[10]Edison Electric Institute, Retail Wheeling and Restructuring Report, June 1995.

[11]See *Electric Utility Week*, MD. PSC Retail Wheeling, August 28, 1995.

changes such as bidding for all new capacity to take advantage of wholesale competition. It is important to recognize that the state governments will be making the decision about the speed at which retail wheeling occurs.

D. The California Experience.[12]

In April of 1994 the CPUC became the first state authority to call for the complete restructuring of the utility industry. The CPUC issued a proposal (the "Blue Book") which promised customer choice through retail wheeling and abolished monopoly service territories. The Blue Book, however, did not abolish the obligation to serve. On May 24 of this year, the CPUC by a 3 to 1 vote issued a proposed policy decision adopting the "poolco" or wholesale pool model as its preferred industry structure, beginning January 1, 1997 with retail wheeling starting after January of 1999.

Under the poolco model, utilities would functionally unbundle generation, transmission, and distribution, and place transmission under the control of an independent system operator. The CPUC is committed to preserving the financial integrity of utilities during the transition and would honor past commitments. Stranded costs would be recovered.

To address the problems associated with the question of state/federal jurisdiction, the CPUC has espoused a strategy to engage their colleagues on the

[12]Due to environmental mandates, there are no coal plants in California. The heavy guidance of the CPUC and the state legislature also has resulted in some of the highest electric rates in the country.

FERC and other state regulatory commissions in what it calls "cooperative federalism" -- a "scheme of shared responsibility" in articulating a new industry structure.

IV. ENERGY POLICY ACT

A. Background

A continuing and critically important open question in our political/economic system is the relationship between business and government.

Economic activity of business intrudes on the governing function -- and government lays down rules and regulations for the economy -- in an ongoing process in which our economic system and our political order are integrally connected. The mix of government and business is one that is dynamic and ever changing.

This is the context in which we should think first about the Energy Policy Act of 1992.

Before we describe the specifics of the Act, it is helpful to look back at our country's recent history in developing energy policy and the problems the Act is supposed to deal with. The major problem is energy consumption.

The United States is the world's largest consumer of energy. With less than 5% of the world's population, we consume nearly 25% of the world's energy use everyday. In 1990 there were 189 million cars and light trucks in the United States. Our consumption of oil products is a daily average of 3 gallons for every person in the United States. That is more than 25% of all petroleum consumed worldwide everyday. A significant portion of our oil is imported, contributing significantly to our trade deficit, so we are dependent on foreign sources.

In the 70s, we had the oil embargo, which converted energy into a continuing national issue. President Carter, calling it the moral equivalent of war, identified three overriding energy objectives for the United States: (1) The short term objective was to immediately reduce dependence on foreign oil and vulnerability to supply interruptions; (2) The medium term objective was to keep U.S. imports low; and (3) The long term objective was to develop renewable and inexhaustible energy sources for sustained economic growth.

In the spring of 1977, during the Carter Administration, DOE was created to provide the leadership to solve the energy problem. As part of that law, Congress required the President to prepare and submit every two years a proposed national energy plan that would "consider and establish energy production, utilization and conservation objectives". The report was to pay particular attention to full employment, price stability, energy security, economic growth, environmental protection and the efficient utilization of public and private resources.

Our Presidents and the DOE have dutifully reported to the country and the Congress every two years on our energy situation. Included as Attachment C is an appendix taken from a law review article[13] that effectively describes our country's efforts at developing an energy policy since the Carter Administration. This appendix was developed simply by copying the table of contents of these Presidential and DOE reports.

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[13]See Chandler L. Van Orman, "The National Energy Strategy -- An Illusive Quest for Energy Security," 13 *ENERGY L. J.* 251 (1992).

The appendix indicates that under President Carter, the emphasis was on conservation and energy efficiency. Increased production was last. Carter's idea was proactive government with price and allocation regulations mandating conservation. It was under Carter that Congress created PURPA in 1978 which, among other things, required utilities to buy power from QFs. Also, power plant and fuel acts limited the use of natural gas as a boiler fuel for electric generation.

Under President Reagan -- increased production became the No. 1 priority. Reagan's approach was to rely on the private sector rather than government apparatus to manage energy markets.

President Bush also made energy one of his priorities. He determined to unleash the free market but said "government intervention will be reserved for those instances where necessary to remove or overcome barriers to an efficient market operation." Bush declared that energy security could be obtained not by reducing imports of foreign oil but by reducing the importance of foreign oil. Bush -- similar to Carter, moved "conservation and energy efficiency" to No. 1 and "increased production" to No. 5.

The point is that the Federal government has reshuffled our energy priorities, on a regular basis, about every two years. The reasons is that the three Es: economy, energy, and the environment -- are unextrically linked and interdependent, and therefore difficult to balance. One cannot really focus on one at the exclusion of the others, but rather must find a balance among all elements.

As far as the electricity business is concerned, in the DOE's interim report of April 1990, DOE reported that people were concerned about adequacy of electricity and fuel supplies. Several areas of the country had recently faced shortages of energy during both summer and winter peak periods of demand and DOE's deputy secretary Hansen Moore declared "utilities are not moving ahead with necessary capacity additions because the risk is too great. The industry stands paralyzed by a lack of confidence that sound business decisions made today will continue to enjoy public support in the future when subject to perfect 20/20 hindsight."

B. Desert Storm.

The Energy Policy Act of 1992 had its start in the fall of 1990 when Saddam Hussein invaded Kuwait, ultimately leading to Operation Desert Storm. This crisis evoked fears of oil price shocks and there were widespread calls for a new national energy policy. President Bush, in his 1991 State of the Union message, announced his intention to impose a plan to promote "energy conservation and efficiency, increased development and greater use of alternate fuels". However, following the brief Gulf War, the public's interest in energy policy again began to fade quickly. Bush quickly released his plan and there were alternate versions submitted by leaders of the House and the Senate.[14] After 18 months of consideration, Congress enacted a massive piece of legislation with some 30 separate titles designed to change the way

[14]For an informative history of the development of the Energy Policy Act of 1992 see, Jim Rossi, "Lessons From the Procedural Politics of the Comprehensive National Energy Policy Act of 1992," 19 *Harv. Envtl. L. Rev.* 195, (Winter 1995).

the United States consumes and produces energy. (Included as Attachment D is the actual index to the Energy Policy Act.)

C. Electricity Titles.

For electric utilities we need to be concerned principally with two titles -- Title 1 and Title VII.

The centerpiece of the Energy Policy Act is Title I, entitled "Energy Efficiency". This section includes seven subtitles including sections that require state regulatory commissions to consider two new regulatory standards. The first standard would require electric utilities to employ Integrated Resource Planning or IRP.

Under this section of the Act, when seeking out new energy resources, electric utilities must look at a full range of alternatives including conservation and demand-side management or DSM. This is the second new standard, and under it energy efficiency programs are to be at least as profitable as new energy supply options.

By requiring these activities, the Energy Policy Act increases state regulation and transfers decision-making concerning future electric power resources from electric utilities to state regulators.

The second title of interest is Title VII, in which Congress essentially sought to encourage competition in the electric utility industry, by amending the Holding Company Act, creating a new class of exempt wholesale generators, and second by, providing the FERC with authority to order the wheeling of electricity. In dealing with our question of evolution vs. revolution, we have to recognize that through the Energy Policy Act Congress acted to increase <u>both</u> competition and regulation. For there to be either rational evolution or revolution, there must be a reconciliation of these competing ideas of increased competition and increased regulation.

However, *in combining these activities once thought to be mutually exclusive,* Congress did not create a new regulatory system or act to reallocate existing regulatory responsibilities between the federal and state government. This is an important and vexing problem that has yet to be resolved.

V. THE THIRD REVOLUTIONARY IDEA: INTEGRATED RESOURCE PLANNING AND UTILITY SUBSIDIZED CONSERVATION PROGRAMS OR "DSM"

Another revolutionary-force affecting the electric utility industry is the interest of government in requiring investments by electric utilities in conservation to reduce customers' electricity consumption. These initiatives have variously been labeled "negawatts: or demand-side management or DSM programs. The object is not to have electric utilities expand their plant to meet projected electricity demand, but to require electric utilities to balance supply and demand in the most economic way possible. In the Act, there is also a requirement that this process provide opportunity for public participation and that the plan that is determined by the state commission be implemented. More than 30 states have adopted programs for IRP and DSM initiatives. They have also adopted extensive rules and regulations for preparing an IRP. How do we square mandated DSM/IRP procedures -- which are centrally controlled and regulated -- with the competitive/market model that relies on the decisions of individual consumers? The disturbing answer is that many apparently believe that government must act to influence market decisions for desired social outcomes.

In a typical IRP proceeding, an electric utility will prepare and file its load forecast and a proposed resource plan with the state regulatory commission. The utility's filing will normally be developed by following comprehensive state regulations and will provide forecast data typically looking into the future some 20 or more years. The utility's filing will then be subject to review and hearing including representatives of the public such as the state's consumer advocate and the commission's technical staff; representatives of low income consumers; representatives of large and small industrial customers; representatives of large and small commercial customers; representatives of city and municipal governments; and representatives of environmental groups. Also appearing in these proceedings are representatives of competing fuels such as, gas, coal, and of course, representatives of alternate power suppliers, cogenerators, IPPS, and EWGs. Since the proceeding will be reviewing the utility's efforts to balance supply and demand, you may also hear from those representing heating and air conditioning contractors. The end result is supposed to be an appropriately-balanced plan reflecting both supply-side and demand-side programs. Of course, the idea of utility subsidized conservation and competition are ideas normally thought to be mutually exclusive.

VI. THE FOURTH REVOLUTIONARY IDEA: COMPARABILITY AND TRANSMISSION ACCESS

A. The FERC.

The members of the current FERC were all appointed by President Clinton. Senator Bennett Johnson (D-La) has labeled the group the "dream team."[15]

Elizabeth "Betsy" Moler is a Democrat born in Salt Lake City, Utah. She has a BA, American University; JD, George Washington University and has a Capitol hill background, last as senior counsel to the U.S. Senate Energy and Natural Resources Committee.

Vicky A. Bailey is a Republican born in Indianapolis, Indiana. She has a BS from Purdue and is a former Indiana URC Commissioner.

James J. Hoecker is a Democrat born in Eagle River, Wisconsin. He has a BA, Northland College; MA/Ph.D, University of Kentucky; JD from the University of Wisconsin and is a former FERC staffer.

William L. Massey is a Democrat born in Malvern, Arkansas. He has a JD from the University of Arkansas and Master of Laws from Georgetown. He served as chief counsel to U.S. Senator Dale Bumpers (D-Arkansas).

Donald F. Santa, is an Independent and was born in Connecticut. He has an AB from Duke and a JD from Columbia. He was formerly counsel for the Senate Energy and Natural Resources Committee.

B. FERC's Initiatives.

The "Dream Team" hit the ground running with these initiatives and cases:

(a) Initiatives

(1) Regional Transmission Groups RM93-3-000

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[15]One assumes the reference is to the U.S. basketball team comprised of NBA stars that dominated and won the gold medal in the 1992 Summer Olympics and not the movie of the same name that starred Michael Keaton in the funny story about four inmates from a mental hospital whose psychiatrist is mugged on the way to a ball game, leaving the patients to fend for themselves.

(2) Reporting Requirements Implementing Section 213(b) of the Federal Power Act, RM93-10-000

(3) Inquiry Concerning Transmission Pricing, Notice of Technical Conference and Request for Comments, RM93-19-000

(4) FERC Policy Statement on Good Faith Requests for Transmission Access and Responses Thereto Under the Energy Policy Act, PL93-3-000

(5) Notice Requirements for Section 211 Applications, RM93-22-000

(b) Section 211 Applications for Transmission Service

(1) Tex-La Electric Cooperative of Texas, Inc., Docket No. TX93-1-000

(2) Cities of Bedford, Danville, Martinsville and Richlands, Virginia, Blue Ridge Power Agency, Docket No. TX93-2-000

(3) Wisconsin Electric Power Company, Docket No. TX93-3-000

(4) Florida Municipal Power Agency v. Florida Power & Light Company, Docket Nos. EL93-51-000 and TX93-4-000

C. Comparability and Transmission Access.

On March 29, 1995, FERC proposed a new rule entitled:

Promoting Wholesale Competition Through Open Access

Non-Discriminatory Transmission Service in Public Utilities.

RM95-8-000

and

Recovery of Stranded Costs by Public Utilities and Transmitting Utilities

RM95-7-000

This is the "Mega-NOPR."

The FERC states that the purpose of the proposed rule is to (1) promote wholesale competition, (2) remedy undue discrimination in the provision of wholesale transmission services by public utilities and (3) establish standards that a public utility or transmitting utility must meet to recover stranded costs through FERC jurisdictional rates.

Each public utility that owns or controls interstate transmission facilities must have on file at FERC open access tariffs that offer wholesale transmission services comparable to those that the utility provides to itself in serving its own power customers. The tariffs must offer network and point-to-point wholesale transmission services, and ancillary services, to any entity eligible to request transmission under § 211 of the Federal Power Act. The FERC also proposed specific tariffs for comment.

Under the proposed rule, each public utility must functionally unbundle its wholesale transmission services. That is, it must:

1. Quote separate prices for wholesale generation and transmission;
2. Take transmission service for wholesale power sales and purchases under its own tariffs;
3. Through a RIN (real-time information network), get information about its transmission system, for its own wholesale power transactions, in the same way as its competitors do.

The rule also proposes a clearer distinction between transmission and local distribution facilities in an attempt to draw a bright line between federal and state jurisdiction.

In the Mega-NOPR, the Commission has chosen to exercise its new powers under the Energy Policy Act of 1992 in a bold and constructive way to order wholesale transmission service and to further open wholesale markets to competition. The Commission's effort, however salutary, leaves unresolved at least three critical questions.

(1) What mix of competition and regulation will best serve the public interest to assure an abundant supply of economic electric energy throughout the United States?

(2) How is this mix of regulation and competition to be allocated among the state and Federal governments?

(3) How are these determinations going to be made?

Drawing lines to determine the appropriate jurisdiction and mix of state and Federal regulation over electric utilities is critical to the promotion of competition. More important, is who draws the lines: is the development of the answer to these questions to be left to the Congress?; to the various state legislatures?; to various state and Federal courts with the Supreme Court having the final word?

The National Association of Regulatory Utility Commissioners (NARUC) Executive Committee has adopted a statement giving some support to the Commission's wholesale competition goals but also posing a challenge to FERC on the issue of where Federal jurisdiction ends and state jurisdiction begins. At the heart of the debate between the Federal and state governments is the critical question of what is the best institutional framework to ensure rational and efficient business conduct on the part of utilities to assure the provision of reliable and economic electric service to consumers.

To deal with the jurisdictional confusion between the two sovereigns over the regulation of electricity, perhaps the FERC should avoid the adoption of a preemption principle and instead send a plain message that state legislatures and regulators should deal with retail competition. If the FERC believes it is unable to do this based on its understanding of the current state of the law, then perhaps it should take the initiative to develop a legislative proposal to have the issue resolved by the Congress and not by the courts.

The statute books of every state contain innumerable laws and regulations which touch the central nervous system of the competitive order for electric utilities. Regulatory control of industries affected with a public interest is applied when the operation of market forces would be inadequate to protect the public. Indeed, under existing laws, regulatory agencies are required to take competitive considerations into account in their decision-making processes along with the many other factors as may bear on the public interest. In promoting the restructuring of the electric industry, the real concern should be with the coordination of regulation and competition to provide a rational system of controlling business conduct that will meet the current needs of our nation and our economy. When, as here, there are opposing arguments that the Congress has thus far failed to deal with on this difficult policy question, the burden of reconciling regulatory and competitive objectives, absent action by FERC, will be passed to the judiciary with the Supreme Court acting as final arbiter. Common sense should tell us that these policy questions should not be resolved in an adversarial context. A court has none of the resources for the legislative-type investigation needed to reach rational and productive decisions with respect to the best means of ordering economic behavior in the public interest. The political tools of policy-making -- bargaining, advocacy, negotiation and compromise -- are the means by which workable solutions can be found to these issues, and those tools should be employed to build a consensus with all parties with a vested interest in restructuring.

VII. New Directions

A. Electric Utilities are Traveling on Different Paths.

(1) Diversification Efforts

(2) Mergers and Acquisitions

(3) Foreign Ventures

(4) IPP/EWG Development

(5) Conservation Subsidiaries

(6) Payments to Appliance Manufacturers to Produce More Efficient Appliances (Golden Carrot Investments)

(7) Electric Cars

(8) Transmission Haves v. Have-Nots

(9) Loop Flows

(10) Decline In Level of Cooperation With Interconnected Neighbors

B. State Commissions are Also Traveling on Different Paths

(1) Approach to IRP Proceedings

(2) Externalities

(3) DSM

(4) Revenue Decoupling

(5) Incentive Rates

(6) Competitive Bidding

(7) Retail Wheeling

C. Coal and Electricity Markets.

What does the future look like for coal and electricity? Current coal industry reports have one group of analysts forecasting that coal's share of U.S. electricity production -- which is currently around 56% -- will decline to about 52% by the year 2000. Another, presumably just as learned, expects the use of coal for electric generation to increase to 60%. The difference in perception recalls an old story on market research.[16] It seems that some years ago a top shoe manufacturer decided to determine the market potential for its shoes in one of the world's lesser developed countries. Being very cautious the shoe manufacturer employed two independent market research firms. Each firm dispatched its own group of market consultants and conducted its own market study. In due course the shoe manufacturer received two

[16]Glenn G. Wattley and Lenore West, "A New World of Challenges and Opportunities for Coal Producers Serving the Utilities Industry," *Coal*, p. 52, June 1995.

reports. The first report concluded -- No market here. Nobody wears shoes. The second report concluded -- Great market here. Nobody wears shoes and there are no competitors.

The story is not to be critical of market researchers but to point out that when people talk about the outlook for coal and electricity, we tend to hear about either a doomed market or a booming one.

VIII. Conclusion

Let's sum up the problems the Energy Policy Act of 1992 set out to solve.

1. We consume too much energy. A big part of it is driving around in 189 million cars and light trucks.

2. We need to reduce our dependence on foreign oil.

3. People are concerned about their supply of electricity because utilities are reluctant to build. People also are concerned about energy production and consumption and what that is doing to the environment. The answer appears to be to increase energy efficiency, which will reduce pollution, our dependence on imports and reduce the cost of energy.

As we look at the Energy Policy Act, we can ask if there really was congressional action on these concerns. But as we look at the revolutionary and evolutionary forces that are changing the industry, we must still ask is there a clear vision of where the electricity sector is going, how it is going to get there and why we think that its a good idea to go there in the first place.

ATTACHMENTS

LEGAL NOTICES

NOTICE OF REQUESTS FOR PROPOSALS

Southwestern Public Service Company (SPS) headquartered in Amarillo, Texas, intends to issue five Requests for Proposals (RFPs) on September 15, 1995 in an all-source bidding process. The RFPs are expected to be issued for Demand-Side Management Alternatives, Interruptible Loads, Supply-Side Resources, Renewable Resources and Off-System Power Purchases. SPS expects to procure approximately 200 MW of capacity to be on-line as of June 1, 1998 and an additional 100 MW to be on-line as of June 1, 1999. Parties wishing to receive a copy of an RFP should indicate which RFP and contact:

Southwestern Public Service Company
Attention: Mr. Alan Higgins
Mail (USPO) . . . P.O. Box 1261
Amarillo, TX 79170
Courier . . . Sixth and Tyler, Suite 2401
Amarillo, TX 79101
Voice . . . (806) 378-2150
Fax . . . (806) 378-2181
E-Mail . . . alanh@arn.net

B6 THE WALL STREET JOURNAL FRIDAY, SEPTEMBER 1, 1995

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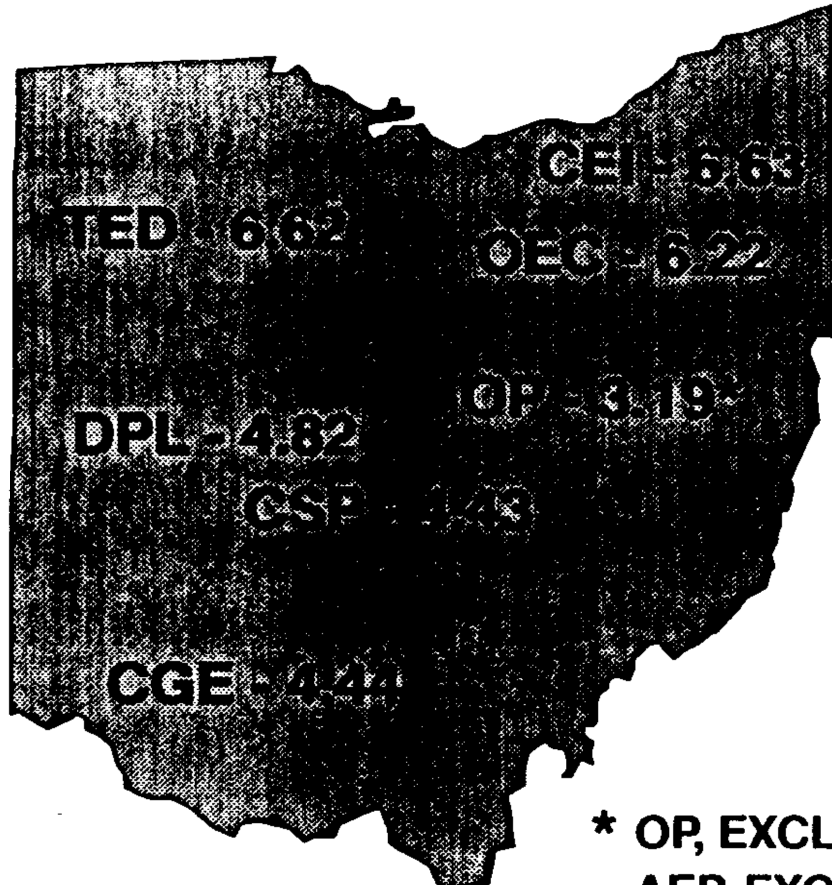


* OP, EXCL. ALUM. = 3.86
AEP, EXCL. ALUM. = 3.97

National Energy Policies — Tables of Contents Comparison   Appendix A

Table of Contents Order	1977 CARTER	1979 CARTER	1981 REAGAN	1983 REAGAN	1985 REAGAN	1987 REAGAN	1990 BUSH	1991 BUSH
1	Conservation and Energy Efficiency	Conservation and Energy Efficiency	Increased Production	Regulatory Reform	Increased Production	Increased Production	Conservation and Energy Efficiency	Conservation and Energy Efficiency
2	Alternate Fuels Development and Use	Regulatory Reform	Regulatory Reform	Increased Production	Research and Development	Conservation and Energy Efficiency	Increased Production	Research and Development
3	Research and Development	Alternate Fuels Development and Use	Conservation and Energy Efficiency	Conservation and Energy Efficiency	Regulatory Reform	Regulatory Reform	Research and Development	Regulatory Reform
4	Regulatory Reform	Research and Development	Alternate Fuels Development and Use	Research and Development	Conservation and Energy Efficiency	Research and Development	Alternate Fuels Development and Use	Alternate Fuels Development and Use
5	Increased Production	Increased Production	Research and Development	Alternate Fuels Development and Use	Alternate Fuels Development and Use	Alternate Fuels Development and Use	Regulatory Reform	Increased Production

1977- Exec. Office of the President, *The National Energy Plan*, (1977).

1979- U.S. Dep't of Energy, *National Energy Plan II*, (1979).

1981- U.S. Dep't of Energy, DOE/S-0008, *Securing America's Energy Future, The National Energy Policy Plan*, (1981).

1983- U.S. Dep't of Energy, DOE/S-0014/1, *The National Energy Policy Plan*, (1983).

1985- U.S. Dep't of Energy, DOE/S-0049, *The National Energy Policy Plan*, (1985).

1987- U.S. Dep't of Energy, DOE/S-0057, *Energy Security: A Report to the President of the United States*, (1987).

1990- U.S. Dep't of Energy, *Interim Report, National Energy Strategy: A Compilation of Public Comments*, (1990).

1991- U.S. Dep't of Energy, *National Energy Strategy, Powerful Ideas for America*, (1st ed. 1991/1992).

SECTION 1. SHORT TITLE; TABLE OF CONTENTS.

(a) SHORT TITLE.—This Act may be cited as the "Energy Policy Act of 1992".

(b) TABLE OF CONTENTS.—

TITLE I—ENERGY EFFICIENCY

Subtitle A—Buildings

Subtitle B—Utilities

Subtitle C—Appliance and Equipment Energy Efficiency Standards

Subtitle D—Industrial

Subtitle E—State and Local Assistance

Subtitle F—Federal Agency Energy Management

TITLE V—AVAILABILITY AND USE OF REPLACEMENT FUELS, ALTERNATIVE FUELS, AND ALTERNATIVE FUELED PRIVATE VEHICLES

TITLE VI—ELECTRIC MOTOR VEHICLES

Subtitle A—Electric Motor Vehicle Commercial Demonstration Program

Subtitle B—Electric Motor Vehicle Infrastructure and Support Systems Development Program

TITLE VII—ELECTRICITY

Subtitle A—Exempt Wholesale Generators

TITLE XII—RENEWABLE ENERGY

TITLE XIII—COAL

Subtitle A—Research, Development, Demonstration, and Commercial Application

Subtitle B—Clean Coal Technology Program

Subtitle C—Other Coal Provisions

TITLE XIV—STRATEGIC PETROLEUM RESERVE

TITLE XV—OCTANE DISPLAY AND DISCLOSURE

TITLE XVI—GLOBAL CLIMATE CHANGE

TITLE XVII—ADDITIONAL FEDERAL POWER ACT PROVISIONS

TITLE XVIII—OIL PIPELINE REGULATORY REFORM

TITLE XX—GENERAL PROVISIONS; REDUCTION OF OIL VULNERABILITY

Subtitle A—Oil and Gas Supply Enhancement

Subtitle B—Oil and Gas Demand Reduction and Substitution

TITLE XXI—ENERGY AND ENVIRONMENT

Subtitle A—Improved Energy Efficiency

Subtitle B—Electricity Generation and Use

Subtitle C—Advanced Nuclear Reactors

TITLE XXII—ENERGY AND ECONOMIC GROWTH

TITLE XXIII—POLICY AND ADMINISTRATIVE PROVISIONS

TITLE XXIV—NON-FEDERAL POWER ACT HYDROPOWER PROVISIONS

TITLE XXV—COAL, OIL, AND GAS

TITLE XXVI—INDIAN ENERGY RESOURCES

TITLE XXVII—INSULAR AREAS ENERGY SECURITY

TITLE XXVIII—NUCLEAR PLANT LICENSING

SEC. 2. DEFINITION.

For purposes of this Act, the term "Secretary" means the Secretary of Energy.

MATRIX OF RETAIL WHEELING AND COMPETITION ACTIVITIES IN THE STATES

June 1995

State	Regulatory Commission Actions	Legislative Actions	Comments/Other Activities
Alabama			
Alaska			
Arizona	Restructuring Inquiry continues in workshops	Retail Wheeling Bill Died	
Arkansas			
California	Proposed Decision adopting Poolco 5/24/95	Legis. and Hearings on restructuring	Comments on PUC proposal due 7/24, replies 8/23
Colorado			
Connecticut	Restructuring Inquiry expected 7/95	Study bill expected to pass	Retail Wheeling rejected by DPUC 9/94
Delaware		Alternative Regulation bill expected to pass	Govnr Task Force report 5/94
D.C.			
Florida		Study bill died	
Georgia			
Hawaii			PUC to investigate NUG competition
Idaho			
Illinois	Task Force report issued 5/1	Study Bill passed, Retail Wheeling Bill defeated	Follow-on Task Force meetings scheduled
Indiana	Informal discussions on competition	Alternative Regulation and Study Bill became law 4/95	
Iowa	Retail competition inquiry hearing 4/95		
Kansas		Educational hearing on retail wheeling set for legislative interim	
Kentucky			9/22/94 conference on retail wheeling
Louisiana	Petition for self-service wheeling pending	Retail wheeling bill introduced	New Orleans PUHCA and competition inquiry
Maine	Stranded Cost Rulemaking terminated	Retail Wheeling, Muni bills defeated; Study bill expected to pass.	Rate, competition, Muni matters before PUC
Maryland	Competition inquiry order expected 6/95		
Massachusetts	Restructuring inquiry, incentive reg NOI final order 2/95, wwires access bidding pilot proposed	Retail Wheeling, Discount, Muni & study bills pending	Rate, competition, restructuring, collaborative and retail wheeling proposals.
Michigan	ALJ wheeling experiment rate decision 2/95; PSC final order expected		Detroit Edison federal appeal of PSC interim decision dismissed without prejudice
Minnesota	Investigation of competition opened 4/95		
Mississippi			
Missouri			
Montana			
Nebraska			
Nevada	Inquiries to inform PSC retail wheeling restructuring impacts on state	Study bill expected to be introduced	Retail wheeling lawd for 1 new plant 6/93
N. Hampshire	Competition roundtable; Reseller May Sell at Retail 5/31/95	Retail Wheeling pilot and study bill pending; other bills deferred	Roundtable report due 6/95

New Jersey	Retail Wheeling inquiry expected later	Alternative Reg. and Flex. rate bill	Energy Plan adopted 3/95
New Mexico	*PSC commissioned retail wheeling* reports	*Retail Wheeling, discount, diversification* bills died; study bill passed	*Study cmte recommended further study of* retail wheeling 1/95. Study bill vetoed
New York	Competition inquiry continues; Retail Wheeling petitions; NUG Retail Sale Appealed	Draft bill for in-service area retail wheeling for NUGs renegotiating 6¢ contracts, circulated	PSC colloborative on principles & models continue
N. Carolina	Petition for retail wheeling inquiry 2/8		
N. Dakota	PSC to open alternative regulation rulemaking		
Ohio	Roundtable discussions on competition continue	Reintroduction of retail wheeling bill expected; 1994 bill died	Meetings with retail wheeling legislator; power supply matters
Oklahoma	Rulemaking on special contracts voted 2/10/95		
Oregon		Bill introduced to clarify PUC's alternative regulation authority	
Pennsylvania	Retail wheeling inquiry order expected 6/95; Retail Wheeling petition		
Rhode Island	*Colloborative principles on restructuring* & retail wheeling filed 5/12/95	*Bill to remove utility franchise to serve* industrial park pending 5/12/95	*Industrial park selected non-utility* supplier
S. Carolina			
S. Dakota			
Tennessee			
Texas		Legislation passed expanding wholesale competition, setting competition study; retail wheeling deleted	Passed Bill did not address retail or self-service wheeling
Utah	PSC participating in informal restructuring/competitions discussions		
Vermont	*Roundtable discussions continue; report* expected 7/95	*Retail Wheeling study bill died*	*Large user group formed*
Virginia			"Muni - lite" request
Washington	Competition inquiry continues		
W. Virginia			
Wisconsin	Competition inquiry continues with advisory committee recommendations due 9/95; PSC report 12/95		
Wyoming			Conference 10/94

UPDATE ON EXTERNALITIES

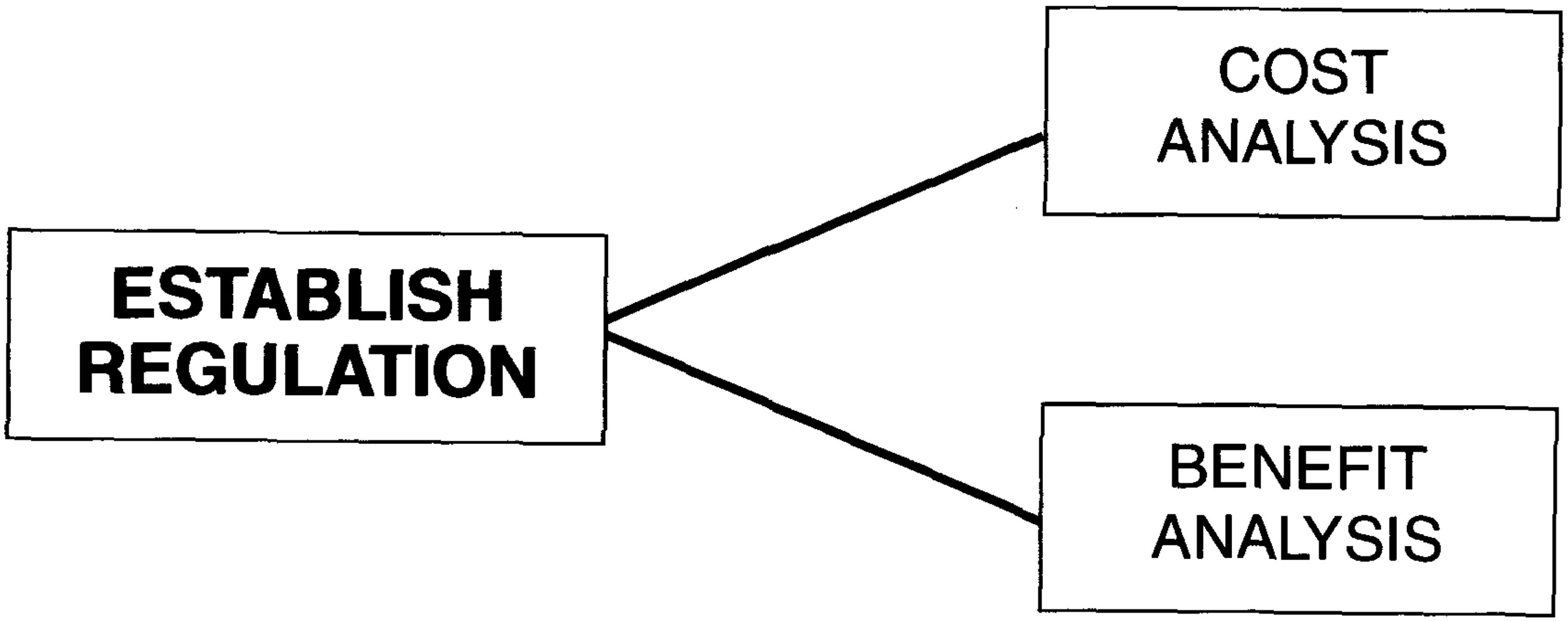
PALMER, FRED
WESTERN FUELS ASSOCIATION

ENVIRONMENTAL EXTERNALITIES IN COST/BENEFIT ANALYSIS

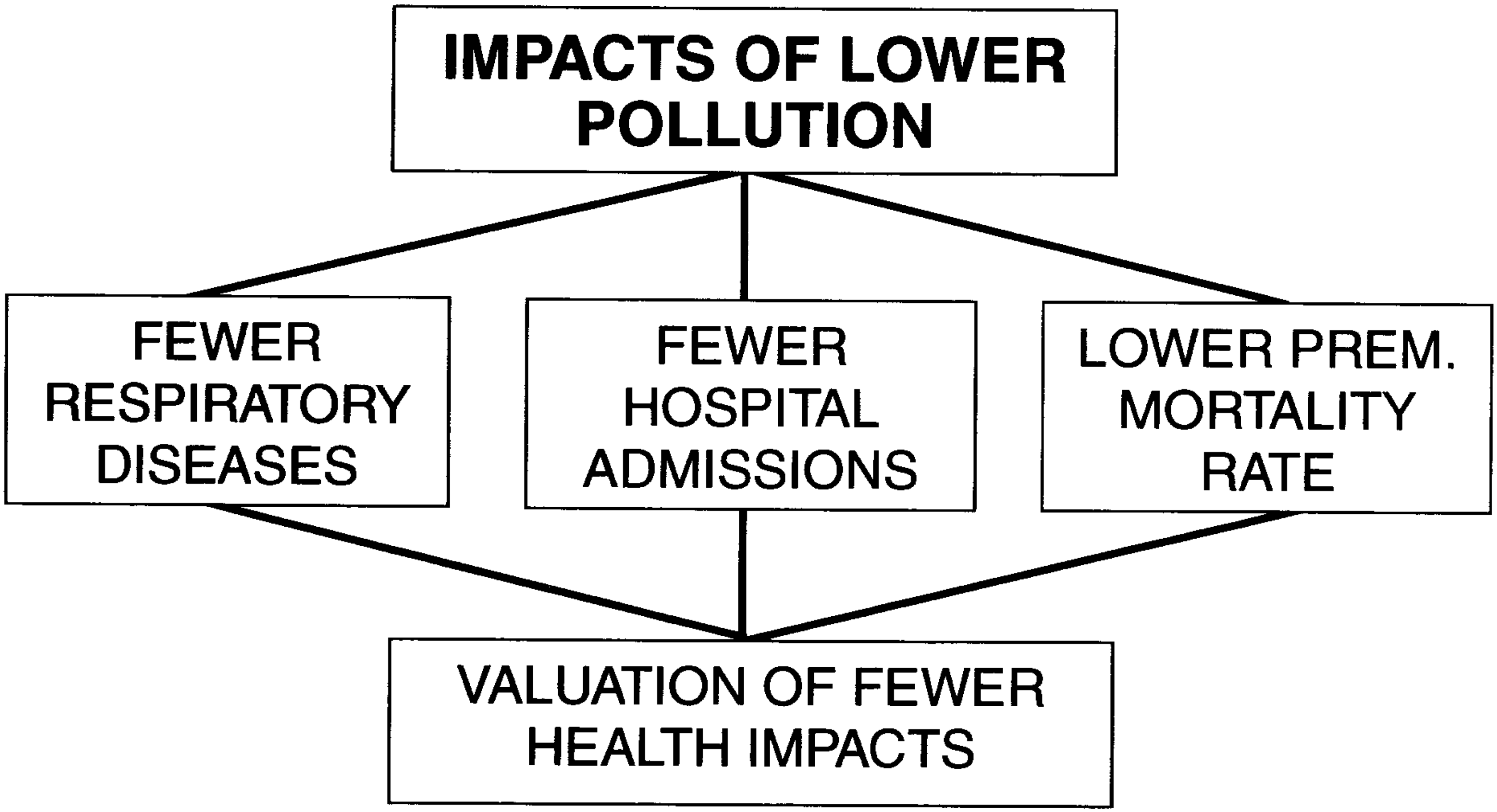
- ENVIRONMENTAL LAWS AND REGS:
  NEED TO VALUE ENVIRONMENTAL BENEFITS,
  COMPARE WITH COSTS

- CALCULATIONS OF DAMAGE USED IN
  EXTERNALITY VALUATION ALSO NEEDED
  FOR COST/BENEFIT VALUATION
  - COST OF PRESENT EMISSIONS
  - BENEFITS OF REDUCED EMISSIONS

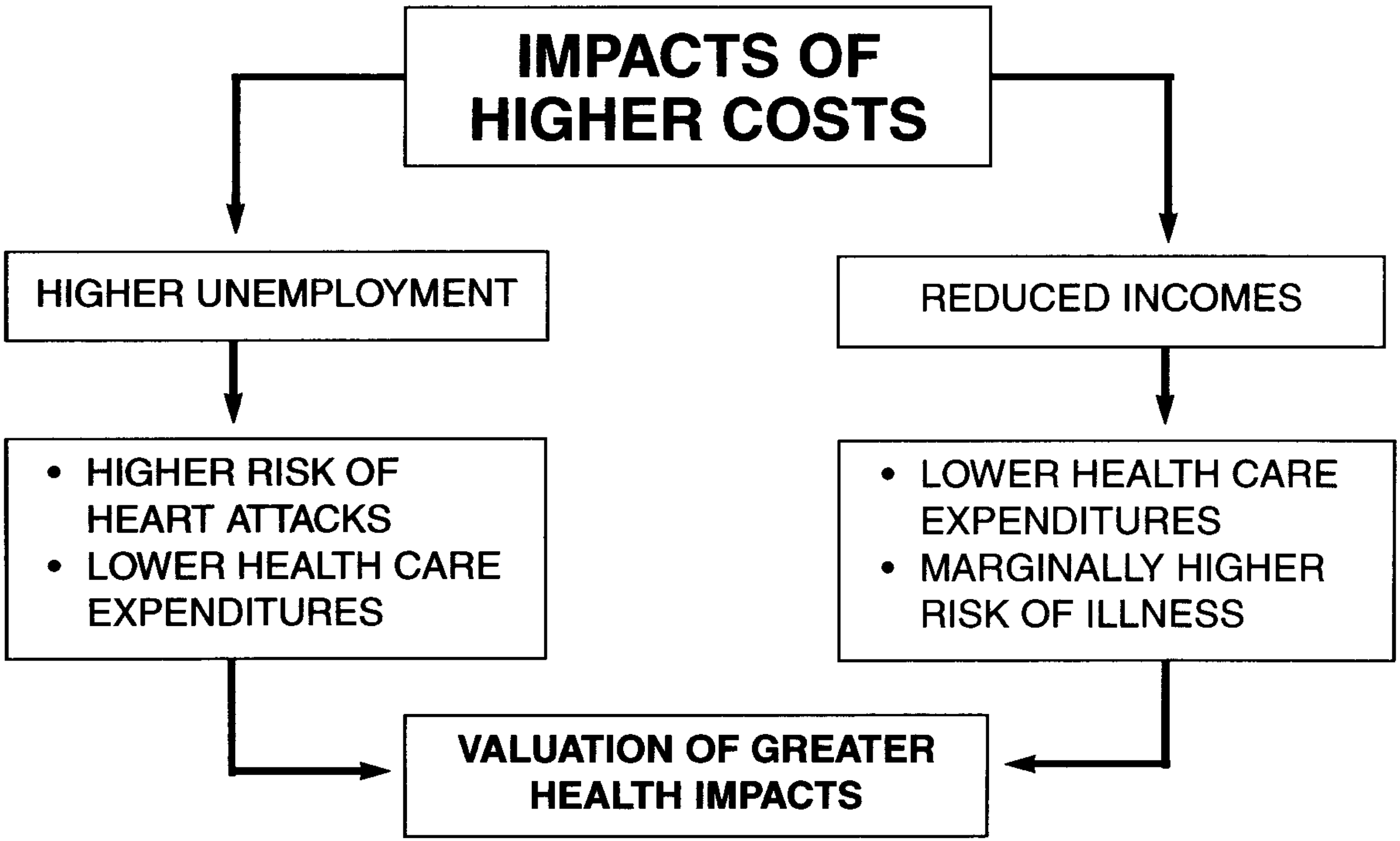
PARTIAL COST/BENEFIT ANALYSIS FOR ENVIRONMENTAL REGULATIONS



PARTIAL BENEFIT ANALYSIS



PARTIAL COST ANALYSIS



INCREASED SOCIAL COSTS DUE TO CHANGES IN UNEMPLOYMENT, PER CAPITA INCOME, AND THE BUSINESS FAILURE RATE DURING THE 1973-74 RECESSION
(In 1980 Dollars)

Social Stress Indicator	*Impact on Economy*	*Increased Social Cost ($)*
Total Mortality	Total Fatal Illnesses	26 Billion
Cardiovascular Mortality	Diseases of Circulatory System	16 Billion
Population in Mental Hospitals	Hospitalization in State & County Mental Institutions	496 Million
Suicides	Suicides	31 Million
Total Arrests	Criminal Justice System	2 Billion
Arrest for Fraud & Embezzlement	White collar Crime	3 Billion
Homicides	Homicide	137 Million

Note: *The 1973-74 recession was defined by the peak of November 1973 and the trough of March 1975.*

Source: *Joint Economic Committee of U.S. Congress, 1984*

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EXAMPLES OF RECENT CALCULATIONS OF ECONOMIC IMPACTS OF EMISSIONS

- 1995 AMERICAN LUNG ASSOCIATION STUDY: "DOLLARS AND CENTS"

  CALCULATES ECONOMIC BENEFITS OF REDUCTIONS IN PARTICULATE EMISSIONS

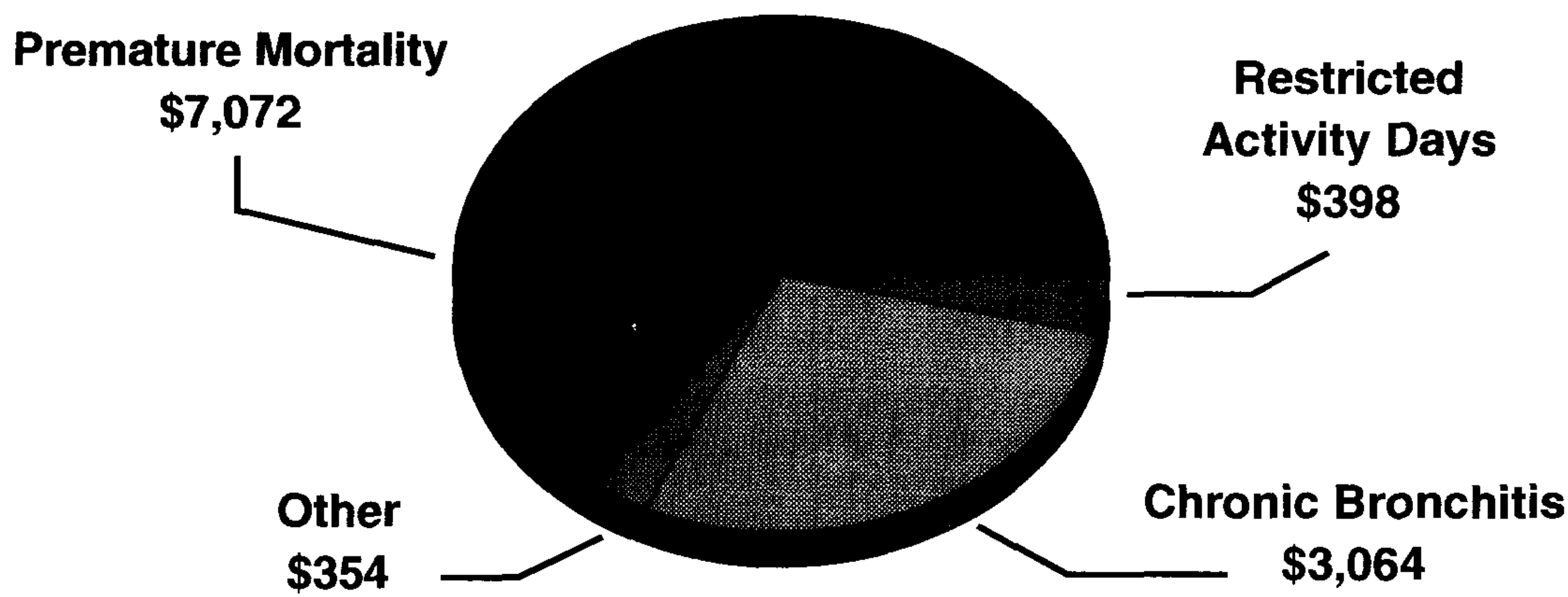
- "CONTROLLING URBAN AIR POLLUTION: A BENEFIT-COST ASSESSMENT," IN <u>SCIENCE</u> MAGAZINE, APRIL 1991

  CALCULATES COSTS OF TODAY'S EMISSIONS

Estimated Annual Health Benefits if 1993 U.S. PM_{10} Concentrations were Reduced to Current California Standards

(AFTER MEETING CURRENT FEDERAL STANDARDS)

Millions of 1st Quarter 1995 Dollars



SOME ISSUES IN DEVELOPING EXTERNALITY COST ESTIMATES FOR C/B ANALYSIS

- WHAT IS THE VALUE OF REDUCTION IN RISK OF DEATH?
  - POLITICAL ISSUE WITH RECENT WORLD BANK CALCULATION
  - DEGREE OF PREMATURE MORTALITY
  - ACCIDENTAL DEATH STUDIES
- HOW VALUE GOODS NOT IN MARKETS?

ALTERNATIVE METHODS TO C/B ANALYSIS FOR EVALUATING ENVIRONMENTAL RISKS?

- HEALTH/HEALTH ANALYSIS
  - AVOID CONTENTIOUS ISSUE OF VALUATION OF HUMAN LIFE

    BUT IS THIS NECESSARILY RIGHT?
  - DOESN'T INCLUDE NON-HEALTH IMPACTS IN VALUATION

EXTERNALITIES AND CLIMATE CHANGE

- CAN'T MONETIZE AN EXTERNALITY UNLESS CAN CALCULATE DAMAGE

- NEVERTHELESS, SOME EARLY ATTEMPTS TO DEVELOP EXTERNALITY FIGURES

- OFFSETS POLICIES AS ALTERNATIVE
  - STATES
  - DOE *CLIMATE CHALLENGE* PROGRAM

NEED FOR ADDITIONAL SCIENCE TO BETTER ASSESS POTENTIAL CLIMATE CHANGE: AN EXAMPLE

- RECENT DISCOVERY THAT CLOUDS ABSORB MORE SUNLIGHT THAN SCIENTISTS HAD THOUGHT
  - RESULT: LESS NEED TO USE "FUDGE FACTORS" IN COMPUTER MODELS
  - DON'T YET KNOW EFFECT ON GLOBAL OR REGIONAL MODELLING
- MAY NEED SEVERAL MORE SUCH SCIENTIFIC ADVANCES

SUMMARY

- EXTERNALITY CALCULATIONS WILL SURVIVE AS LONG AS THERE IS INTEREST IN COST/BENEFIT ANALYSIS
- REGULATORY USE OF MONETIZED VALUES, HOWEVER, IS LESS EASILY PREDICTED
- RESEARCH MUST CONTINUE, TO HELP PROVIDE BETTER ANSWERS
- STILL, THERE WILL ALWAYS BE DISPUTES OVER SCIENCE AND ECONOMICS

At the Fourth Annual Clean Coal Technology Conference
Thursday, September 7, 1995

Presentation of Thomas J. Grahame
U.S. Department of Energy
"Current Externalities Issues: Update on Economics and Science"

When I saw that Fred Palmer was speaking on externalities today, and that he was speaking before me, I recognized that with regard to the legal status of externality issues in the various states, the field would be preempted. Instead, my talk today goes beyond the kind of talk that I have given on externalities previously. While my previous talks looked at issues in individual states, today I am not going to do very much of that, partly because of Fred's discussion, but also partly because it is very clear that the trend toward monetization in individual states seems to be coming to a halt pretty fast for a number of reasons.

However, there are other issues, such as cost-benefit analysis, that are quite important and which tie in very closely with externalities issues. These will be the themes of my talk today. There are increasing calls for cost-benefit analysis, increasing calls for "good science". The academic community has been calling ever more loudly for a couple of decades for more cost-benefit analysis, and in the last 5 years or so politicians have also been calling more loudly for "good science" (whatever that means) and for more cost benefit analysis.

There is a perception is that we have a lot of laws and regulations that were passed without the benefit of this kind of examination. Many perceive that perhaps we would not have in place (certainly not in the form they are in right now) laws like the present form of the Superfund law. There are water safety laws and regulations controlling pesticide concentrations in water to a few parts per billion, even if most scientists believe risks from such tiny concentrations are negligible, and without apparent regard of the costs to, or desires of, affected communities. Other areas where some believe that cost-benefit analysis and/or "good science" could be usefully applied would include the Delaney clause, and (I would argue) some of the early externality values. There is in fact a close relationship between the calls for "good science" and cost benefit analysis, and newer externality values that have recently been published. I will discuss these "good science" externality values in a few moments.

I'll summarize my main points and then address a couple of them in greater detail. The first point is that the early "proxy", externality values constituted "bad science." These early values were not based on any estimate of damage, and as most of you know, the theory of externalities is that if there is some impact, positive or negative, that is not reflected in the price of a good, then the customer is not seeing the full price of the production and/or consumption of that good. In the case of pollution, normally the externality would be damage, so there would need to be some scientific calculation of that net damage. These early proxy values simply did not examine damage. Proponents of these "proxy" values simply said, we know there is damage but we can't figure out what it is, it's too complex. So we'll try a different method. This is bad science: there is no physical science, and bad economic science.

My second point, corollary to the first, is that environmental cost-benefit analysis needs good science estimates of net, actual impacts. If you are going to do cost-benefit analysis of environmental laws or regulations, and you want to base the analysis on good science, you need economic tools to estimate dollar values for environmental impacts. You can't do cost-benefit analysis of an environmental law or regulation unless you can put dollar values on the impacts of the pollutant, if that is what you are looking at. So cost-benefit analysis needs good science.

Third point: in my judgement, we are beginning to develop such good science studies. In the context of externalities, these studies are called "damage function method" (DFM) studies, and they are simply studies that attempt to explicitly and carefully identify and quantify all important impacts, and put a net economic value on them. We now have some studies that I would argue use this good science method. Oak Ridge National Laboratory, with Resources for the Future, has done studies for the Department of Energy which took about 3 years to complete, and there is now a study from New York State which utilized some of the experience of the Oak Ridge study and was completed in a shorter time.

I do need to say, however, that while use of the damage function method is a necessary condition for a "good science" externality study, it is not a sufficient condition. There is another study, done by Pace University Law school, which some economists would say was a sloppy attempt to try to estimate damage costs. The Pace study developed numbers that attempted to represent damage, but scientists that have reviewed the study found that the job done in that study was simply not adequate. So the DFM is necessary but not sufficient for a "good science" examination of externality values.

The fourth point is that difficult issues remain on both the cost side and the benefit side for cost-benefit analysis. The Oak Ridge and the New York studies are state-of-the-art, but that doesn't mean that they are necessarily good enough to do the kind of cost benefit analysis that will be accepted by economists or by the public. The faults, such as they may be, lie not with the studies themselves, but with the current state of economic science. These issues must be addressed before political bodies and the public can have confidence in the results.

The last issue, that the future of externality values at the state level is uncertain, has been covered by many speakers, here and elsewhere. The advent of competition may put the last nail in the coffin of expanding state use of monetized externalities, at least in the near term.

Going back to the third and fourth points, regarding cost benefit analysis, let me introduce what may be the question of the day: could, and would, cost-benefit analysis justify lowering ambient air quality standards? This is the kind of issue, rather than externalities, that good DFM science may most likely be used to address in the near term. Currently, EPA is going through the process of examining air quality standards for three pollutants -- ozone, particles, and sulfur dioxide. By law, EPA cannot consider cost-benefit analysis in *establishing* the national ambient air quality standards (NAAQS), but that doesn't mean that the government can't do the analysis. The public, politicians, and academics will want to know if we are getting our money's worth when we require lower pollution levels, but at higher costs of goods and services, and attendant impacts on incomes and jobs.

I mentioned the damage function method: I will be quick and run through how the DFM works. In the first stage, dispersion and deposition of air emissions from a source, e.g., a new power plant, are modelled. In the second stage, changes in environmental quality are estimated. For this, modelers need baseline levels of ambient air concentrations. The increment of emissions over baseline is added, incremental deposition is determined, and any change in net ecosystem impacts as a result of the incremental change in deposition is examined. This is the change in environmental quality. For instance, a reduction in sulfur dioxide emissions might improve water acidity in a given watershed. Third, environmental and social impacts are estimated: these would include changes human health and ecosystems. It appears that most of the damage from air pollution, in economic terms, may have to do with human health impacts. There is controversy in the epidemiological studies which appear to find adverse human health impacts at contemporary pollution levels, but there is less above this line [see chart] than below.

In the fourth stage, economists try to determine economic values for damages or changes in well being, measured by economic studies of willingness to pay for reduced risks to health or environmental values, or willingness to be compensated for higher risks. An example of economic valuation would be the determination of the dollar value of reducing the risk of hospital admissions that may be linked to environmental conditions, or reducing the potential risks of premature mortality.

Most of these studies -- the Pace University study, the epidemiological studies, and the economic valuation studies -- are difficult to do. Unsurprisingly, proponents of different viewpoints all seem to have studies demonstrating the reasonableness of their viewpoint. It may take several years before consensus is approached, an several more years before controversy dies down.

Mark Twain, a century ago, found many of these same kinds of issues were present then. They probably will be here a century from now, as well. If there are big ticket expenditures, if several interest groups are involved, and if the science is difficult, then you are likely to find spin control and opportunism. Indeed, we have this call from academia for good science precisely because there is a perception that in heated political debate, science has often taken a back seat to the passion of the moment, or to the spin control of the moment.

With this in mind, I'd like to share with you Mark Twain's view, from a century ago, on these issues. As background, here are two late 19th century academic calls for good science [see slide], "It is a capital mistake to theorize before one has data. Insensibly one begins to twist facts to suit theories, instead of theories to suit facts" -- Sir Arthur Conan Doyle. Another quote [see slide]: "It is also a good rule not to put too much confidence in experimental results until they have been confirmed by theory." -- Sir Arthur Eddington. And now, Mark Twain's pithy view [see slide]: "First get your facts; then you can distort them at your leisure."

A brief word on some activities at selected state regulatory agencies. Most of the states that have monetized values also note that if offsetting your pollution is the least cost of dealing with it, offsetting would be allowed and/or encouraged. For instance, in Wisconsin there is an externality cost for CO_2 of $15 a ton. Regulators encourage any incremental builder of a facility that emits CO_2 to offset their emissions by tree planting, which is much less expensive. Fred Palmer has already mentioned Minnesota. I'll mention that while the staff in New York State is recommending fairly high externality values, as the state reviews its present policies, an ALJ is recommending no monetized values at all, primarily because of the impacts of competition. The new study I mentioned, using the damage function method, might be adopted as well, but the ironic fact seems to be that the DFM values reflect damages with economic values that are so low that it probably wouldn't make much sense to adopt them because they probably wouldn't have any impact. The main benefit of adoption might be to reassure the public that damages from new plants are very small.

Turning to the main subject I'd like to bring to your attention today, this is what I call state-of-the-art good science that may not be "good enough" good science [see slide]. After summarizing the findings of these studies, I'll tell you why some people might find that "state-of-the-art" might not yet be "good enough" science.

Here are the mean damages from the two studies I mentioned. This is the Oak Ridge study for the southeast site, this is the RCG Sterling site in New York state. Looking at all the externalities which they thought they could quantify, starting from the coal-mine, the Oak Ridge study found total monetized externality values of about 1.2 mills at the southeast site. For the relatively populous New York state area, the monetized value was 2.6 mills, compared to private costs of over 60 mills. Externalities represent about 2-4% of total costs, looking at both studies. I would also add that both of these studies assumed the new unit would have NOx emissions equal, or nearly so, to the 1990 new source performance standard (NSPS) of .6 pounds/mmbtu. Since the state-of-the-art coal plant will be much better than this, the NOx numbers will come down 50% or more. The bottom line: (1) these studies show damage function studies are quite feasible today, and (2) they also demonstrate that for a new pulverized coal plant, not even a state-of-the-art plant that substantially exceeds NSPS, monetized externality numbers are extremely low.

The only major externality value that is not on the charts summarizing these studies is CO_2, because we can't get anywhere near doing a damage function method for CO_2 today. I'm sure Fred will amplify on this theme for you.

Basically, if you are going to look at the regulation and laws from a cost-benefit viewpoint, you must compare them to costs in the same metric, that of dollars: this is the essence of cost-benefit analysis. On the cost analysis side, although there is always some controversy, traditionally you simply had out-of-pocket costs. If you had to supply catalytic converters on automobiles, the cost side included the extra cost of buying the converters, times the number of cars sold with the newly-required converters. The cost of scrubbers, in electricity production, included the costs of both building and operating the scrubbers.

On the benefit side of the analysis, it turns out that if you look at the ORNL and New York studies, the vast majority of monetized externality costs from the criteria air pollutants, perhaps surprisingly to some, are not costs to do with the ecosystem, acid rain, etc. Virtually all such costs from the hypothetical new power plants, small though they are, stem from potential health impacts.

Let's look at these impacts of lower pollution. EPA has done an excellent job of compiling, in their draft Criteria Document for particulate matter, a large number of statistical studies examining the relationship between pollution levels and health impacts. For instance, several studies of Philadelphia look at 10 or more years of data on mortality rates and hospital admission rates for each day, pollution level for these days, temperature and humidity levels, and do regressions analyses to measure the statistical relationship between health impacts and the pollution levels. These studies are controversial, but are becoming a bit less controversial than they have been, as more studies, and more precise studies, become available.

These studies basically find that on days with lower particle levels there is a slightly lower risk of premature death and a slightly lower risk of hospital admission. Thus the EPA criteria document finds that in a city of 1 million people, if you go from a moderately high pollution day (with pollution at 100 micrograms per cubic meter), and you increase that by 50% to 150 micrograms per cubic meter, the statistical study says that you might have one extra death per day. This is the basis for establishing the adverse health impact from this particular pollutant. As I said, this result is controversial. There are questions about whether some other pollutant, such as carbon monoxide, might be highly correlated with particulate matter; whether various weather effects might be so highly correlated with particulates that the weather itself is responsible (think of the heat-wave related deaths in the midwest this summer); and there are questions about whether the synergistic effects of different pollutants, or all types of particulate matter, or just some types, might be implicated in this effect.

But these controversies are small compared to this one: how do you place a value on the risk of someone dying prematurely because of air pollution? If science were to find that the person who might die prematurely in reality dies a few days before the death would have occurred anyway, how does that affect the valuation? What if the time difference were a few weeks? A year? What economic valuation to place on the risk of premature mortality is a difficult question.

Some people historically take the view point that if there is a risk of mortality, that is all we need to know: we must control as much as you need to prevent any premature mortality. This is no longer a viewpoint that wins acceptance in the academic community, however, for two reasons. First, many of these studies purport to find that there is no pollution threshold below which there is no adverse health effect. We know that we will not reduce the sum of automobile, factory, utility, and home heating emissions to zero, so that means we have to determine how far to lower the standard. In this context, economics can help provide us with sensible analysis to help our determination. Secondly, meeting a societal objective of reduced pollution imposes costs in the form of reduced incomes, reduced economic activity, and increased unemployment, and there is growing recognition that these impacts themselves have adverse health impacts. So, at least implicitly, most of recognize the need to balance the health impacts, or their economic value, on both the cost and the benefit sides of the equation.

The traditional way to compute the cost side of a cost-benefit analysis would be to sum up the total out-of-pocket costs of the regulation. Starting about 6-7 years ago, economists began to publish articles recognizing that there are additional adverse impacts stemming from the reduced economic activity, e.g., adverse health impacts. Using standard economic models, such as those used by the federal reserve and banks to forecast the next quarter's unemployment rate and incomes, one can calculate the increase in unemployment that would occur due to a costly new regulation. Another group of studies, similar to statistical studies of air pollution, finds highly significant statistical associations between increases in unemployment and decreases in wages, on the one hand, and higher risks of premature mortality, illnesses, and other social pathologies (such as suicide and divorce) on the other hand.

This chart is from the Joint Economic Committee of the U.S. Congress in 1984, when the Senate was Republican and the House was Democratic. Thus it is likely to be the best shot we'll have at getting a neutral piece of research from Congress. Here [see chart] is the increase in social cost due to changes in unemployment, incomes and the business failure rate during the 1973 recession. If you look under the social stress indicator, here are dollar figures for increases in total mortality, total illnesses, etc. The total increase in social costs -- meaning the monetized costs of adverse health effects due to changes in unemployment, incomes, and business failure rate -- due to the 1973 recession is 26 billion dollars. The largest mortality component, $16 billion, is cardiovascular mortality, basically strokes and heart attacks due to increased stress, presumably from being unemployed or working 70 hours a week to keep one's job.

So, as you see, you do get adverse health impacts on the cost side when you have higher unemployment and lower incomes. These results have been confirmed by later studies done for other groups. We have the same impacts, adverse health impacts, on both sides of the equation. We also have the difficult issue of valuing the cost of the risk of premature mortality.

The American Lung Association has just issued an August, 1995 study, called "Dollar and Cents", in which the ALA calculates the economic benefits of reductions in particulate emissions. In calculating the annual benefits of reducing particulate pollution levels, the risk of premature mortality is given an economic value of approximately $4 million per statistical lost life. Thus the figure of about $7 billion, for premature mortality, is the vast majority of the $11 billion in total benefits [see chart]. This is the bottom line slide: What is the value of reduction in the risk of premature death? How can we satisfactorily derive this value? Is this value the same in all cases, e.g., is it the same for someone age 20 as for someone age 70? Should it be?

Accidental death studies are pretty much the only way we currently have, from an economist's point of view, to place a value on an increase in the risk of premature mortality. An important feature of accidental death studies is that instead of a bureaucrat or an economist determining, on their own, what they think such a value should be, it is individual people, based upon their own actions, who determine such a value. An accidental death study would examine two occupations that are pretty much the same in terms of physical and educational requirements, except that one is riskier than the other. The riskier occupation usually requires higher wages and benefits in order to attract people to that occupation, rather than the less risky one. When we examine the difference in total benefits packages between the occupations, divided by the difference in mortality rates, the numbers are generally about 2 to 4 million dollars per statistical lost life.

Well, if economists have derived these numbers from real world choices, they must be right, and people probably accept it, right? As my high school english teacher used to say, Not So!

Let's look at one reason that these apparently (economically) reasonable numbers have not readily been accepted, as applied very recently in a World Bank calculation. The World Bank study used a value of approximately $1.5 million per statistical lost life, as applied to the industrialized world. For the third world, where wages are far lower, the World Bank study estimated a value of $100,000 per statistical lost life. The economist in charge of this study is very highly regarded. But you can understand, from the point of view of people from the third world, why some said, "How dare you say our lives are not worth the same as yours!" Nevermind that is not what the economist who did the study was saying, or thought he was saying.

Here's another important issue in placing an economic value on a statistical life lost: is the degree of prematurity important? In the studies associating particulate air pollution with premature mortality, based upon information on death certificates, the authors concluded that the great majority of the people who may have died prematurely were over 65 and already in poor health. In contrast, in the study from the U.S. Congress which associated unemployment with adverse health effects, notably stroke and heart attack deaths, these people tended to be people still working, with perhaps two to three or more decades of life remaining. Is it economically appropriate, or fair, to take an economic valuation, derived from working people in the prime of life, in occupations that are a bit dangerous, and apply that value to people who are likely to have weeks, months, or a few years of life remaining? Other than one recent survey of 3,000 households, which found that the median respondent thought that saving one 20 year old was equivalent to saving seven 60 year olds, we don't have any studies which might address this question. So this is probably why the ALA used the figure of about $4 million per statistically lost life in its study, "Dollars and Cents;" but this probably is not the right number.

If you can't derive an economic valuation, you cannot do a cost-benefit analysis. We have seen that deriving such a number is difficult, but it doesn't seem impossible, at least not economically impossible. Also, in addition to the difficulties in deriving an economically reasonable valuation for risks of premature mortality, some people strongly object to the notion of ever putting an economic value on any risk of mortality. If, for these or other reasons, a cost benefit analysis is thought to inappropriate, there is an alternative. It is called "health-health" analysis.

In health/health analysis, we utilize the same studies discussed earlier, e.g., those which used statistical relationships between health endpoints and pollution, or between health endpoints and unemployment or lowered incomes, but without proceeding to the next step of doing a valuation. Thus one doesn't have to use the same value as applied to risks of premature mortality at different stages of the life cycle, or try to derive different values, based on little economic science. On the benefit side of the equation, there are the benefits in reduced risks of premature mortality, fewer hospital admissions, and lower morbidity if air pollution concentrations are lower. On the cost side, with tighter regulations and higher electric rates, prices in the economy will be higher, and as we have seen, there will be increases in premature mortality and hospital admissions due to lower incomes and higher unemployment. In theory, we now have an "apples to apples" comparison. However, is this necessarily right? We still have the difficulty of differences in years of life lost: on the cost side, those at risk of premature mortality may have decades to live, and on the benefit side, months or a few years to live. We still haven't solved our problem of whether the risks of premature mortality on either side of the equation should be weighted equally, and if the answer is no, how should we weight them? Perhaps, having seen the alternative, we might want to go back and try cost-benefit analysis again. (One caveat: I have not discussed the non-health impacts, e.g., the benefits of reduced emissions from an individual power plant for effects like forest impacts, materials and ecosystem damages, etc., because these effects, in economic terms, tend to be small in comparison to the values for health effects.)

In conclusion, externality calculations will survive as long as there is interest in cost/benefit analysis, because the same kind of calculations are involved in each case. Those of us who believe in the usefulness of cost/benefit analysis may be subject to the aphorism about being careful what one wishes for, because it is a pretty contentious issue. As long as we have that interest, we are going to be doing the same kind of studies, with economic values that can be used to monetize externalities. A second conclusion is that it is hard to predict whether regulators will actually use monetized externality values in the future, even if they can be monetized to the satisfaction of most observers. Rather than monetize for individual states, some proponents of externalities are attempting to use them, in the context of electricity restructuring, in "wires charges" that will be applied to use of transmission lines. With this as a long-shot possible exception, we probably won't see much more application of externality values at the state level. Third, economic research must continue. I think the Oak Ridge and New York studies are clearly the best we have right now for economic valuation that can be used in cost benefit analysis. As such, they represent "good science." But they don't represent "good enough" science, if our object is to have methodology and valuations that are widely accepted, and make intuitive sense. And finally, as implied by Mark Twain's comment, there will always be disputes over science and economics, so let's not allow that to cause us worry. Thank you very much.

CURRENT EXTERNALITIES ISSUES: UPDATE ON ECONOMICS AND SCIENCE

Thomas J. Grahame

U.S. DEPARTMENT OF ENERGY
FOURTH ANNUAL CLEAN COAL TECHNOLOGY CONFERENCE

September 7, 1995

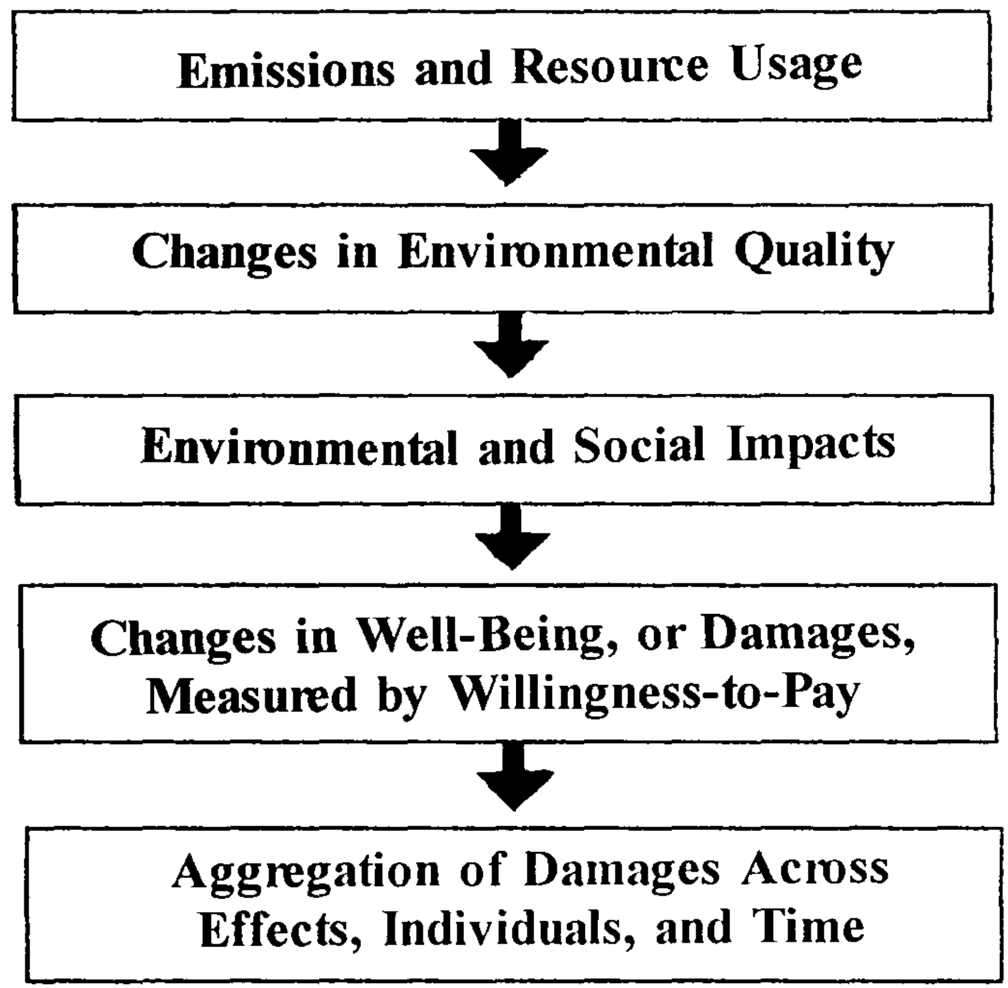
THEMES

- CURRENT ISSUES
  - COST/BENEFIT ANALYSES
  - "GOOD SCIENCE"
- CLOSE RELATIONSHIP OF THESE WITH EXTERNALITY ISSUES

SUMMARY OF MAIN POINTS

- EARLY "PROXY," EXTERNALITY VALUES -- BAD SCIENCE
- C/B ANALYSIS NEEDS "GOOD SCIENCE" ESTIMATES OF ENVIRONMENTAL DAMAGE
- BEGINNING TO DEVELOP SUCH "GOOD SCIENCE" STUDIES
- DIFFICULT ISSUES REMAIN FOR BOTH COSTS AND BENEFITS
- FUTURE OF EXTERNALITY VALUES AT STATE LEVEL IS UNCERTAIN

Simplified Environmental Damage Function Method



Source: RCG/Hagler Bailly, 1993

ENVIRONMENTAL EXTERNALITIES: CURRENT STATUS AND USE

- AT STATE REGULATORY AGENCIES
- IN COST/BENEFIT ANALYSIS
- LINK WITH SOME RECENT CLIMATE CHANGE ISSUES

ENVIRONMENTAL EXTERNALITIES IN STATE REGULATORY PROCEEDINGS

- IN RECENT CASES, ESTABLISHMENT AND USE OF MONETIZED EXTERNALITIES HAS BEEN REJECTED

- ALTERNATIVE OF OFFSETS

- MINNESOTA: MAJOR OUTSTANDING CASE, MAY BE DECIDED BY SUMMER OF 1996

- IMPACT OF COMPETITION

Mean Damages[a,b] from Electricity Fuel Cycles By Study--Site *(mills/kWh)*

	ORNL/REF-SE	RCG-Sterling	Private Costs (RCG)
Pulverized Coal	1.2	2.6	62
Nuclear PWR	0.3	0.1	
Gas CCGT	0.2	0.2	48
Oil CT	0.2 (Low emissions boiler)	1.4	
Biomass	1.1 (stoker boiler)	3.1 (Mass Burn)	60
Occup. Health included?	X		
Nuclear Accidents?	X		
Road Damage?	X	X	
SO2 Damages?			

a. Excludes employment and taxes.
Excludes global warning.

b. Pace (1990) - 6¢ kWh for coal.
"Proxy" state adders — 3-4¢ kWh for coal.

Resources for the Future

Energy Choices in a Competitive Era
Cost Effective Environmental Strategies

Presented to

4th Annual Clean Coal Technology Conference

Mariott City Center

Denver, CO

Presented by

Ronald L. McMahan, Ph.D.

Resource Data International, Inc.

1320 Pearl Street, Ste. 300

Boulder, CO USA 80302

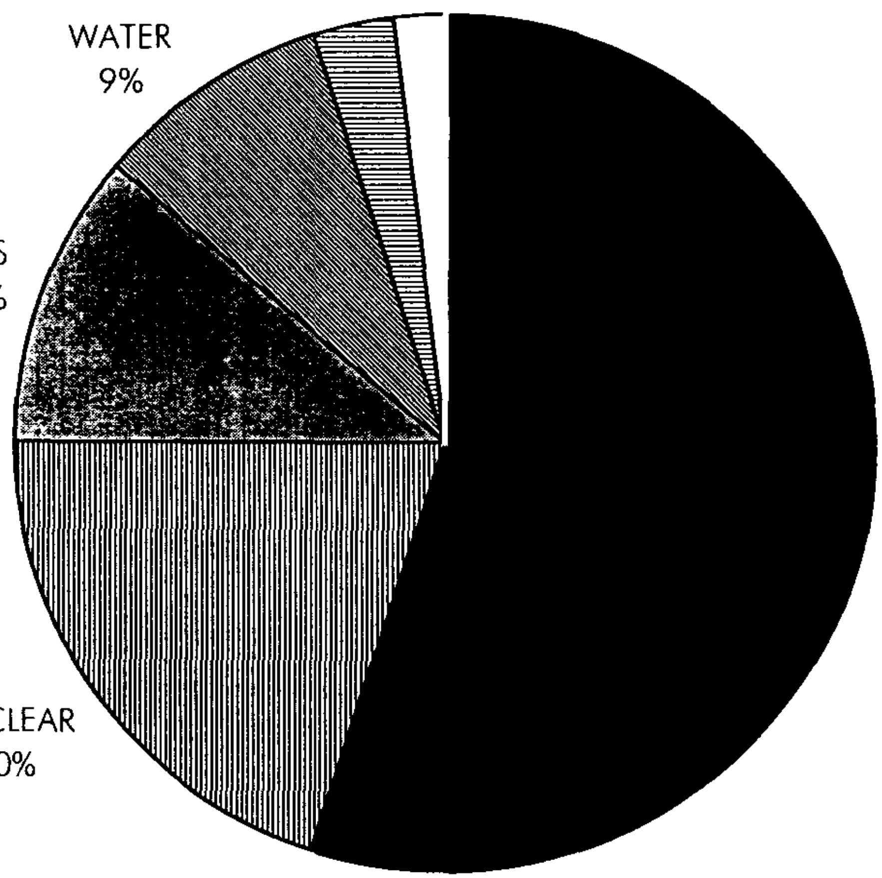
(303) 444-7788

September 7, 1995

RESOURCE DATA INTERNATIONAL INC

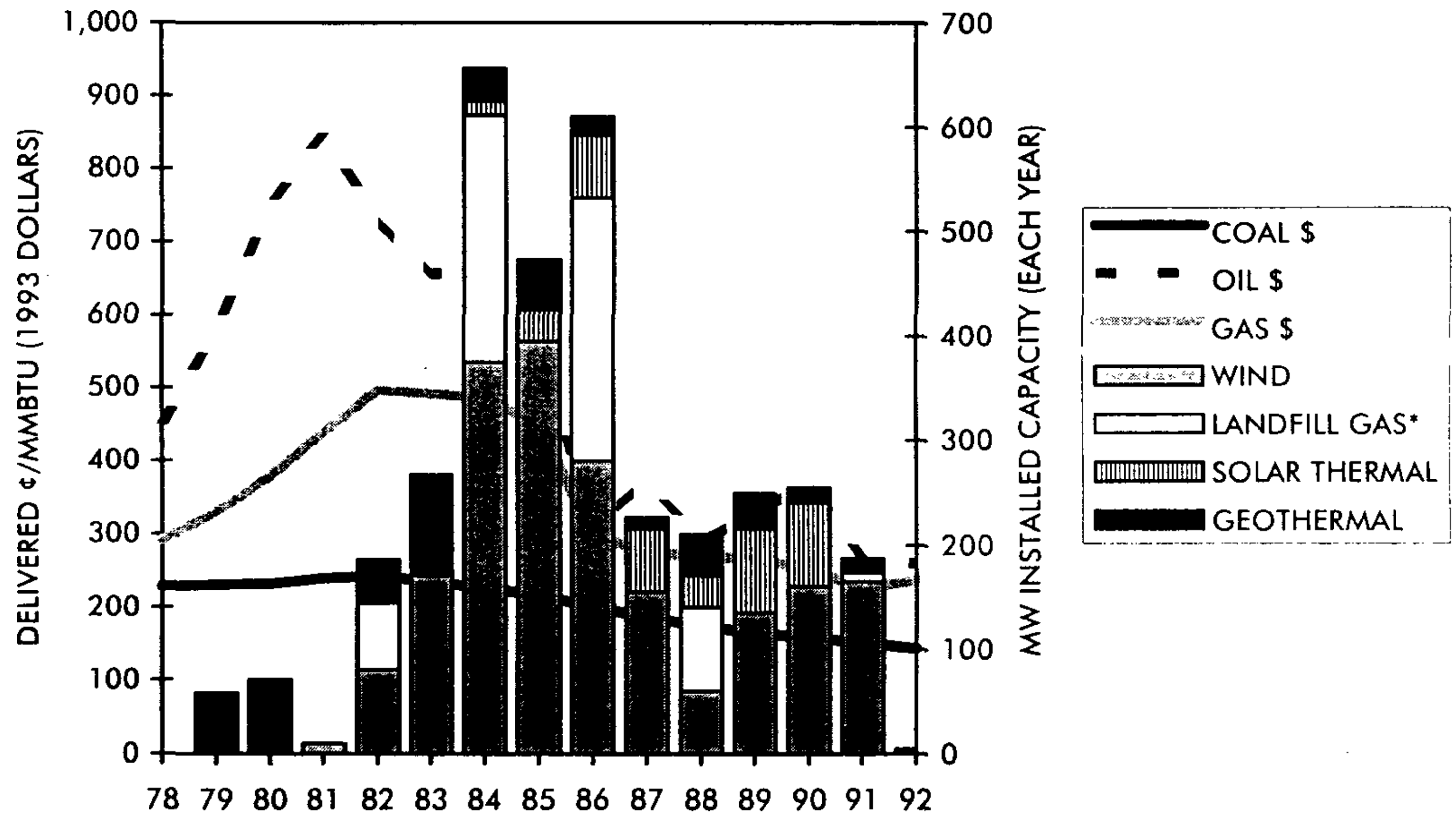
U.S. generation mix - 1994

(Based on Utility and Non-Utility generation)



RESOURCE DATA
INTERNATIONAL INC

Renewable capacity additions vs. delivered fuel prives



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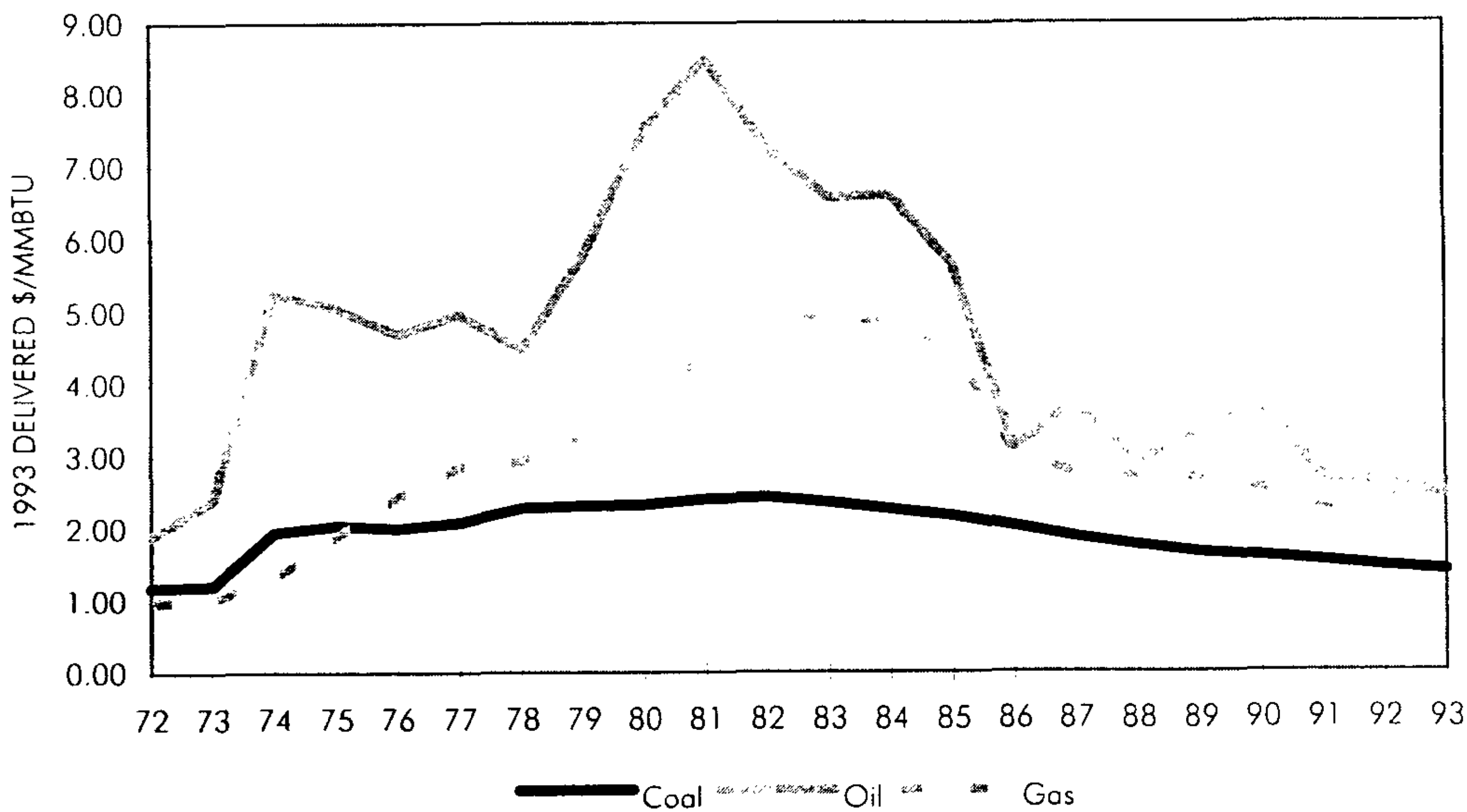
Oil, gas, and coal prices paid by electric utilities, 1972-1993

Delivered \$/mmBtu (adjusted for inflation (1993=100)



RESOURCE DATA INTERNATIONAL INC

Summary of key findings

All electric generation technologies, including renewables, present adverse environmental impacts.

RESOURCE DATA INTERNATIONAL INC

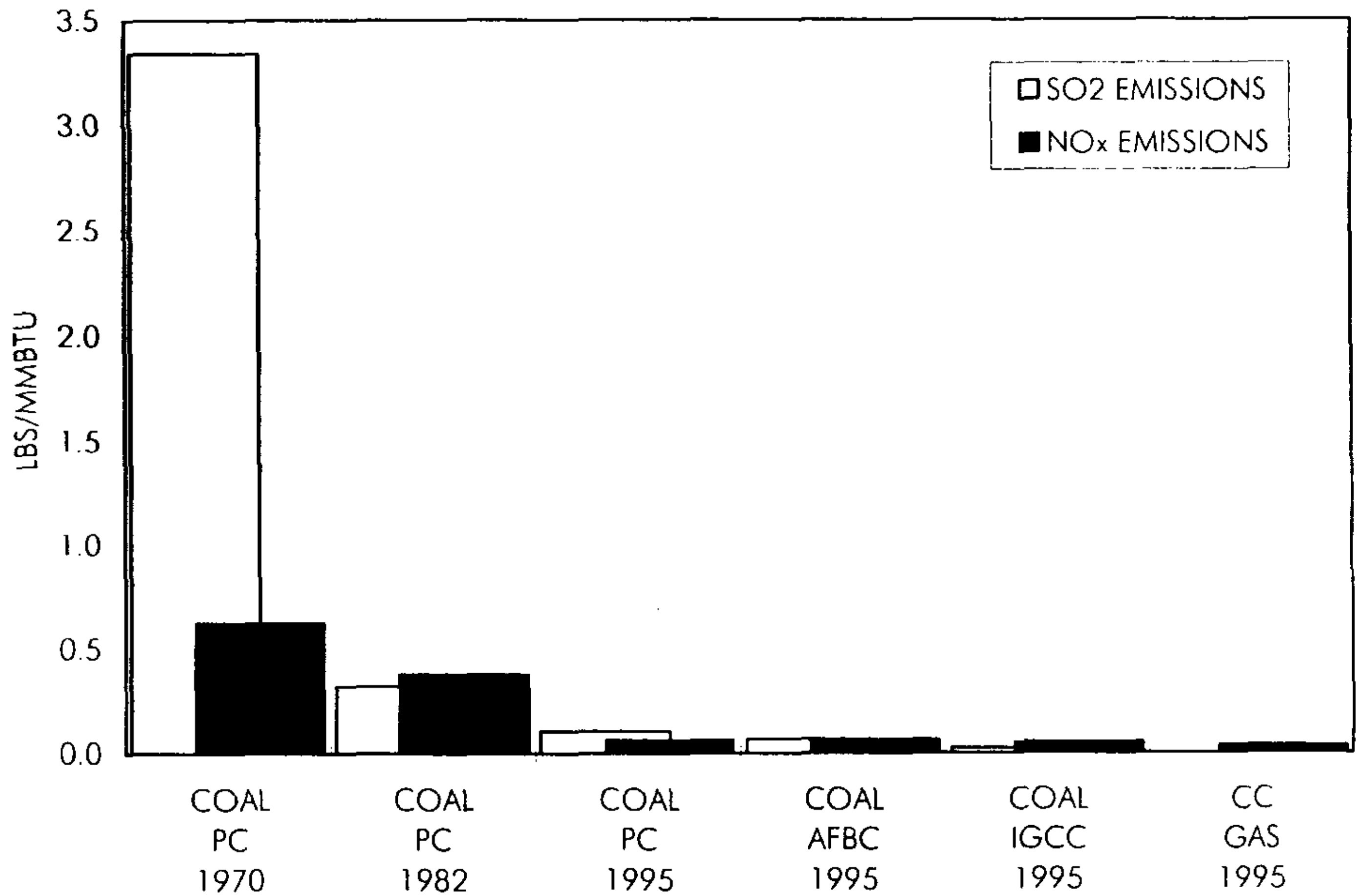
Summary of key findings

Approximately 71% of non-hydro renewable generation currently comes from combustion technologies--not wind, solar or geothermal processes.

Outside California, nearly all existing renewable generation comes from combustion technologies.

RESOURCE DATA INTERNATIONAL INC

Comparison of emissions from vintage coal and gas technologies



RESOURCE DATA INTERNATIONAL INC

Summary of key findings

All renewable resources have technological or logistical obstacles that limit their ability to produce and provide reliable electricity to the grid -- obstacles that cannot be overcome, even through the use of subsidies.

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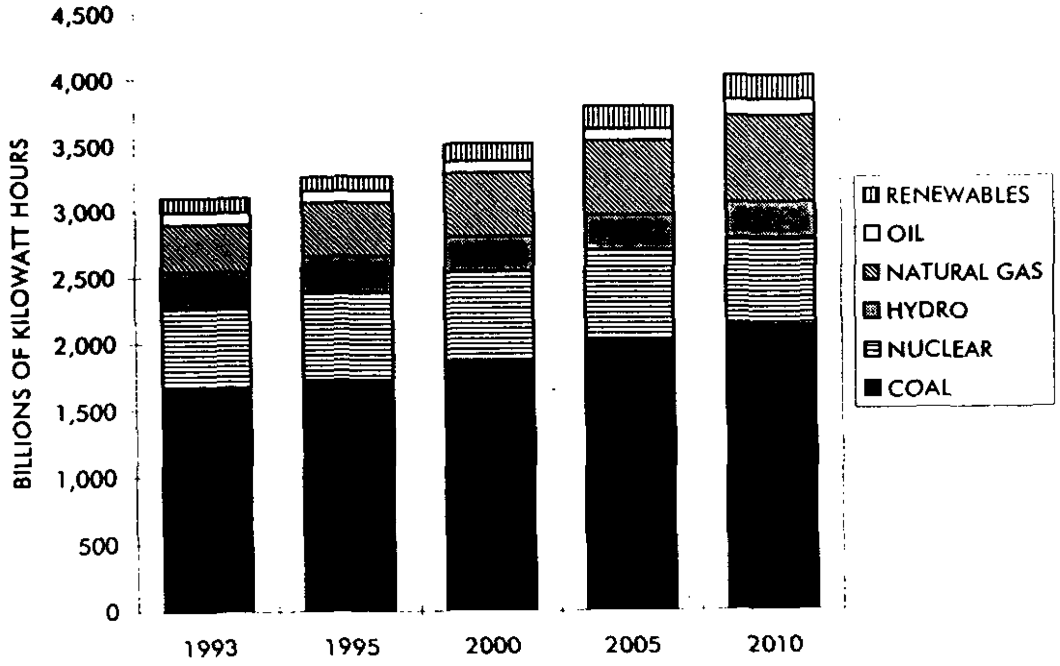
Regional levelized costs in ¢/kWh

Base case scenario

	SOUTH ATLANTIC	EAST NORTH CENTRAL	EAST SOUTH CENTRAL	MIDDLE ATLANTIC	MOUNTAIN	NEW ENGLAND	PACIFIC	WEST NORTH CENTRAL	WEST SOUTH CENTRAL	BASE CASE
PULVERIZED BITUMINOUS COAL	3.9	-	-	4.1	-	4.2	-	-	-	4.1
PULVERIZED SUBBITUMINOUS COAL	-	3.8	3.6	-	3.5	-	4.0	3.5	4.0	3.7
ATMOSPHERIC FLUIDIZED-BED COMBUSTION - CIRCULATING	4.6	4.5	4.3	5.0	4.2	5.1	4.7	4.2	4.7	4.6
NATURAL GAS COMBUSTION TURBINE/COMBINED CYCLE	5.0	4.3	4.4	4.3	4.0	4.5	4.1	4.0	4.0	4.3
WIND - VARIABLE SPEED TURBINE- WIND CLASS 4	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8
WIND - VARIABLE SPEED TURBINE- WIND CLASS 5	6.1	6.1	6.1	6.1	6.1	6.1	6.1	6.1	6.1	6.1
WOOD-FIRED FLUIDIZED BED COMBUSTION - RESIDUE	8.3	8.7	8.5	9.3	9.0	9.3	9.0	8.7	8.5	8.8
WOOD-FIRED FLUIDIZED BED COMBUSTION - ENERGY CROP	11.5	11.8	11.7	12.5	12.2	12.5	12.2	11.8	11.7	11.8
MUNICIPAL SOLID WASTE - MASS BURNING	8.5	9.3	9.0	10.6	10.0	10.6	10.0	9.3	9.0	9.3
GEOTHERMAL - DOUBLE FLASH	-	-	-	-	9.2	-	9.2	-	-	9.2
GEOTHERMAL - BINARY	-	-	-	-	8.0	-	8.0	-	-	8.0
PHOTOVOLTAIC CENTRAL STATION FLAT PLATE	28.7	31.6	32.8	42.4	19.6	38.4	24.5	24.1	23.5	27.4
SOLAR THERMAL - PARABOLIC TROUGH	-	-	-	-	22.6	-	21.9	-	20.2	21.0

RESOURCE DATA INTERNATIONAL INC

RDI base case generation mix forecast



GENERATION (BILLION KWH)

	1993	1995	2000	2005	2010
COAL	1,674	1,730	1,862	2,017	2,126
NUCLEAR	610	659	678	679	661
HYDRO	265	272	266	268	268
NATURAL GAS	353	410	484	564	656
OIL	97	83	86	88	122
RENEWABLE:					
COMBUSTION	53	54	67	87	92
NATURALLY OCCURRING	20	21	30	51	88
TOTAL	**3,072**	**3,229**	**3,472**	**3,754**	**4,011**

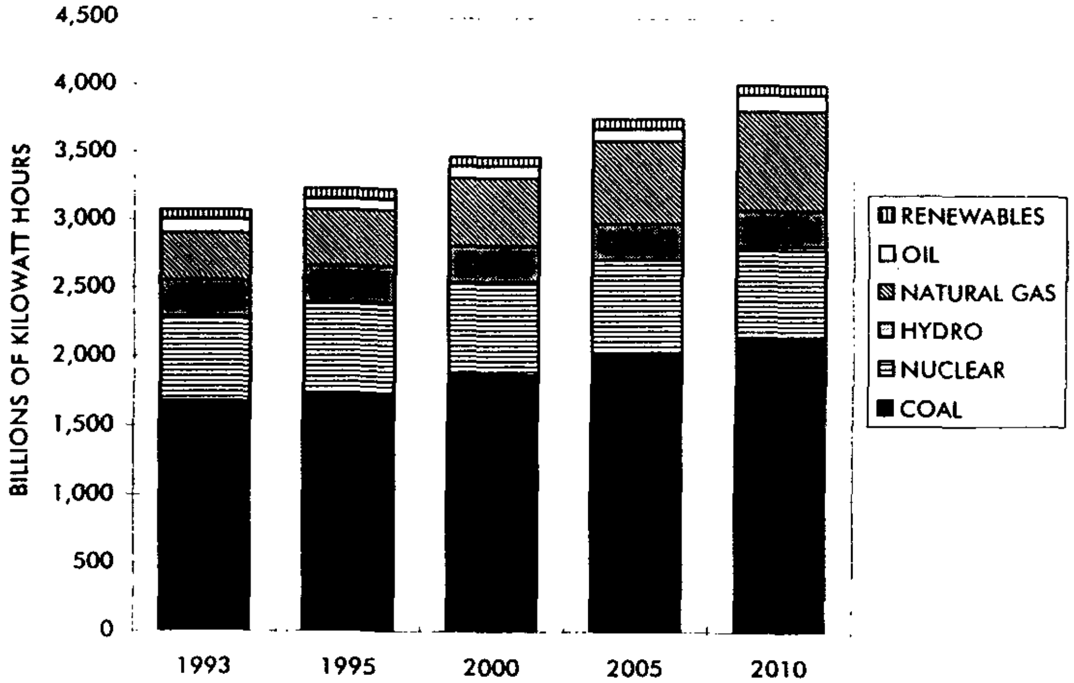
RESOURCE DATA INTERNATIONAL INC

Summary of key findings

Under current levels of tax incentives and regulatory support, renewable energy (excluding hydro technologies) is projected to grow from its current 2% of all U.S. electricity generation to 4% by 2010.

Such an increase in market share will occur at a cost of about $52 billion (in 1995 $) above today's most competitive power alternatives.

RDI full and open competition scenario generation mix forecast



GENERATION (BILLION KWH)

	1993	1995	2000	2005	2010
COAL	1,674	1,730	1,867	2,033	2,153
NUCLEAR	610	659	678	679	661
HYDRO	265	272	266	268	268
NATURAL GAS	353	412	500	614	737
OIL	97	83	86	88	122
RENEWABLES:					
COMBUSTION	53	53	56	56	55
NATURALLY OCCURRING	20	20	19	16	16
TOTAL	**3,072**	**3,229**	**3,472**	**3,754**	**4,011**

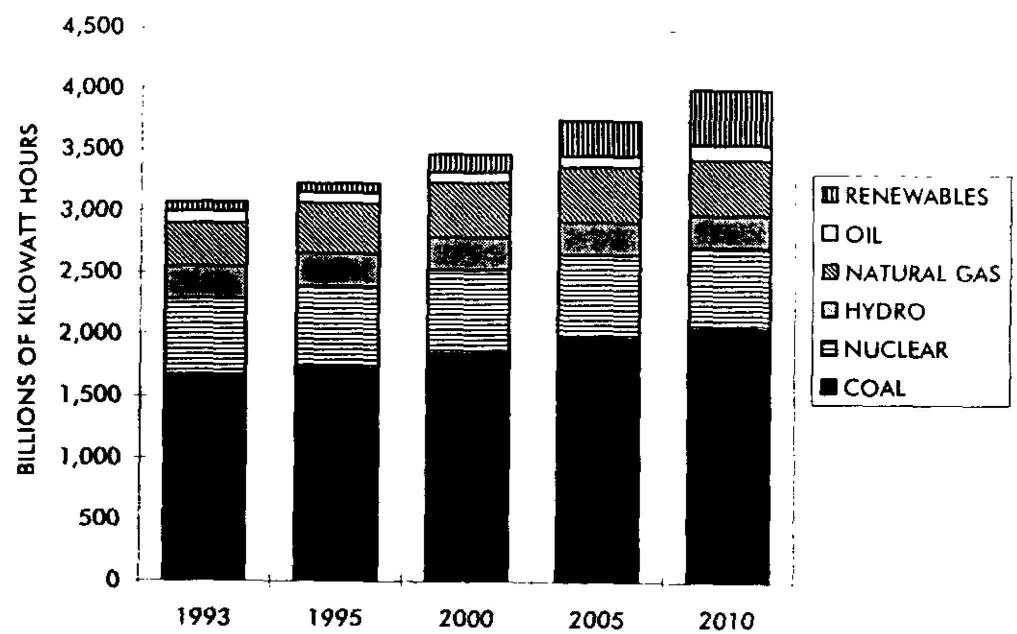
RESOURCE DATA INTERNATIONAL INC

Summary of key findings

With open and direct competition in electricity, generation from renewable energy could shrink to just 1% of U.S. electricity in 2010.

RESOURCE DATA INTERNATIONAL INC

RDI subsidy intensification scenario generation mix forecast



GENERATION (BILLION KWH)	1993	1995	2000	2005	2010
COAL	1,674	1,729	1,849	1,979	2,058
NUCLEAR	610	659	678	679	661
HYDRO	265	272	266	268	268
NATURAL GAS	353	409	446	450	452
OIL	97	83	86	88	122
RENEWABLES:					
COMBUSTION	53	56	81	105	129
NATURALLY OCCURRING	20	20	66	185	321
TOTAL	**3,072**	**3,229**	**3,472**	**3,754**	**4,011**

RESOURCE DATA INTERNATIONAL INC

Summary of key findings

Even with the imposition of exceptionally aggressive subsidies from public and private sectors, renewable energy would provide a maximum of just 11% of the nation's electricity by 2010.

Such an ambitious increase would cost taxpayers, consumers and/or utilities about $203 billion (in 1995 $) in subsidies between now and 2010.

RESOURCE DATA INTERNATIONAL INC

Summary of key findings

Because renewables and natural gas occupy similar dispatch positions, gains in generation share by renewables will tend to displace growth in natural gas generation, and similarly, losses in renewables will tend to go to natural gas.

RESOURCE DATA INTERNATIONAL INC

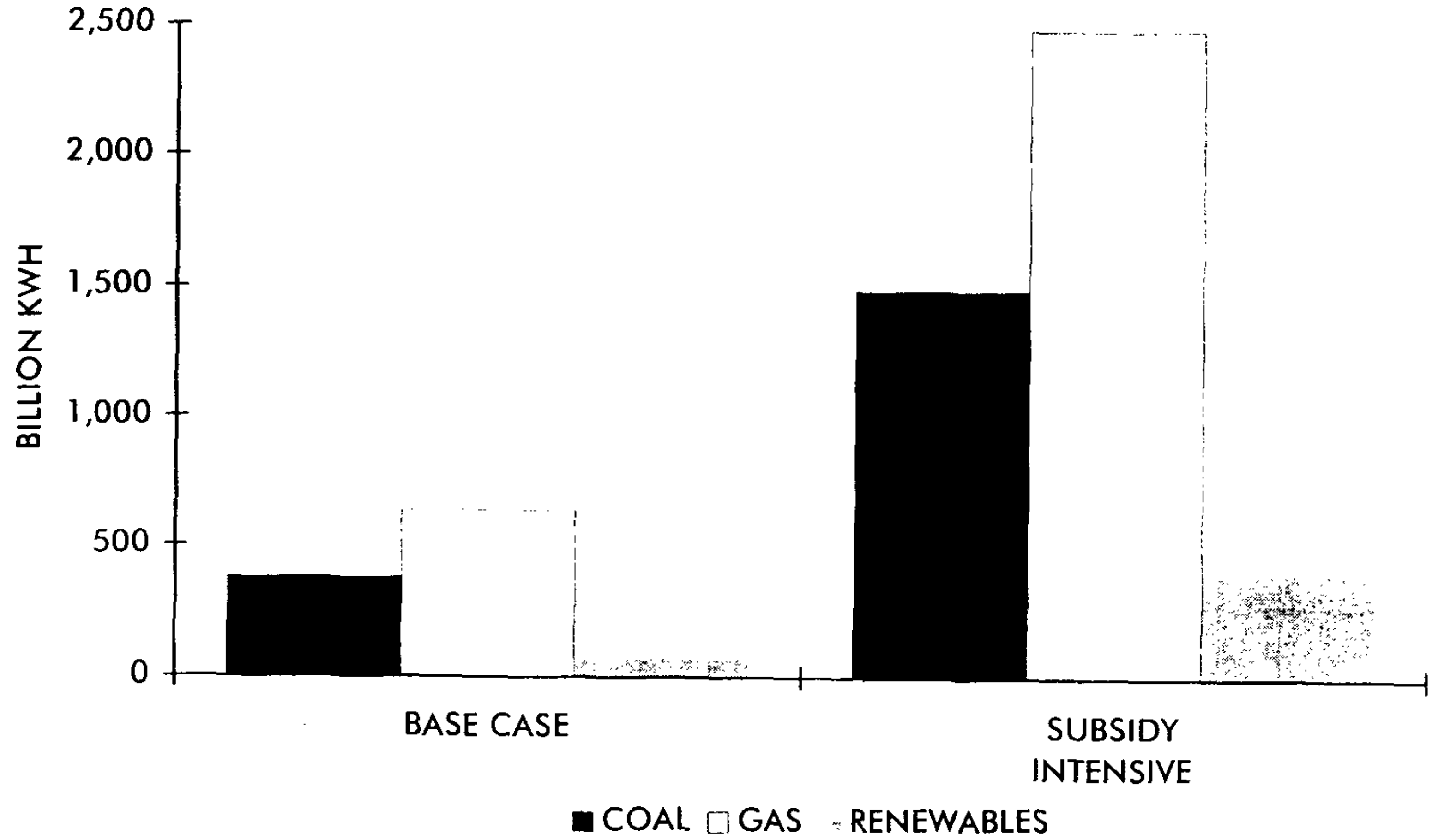
Forecast scenario comparisons

Growth by resource: 1995 to 2010

	BILLIONS OF KWH		
	BASE CASE	**FULL & OPEN COMPETITION**	**SUBSIDY INTENSIFICATION**
COAL	396	423	329
NUCLEAR	2	2	2
HYDRO	(5)	(5)	(5)
NATURAL GAS	245	325	43
OIL	39	39	39
RENEWABLES:	-	-	-
COMBUSTION	38	3	74
NATURALLY OCCURRING	67	(4)	301
TOTAL	**782**	**782**	**782**

RESOURCE DATA INTERNATIONAL INC

Number of new kilowatt hours purchased with renewable subsidies
(Constant 1995 dollars)



RESOURCE DATA INTERNATIONAL INC

Summary of key findings

Despite government incentives and private sector subsidies, renewable resources cannot replace fossil fuels in the nation's generation mix.

Coal will remain the baseload fuel of choice, supplying more than half of all electricity generation in 2010, even assuming aggressive subsidies for renewables.

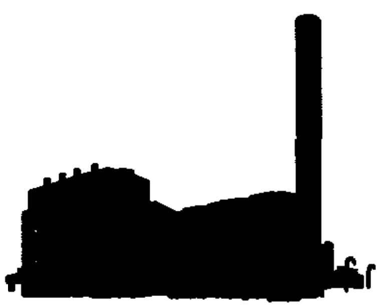
RESOURCE DATA INTERNATIONAL INC

JUMPING INTO A "POOL"
A DISCUSSION OF ALTERNATIVE POWER MARKETING AND INDUSTRY RESTRUCTURING
HEIDI HEITKAMP, ATTORNEY GENERAL, STATE OF NORTH DAKOTA

I have kind of an interesting history here. When they first called my office and asked me to talk at the Clean Coal Conference, I assumed that it was a result of our involvement in the Externality Proceeding, one argument that we are making in that proceeding is that the imposition of externality is having an adverse environment impact because it is having a chilling affect on the development of Clean Coal Technologies throughout the country. So as I prepared my lecture which I have given many times on that topic only to get the program and be somewhat surprised I though well I could come up with a lot of reasons why they asked me, maybe it is because I was an ex-tax collector, no, not this group, probably not. But as that rule as ex-tax collector I developed many skills, one of which is adequately explaining to North Dakota Farmers why it was when they went broke, and had debt forgiveness they owed income tax, I thought that had a lot of analogy to try and explain the externality concept they have in front of you. I thought maybe that I am the Chief Legal Officer for the State of North Dakota and as such as an ex-environmental attorney, I spent some time working for EPA as my specialty at Louis & Clark was environmental law. They might think this interesting to get from a person who previously, as Jack said earlier, was one to destroy the western civilization a little bit earlier, what would be my perspective on externality. It's been interesting development in North Dakota. We started out knowing nothing about externalities and except what we knew in theory and what we knew from economic as well as environmental theory and when this was brought to North Dakota tax payers and presented to North Dakota decision makers they were asked to make an investment of over $500,000 in a lawsuit and they came to bat for what I think is out their, fighting an idea that is, I wouldn't go as far as what Mr. Palmer say is destined to destroy western civilization, but is a very bad idea with very bad economic consequences. So North Dakota has come to the plate not only with the dollar resources to fight the State North Dakota tax resources to fight the externality issue but have come forward as one of the first states through legislation to say this is a very bad idea with very bad economic consequences and we are not going to allow externalities to be imposed in North Dakota. So I thought one of things that you would be interested in is that in North Dakota we have in fact an imposed a 2 cent per ton tax on coal which is destined for use in the research area. We have a council called the late night research council which funds projects some of which have been clean coal projects over the years we have bonding authority to put money, state money, resources into providing clean coal resources & technologies for public/private partnerships and have made a commitment to continuing the resource and utilization, coal resource in North Dakota . Then I thought well maybe it is because Attorney Generals' throughout the country our consumer advocates and more than anything else that I have listened to in this room today and we can talk about charts and graphs and you have heard about a calculation of what in fact it costs if someone dies before their time which all seems very morbid, and I can't help wonder as I listen to this entire discussion what 100 average North Dakotans maybe from the mall, pack them in here, and present this all to them, what would be their perceptions today of what direction the coal energy industry is headed. What would they know more then what they came in with, and that I think as I told Ed as he left is the fundamental basis of my discussion today. You heard Ed talk as we are looking at projections of what's going to happen with marketing of electrical utility with electricity into the future, what is going to happen with retail wheeling, wholesale wheeling, what are we anticipate to be the political response or certainly the legal response from a standpoint of ? investor owned who are opposing some of these reforms. And yet we all have to step back and think about the true customers the true stakeholders in all of that and they are the citizens who I will tell you who I think have in this country enjoyed enormous stability and cost-savings in air utilization of electricity. We have without a doubt, have the best system in the world and it has been absolutely crucial to not only to our economic growth but to our quality of life. As the Commissioner from the State of Pennsylvania said at the very beginning of this panel what we are looking is how do we fine tune that system to make it even better but also guarantee that our citizens will have a reliable, low-cost source of electricity that is going to guarantee a quality of life. That is why all of you are here, that's why there is government regulation in this area, because what you do is so enormously important. So although I am not an expert about polling I think that I have over my 15-16 somewhat years in public life had an opportunity to watch deregulation. Now you may say what does that come to, as tax collectors we tax at the wellhead, natural gas and oil. Some of you who know a little bit about North Dakota's history you know that we actually increased the oil tax in the early 80's when the big times were coming. And all of that was geared economically, it wasn't just prairie populism run amuck, for those of you who disagreed with some of the decisions made. There was an economic rationale behind that because if you remember oil was deregulated using the windfall profits tax and the government was going to take the windfall they weren't going to let the oil companies get the windfall from this large increase in oil prices that were going to occur when they eliminated the regulation. What they allowed in that was a deduction in state severance taxes. So 70% of what we actually received in the State of North Dakota from this windfall was money we were actually going to take from the federal government. Being very clever and believing in reverse mandates, we went out to seek our fame and fortune by taxing the government. Guess what, in two years there was no windfall profit. We saw oil prices plummet and we saw a very real economic impact of that 11 ½% tax on the wellhead. That had a dramatic affect and the people of North Dakota argue the opposite that tax was too high, but no one figured out that that tax was a direct state government regulatory response to a federal regulation or deregulation, no windfall. Let's examine natural gas and I've been party to some interesting litigation as it relates to natural gas. I am probably one of the few regulators or state tax officials who attempted to litigate a netback case, those of you who know what that is we didn't believe that the price that they were charging or what they were telling us at the wellhead was the true value of natural gas so we tried to net back from the plant from the refinery. After we spent about $200,000 - $300,000 in expert witnesses there, I figured that wasn't a very cost-effective way to collect a few dollars taxing natural gas, we changed it but there is that the decision that we made was so driven by the deregulation this was going to be the happy times of the high natural gas prices, not happy for the consumers, but certainly happy for those in the oil patch who were once again believing that associated gas was going to have some value, the tax system responded to what was going to be the regulatory response and we failed. And so I approach all of this from the standpoint of predictability. And I think what Ed has told you, we start out without a plan, we start out without educating the public on what you intend to do with their enormously important power supply and generational electrical delivery you start out without a foundation that is going to work. And so, now as Ed told you, the public outcry did not come before the political change, we had political change before the public outcry. Anyone of us could imagine would be the look on the face if we walked out this door and we asked the first passerby what they thought about political wheeling, they would say huh. They may imagine it is about the motor industry. We would ask them what they thought about the new Federal Power Act and the impact on competition on the grid, once again we would get those blank but we are dealing with so enormously important to their economic livelihood and their standard of living. It is absolutely incumbent on you if you want these changes to last, if you want these changes to be understood, it is incumbent of you to begin that process of educating the public. I try and how I explain it and you know I haven't figured all this out either, but as I told you Jerry Spence and his recent book, and those of you who have a chance and there are some of you that might not agree with him politically, he is quite the environmentalist, he makes a very persuasive argument as we can all agree judging from the results that he gets in the courtroom that you should always tell the truth. So I am going to tell the truth, I am not an expert in power polling, I have in fact examined those issues as it related to tax, I have examined those issues as it relates to litigating our externality case and making the argument of economic impact to North Dakota. But I think I know a little something about educating the consumers on issues. I like to tell people when I talk about these issues, that imagine the early days of automobiles that you had a highway system that was owned privately. You didn't have a government system, you only had privately owned roads and to get on those privately owned roads you had to ride in a car that was furnished by someone else. So someone else drove you to that border and you got in the car that was furnished by someone else and you drove around. That is kind of what you have with vertically integrated power companies, not only they control the generation and the distribution, they sold you appliances, still do a lot of them. The one we have in North Dakota is getting out of the appliance business. Hope my warrantee is still good. Now that is what you have, how would that work for transportation, how would that work for the average consumer who wanted to get from point A to point B and then you explain that in fact that is how delivery of electricity is structured in this country or at least was until we got to retail wheeling. Now with the new Power Act as I see it you are going to have the regulatory system that puts up toll booths on those highways and allows you to drive your own car. Right, they are going to give you access to those roads, but what you put in them is going to be perhaps something else or because it is fungible a paper exchange. Now explain to these folks that this is going to be like telephone company deregulation and their roll their eyes. We are going to have more choices, that is the last thing that they want is more choices in telephone deregulation, they are sick of it and you know what is happening with telephone deregulation and you know about the competition for not only the inter-lattice but the lattice and there is continuing to be legal fights and I was involved in one in our state. Let's take you back to that North Dakota Farmer who is sitting in this room and we tell him that we are going to deregulate, he thinks about, he thinks about what happened to his delivery of airline service. Lets get to retail wheeling and I know there is probably some very big proponents of retail wheeling here and some who are not big proponents and I don't know if I know the concept well enough but I do know what my concerns are and I know what my concerns are for that North Dakota Farmer, who's on the farm, who can no longer can fly from North Dakota to Sewall Falls without paying $700. He can go to the Netherlands cheaper than to Sewall Falls, SD. Why? And he looks at you and you come to him that you have a plan, you have a system that will save you money, and he thinks you have a plan that is going to save someone else money and it is going to cost me money, because there is a built in net infrastructure that is involved in this industry that someone is going to have to pay for. Furk acknowledges it, Furk recognizes it and it is probably the biggest hangup to all of this happen. You know it you heard it today but you somehow have to give the public assurances that you have in your interest their best interest. That you truly want to provide them a more reliable, cheaper source of power, if you want this to happen politically and you must start educating them now, because we can't be behind the eight ball in externalities. You know I have a long history of being concerned about a number of issues, including environmental issues, but externalities is just a dumb, dumb idea that somehow has captured peoples imagination that they went to one form the environmental regulators and jump up and down and said that this is a problem and no one believed them because they knew better. Maybe they think it is a problem but they don't believe it is this magnitude this science doesn't prove it they are not comfortable doing that so they go to the least educate and not least educated on regulating industries but the least educated on environmental concerns that say save us from this horrible thing of global warming. Now, you take what happens and kind of how it caught fire and you think about the massive changes that you are trying to make. They don't even involve externalities but they involve peoples, the way people are going to turn on their light switch and have power that they are going to be able to afford. And you think about don't you really have an obligation as an industry and we saw that major rule that coal industry played to educate the public. You did it with the Btu tax you find that when the wolves are at the door you find the resources and the ability and the cleverness to actually educate them of what the consequences are. Why not be proactive and that is why I accepted this invitation because I wanted to give you that message because so many people don't know what's going on. I think GM knows what is going on, I think the utility industry knows what is going on, and some of the brewers know what is going on, the aluminum companies, but the senior citizen, or the farmer, or the retail businessmen who has to rely on cheap power don't know what is going on and it is up to you to educate them and if you don't the consequences of that will be a back sliding of what you think you gained with these efforts for deregulating because you don't have that base of political support for these changes. With that said I want to wrap up and tell you that I learned a little lesson from my sons kindergarten bus driver the other day and as I think about predictability and think about what is ahead. He doesn't like to ride the bus or going to school much he is 5 years old and the world is ending as he knows it, he is like all of us he doesn't like change and I asked him why he doesn't want to go to kindergarten and he said because it is going to be really boring and they are going to tell me what I have to do all the time. Well how can you argue with that because that is the true and that's life and so I am shoving him on the bus the bus driver looks down and say, Nathan it is going to be a long 12 years, so I think in the struggle for deregulation and in the struggle to educate the public and really we talk about revolution versus evolution I agree with Ed we are at a point where things could really happen where we can really make things happen but I think we have a long 12 years.

Emission Regulations - What's Next?

William Harnett
U.S. Environmental Protection Agency



Overview

- Background on multiple air effects, regulations on power generation
- Numerous CAA requirements involve utilities, directly or indirectly
- Forecast likely/possible air issues for utilities over next 10 - 15 years
- Put into perspective of restructuring, what are likely, possible environmental effects
- Begin exploration of most efficient approaches to issues

Ozone Program Implementation in Relation to other Utility Air Regulation

Ozone Nonattainment Program

NSPS Proposal

Modeling Demonstration

Moderate Area Attainment Date

Modeling Complete

Final NSPS

RACT & NSR Compliance

New Ozone NAAQS?

OTAG State recommendations on regional NOx strategy due

Phase II NOx Implementation OTC

Serious Area Attainment Date

Mid-course correction SIPs, New NAAQS modeling

Phase III NOx Compliance OTC

Severe 05 Area Attainment Date

94 95 96 97 98 99 00 01 02 03 04 05

NO2 NAAQS Decision

Acid Deposition Standard Study

Hg Study

Utility Air Toxics Study

New Fine PM NAAQS?

Utility Air Toxics MACT

Phase II Acid
NOx

Implement C. Bay NOx?

Phase II Acid Rain Compliance

CLIMATE?

Acid Rain, Toxics, Other

SELECTING TECHNOLOGIES IN THE POWER GENERATION COMPETITIVE ERA

FOURTH ANNUAL CLEAN COAL

TECHNOLOGY CONFERENCE

SEPTEMBER 5-8, 1995

DENVER, COLORADO

PRESENTED BY

MARSHALL L. PENDERGRASS

ASSISTANT GENERAL MANAGER

TRI-STATE G&T ASSOCIATION

P. O. BOX 1149

MONTROSE, CO 81402

Selecting Technologies in the Power Generation Competitive Era.

Competition? In the electric utility business? C'mon. New technologies? That's something that EPRI is supposed to take care of. What, me worry?

You bet! The recent pace of change in the electric utility business is phenomenal! Mergers, acquisitions, buy-outs, bankruptcies, Transco's, Poolco's —. Just when we thought we were trying to get lined up in the starting gate for the race, some of the thoroughbreds are already in the back stretch trying to get to the finish line. So, how does an electric utility make a technology decision for new generation in this new era of competition?

To start with (and probably end with), the end product, bus-bar cost of the project has to be economically attractive and be competitive within the utility's blended generation cost. The criteria important to us would be:

- Economically Competitive
- Demonstrated Technology
- Fuel Flexibility
- Environmentally Demonstrated
- High Availability/Reliability

The Clean Coal Technology program is certainly assisting us in finding solutions within the defined criteria.

Tri-State is very pleased to be the owner/operator of the Nucla facility which is one of the completed Clean Coal Technology projects. The facility is a 110 MW Atmospheric Circulating Fluidized Bed (ACFB) system that was retrofitted into an old stoker-fired station in Southwest Colorado. A paper was presented in this morning's technical session on the benefits and current operating statistics of this project. The bottom line to Tri-State for this facility includes the following results:

- Utilization of a Local Coal Supply That is Our Second Lowest Cost in Order of Dispatch.
- Very Low NO_x and SO_2 Emission Levels Without the Expense of Scrubber Facilities.
- Economic Benefits to the Community/County in Lieu of Shutting Down the Facility.
- Economic Performance of the Unit is Resulting in Repayment of the Loan to DOE for the Past 2 Years.

Needless to say, we are grateful to DOE, EPRI and the other participants for their help in making this a successful project.

Now back to selecting technologies for future generation. We generally categorize these into three broad areas to shop from:

- Renewables
- Nuclear
- Fossil

The renewables are generally small capacity and include hydro, wind, biomass and photovoltaic. If your from the West, you understand the sensitivity and priorities on the use of water and along with the environmental permitting issues does not make this a feasible choice. Wind powered generation, although technically feasible, has imitations as to seasonal energy, restricted dispatch, marginal economics and a question-able economic life. We are participating in the Wind Project in Wyoming, but primarily since it is within our distribution Co-op areas. Photovoltaics and biomass are in the demonstration phases and not economic in our area at this time.

Although I'm a degreed nuclear engineer and love the associated technology, it is not an industry that can compete in the competitive area of new generation. High capital costs, waste disposal and licensing issues, intensive operating costs - all are real disadvantages in the new market-place.

That brings us, Tri-State in particular, back to the fossil fueled arena. In the Rocky Mountain states, coal has historically been King. But the current and forecasted lower natural gas prices are challenging coal as the fuel of choice. By far, fuel expense is our largest operating-cost and the trick is to match a long term fuel supply to support a 30-year resource life of a facility. At least, our existing facilities meet this long life criteria. New technologies have different effective lifetimes that must get factored into the overall evaluation.

The demonstrated fossil fuel technologies include:

- Pulverized Coal-Fired Steam Units
- Simple Cycle Combustion Turbines
- Combined Cycle Combustion Turbines
- Fluidized Bed Coal-Fired Units

There are many new exciting technologies in the development/ demonstration phase that offer lower emissions, better heat rates and distribution generation. These include:

- Integrated Gasification - Combined Cycle
- Pressurized Fluidized Bed Combustion
- Fuel Cells

Comparison of the demonstrated technologies yield the following range of values for mid-size generation units:

Output	100 MW - 250 MW
Capital Cost	\$300/kW - \$1500/kW
Heat Rates	6500-10,250 BTU/kWh
Power Costs - 75% C.F.	\$25/MWh - \$40/MWh

These certainly vary based on siting and fuel supply, but are good for screening and comparison of options. These reflect coal prices of \$0.75/MMBTU and gas at \$1.50/MMBTU which are representative in this area.

I would like to close by presenting some of our observations pertaining to new generation technologies.

- Our Supply Side Planning Choice is Fossil Fuel
- Reduced Natural Gas Prices are Providing Fuel Diversity Choices.
- Simple and Combined Cycle Units Can be Designed and Sited to be Converted to Coal.
- Emissions of New Coal-Fired Technologies are an Order of Magnitude Lower Than Commercial Technologies.
- When These Newer Technologies are Available, Permitting Requirements Will Dictate Their Selection.
- Federal and State Funding Will be Needed to Move Some of These Technologies Into Commercialization - Competitive Utilities Won't Take All the Risk.
- In Addition to Purchasing Coal Reserves, Utilities Should Acquire and Control Natural Gas Resources.
- The New, High-Efficiency Simple Cycle Combustion Turbines are Not Limited to Just Peaking.
- Fluidized Bed Generation Will be the Coal Choice of the Future.

I would like to thank you for your attention and again, I would like to commend DOE for their Clean Coal Technology Program and its successes and promises for future generation technology.

International Projects

CLEAN C

My company, Custom C
Limited, which has rece
operate coal slurry pip
deep clean, transport c

A central aspect of our
almost always less tha
deep cleaning technolo
United States.

Now let me share data which led us to conclude that insufficient coal transportation infrastructure in China may cause coal shortages which will dwarf Asia's current import demand.

In 1994, China is expected to produce 1.3 billion metric tons of coal. It exports approximately 20 million tons at present. Eiighty-five percent of all energy used in China is coal, so there is a very high correlation between growth in the Chinese economy and its coal demand. In 1993, the economy of China grew by 13 percent. Although attempts are being made to cool the economy, most estimates are that growth will exceed 10 percent again this year. China has trillions of tons of proven coal reserves, adequate to supply its energy requirements for hundreds of years, even at accelerated rates of consumption. Unfortunately, most of the growth of the economy is taking place in the South and East and most of the coal reserves are located in the North and West.

Today, less than an 8 percent increase in energy demand equates to a 100 million ton per year increased coal demand in China (85 percent of 1.3 billion tons). Growth may slow, but even a 6 percent annual growth in coal demand would double, to 2.6 billion, the annual tons of coal which will be required in China by the year 2006. While these are higher than official coal requirement projections, official Chinese projections of economic growth have consistently been lower than actual experience.

Given the new openness of the Chinese government to business development, a disciplined competitively priced labor force, a generally low standard of living and high expectations of a large population of well educated and trained Chinese, it is difficult to imagine a sustained period of slow growth in China in the foreseeable future. One way to put the effective rapid Chinese economic growth into the context of the Asian coal market is to consider a few facts.

⇒ All Asian countries together imported 193 million tons of coal in 1992.
⇒ Total international coal shipments are approximately 350 million tons. Australia supplied 127 million tons to Asian markets in 1992; China 19 million.
⇒ Asian imports, exclusive of Chinese demand, are expected to increase by 183 million tons per year by 2010. Australia will increase its exports by 108 million tons per year by 2010 but cannot meet total demand.
⇒ China currently produces and uses 1.2 billion tons per year of high rank coal.
⇒ World production of hard coal is 3.4 billion tons per year.
⇒ China's population is 1.2 billion; roughly one person per ton of coal produced.
⇒ Each American uses approximately 100 times the efficiency adjusted Chinese per capita energy equivalent annually.
⇒ When China uses 5 percent of the per capita energy of the U.S., it will require 6 billion tons per year of hard coal annually.
⇒ China's coal fired electricity generating capacity was 110 gigawatts in 1992.
⇒ China's coal fired capacity is projected to be 200 gigawatts in 2000 and 350 gigawatts in 2010.

If China, because of an inability to supply its own coal demand, should become a net importer of coal it could easily destabilize the Asian and world coal markets. If it imported 10 percent of its current requirements, 130 million, it would match the current import tonnage of Japan and South Korea combined. It would increase by more than 60 percent the 192 million tons of coal imported by all Asian countries in 1992; one third of the coal shipped worldwide. Sustained incremental demand of tonnages approaching this magnitude would, almost certainly, create shortages and much higher energy prices.

Dr. Charles J. Johnson in a 1993 article for the East-West Program on Resources: Energy and Minerals, suggests that "without government restrictions, imports could exceed 50 million tons by 2010." Adding to the significance of this number is that China is currently a net exporter of 20 million tons per year, therefore, imports of 50 million tons per year would represent a net shift of 70 million tons per year. Dr. Johnson believes that massive infrastructure spending and government restrictions may cause import demand to be less than he projects. In fact, in December 1993 China Material News reported that 32 million tons shortfall in production in 1993 was made up by drawing down reserve stocks. The same article projects a production of 40 million tons in 1994. These reports suggest that China is already failing to meet its own coal market demand with current production.

In fact, substantial arguments can be made for a much earlier and larger shortfall of domestic Chinese coal production versus domestic demand than Dr. Johnson predicts. For example, it may simply be impossible, even if funding is available for transportation and mine infrastructure, for construction to catch up and keep pace with domestic coal demand. Additionally, Mr. Morita, head of the Coal and Gas Group of the Institute of Economics in Japan concludes, in a 1993 article, that there are insufficient mining engineers being trained in China to supervise the growth in mining required to meet projected growth. Another factor, as mentioned earlier, growth in the Chinese economy may be much greater than current official projections. Currently, official estimates are that coal production and consumption rates of 1.485 billion metric tons will be required by the year 2000. This is less than a 25 percent increase in eight years (using a 1.2 billion ton figure for 1992). This seems very conservative when one considers that a 9 percent average rate of growth would require a doubling of coal production to 2.4 billion tons per year to meet demand and that current growth rates and those of the recent past have exceeded 10 percent.

The participation of foreign investors in the Chinese power sector and their requirement for financing from the international community requires a dependable long term supply of fuel. Seaborne supply from Australia is currently, far than from the interior of China. The need to have a dedicated long term supply of fuel for financing purposes may result in the choice of Australian or South African coal principally on the basis of its reliability. In addition, the deregulation of Chinese coal prices and transportation costs have recently made Australian coal competitive on a price basis for the first time. For foreign investors in the Chinese power in Australia there is also a quality issue. Most export Chinese steam coal is not washed at present, is sourced from multiple seams, and therefore has a reputation for inconsistent and poor quality. Although Chinese environmental law is still lenient, international financial institutions will almost certainly require low admissions, i.e., clean coal in anticipation of more stringent environmental standards during the life of the power project before they will participate as financiers.

Another factor against China being able to meet even its own projected coal production levels is that rail capacity must be increased at rates well beyond historic levels at costs which are a disproportionate percentage of the Chinese budget. A recent China Today article points out that in spite of more than doubling its truckage since 1949, "China still possesses (only) 50 kilometer of track per 10,000 square kilometers, 70th in the world" and that "China's two North-south arteries, the Beijing-Guangzhou and Beijing-Shanghai lines can support only 40 percent of consigned railway freight... which means that freight is piling up at 3 million tons per year." It is a coincidence that 40 percent of all freight in China is coal, the precise percentage for which there is no capacity.

These scenarios raise the question as to what can be done to avert the consequences of China becoming a major coal importer. One possibility which has been favorably mentioned by the Chinese Government is coal by wire. This is the practice of building mine mouth power stations and transmitting energy by high voltage transmission lines. A principal advantage of this approach in China is that coal generally exists in the interior where power station pollution directly affects fewer people and is delivered to heavily populated cities as electricity. Its disadvantages include:

⇒ Power stations in rural areas have less opportunity to increase energy efficiency through cogeneration than those which are in metropolitan areas. China has consistently found multiple constructive uses for waste heat in metropolitan areas.

⇒ Long distance transmission of energy by wire is the most expensive mode of transportation available when all true costs are factored.

- Capital cost, including transmission power and right-of-way; and
- Line resistance losses are of net usable energy which is only a 35 percent (at best) conversion of the energy contained in coal.

⇒ Environmental effects of high voltage transmission

- Reduced agricultural acreage;
  Human health effects of high voltage proximity; and
- Water use by power plants in water short agricultural areas.

⇒ Financing — Because of the very high capital cost required by having to purchase both power stations and extensive transmission lines, capital financing per unit of energy delivered is much higher than when power stations are built close by the end user.

This brings us back to coal slurry pipelines as a method of unclogging the transportation bottleneck which currently exists in China. Features of coal slurry pipelines include:

⇒ Cost. (Comparative costs in the U.S. to transport coal 500 miles, on a ton/mile basis are 1.5 to 2.5¢ by coal slurry pipeline; 2.5 to 4¢ by railroad; and 6 to 9¢ by truck.)
⇒ No loss of coal in transport. (On average, 5 percent of all coal shipped by rail is lost in transport)
⇒ No fugitive dust when stored or in transit.
⇒ Noiseless in transit.
⇒ Reliable. Slurry pipeline is subject to minimal outside factors when compared to rail or truck transportation.
⇒ Insignificant en route loss of productive land. Because the coal slurry pipelines operate underground they provide minimum intrusion in crowded agricultural and urban environments.
⇒ Coal slurry pipelines do not delay surface traffic.
⇒ There is little chance of human injury caused by the operation of a coal slurry pipeline.
⇒ Coal slurry pipelines provide water for power station use, alleviating requirements to water starved Asian cities.

⇒ Coal slurry pipelines are most efficient and dependable when charged with fine deep cleaned coal. This coal is environmentally superior to uncleaned coal when burned contributing materially to air quality in the communities where it is used.

Along the single right-of-way, unnoticed by the farmers tending their crops above it, a 15 million tons per year coal slurry pipeline can silently deliver 940,000 16-ton truck loads or 2,500 coal unit trains of 100 wagons loaded with 60 tons each.

In congested Asia, this avoided traffic and its attendant noise would be reason enough to pay a premium for coal slurry by pipeline, but instead it is delivered cheaper when compared to alternative subsidized cost in almost all long haul situations.

In China, where the average distance from coal source to user is roughly 500 miles, coal slurry pipelines are ideal. Wherever space is limited and noise and traffic are factors, we believe coal slurry pipelines should be considered as an alternative to rail and truck transportation.

China Coal Pipeline Company is proceeding to demonstrate, with its first project, that pipelines can provide a coal transportation alternative, that if Asian coal demand develops as we believe, and can be financed on the strength of long term contracts for the coal they transport. The ability to independently slurry pipelines may be the key to their availability in sufficient numbers to help alleviate the transportation bottleneck which now exists and is growing in China.

IGT's Coal Gasification Project in China

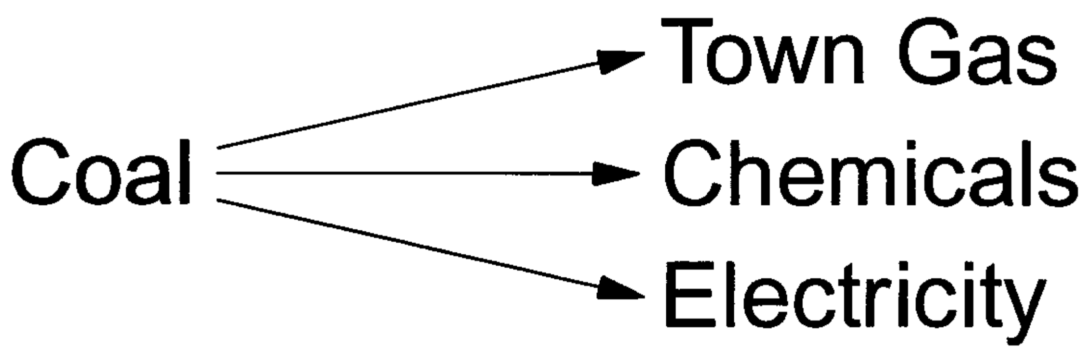
by

Bernard Lee
Institute of Gas Technology

China Coal Production & Consumption

Year	Production, billion tonnes	Consumption, % of total energy
1990	1.0	76
2000	1.4	70
2020	2.0	50

TRIGEN PROJECT



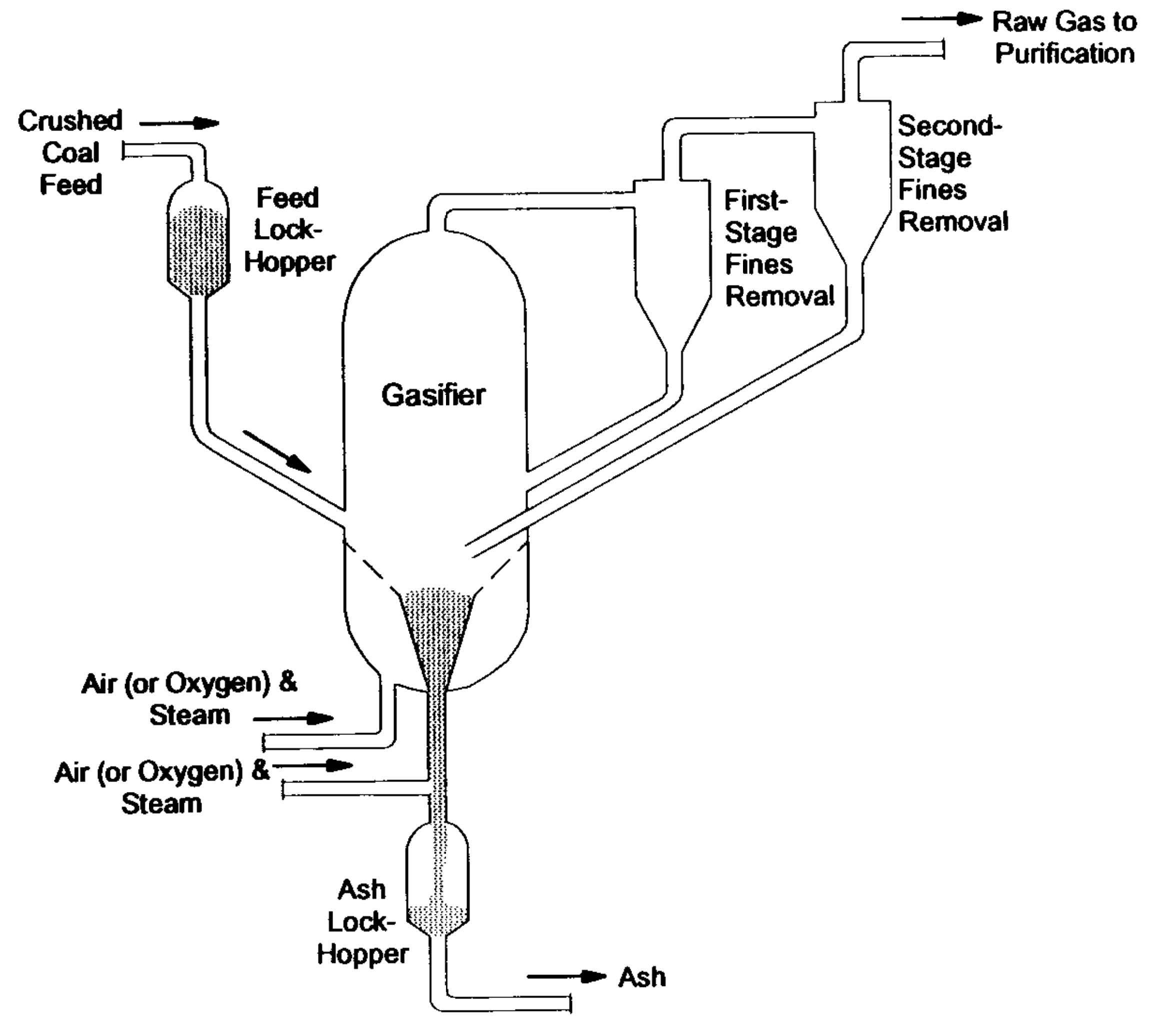
Trigen Project Technology Requirement

- Efficiency
- Environment
- Economics

U-GAS Process

- Single fluidized bed
- High coal conversion
- Air- or oxygen-blown gasification
- High- or low-pressure operation

U-GAS Schematic Diagram



U-GAS Gasifier

Single-stage fluidized bed

- Decakes
- Devolatilizes
- Gasifies
- Agglomerates

U-GAS Gasifier Feedstock

- Coke
- Coal
- Peat
- Oil shale

Coal Types

- Washed and unwashed
- Lignite, subbituminous, bituminous
- Australia, China, France, India, Poland, USA

Coal Properties

Moisture content, %*	1 to 40
Volatile Matter, %**	3 to 65
Ash content, %**	6 to 35
Sulfur content, %**	0.6 to 4.6
Heating values, MJ/kg*	13 to 29

* As received
** Dry basis

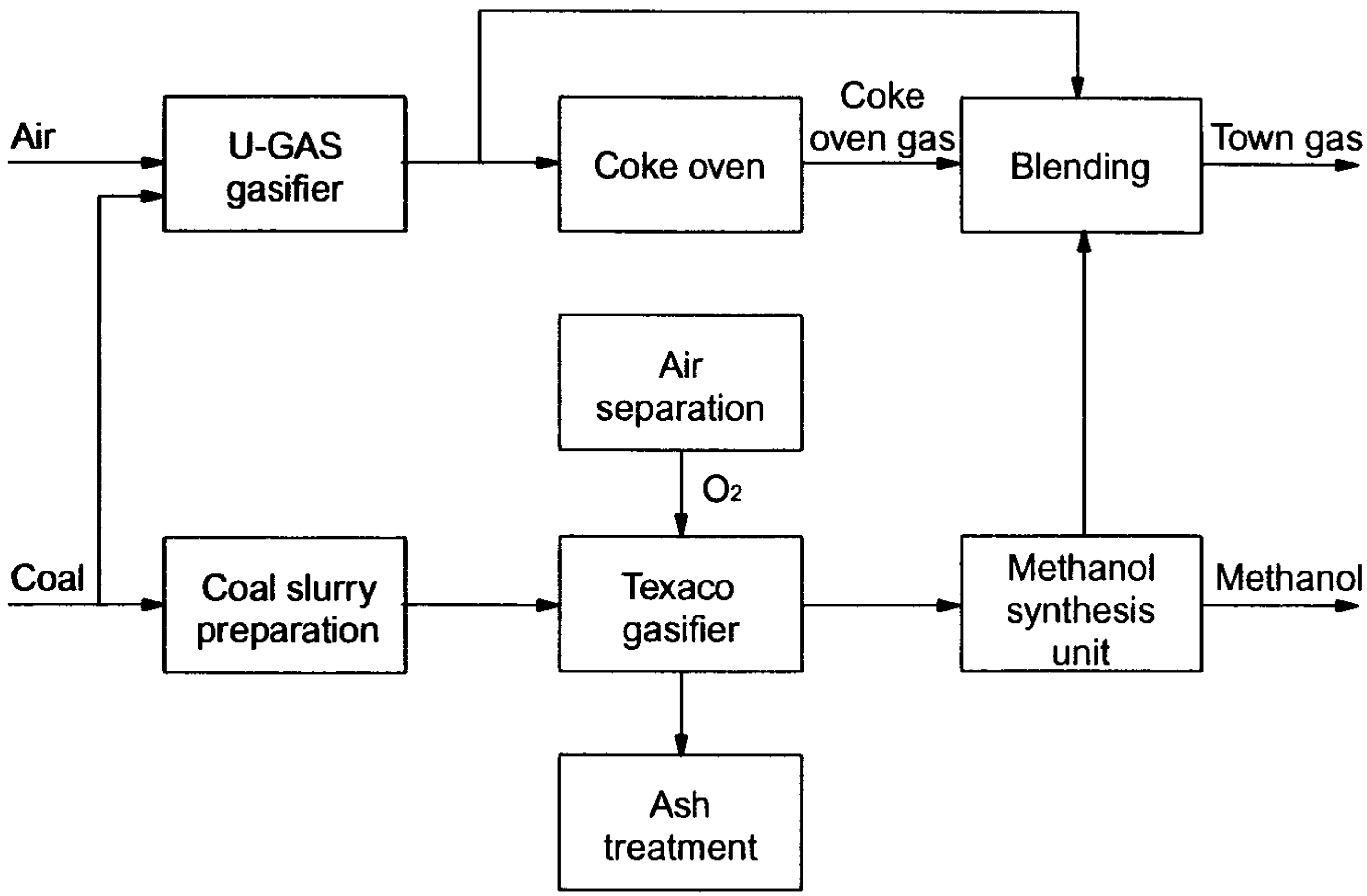
Operating Conditions

Temperature, °C:	840 - 1040
Pressure, bar:	1 - 30
Superficial velocity, m/s:	0.8 - 1.5
Oxidants:	air & oxygen

U-GAS Applications

- Industrial fuel
- Power generation
- Chemical production

SCCPG TRIGEN Plant
Block Flow Diagram



SCCPG U-GAS Plant

Coal feed capacity:	800 tonne/day
Gas production rate:	3 million Nm^3/day
Gas heating value:	1300 Kcal/Nm^3

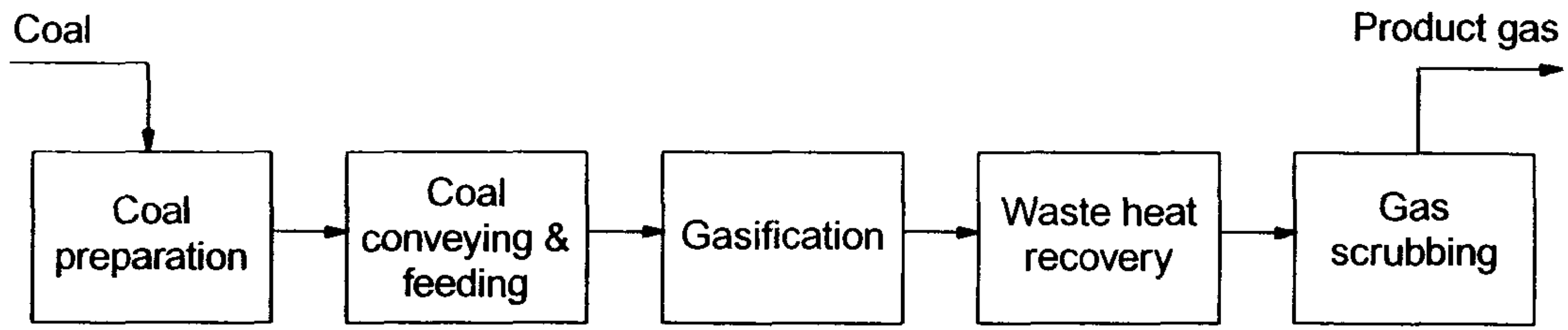
SCCPG U-GAS Gasifiers

- 8 low-pressure air-blown gasifiers
- 2.6-m internal diameter
- 15 m tall
- refractory-lined
- 3 fines cyclones

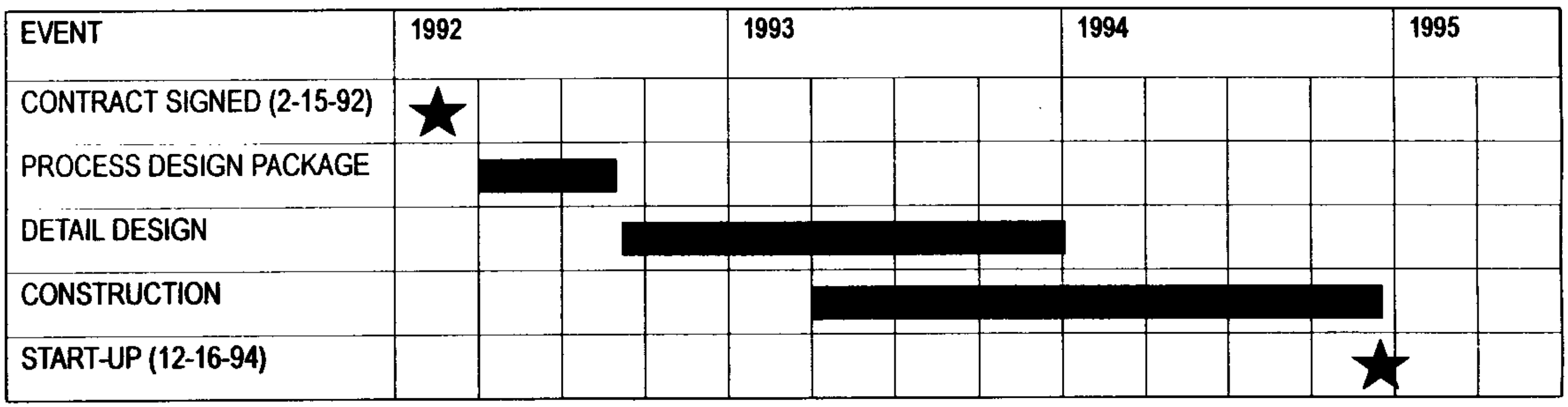
Coal Analyses

Proximate	wt% as rec'd
Moisture	7.8
Volatile matter	31.0
Ash	4.8
Fixed carbon	56.4
Ultimate	**wt% dry**
Carbon	78.0
Hydrogen	4.5
Nitrogen	0.9
Sulfur	0.2
Oxygen	11.2
Ash	5.2

U-GAS TRIGEN
Block Flow Diagram



Schedule


EVENT
1992
1993
1994
1995
CONTRACT SIGNED (2-15-92)
PROCESS DESIGN PACKAGE
DETAIL DESIGN
CONSTRUCTION
START-UP (12-16-94)

Status

- Achieved design coal feed rate
- Produced designed fuel gas heating value
- Operated Number 1 gasifier for 1300 hours, 1000 hours continuously (voluntary shutdown for plant inspection)
- Started operation of 3 other gasifiers
- Completed refractory curing of the remaining 4 gasifiers

Future Plans

- Achieve normal operation of 4 gasifiers by this Fall
- Inititate U-GAS-to-Electric-Power project

MEETING CUSTOMERS' NEEDS - TEXACO'S EXPERIENCE DEPLOYING GASIFICATION TECHNOLOGY IN CHINA

Robert S. Horton
Project Manager
Texaco, Inc.

Fourth Annual
Clean Coal Technology Conference
September 5 - 8, 1995
Denver, Colorado

(Slide 1)

Good morning. My name is Bob Horton and I'd like to share with you some of Texaco's experience deploying our gasification technology in China.

(Slide 2)

Over the past 15 years, Texaco has marketed our gasification technology to customers in the Chinese oil and chemical industries for use in making chemicals and ammonia-based fertilizers from coal and heavy oil feedstocks. More recently, we have offered a version of our technology that produces electricity, known as Texaco Gasification Power Systems, to the Chinese electric power industry.

Over these 15 years, Texaco has experienced remarkable success deploying our gasification technology in China. As this map shows, today there are 6 commercially operating plants in China that use our gasification technology to make chemicals or ammonia based fertilizers. Some of these gasifiers have been operating for 12 years. One just began commercial operation earlier this year.

In addition to these operating plants, there are 8 more plants in various stages of design and construction. One of these 8 plants is right now undergoing commissioning and startup of its Texaco coal gasifiers. Two other plants, one using Texaco coal gasification and the other using Texaco heavy oil gasification will begin their commissioning and startup activities later this year.

Also, earlier this year we entered into a multi-plant agreement with SINOPEC and the Chinese Ministry of Chemical Industry for 9 projects whereby Texaco coal gasifiers will be installed as retrofits to existing ammonia plants at 9 different locations throughout China. These Texaco gasifiers will replace other gas producing technologies now being used in those ammonia plants. These nine coal gasification projects will have individual commercial operation dates ranging from 1998 to 2004.

All told, this amounts to 23 publicly announced projects in China, which makes China far and away our best customer for Texaco gasification technology.

Before moving on, I should also point out that there is an interesting pattern to the timing of this technology deployment. In the early 80's, Texaco "planted its seeds" (so to speak) in China. Winning one project every couple of years was as rapid a pace of technology deployment as could realistically be achieved in those early days. Now, though, in 1995, we have reached the point of winning as many as 9 projects in one year.

Although we have only just started on the path of offering Texaco Gasification Power Systems in China, it is our goal to achieve the same accelerating pattern of growth for its deployment in China over the next 15 years.

Going back to the past 15 years, though, what is it that has led to this accelerating pattern of success for Texaco gasification in China?

The technology, itself, certainly has a lot to do with this success. Since Texaco first developed our gasification technology in the 1940's, we have continuously enhanced and improved it, thereby insuring our continuing position as a world leader in gasification.

But equally important is the relationship we have built with our customers over these 15 years, that has made them repeat customers, time and time again. From the top of our China business team to the bottom, we have built this relationship by a focus on <u>understanding and meeting our customers' needs</u>.

(Slide 3)

There are many facets to meeting the customers' needs. Some are well recognized and practiced (or at least strived for) by all technology suppliers. Reliability, efficiency, affordable capital and operating costs, as well as environmental performance are just a few that come to mind.

(Slide 4)

Other facets to meeting customers' needs are sometimes more subtle. Simplicity of design, maintenance and operation is something anyone who ever owns and operates a complex process plant will come to cherish. A hallmark of Texaco's Quench Gasifiers is such simplicity, --- which leads, in turn, to such previously mentioned characteristics as reliability and affordability.

Feedstock flexibility is another need that some customers have. Not only can Texaco's gasification technology handle a wide spectrum of coal and oil feedstocks, it can also utilize petroleum coke, orimulsion, and a variety of waste materials including sewage sludge, contaminated soils, refinery and chemicals wastes, and even waste plastics.

Product flexibility will have value to certain customers, --- particularly the flexibility to co-produce multiple products such as chemicals, fertilizer, electric power, town gas, and hydrogen for use by petroleum refiners. Such a co-production facility can be configured to produce multiple products, each of which, because of economies and synergies associated with co-production, end up costing less to produce than what they would cost in a plant that produced power only, chemicals only, town gas only or hydrogen only.

(Slide 5)

Keys to building a successful relationship with Chinese customers (or customers anywhere, for that matter) include being a good listener and having patience. Don't panic or push too hard when things move slower than you would like.

The Chinese approval process for major projects is a complex one. It will move at its own pace, which often is dictated by overriding factors completely external to the project at hand. When you encounter this, you may show the customer some ideas and approaches that could help move the project along, --- but ultimately it is China who will set the project's schedule.

Cooperation is another key. This can mean working side by side with engineers from a Chinese Design Institute, --- who, by the way, we have found to be as talented a group of engineers as you will find at any Western engineering firm. It also means extensive support of a project's commissioning and startup activities, including both field and home office personnel. More than anything, though, it means negotiating mutually beneficial deals and then delivering 100% of what the customer bargained for. Anything less, and you may have done your last deal in China!

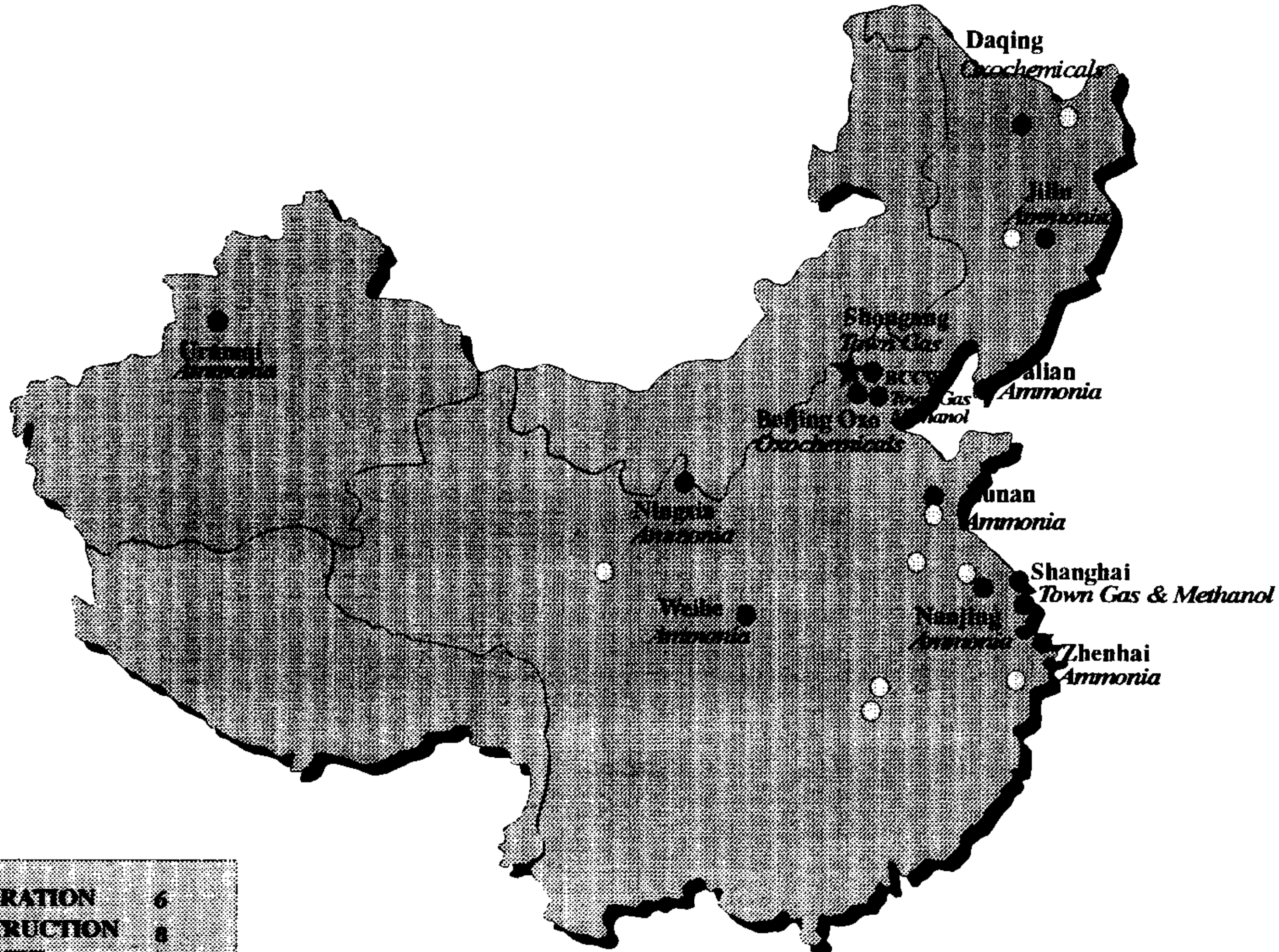
To sum it all up: having the technology gets you into the game, --- but listening to your customers, cooperating fully with them and meeting their needs is the way to score the winning touchdown. Thank you for your attention. If you have any questions. . .

MEETING CUSTOMERS' NEEDS

TEXACO'S EXPERIENCE DEPLOYING GASIFICATION TECHNOLOGY IN CHINA

NK1995.PRS

CHINA GASIFICATION PROJECTS



KEY:

IN OPERATION	6
CONSTRUCTION	8
RETROFIT	9
	23

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CUSTOMER NEEDS

- Reliability
- Efficiency
- Affordable Capital/Operating Costs
- Environmental Performance

OTHER CUSTOMER NEEDS

- SIMPLICITY
    - Design
    - Maintenance
    - Operation

- FEEDSTOCK FLEXIBILITY

- PRODUCT FLEXIBILITY

KEYS TO A SUCCESSFUL RELATIONSHIP

- LISTEN
- HAVE PATIENCE
- COOPERATION

AHLSTROM

CIRCULATING FLUIDIZED BED COMBUSTION TECHNOLOGY:

THE ECO-FRIENDLY SOLUTION TO MEET INDIA'S POWER REQUIREMENTS

Fourth Annual Clean Coal Technology Conference

September, 1995

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Emerging International Market for Clean Coal Technology

- 390 Gigawatts- retrofit of existing facilities
- 330 Gigawatts new capacity by 2010-primarily in India and China
- World Bank revised Environmental Standards
- Possible creation of 70,000 US export related jobs

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Opportunities in India for Clean Coal Technology

AHLSTROM

- 142,000 MWe's planned by 2005
- Currently 50,756 MWe's of private power solicitations
- 60% of power generated by coal
- Coal is high ash, abrasive, medium sulphur
- Other fuels include high sulphur lignite
- Environmental requirements changing

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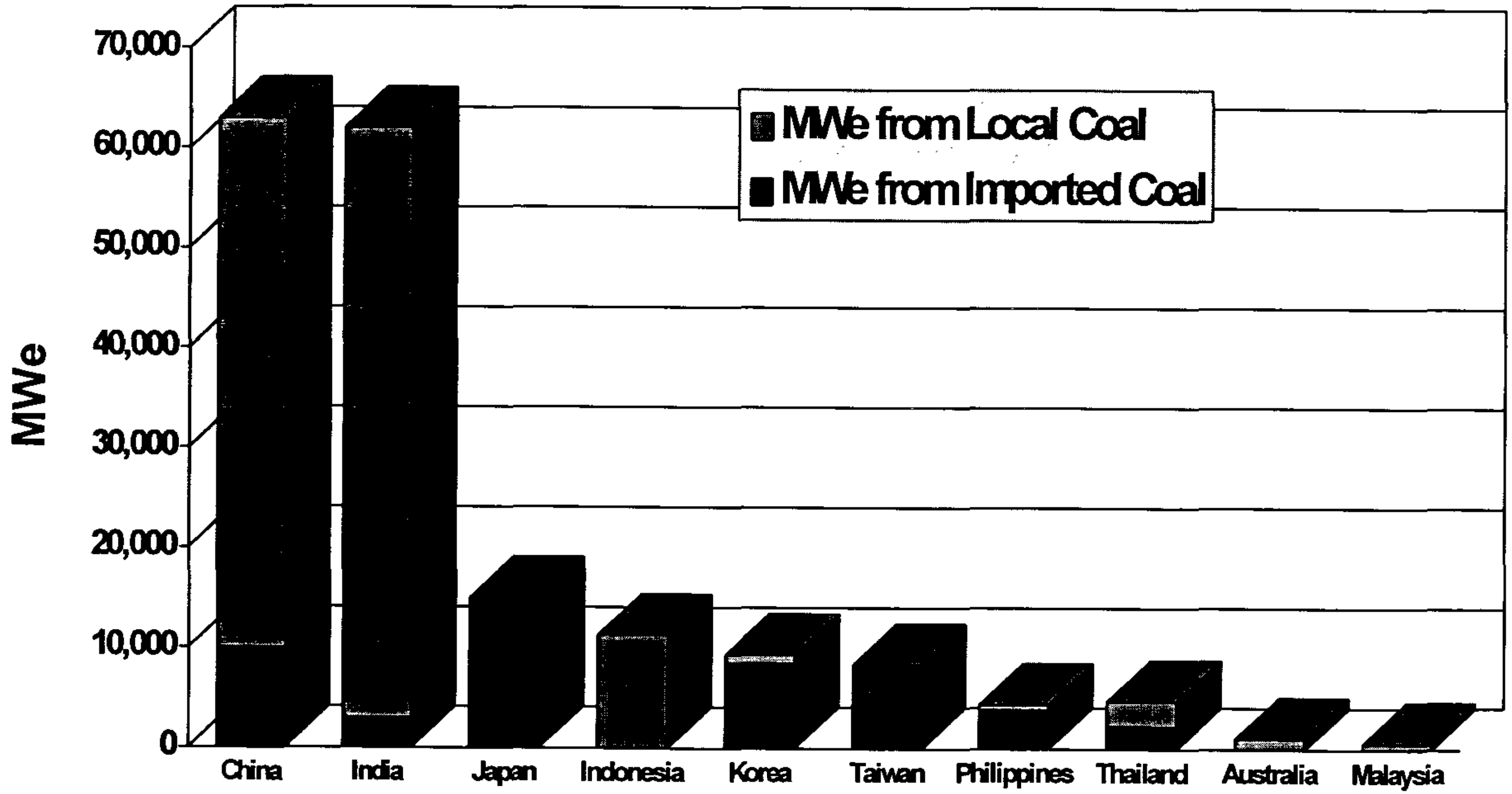
Incremental Coal-Fired Capacity Present Through Year 2000

AHLSTROM



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Coal Trends in India

AHLSTROM

- Demand is growing faster than supply
  - Particularly for PC-quality fuels
- New supplies will be lower in quality and higher in price
- Higher quality fuels will be sold at a premium
- Fuel flexible projects will have lower fuel costs (higher returns)
- Environmental controls will get more stringent

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India's Recoverable Coal Reserves

AHLSTROM

	Bil. Tons
• Bituminous coal	66.8
• Lignite & Subbituminous coal	2.1

Source: Coal India Ltd

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Coal India Production Forecast by Sector

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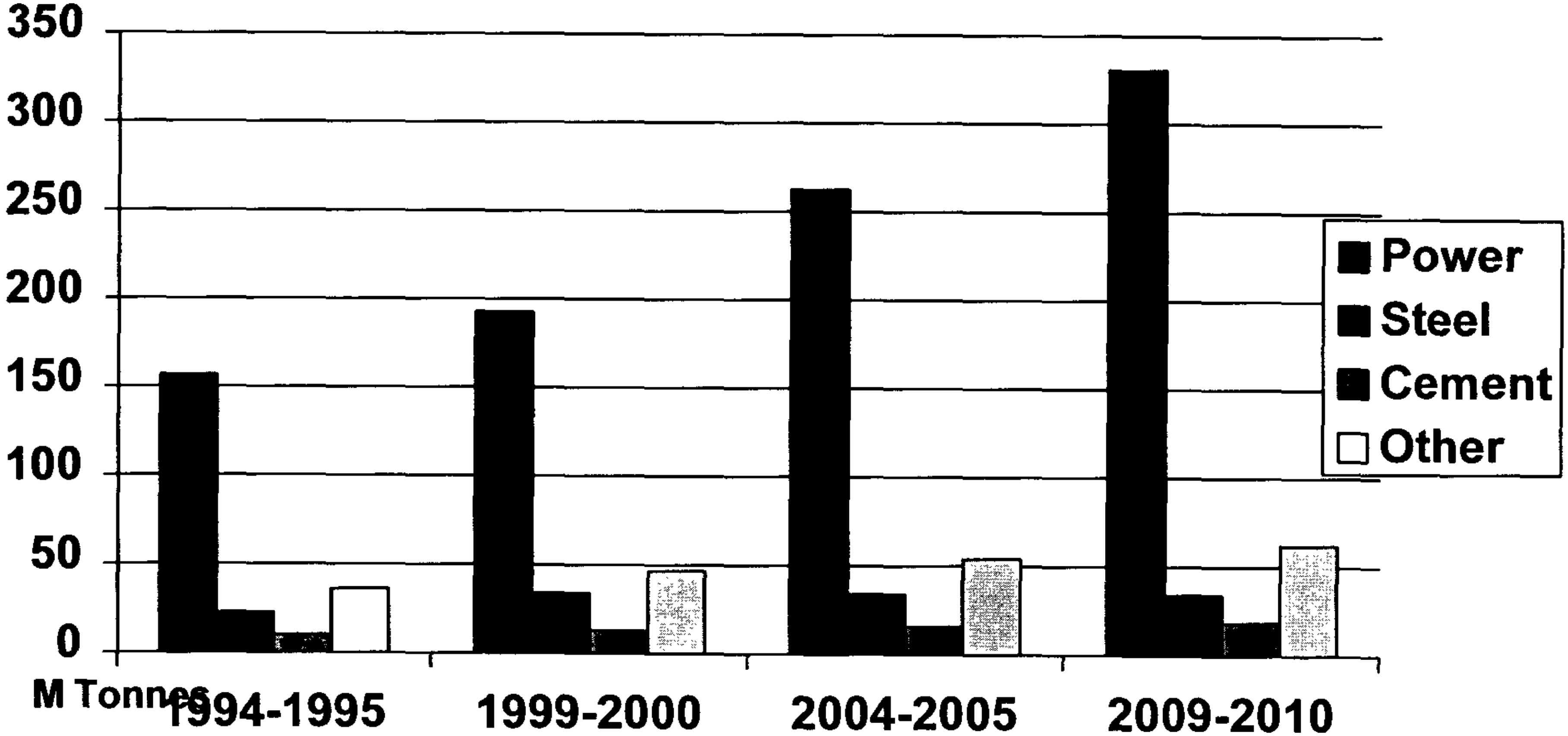

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Barriers to Meeting Production Forecast

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- Massive mine expansion required
  - need for new technology
  - need for capital
  - need for infrastructure development
- Coal washeries required at existing mines
  - need for capital
  - need for higher quality coal for transport

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Coal Supply & E Demand

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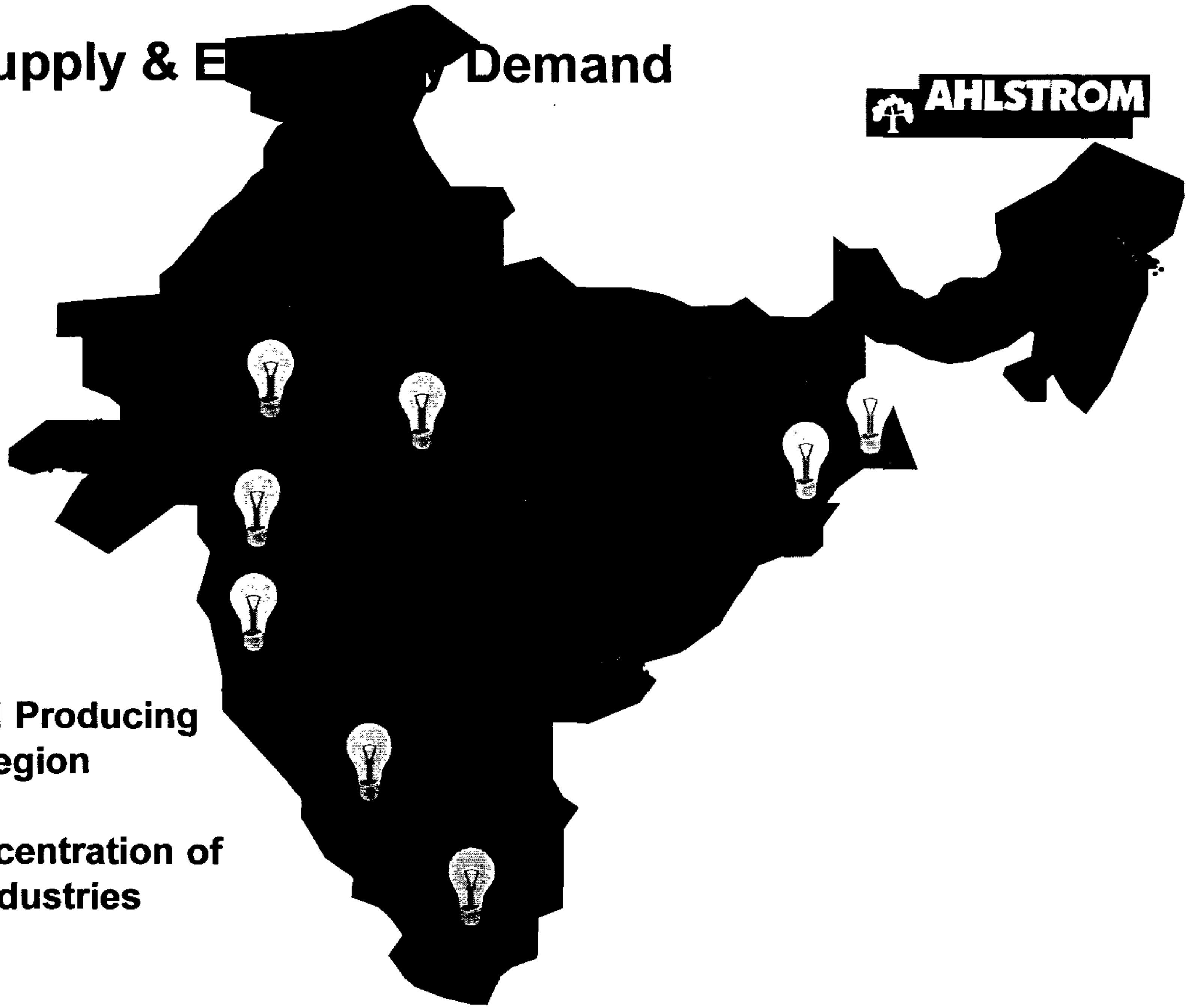

Coal Producing Region

Concentration of Industries

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Issues Specific to India

AHLSTROM

- Transportation of coal by rail problematic
  - high cost
  - low efficiency and reliability
  - over burdened railroad system
- Quality of coal
  - low calorific value, greater tonnage required
  - washing reduces ash, increases cost by $2-3/ton (USD)
  - very abrasive

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What Are The Solutions?

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- Increase rail transport
- Mine mouth power plants - coal by wire
- Wash coal to reduce ash and sulphur
- Utilize existing low quality and waste coals
- Import coal

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India Can Utilize Existing Low Quality and Waste Coals

AHLSTROM

- Burn Indian coal in CCT power plants

OR

- Increase coal washing to produce higher quality coal
- Transport only high quality coal
- Burn middlings and coal washery waste in mine mouth CFB power plants

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Integrated Coal Washery / Waste Fueled CFB Power Plant

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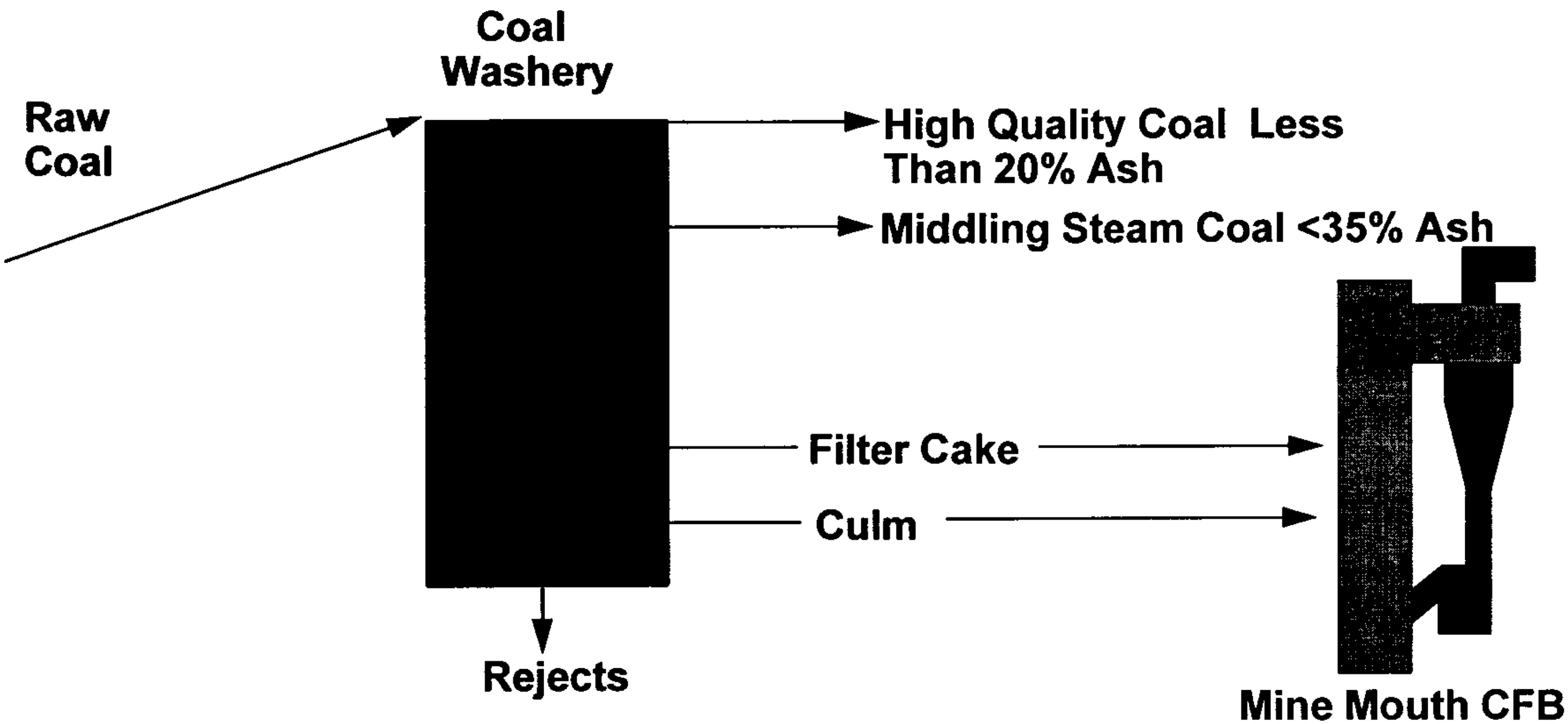

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How Can Captive CFB Power Plants Make Coal Mines More Competitive?

AHLSTROM

- A CFB Can Cleanly Burn Waste Fuel From An Industrial Process
- A CFB Can Closely Match An Industrial's Power and Steam Requirements
- A CFB Can Provide Low Cost Power and Steam To An Industrial

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Fuel Flexibility Saves Money

AHLSTROM

- Fuel Can Typically Represent 40% to 60% of Plant Life Costs
- Published Data on Paiton I (2x 615 MWe) Indicates 30 Year Fuel Contract Equals 220% of Plant Capital Costs
- Savings Over Project Live Easily Exceed Minor Capital Cost Difference Paid for Fuel Flexibility
- $10 Change in Fuel Cost Translates to Increase of $0.01/kWh

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Capital vs Fuel Cost For A Power Plant

AHLSTROM

- A One Million US Dollar Increase In Capital Cost Will Result In A Decrease of 18 Basis Points In After Tax Yield

- A One US Dollar per tonne Decrease In Fuel Cost Will Result In An Increase of 123 Basis Points In After Tax Yield

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CFB Opportunities in India

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- Low rank fuels (120-250 MWe/unit)
  - high sulfur lignite
  - high ash
  - petroleum coke
- Environmental areas (120-250 MWe/unit)
  - Taj Mahal
  - price competitive with PC/scrubber
- Waste coal (50-100 MWe/unit)
  - washery rejects
- Rural electrification

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CFB: The Modern Way to Burn Coal and Other Fuels

AHLSTROM

- Optimized Performance Over a Wide Range of Coals and Other Fuels
- Low Emissions
- Easy to Operate
- Proven Reliability
- Competitive Cost

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CFB Accepts a Wider Range of Coal Properties

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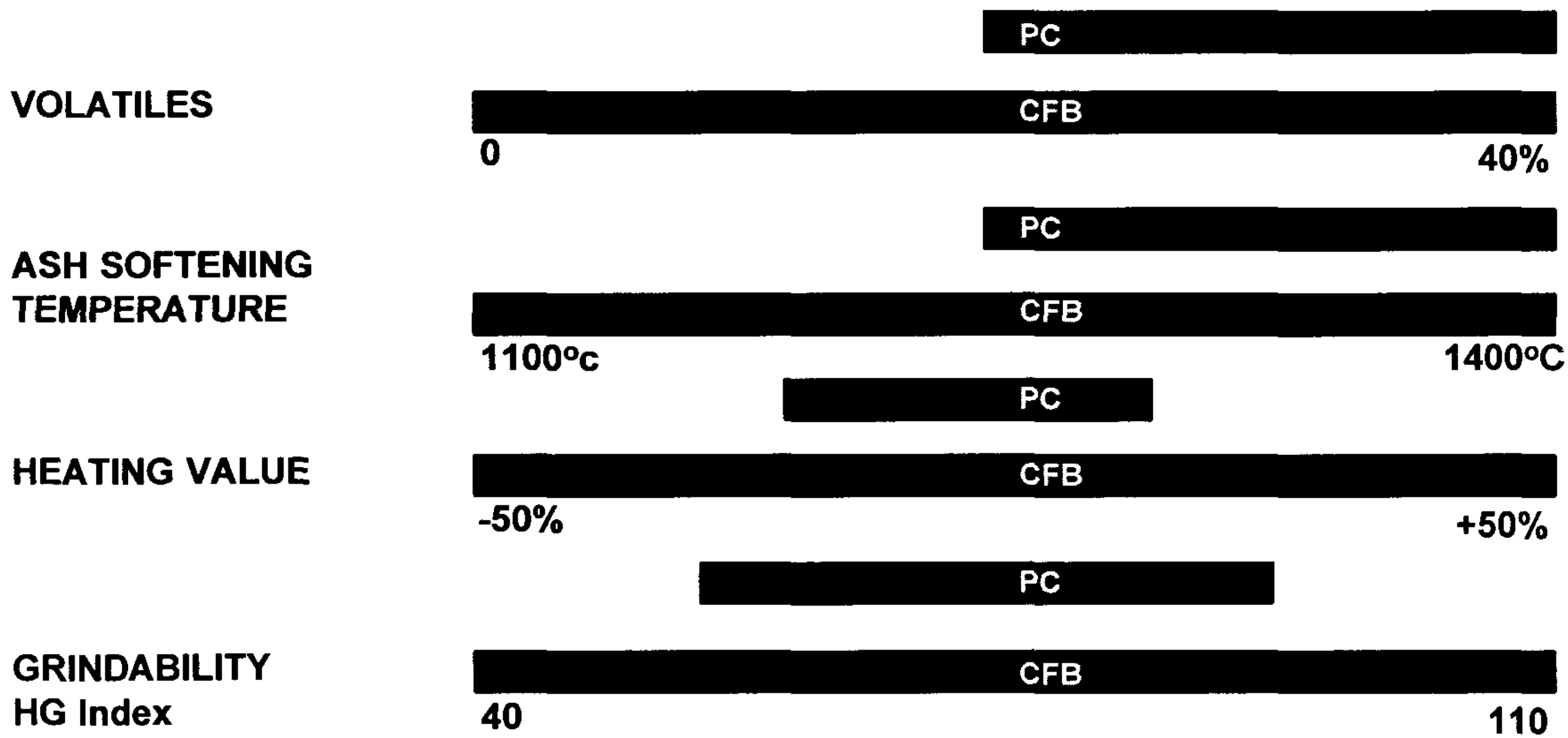

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CFB Technology Offers Greater Fuel Flexibility

AHLSTROM

- Coal
  - Anthracite
  - Bituminous
  - Sub-Bituminous
  - Lignite
- Waste Coal
  - Anthracite Culm
  - Bituminous Gob
- Petroleum Coke
  - Delayed
  - Fluid
- Woodwaste
- Tires
- Oil Shale
- Oil
- Gas
  - Natural
  - "Off" Gases
- Sludge
  - De-Inking
  - Municipal
  - Paper Mill
- Refuse Derived Fuel
- Peat
- Agricultural Waste

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Nature of CFB Advantages With Respect to Coal Properties

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	Typical PC	Typical CFB
Calorific Value	*Minimum C.V. of 4,000, Ability* to Vary +/- 15%	C.V.'s as Low as 1,400 in
Volatile Matter	Most Designed to Burn Minimum V.M. of 25%, Incomplete Combustion if Too Low	Long Residence Time Allows Very Low V.M., 7% V.M. Gilberton Anthracite
Moisture Content	Typical Moisture of 12%, Fuel Needs to be Dried to 3%, *Capable of up to 40% but* Units More Costly to Build	Much Lower Effect on Unit Cost, 55% Moisture Peat at Seinajoki
Ash Content	Accumulation of Ash Deposits Reduce Boiler Capacity, Normally 15% (30% Maximum)	Much Lower Effect on Unit Cost, 60% Ash at Northbranch Bituminous Gob
Fuel Hardness	Fuel Must be Finely Ground Normally Requiring Softer Fuel with HGI>40, However Fuel Must not be Too Soft	Little Effect as Pulverization is not Required
Ash Softening Temp.	*Accumulation of Ash Deposits* if AST Too Low, Normally Must be Above 1,200°C	Little Effect Due to Lower Firing Temperature
Sulfur Content	Normally requires 1% Sulfur or *Less or FGD Required, FGD* Adds to Plant Cost and Higher O&M	CFB's Designed to Remove *Sulfur in the Furnace, 6%* Sulfur Handled with Hyundai Oil Petcoke

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CFB Technology Reduces SO_2 Emissions

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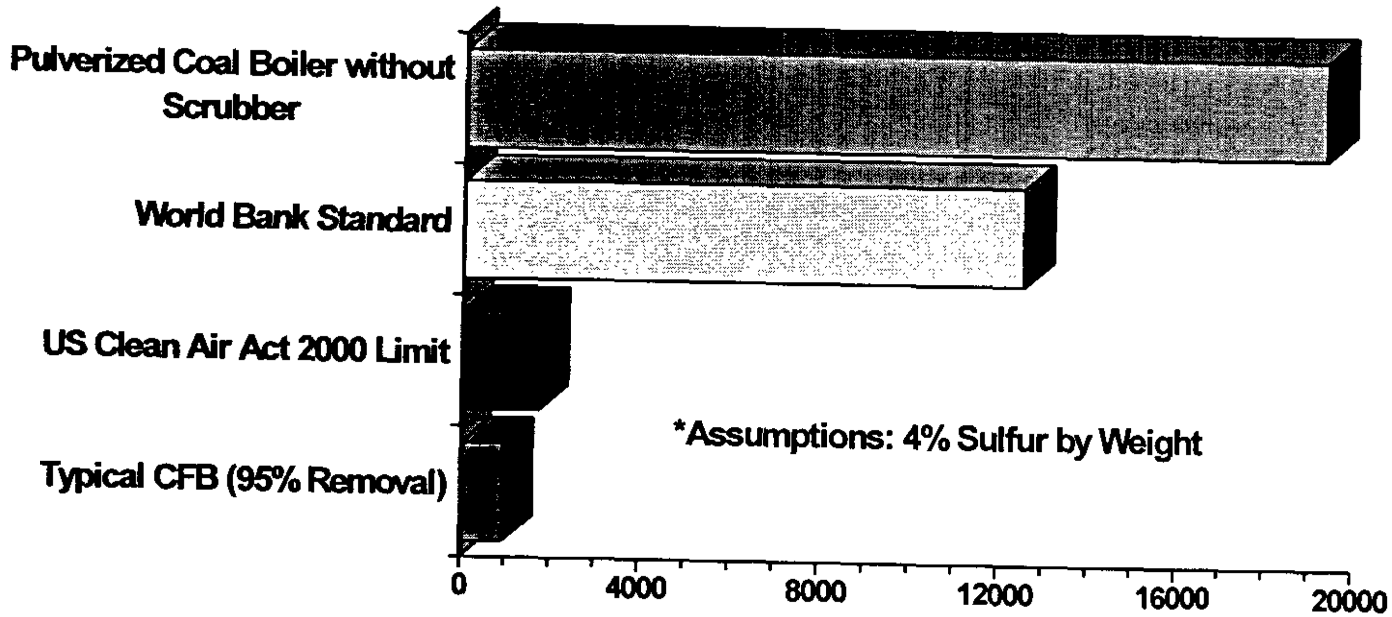

SOURCE: The World Bank Environmental Guidelines

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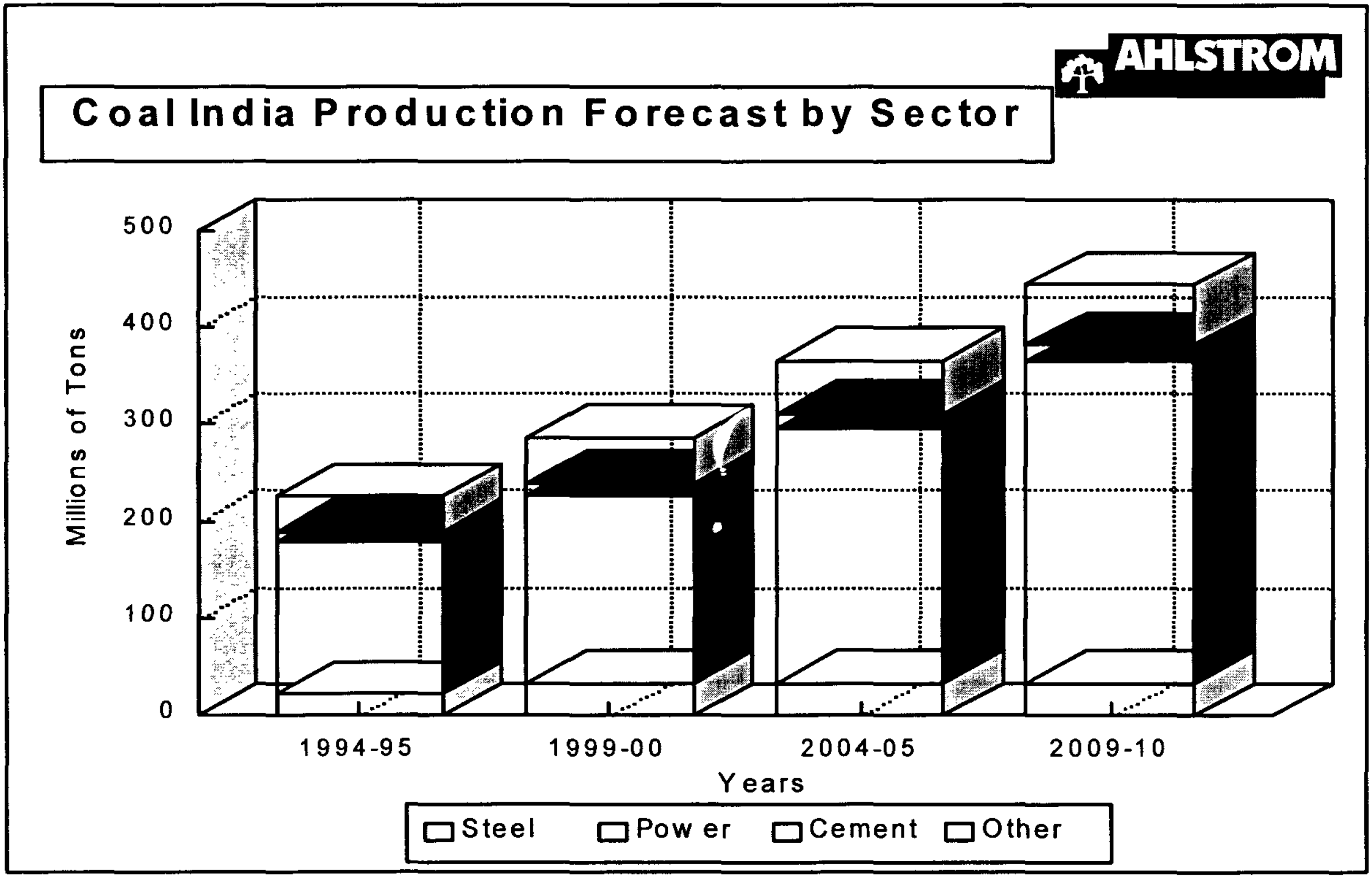

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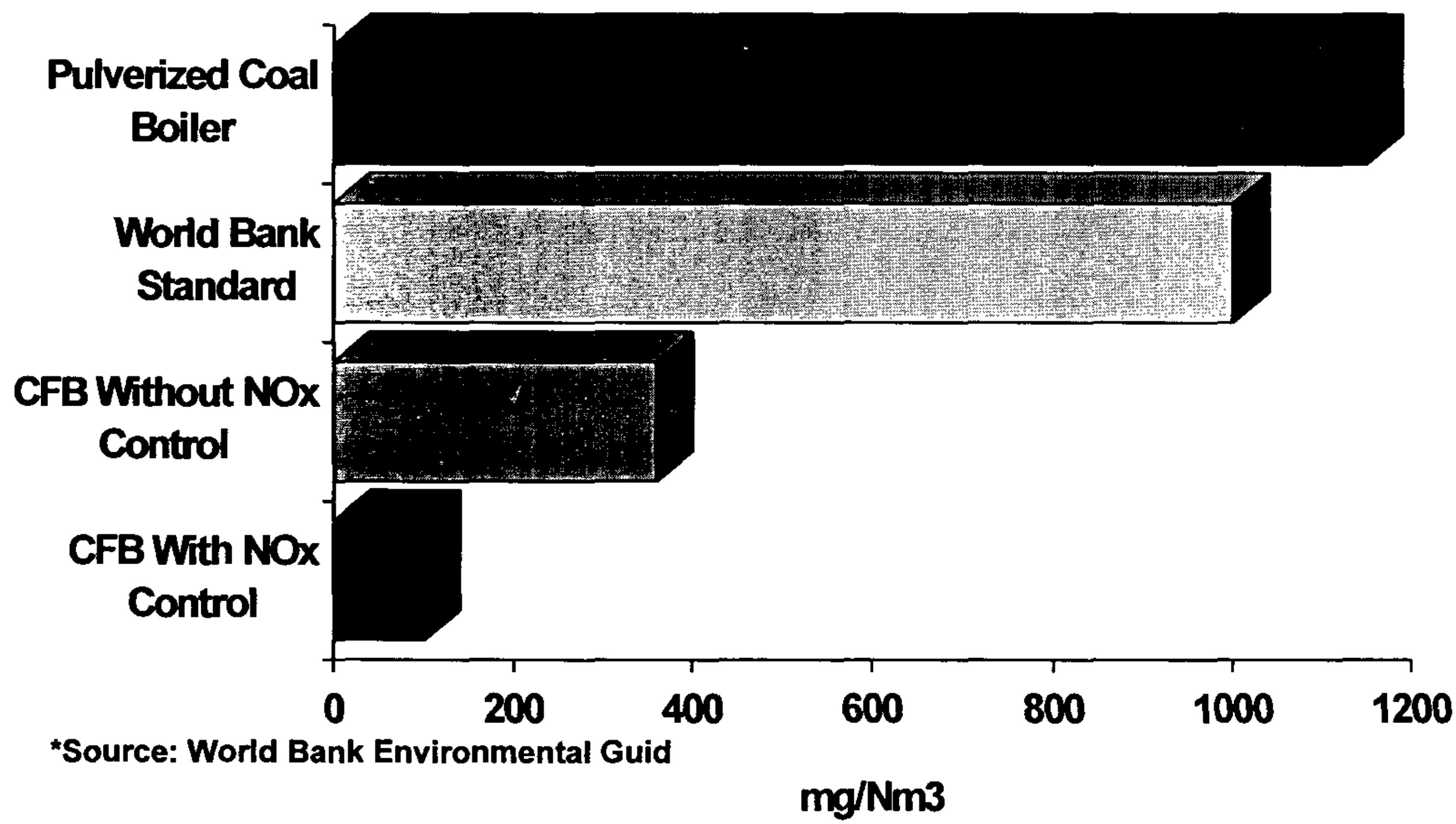
CFB Technology Reduces NO_x Emissions

AHLSTROM



*Source: World Bank Environmental Guid

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Typical CFB Project Emissions

AHLSTROM

• Particulate	11 mg/m^3 (with baghouse)
• Opacity	< 2%
• SO_2	*95 mg/MJ
• NO_x	110 mg/MJ (uncontrolled)
– With $DeNO_x$	30 mg/MJ
• VOC	2 mg/MJ
• CO	45 mg/MJ

* Based on 2% Sulfur, 20,935 KJ/kg, 95% SO_2 Removal

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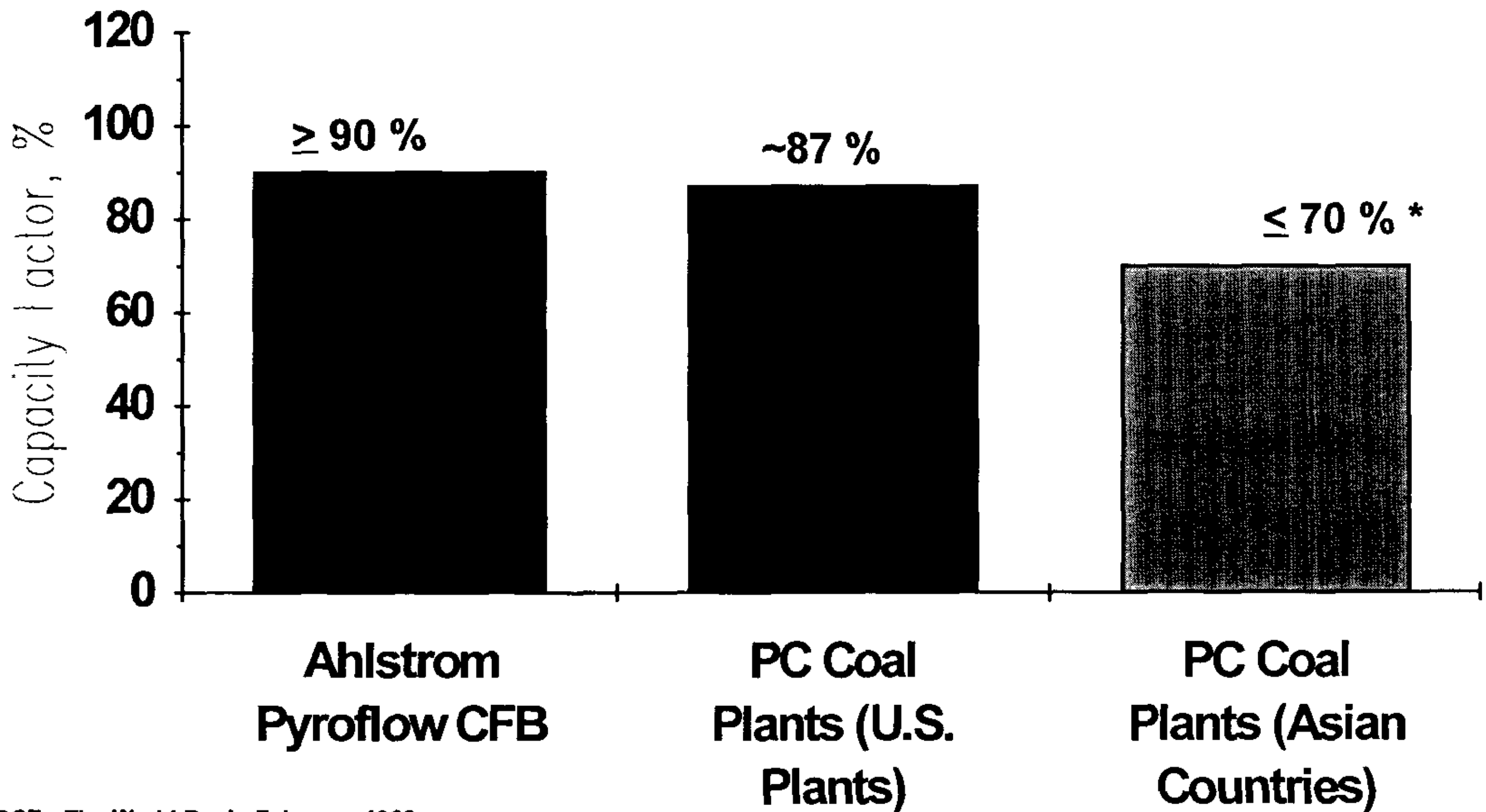
Capacity Factors: Ahlstrom CFBs vs. PC Technologies

AHLSTROM



* SOURCE: The World Bank, February 1990

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There are Many Beneficial Uses for CFB Ash

AHLSTROM

- Agricultural soil amendment
- Waste/sludge stabilization
- Road base materials
- Landfill capping
- Mine reclamation
- Building materials

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Summary

AHLSTROM

- India must expand coal production capacity
  - open new mines
  - wash transported coal
  - use washery waste and mine tailings in mine-mouth CFB
- Environmental standards are becoming more stringent
  - New World Bank standards
  - eco-sensitive areas
  - lenders will require eco-friendly technology

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Conclusion

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- CFB is the best technology for India
  - fuel flexibility
  - meets highest environmental standards in the world
  - high reliability
  - lowest lifecycle cost

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COMMERCIAL MILD GASIFICATION CLEAN COAL TECHNOLOGY APPLIED TO LOW-RANK INDONESIAN COALS

by

Dennis W. Coolidge
General Manager
The TEK-KOL Partnership
Gillette, Wyoming

Robert E. Nickell
Consultant
The TEK-KOL Partnership
Poway, California

1. Introduction

With the ENCOAL Liquids From Coal (LFC) Plant near Gillette, Wyoming, now beginning its fourth year of operation and its second year in a production mode, the TEK-KOL Partnership between ENCOAL's parent company, Zeigler Coal Holding Company, and SGI International, the original developer of the LFC mild gasification technology, is turning its attention to commercial opportunities in both the United States and overseas. The primary emphasis remains on the upgrading of some portion of Zeigler's low-rank Powder River Basin (PRB) coal reserves for midwestern U. S. steaming coal markets, as well as seeking joint-venture applications with other PRB producers. However, the similarity of data from preliminary testing [1] of low-rank subbituminous and lignite coals from other regions of the world with those for Buckskin Mine coal-- the feed for the ENCOAL LFC Plant-- is an inducement to license the technology to potential users elsewhere, in order to help recover the costs of LFC technology development. This inducement is particularly compelling when the economics of coal upgrading for these potential overseas projects are extremely favorable, inclusive of technology licensing payments.

Three factors that favor investment in LFC coal upgrading projects in the PRB also favor investments in LFC projects in Indonesia [2]. First, the reserves of low-rank coal in both locations is vast. Although Indonesian coal reserves are modest in comparison to those in the PRB, the country has almost five billion metric tonnes of measured reserves, another nineteen billion tonnes of indicated reserves, and twelve billion tonnes of hypothetical reserves. The majority of these reserves are high-moisture subbituminous coals or lignites that are not directly suitable for steaming coal export markets without some form of coal upgrading. Two-thirds of the Indonesian coal reserves are located on the island of Sumatra, mostly in South Sumatra, while the bulk of the remainder is located in East and South Kalimantan, on the island of Borneo.

Second, the seam thicknesses and stripping ratios favor efficient surface mining operations. Again, there are non-trivial differences between mining conditions and efficiencies in the PRB and in Indonesia, and differences within Indonesia; however, in general, Indonesian surface mining opportunities are considerable in spite of the lack of a developed infrastructure in many locations. The relatively low mining costs, in comparison to the value of the upgraded product in the East Asian steaming coal markets, would appear to accommodate the expense of coal upgrading, similar to the economics in the PRB.

Third, the distances to Indonesia's steaming coal markets, including those within the country itself, place a premium on reducing the costs of transportation, especially that portion of the cost attributable to transport of moisture and excess volatile matter. Again, this similarity to conditions in the PRB, where between one-quarter and one-third of the transport cost is associated with transport of coal moisture, is an opportunity to offset a portion (if not most) of the coal upgrading cost.

Finally, other reasons for investing in Indonesian coal upgrading opportunities are related to the unique position energy supply and demand situation in Indonesia and the rest of Asia. Indonesia is rapidly depleting its oil reserves and, therefore, the principal source of foreign exchange for its economic development program, and that economic development program includes a rapid increase in coal-fired electric power generation. The rate of increase in coal-fired power generation is also rapid elsewhere in Asia. The double-edged opportunity to offset some of the declining domestic oil production with coal liquids and to upgrade low-rank coals to higher-value solid fuel is compelling.

In the following sections, this investment opportunity is described in terms of three types of Indonesian commercial clean coal technology projects and associated technology licensees: (1) a project related to a Coal Concession Contract between the Indonesian state coal mining company, P. T. Tambang Batubara Bukit Asam (PT TBBA) and the private sector, with both Indonesian and foreign private participation, such as the Berau Lati project described in Section 4; (2) a project related to mining properties operated directly with PT TBBA, such as the Tanjung Enim project described in Section 5; and (3) a project related to Indonesian private mining interests, such as the Musi Rawas project. The latter will not be covered in any detail here, but has been discussed elsewhere [2].

Before describing these potential Indonesian projects, Section 2 will provide a brief description of the LFC technology and Section 3 will address the status of the commercialization of the technology.

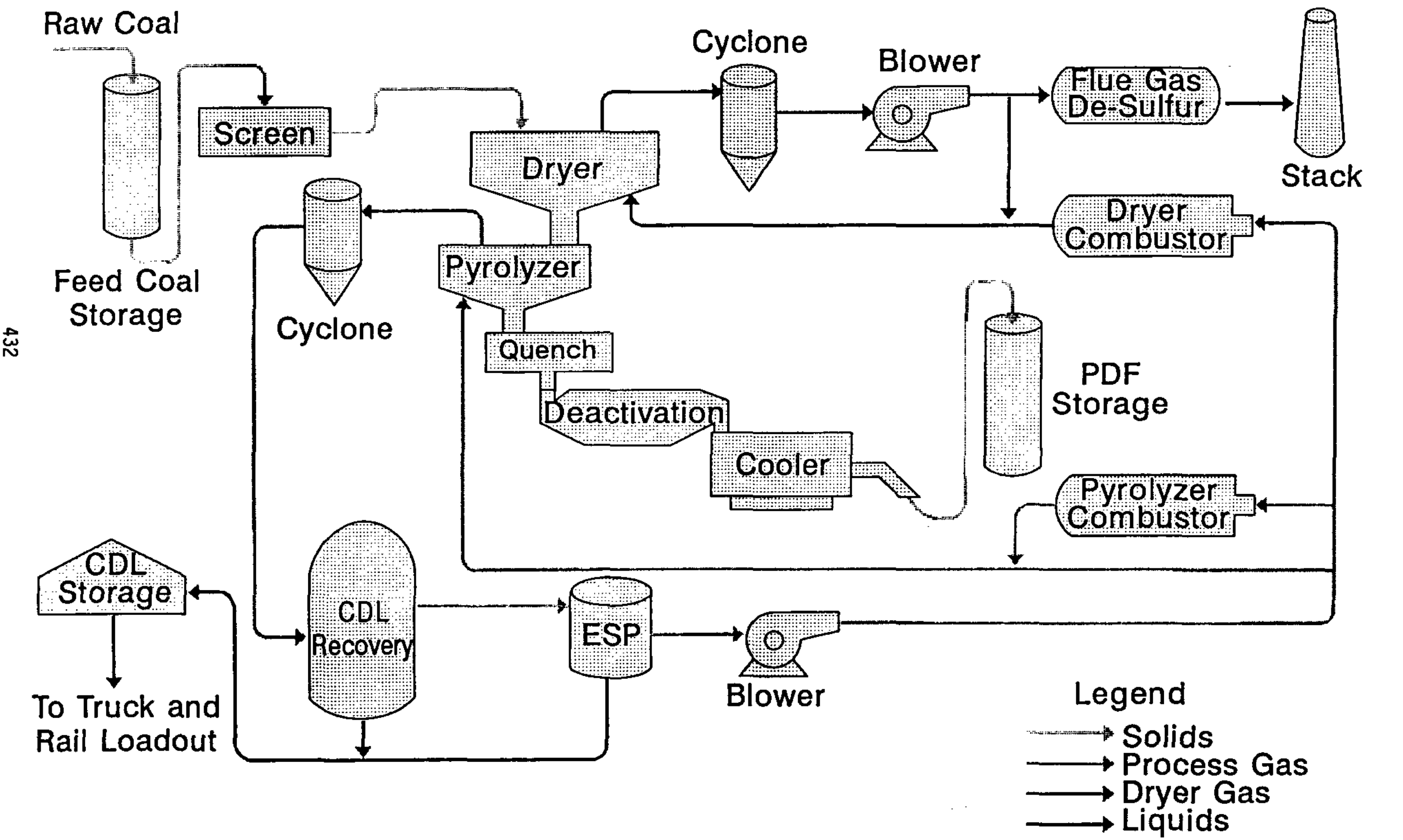
2. The LFC Process

The LFC process is a mild pyrolysis, or mild gasification, pre-combustion clean coal technology ideally suited for upgrading low-rank subbituminous and lignite coals while, at the same time, producing high-value coal liquids. A schematic of the process as applied to Powder River Basin subbituminous coal is shown in Figure 1. The processing consists of three basic steps:

- convective drying, in order to remove almost all of the inherent moisture, using a controlled-oxygen gas (e.g., products of combustion), at drying temperatures such that hydrocarbon gases do not evolve and at sub-fluidization superficial gas velocities for all but the smallest coal particles;

Figure 1

Simplified Process Flow Diagram



- convective mild pyrolysis, in order to remove over 60 % of the volatile matter, again using a reducing atmosphere, at controlled particle heating rates, peak temperatures, and residence times specific to the pyrolysis kinetics of a particular coal, and again at superficial convective gas velocities below fluidization levels for all but the tiniest of coal particles; and
- stabilization, which involves quenching the mild pyrolysis reactions, rehydrating the char particles to approximately equilibrium moisture (which has been reduced substantially by the two previous processing steps), removing the heat of rehydration, deactivating most of the reactive surface sites by selective carboxylation, and removing the heat of carboxylation; the application of a dust suppressant may also be required.

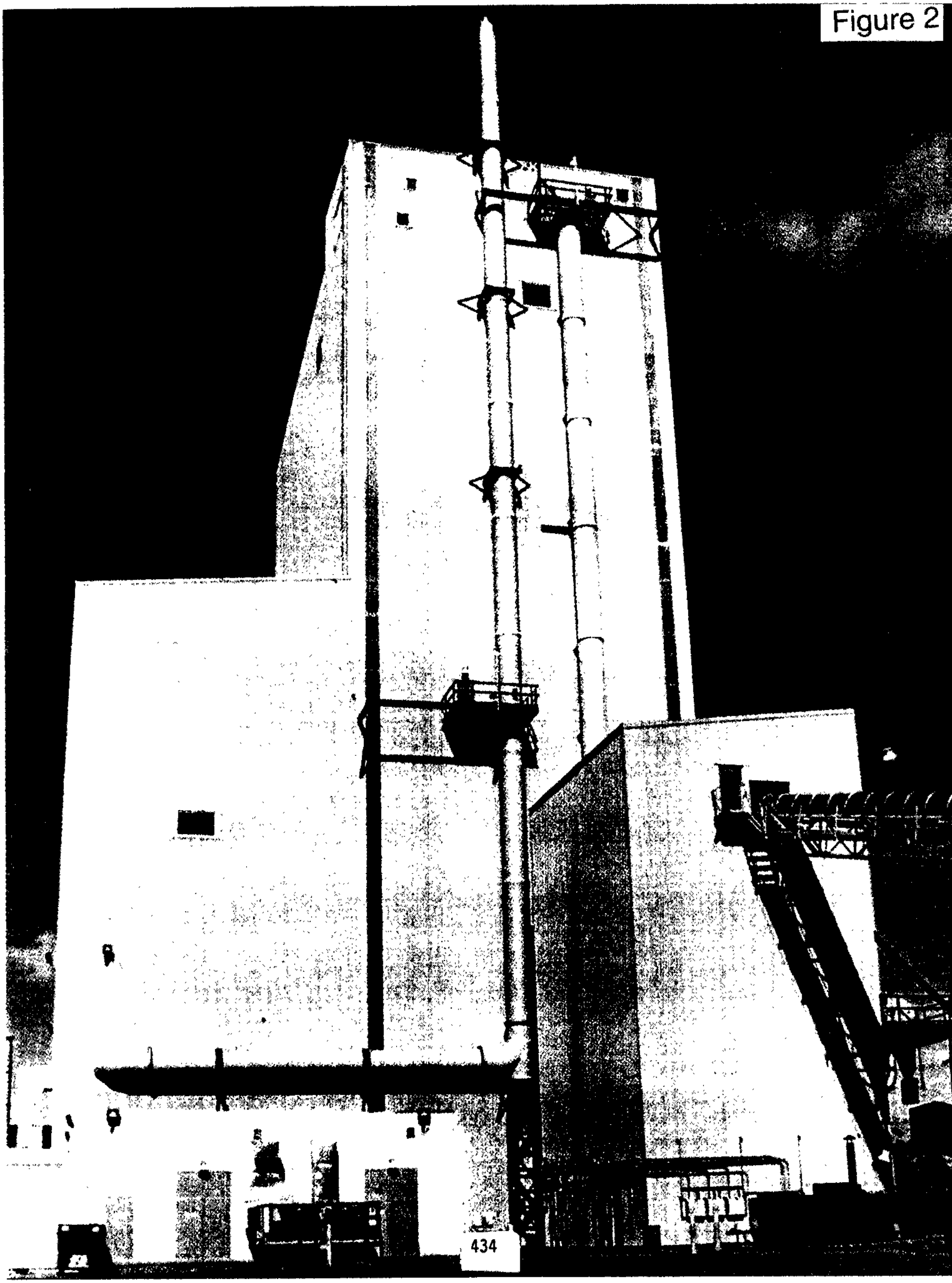
The gas stream from the mild pyrolysis step passes through a cyclone separator and on to the liquids collection system, consisting of conventional quench columns and electrostatic precipitators that remove the condensible portion of the CDL. The non-condensible portion of the stream is a low-heating-value gas that continues on to be combusted to generate most of the heat necessary to dry and pyrolyze the coal. A low background level of natural gas is also fed to the combustors to provide flame stability and transition during startup and shutdown.

These three basic steps are carried out at near-atmospheric pressure (i.e., the system pressures are measured in millimeters, or inches, of water column), at relatively low temperature (i.e., peak mild pyrolysis temperatures of the order of 500°C, or about 900°F), and in relatively inexpensive process vessels. Limiting the superficial gas velocities to below fluidization levels and including off-gas cleanup equipment overcomes one of the fundamental problems associated with mild pyrolysis—solids carryover into the coal liquids. The second fundamental problem, quality of the coal-derived liquids (CDL) is overcome, in part, by matching process conditions with coal pyrolysis kinetics, using a sophisticated control system that couples plant sensors with algorithms that model the process steps. The third fundamental problem, the stabilization of the solid process-derived fuel (PDF) for safe storage and transport, is overcome by limiting the appetite for oxygen consumption by the PDF at nominal handling temperatures.

3. ENCOAL LFC Plant

ENCOAL Corporation, then a unit of Shell Mining Company, entered into a Cooperative Agreement with the U. S. Department of Energy (DOE) in 1990 to design, construct and operate for two years a near-commercial LFC plant, under Round Three of the DOE Clean Coal Technology Demonstration Program. Construction began in October 1990 and was completed in July 1992 [3]. Figure 2 provides a view of the ENCOAL LFC plant, which is ten stories high and designed to process 1,000 tons per day of Buckskin Mine subbituminous coal. The plant operated intermittently during the remainder of 1992 and early 1993 while going through startup operations, and equipment and product testing [4]. Longer periods of operation in the first half of 1993 led to a decision to shut the plant down for major modifications in late 1993 and early 1994. In May, June, and July of 1994, ENCOAL operated the plant for 68 days at 90 % availability, while producing and selling more than 600,000 gallons of specification CDL and more than 12,000 tons of stabilized PDF [5]. The original agreement with the DOE, for

Figure 2



50 % sharing of $ 72 million of allowable design, construction, and operating costs for the first two years of operation, was extended for two additional years in October 1994, with an additional $ 18 million of shared costs. The plant continues to operate in a production mode.

The total production of CDL in 1994 was almost 1,342,000 gallons, of which 963,270 gallons were sold and shipped in 45 railroad tank cars to three different industrial customers for test burns and compatibility testing. Additional efforts are underway to optimize the value of the CDL by separation into fractions with particular market attributes.

ENCOAL shipped its first half-unit train containing PDF to the Western Farmers Cooperative power plant in Hugo, Oklahoma, on September 17, 1994, for a combustion test burn. The shipment consisted of 5,500 tons of 15 % PDF and 85 % Buckskin run-of-mine (ROM) coal. The PDF was delivered stable and not dusty. The blend handled well and the boiler results were favorable. Three additional half-unit trains were shipped to Western Farmers on September 24, 1994 (21.2 % PDF blend); October 1, 1994 (25.1 % PDF blend); and October 10, 1994 (31.9 % PDF blend). A full unit train of 24 % PDF blend was shipped to Western Farmers on October 24, 1994.

The remaining 1994 PDF shipments were made to Muscatine Power and Water in Muscatine, Iowa, comprising two half-unit trains--November 23, 1994 (39 % PDF blend) and November 29, 1994 (66.6 % PDF blend)—and one full unit train—December 13, 1994 (90.7 % PDF blend). Combustion test burns were very successful and the PDF exhibited no handling, dustiness, or self-heating problems.

Efforts are now underway to build upon the experience gained with the ENCOAL LFC Plant by designing a 15,000 ton-per-day commercial LFC plant, composed of three 5,000 ton-per-day modules, to be constructed in the PRB at a mine yet to be selected. The design program is being led by the TEK-KOL Partnership, with extensive participation by engineers from Mitsubishi Heavy Industries, Ltd. (MHI) offices in Hiroshima, Japan. MHI is a licensee of circular grate technology well suited for application to the LFC process, with the possibility of combining two or more of the processing steps into a single piece of equipment, thereby offering the potential to reduce the cost of plant construction significantly. This commercial plant design program will then be used as a template for other commercial plants to be located in Indonesia and elsewhere in the world.

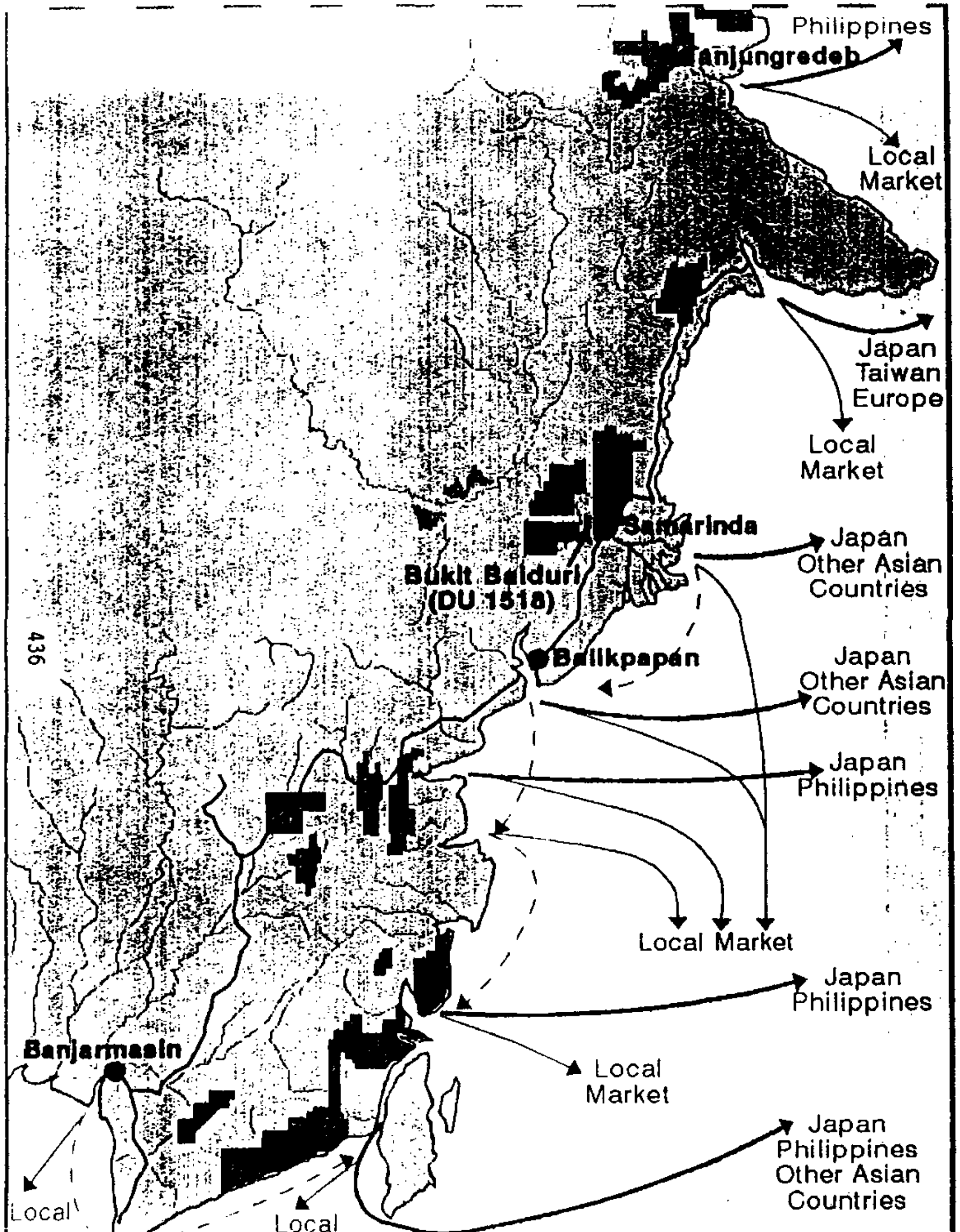
4. The Berau Lati Project

One of the lead locations for a commercial LFC plant is the Berau Lati coal mine in East Kalimantan, Indonesia, on the island of Borneo. The mine is located about 17 kilometers (km) northeast of the village of Tanjung Redeb and 8 km north of the Berau River. Figure 3 shows Tanjung Redeb in relationship to other villages on the east and southeast coast of Borneo, and its proximity to the Celebes Sea and the adjacent island of Sulawesi. Figure 4 provides greater detail of the Berau Agreement Area, including the Lati mine site and the other potential mining sites—the Parapaten, Binungan, and Kelai subareas. The Lati site is the first part of the Agreement Area to be developed, based upon a Coal Concession Contract between PT TBBA and the P.T. Berau Coal Company (PT Berau). PT Berau is owned jointly by P.T. United Tractor, a unit of P.T. Astra International, and Nissho Iwai, a Japanese trading company.

Figure 3

East Kalimantan

Location of Some Coal Areas and Shipment Routes



- Barge Transportation to Transhipment Terminal
- Ship/Barge Transportation to Local Market
- Ship/Barge Transportation to Export Market
- Coal Area
- City
- Major River
- Highway

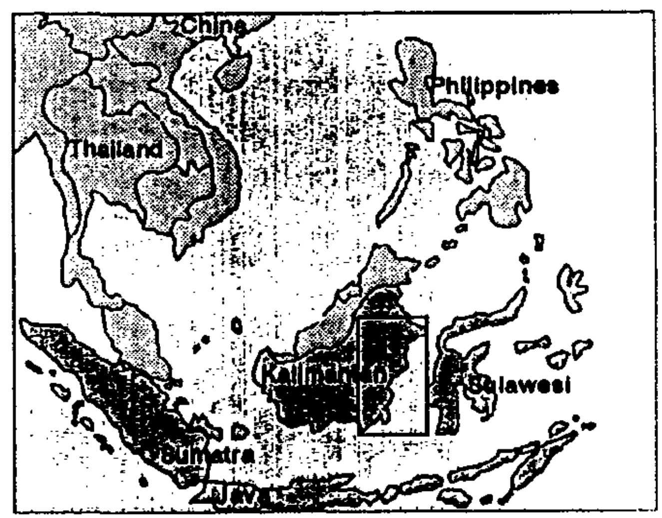
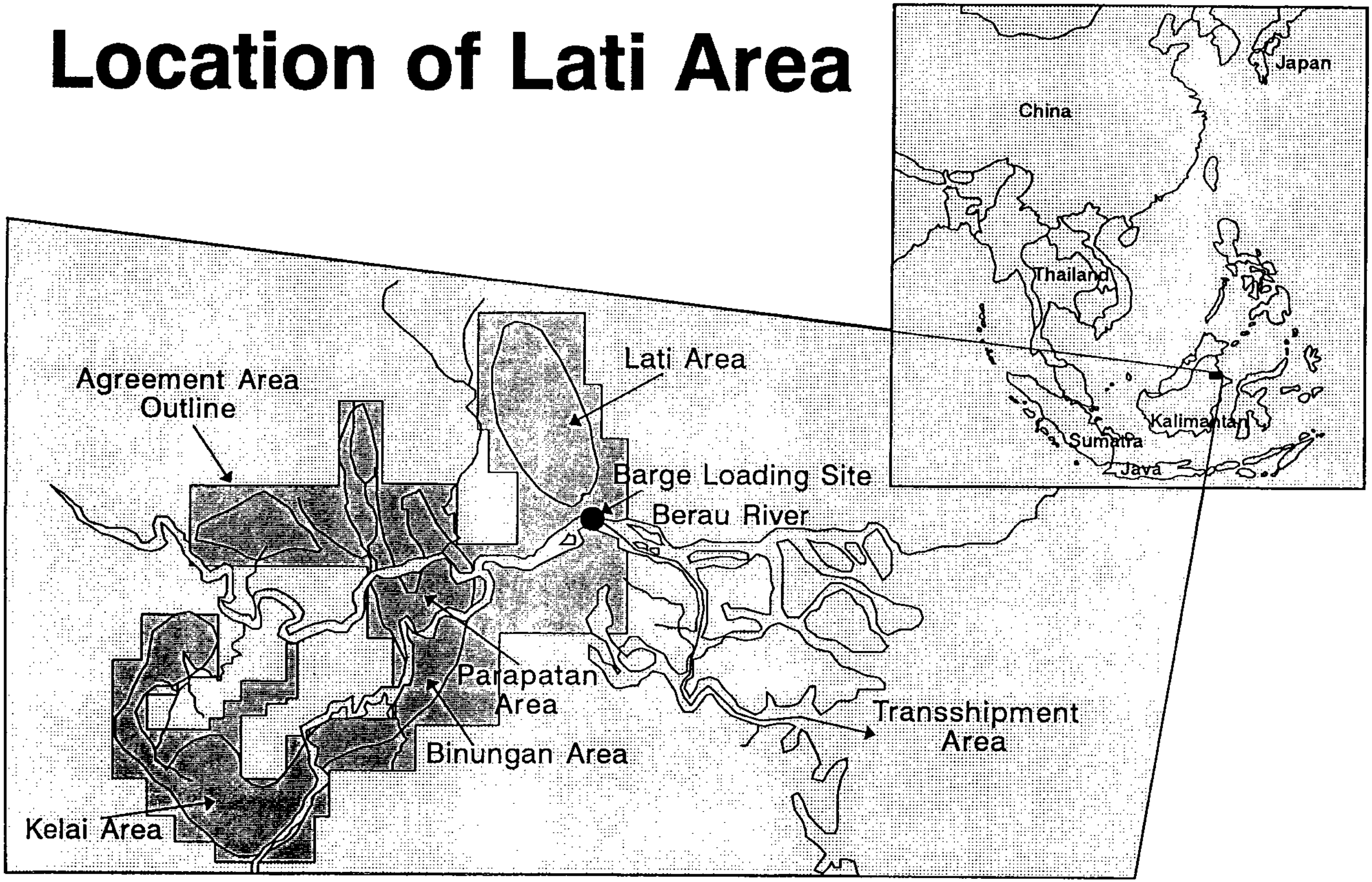


Figure 4

Location of Lati Area



The Lati mine site encompasses about 96 square kilometers, with an estimated 155 million tonnes of mineable coal reserves. The coal is found in four major seams ranging in thickness from 1.7 to 2.4 meters (5.6 to 7.9 feet). The mine also contains about 340 million tonnes of indicated reserves and about 640 million tonnes of inferred reserves which, together with the mineable reserves, gives a total of over one billion tonnes. The Parapaten, Binungan, and Kelai portions of the Agreement Area are set aside for future mining operations.

Figure 5 shows the layout of the Lati mine site, with initial mining operations near the southern end of the site. An 8-km haul road connects the open-pit, truck-and-shovel mining operations to the coal preparation plant on the Berau River. Production coal is hauled from the mine to the preparation plant, where a primary crushing from -600 mm (24 inches) to -150 mm (6 inches), and a secondary crushing down to -50 mm (2 inches) takes place. The crushed coal is then loaded into barges, towed to the open sea, and off-loaded to sea-going vessels for the journey to either Indonesian or export steaming coal markets. Figure 6 gives a perspective of the transport distance to these markets.

The throughput at the Berau Lati mine is limited by the current four million tonnes-per-year crushing operations at the Berau River coal preparation plant, a limit that can be overcome by crushing equipment additions. The infrastructure issue of more concern is the coal handling, barge transshipment, and off-loading capacity to larger sea-going vessels. At present, the only coal terminal capable of off-loading barges to cape-size vessels in East Kalimantan is the P.T. Kaltim Prima deep water terminal at Tanjung Bara, although the new Indonesian Bulk Terminal on the island of Pulau Laut in Southeastern Kalimantan is scheduled to open this year. Other coal loading infrastructure in Kalimantan includes the captive coal terminals of Tanah Merah (P.T. Kideco) and Tarahan (PT TBBA), and the Balikpapan common user coal terminal, scheduled to be in operation in 1995.

Coal from the Berau Lati mine is characterized as subbituminous, with high moisture, low ash content, and very low sulfur. A comparison of the nominal proximate analysis for Berau Lati coal with proximate analysis results for Buckskin Mine coal, the feed coal for the ENCOAL LFC Plant, is instructive. This comparison is given in Table 1. The moisture content for the Berau Lati coal (23.4 %, by weight), is somewhat less than the nominal 29.1 % for Buckskin coal, and the as-received ash content is also somewhat lower (3.4 %, versus 5.3 % nominal ash content for Buckskin coal). The comparison of the nominal ultimate analyses for the Berau Lati and Buckskin coals is shown in Table 2.

The nominal sulfur content of the Berau Lati coal is very low, about 0.66 %, but is somewhat higher than the nominal value for Buckskin coal. In both cases, the analysis of sulfur forms shows that most of the sulfur is organic (e.g., 0.54 % for Berau Lati coal), with small amounts of pyritic (e.g., 0.10 % for the Berau Lati coal) and sulphate (e.g., 0.02 % for the Berau Lati coal) sulfur. This characteristic bodes well for substantial removal of most of this organic sulfur during the mild pyrolysis processing step. A second desirable characteristic is a high hydrogen-to-carbon (H/C) molar ratio, which can be obtained from the ultimate analyses, and which provides some evidence that the yields of CDL will be adequately high. The Buckskin coal H/C ratio is $3.4 \times 12/49.1 = 0.831$, which is above the desirable threshold of 0.8. The Berau Lati H/C ratio is 0.819, which is comparable and also acceptable. A third characteristic

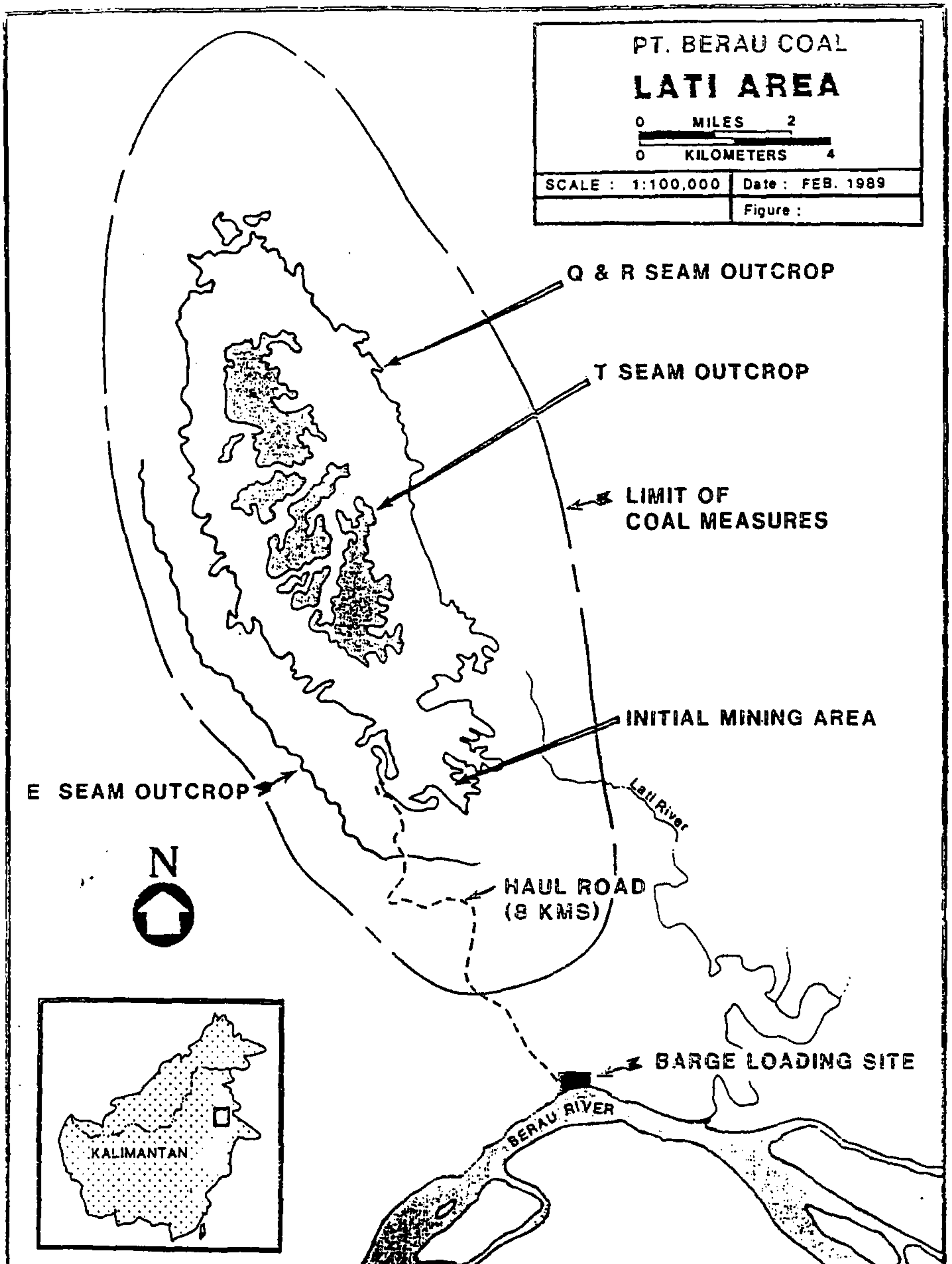

PT. BERAU COAL
LATI AREA
0 MILES 2
0 KILOMETERS 4
SCALE : 1:100,000
Date : FEB. 1989
Figure :
Q & R SEAM OUTCROP
T SEAM OUTCROP
LIMIT OF COAL MEASURES
INITIAL MINING AREA
E SEAM OUTCROP
Lati River
N
HAUL ROAD (8 KMS)
BARGE LOADING SITE
BERAU RIVER
KALIMANTAN

Figure 5

Figure 6

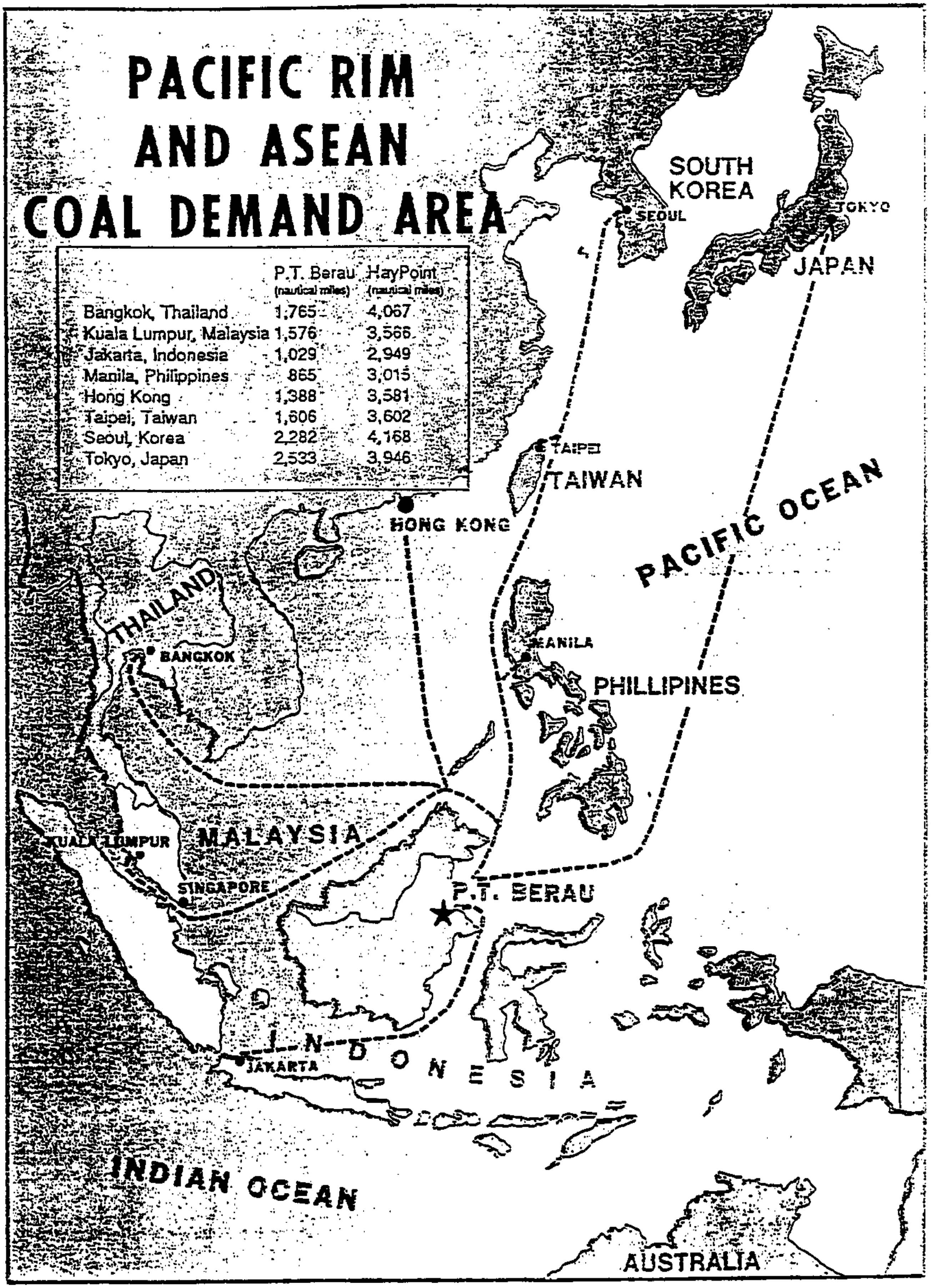

PACIFIC RIM
AND ASEAN
COAL DEMAND AREA
P.T. Berau (nautical miles) HayPoint (nautical miles)
Bangkok, Thailand 1,765 4,067
Kuala Lumpur, Malaysia 1,576 3,566
Jakarta, Indonesia 1,029 2,949
Manila, Philippines 865 3,015
Hong Kong 1,388 3,581
Taipei, Taiwan 1,606 3,602
Seoul, Korea 2,282 4,168
Tokyo, Japan 2,533 3,946
SOUTH KOREA
SEOUL
JAPAN
TAIPEI
TAIWAN
PACIFIC OCEAN
HONG KONG
THAILAND
BANGKOK
MANILA
PHILLIPINES
MALAYSIA
KUALA LUMPUR
SINGAPORE
P.T. BERAU
INDONESIA
JAKARTA
INDIAN OCEAN
AUSTRALIA

Table 1

Berau Lati/Buckskin Mine Coal Comparison

Proximate Analysis

	Berau Lati Coal		Buckskin Coal	
	As-Received	Dry Basis	As-Received	Dry Basis
% Moisture	23.4	—	29.1	—
% Volatile Matter	34.3	44.8	30.6	43.2
% Fixed Carbon	39.9	50.8	35.0	49.3
% Ash	3.4	4.4	5.3	7.5
Heating Value, kcal/Kg	5,164	6,740	4,527	6,387

Table 2

Berau Lati/Buckskin Mine Coal Comparison

Ultimate Analysis

	Berau Lati Coal		Buckskin Coal	
	As-Received	Dry Basis	As-Received	Dry Basis
% Moisture	23.4	—	29.1	—
% Carbon	54.2	70.8	49.1	69.2
% Hydrogen	3.7	4.8	3.4	4.8
% Nitrogen	1.1	1.4	0.7	1.0
% Sulfur	0.7	0.9	0.4	0.5
%Ash	3.4	4.4	5.3	7.5
% Oxygen	13.5	17.6	12.0	16.9

of interest is the ratio of fixed carbon to volatile matter, or the fuel ratio. Upgrading potential is acceptable when the fuel ratio is 1.4, or less, since values higher than that imply adequate amounts of carbon without upgrading. The Buckskin coal fuel ratio is 1.14, while that for Berau Lati coal is 1.16. The two fuel ratios are similar and acceptable. The Hardgrove Grindability Index for the two coals is also similar.

These similarities provide some confidence that Berau Lati coal is a suitable candidate for LFC processing, using experience gained from processing PRB coals. However, one additional set of tests is used to confirm this potential applicability. A small amount (5 kg) of Berau Lati coal was obtained from Nissho Iwai and sent to the SGI Development Center in Perrysburg, Ohio, for testing in a thermogravimetric analyzer (TGA) connected to a Fourier Transform Infrared (FTIR) spectrometer. Fifteen to twenty gram samples were subjected to controlled temperature histories that resemble the LFC drying and mild pyrolysis steps, with the evolved drying and pyrolysis gaseous products spectrographically analyzed. A relatively accurate mass balance can be obtained from such testing. The results for Berau Lati coal showed slightly higher, but almost identical CDL and PDF yields to those obtained on Buckskin coal in the ENCOAL LFC plant. Figure 7 shows the programmed time-temperature and the measured weight-loss profiles for a typical Berau coal TGA test. Figure 8 shows the FTIR integrated gas species evolution from the FTIR scans as a function of time. Finally, Table 3 provides the measured and inferred mass balance for the experiment, based upon the proximate and ultimate analyses of the as-received coal and a small sample of char processed in the TGA apparatus.

The successful testing and evaluation of the Berau Lati coal led to the signing of a Letter of Intent between TEK-KOL, MHI, and PT Berau, and an engineering study for a commercial 5,000 tonne-per-day LFC plant, to be located near the site of the coal preparation plant on the Berau River, is underway.

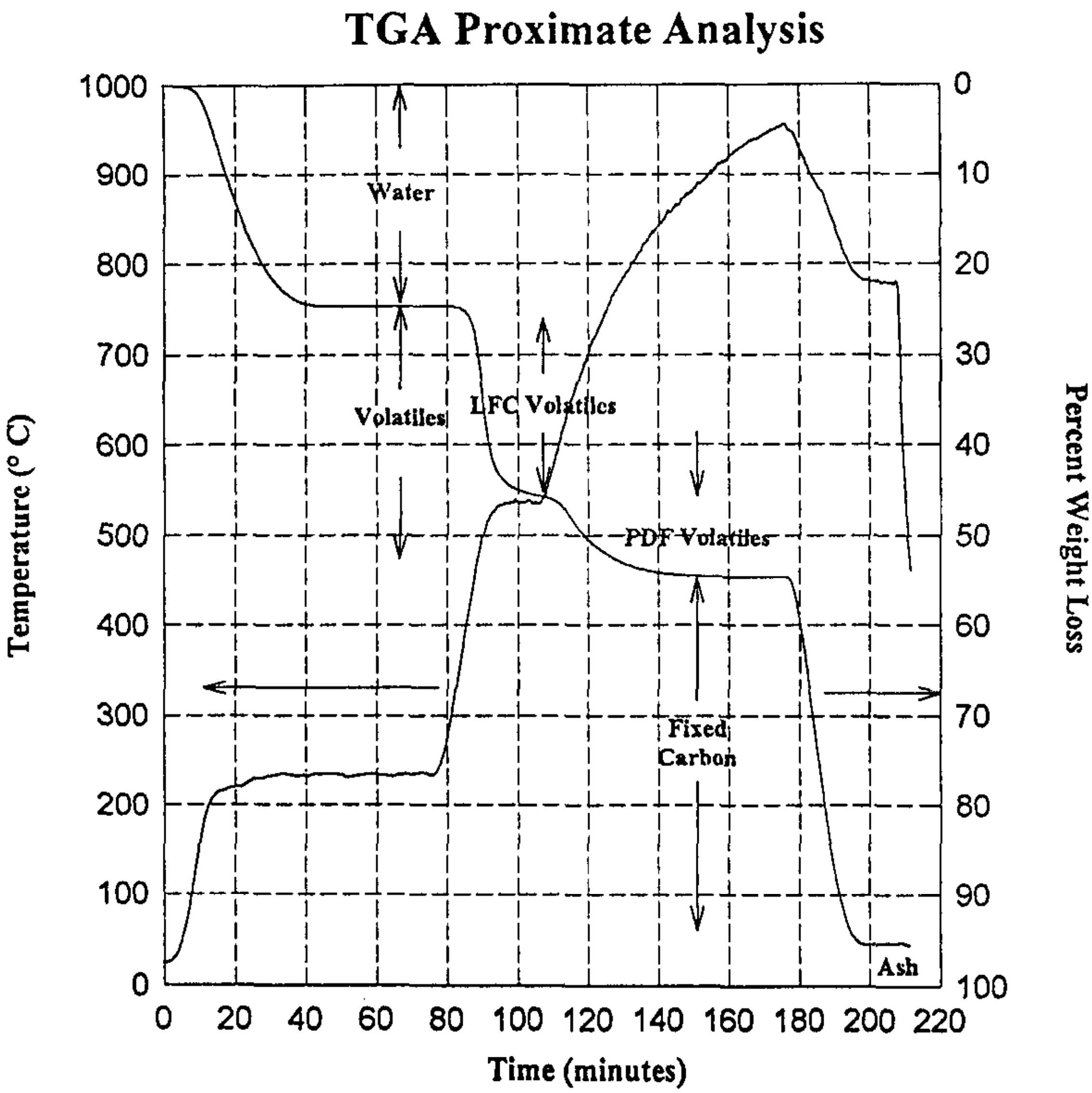
5. The Tanjung Enim Project

TEK-KOL has identified another commercial opportunity in Indonesia that involves the state coal mining company PT TBBA directly. PT TBBA operates a number of coal mines in the Tanjung Enim district of South Sumatra (see Figure 9), including the Air Laya mine. The output from this mine, some five million tonnes per year, is dedicated to the 1600 MW(e) Suralaya power plant complex on the west coast of the island of Java, a complex that is scheduled to expand to 3400 MW(e) within the next few years. At that time the feed coal requirement will be over twelve million tonnes per year. Only the Air Laya mine production can meet the Suralaya plant boiler fuel specifications directly, although blending with the output from adjacent mines could extend the life of the Air Laya mine from about a decade to perhaps fifteen years. A more attractive alternative could be to upgrade coal from the lower-grade mines adjacent to Air Laya, thereby meeting the commitment to supply Suralaya for many decades to come.

In order to determine the feasibility of this alternative, TEK-KOL has tested and evaluated small amounts of coal from eleven mines in the Tanjung Enim district, including the Air Laya mine. The testing and evaluation procedures were similar to those described for the Berau Lati coal. In this case, six of the coals tested (including Air Laya coal) were excellent candidates for LFC processing, while one other coal was marginal (see the results listed in Table 4). The most

Figure 7

Berau Lati Coal



	Coal		Char	PDF
Moisture	24.62			5.00
Volatiles	29.97	39.75	16.40	15.58
Fixed Carbon	40.79	54.12	75.09	71.34
Ash	4.62	6.13	8.51	8.08

Berau Lati Coal TGA Proximate Analysis

Figure 8

FTIR Gas Spectra, Berau Lati Coal

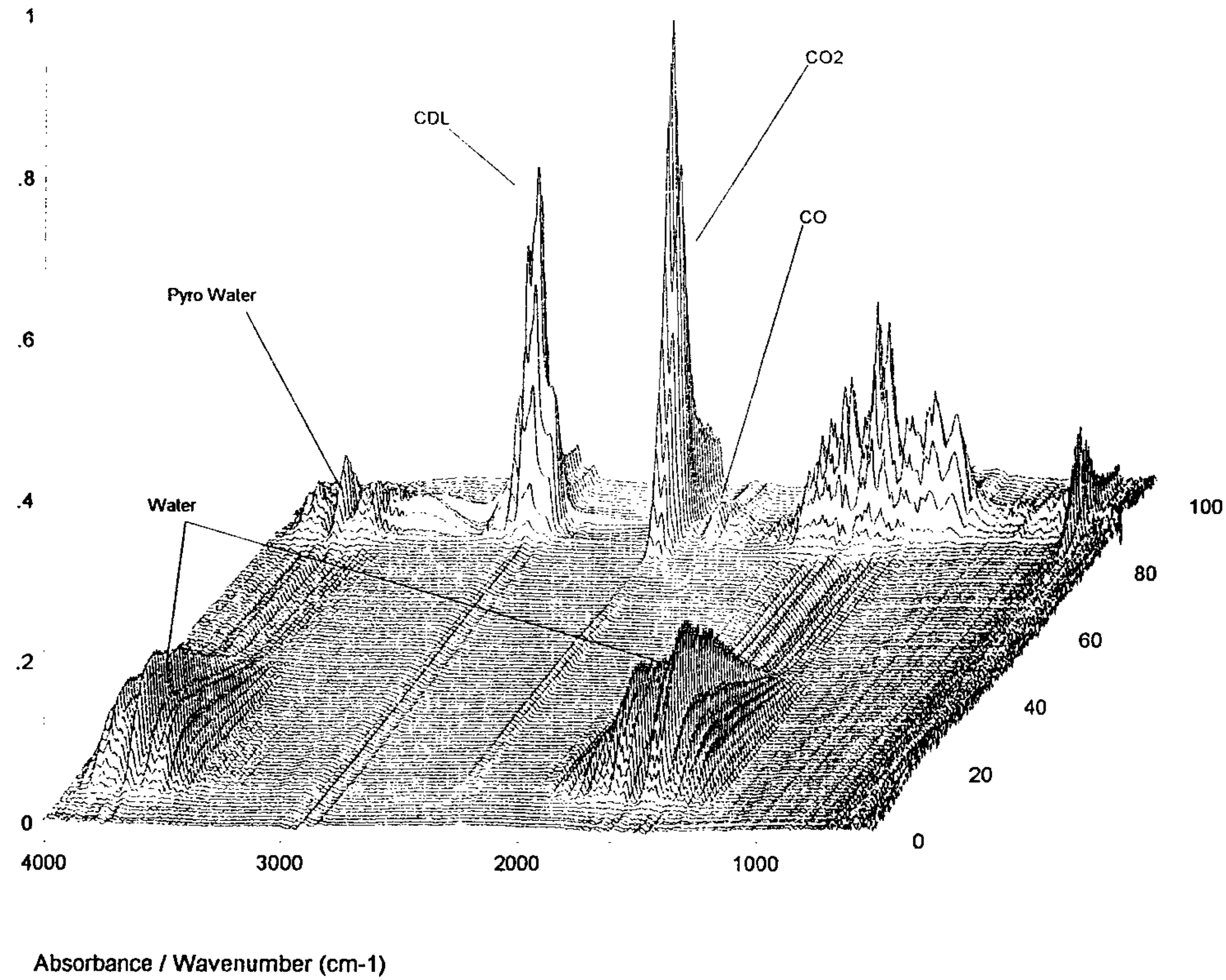


Figure 4-1 Berau Lati Coal FTIR Gas Spectra

Table 3

Berau Lati Coal Analysis Summary

Composite Coal Analysis LFC Prox + Lab Ult*			Dry	Composite Char Analysis LFC Prox + Lab Ult*			Dry		FROM FTIR DATA GAS ANALYSIS				CDL by
	% As Rec'd	% Dry Basis	Basis Grams		% As Rec'd	% Dry Basis	Basis Grams	Total Wt Loss	CO2	CO	CH4	H2O	Differ-ence
H2O	24.62			H2O					0.69	0.34	0.02	0.69	1.46
Vol	29.97	39.75	4.54	Vol	16.40	16.40	1.35	3.19					
FC	40.79	54.12	6.18	F.C.	75.09	75.09	6.17	0.01					
Ash	4.62	6.13	0.70	Ash	8.51	8.51	0.70	0.00					
S	0.55	0.73	0.08	S	0.50	0.50	0.04	0.04					0.04
C	54.55	72.37	8.26	C	83.34	83.34	6.85	1.41	0.19	0.15	0.01		1.07
H	3.76	4.99	0.57	H	3.29	3.29	0.27	0.30			0.00	0.08	0.22
N	1.35	1.79	0.20	N	1.93	1.93	0.16	0.05					0.05
O	10.55	13.99	1.60	O	2.44	2.44	0.20	1.40	0.50	0.20		0.61	0.09
AR Feed 15.15		BD Feed 11.42			BD Char 8.22			3.20	0.69	0.34	0.02	0.69	1.46
							gms/gm AR		0.046	0.023	0.001	0.046	0.096
							gms/gm BD		0.061	0.030	0.001	0.060	0.128

* The composite analysis is composed of the SGI LFC Proximate Analysis conducted using the TGA-FTIR located in the SGI Development Center plus the Ultimate Analysis performed by Commercial Testing and Engineering.

Bukit Asam Mine Area
South Sumatra, Indonesia
LEGEND
Railway Track
Road
Coal Deposit in the Coal Area
Lematang River
Muaraenim
Banjarsari
North Arahan
Enim River
North Suban Jerjij
South Suban Jerjij
Muara Tiga Besar
Muara Tiga Selatan
Tanjung Enim
Air Laya
North West Banko
South Arahan
Lahat
Kungkilan
Ulakpandan
Lahat River
Central Banko
Source: Indonesian Coal Development and Trade
PT. Tambang Batubara Bukit Asam, 1992

Figure 9

Table 4

Indonesian Coals Tested

Coal	CDL Yield (kg/tonne)	
Tanjung Enim District (South Sumatra)		
• Air Laya**	155	
• Banjasari**	145	
• Kungkilan, Seam B**	140	
• Kungkilan**	115	
• Muara Tiga Besar Timur**	100	
• South Arahan, Seam B*	100	Wyoming Buckskin
• North West Banko*	80	Baseline
• Kungkilan, Seam A2	60	
• South Arahan, Seam A2	45	
• Muara Tiga Besar Barat(Very High Moisture)	<40	
• Pendopo(Very High Moisture)	<40	
Musi Rawas District (South Sumatra)		
• Sungaimalam*	80	
East Kalimantan		
• P.T. Berau*	95	

** Excellent LFC Candidate

* Good LFC Candidate (Wyoming Buckskin CDL Yield is about 90kg/tonne)

attractive candidates were the Banjarsari and Kungkilan (Seam B) coals, because of the high estimated CDL yields, but Muara Tiga Besar Timur and South Arahan (Seam B) coals were also considered excellent. Table 4 shows the estimated CDL yields for the eleven coals tested.

Because of the favorable results from the feasibility testing and evaluation program on Tanjung Enim district coals, TEK-KOL, MHI, and PT TBBA have signed a Letter of Intent to carry out an engineering study for a commercial 5,000 tonne-per-day LFC plant to be located at either the South Arahan or the Kungkilan mines. This study will be underway shortly.

6. Conclusions

The Indonesian low-rank coal upgrading opportunities described in the two previous sections are only two of many available to TEK-KOL. Most of the others must be approached with care, since they involve either an undeveloped low-rank coal resource with substantial needs for investment in both mining and transportation infrastructure, or a very marginal coal resource. An example of the former is the potential Musi Rawas project in South Sumatra, where a private Indonesian company, P. T. Triaryani, has access to significant low-rank coal reserves that have been shown to be amenable to upgrading by the LFC process. However, the location of this potential mine is such that, in addition to the mine development costs, the feasibility of transportation by truck, barge, or rail remains to be determined. One possibility under active investigation is to construct mine-mouth coal-fired power plants at the site, with long-term contracts for coal supply used to secure financing for mine development. A combination of long-term supply contracts and a secured export market for the PDF and the CDL might then be used to justify expenditures on transportation options. Such an opportunity must be examined from a long-range perspective, whereas Indonesian coal-mining opportunities are more typically couched in five- and ten-year terms.

Another type of opportunity is presented by dealing in whole or in part with the end-use customer, or a surrogate for the end-use customer. An example of this type is an electric utility with long-range steam coal requirements, such as Taiwan Power Company or the Electric Power Development Company, Ltd. (EPDC). The latter acts as a surrogate on fuel supply arrangements for electric utilities in Japan. Japanese trading companies can play a similar role. The interest of some of these end-user agents in securing the long-term supply of quality fuel at a reasonable price is keen, especially when increased domestic demand, continued export opportunities, and a lack of adequate infrastructure investment combine to disrupt conventional market forces.

The two opportunities described here present less risk since, in both cases, markets for the coal and adequate initial infrastructure are in place. Therefore, TEK-KOL intends to devote much of its resources and energy to a PRB commercial plant follow-on to the ENCOAL LFC plant, using the joint engineering effort with MHI as a building block for commercial LFC plants in Indonesia and elsewhere. The Berau Lati and Tanjung Enim projects are important elements of that commercialization strategy.

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U.S./ Ukraine Power Plant Upgrade Project

John Ruether[1] • Joseph Strakey[1], • Howard Feibus[2], Morton Blinn[3]

Presented at:

"The Fourth Annual Clean Coal Technology Conference,"
Denver, CO, September 5-8, 1995.

1. Pittsburgh Energy Technology Center
U.S. Department of Energy
P.O. 10940
Pittsburgh, PA 15236

2. U.S. Department of Energy
1000 Independence Avenue, SW
Washington, DC 20585

3. Burns & Roe Services Corp.
P.O. 10940
Pittsburgh, PA 15236

The Ukraine Clean Coal Power Plant Upgrade Project

Background

- **Conducted by U.S. Department of Energy at the Pittsburgh Energy Technology Center (PETC)**
- **Substantive consultation by Ukrainian Government and private experts**
- **Overall purpose:**
  - Define the most effective option or combination of options to upgrade the Lugansk power plant in Ukraine
  - Develop costs in sufficient detail to enable the World Bank and others to provide loans to conduct the modernization

USAID/USDOE/Minenergo Project Goals

- **Identify one or more cost effective technology options for upgrading an anthracite-burning power plant to:**
  - Extend life by at least 15 years
  - Reduce gas/oil cofiring to no more than 6%
  - Increase power output
  - Improve environmental performance
  - Improve heat rate
- **Prepare an economic and technical analysis of the preferred upgrade options for the World Bank that will satisfy their information needs for making a loan of up to $200 million**

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Program Participants

- USAID
- DOE/Headquarters
- DOE/PETC
- Ukrainian Ministry of Power and Electrification *(Minenergo)*
- Ukrainian Academy of Sciences
- PETC and DOE Technical Support and others
  - Burns and Roe
  - Gilbert/Commonwealth
  - SAIC
  - Babcock & Wilcox
  - Black & Veatch
  - Coal prep plant designer TBD
- World Bank

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Some Power Generation Stations in Ukraine

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Coal-Based Ukrainian Power Plants

- **There are 17 coal-based power plants in Ukraine**
  - Most are old, built over the period of about 1950-1965
  - Size range between 150 MWe and 3000 MWe
    - Up to 800 MWe: 4
    - 1200-2000 MWe: 9
    - 2400-3000MWe: 4
  - Total capacity is about 21,500 MWe
    - 100-150 MWe Units: 13
    - 200 MWe Units: 51
    - 300 MWe Units: 36 Supercritical
    - 800 MWe Units: 1 Supercritical
  - Boilers are T-Type, Ukrainian design

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Power Production in Ukraine is in Decline, especially by Thermal Generators

Electric Power Production in Ukraine

	1991	1992	1993
Thermal generators			
Billion kW.h	192	171	144
% total power	69	68	62
Hydro generators			
Billion kW.h	12	8	11
% total power	4	3	5
Nuclear generators			
Billion kW.h	75	74	75
% total power	27	29	33

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Reduction in Consumption of Gas and Oil Accounts for Declining Power Output by Thermal Generators

Fuel Consumption by Thermal Generation Stations

	1991	1992	1993
Coal			
Million tons	23	25	26
% fuel use	22	27	31
Fuel oil			
Million tons	15	10	6.5
% fuel use	15	10	7.7
Natural gas			
Billion cu. m.	35	30	23
% fuel use	34	30	23

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Anthracite Feed Quality Has Deteriorated

	Design Coal	Average schtib consumed at Lugansk GRES, 1993
Fixed Carbon	69%	51%
Volatile Matter	4	4
Ash	20	36
Moisture	7	9
LHV-		
kcal/kg	5600	4202
btu/lb	10081	7571

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Fuels Employed at Luganskaya GRES Power Station

- **Anthracite *"shtib"***
  - Minus 6/13mm fraction prepared by screening ROM coal
  - Typical characteristics (AR basis)
    - Moisture, % 5-10
    - VM, % 3-6
    - FC, % 50-58
    - Ash, % 30-36
    - Calorific value, 4300-5100 kcal/kg
    - Sulfur, % 1.5-3.0
- **Anthracite *"schlam"* (waste pond slimes)**
- **ROM anthracite**
- **Heavy oil (mazut)**
- **Natural gas**

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Power Generating Units at Luganskaya GRES

- **"Phase 1" units**
  - 14x50MWe PC boilers feeding 7x100MWe steam turbines
  - Commissioned 1956-58
  - Only two of seven units operable
- **"Phase 2" units**
  - 4x200MWe wet bottom, wall fired, type TP-100 boilers, each with steam turbine
  - Steam conditions: T=1060°F, P=2000psia, single reheat
  - Commissioned 1961-63
  - Currently derated to 145MWe
  - Exceeded design operating lifetime of 200,000 hours

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Power Generating Units at Luganskaya GRES, *(Continued)*

- **"Phase 3" units**
  - 4x200MWe boiler/turbines identical to Phase 2 units
  - Commissioned 1967-69
- **Environmental Controls**
  - Particulates: Centrifugal separators and ESP(undersized)
  - SO_2 and NO_X: None
- **Current Output (July 1995)**
  - 3x200MWe units on line
  - 1x200MWe unit hot reserve

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Approach of DOE/PETC -
Four Step Program is Underway

1. **Use Analytical Models for Scoping**
2. **Conduct an Experimental Program**
3. **Conduct Design Studies for Luganskaya GRES Upgrade**
4. **Prepare *"bankable document"* for Upgrade Options**

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Approach of DOE/PETC -

Use Analytical Models for Scoping

- PC-based capital and operating cost estimations for CCTs
- Effect of upgrade on incremental cost of electricity over equipment lifetime
- Coal preparation simulator to estimate product ash, BTU recovery
- Coal Quality Impact Model (CQIM): Effect of coal quality on PC boiler performance

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Approach of DOE/PETC -
Conduct an Experimental Program

- **CFB combustion tests of 36% ash shtib**
  - 10 kg coal/hr bench unit in Kiev
  - 2.5MWe unit in Alliance, Ohio (B&W)
- **Float/sink testing of shtib**
- **Preparation of 18% ash coal from 36% ash shtib in 1 ton/hr circuit at PETC**
- **PC combustion testing 18%, 36% ash coals in 50 lb coal/hr combustor at PETC**

(130 tons shtib shipped from Ukraine)

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Approach of DOE/PETC -

Conduct Design Studies for Luganskaya GRES Upgrade

- Develop designs, costs, and performance estimates for particular technical options
- Replace two "Phase 1" boilers and turbine (100MWe total) with two new CFB boilers and turbine (125MWe total)
- Evaluate "Phase 2" and "Phase 3" 200MWe units for refurbishment
- Environmental controls, balance of plant
- Coal preparation plant for feed to 200MWe units

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Approach of DOE/PETC -

Prepare "bankable document" for Upgrade Options

- **Factors affecting number of generating units to upgrade and type of upgrade to install:**
  - Anticipated power demand
  - Change in output capacity due to upgrade
  - Capital cost
  - Change in operating cost (esp. change in fuel mix)
  - Required environmental performance
- **Evaluate financial consequences of various upgrade options**
- **Pass results to World Bank and recently privatized Ukrainian power generating company**

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Schedule

■ Coal Shipment Arrives in US	10/30/95
■ Complete Conceptual Design Study	10/30/95
■ Results of Coal Quality Impact Model (CQIM) Application to Ukraine Coals	11/15/95
■ Coal Preparation Plant Concept Design	11/30/95
■ B&W and PETC Combustion Testing Reports	12/15/95
■ Submit Bankable Package to World Bank	1/15/96
■ Review of Program Results withUkraine Officials and Engineers	4/96
■ U.S. Business Opportunities Conference	TBD

Evaluation of Technology Modifications Required to Apply Clean Coal Technologies in Russian Utilities

August 1995

U.S. Department of Energy
Morgantown Energy Technology Center
Morgantown, West Virginia

All—Russia Thermal Engineering Institute
Moscow, Russia

ABSTRACT

Russia is rich in fossils, however, difficulties exist in large distance from resource location and consumers. Thermal power stations (TPS) in Russia are equipped with high-pressure steam units and operate efficiently. Such units could be constructed in the decades to come. The urgent problem is to increase TPS life.

Coal will be an important item in the fuel balance now and in the future. The projects of ecologically clean coal-fired TPS are described based on the National Program of the "Ecologically Clean Generation". Proposals are given on the terms and specifics of the implementation of the US clean coal technologies in Russia.

1. OVERVIEW of RUSSIAN POWER INDUSTRY

1.1. General

Russia possesses rich fuel and energy resources, however remoteness of resources from consumers presents certain problems. Thermal power stations in Russia employ modern steam-turbine units and operate efficiently. Construction and operation of such power stations will continue in future. Among the urgent problems is the life extension and further upgrading of steam-turbine power stations and the development of combined cycle plants, the latter using first gas, and then coal [1].

The industrial and municipal electricity demands in Russia are largely met by construction of thermal power stations (TPS). In the near future, the greater portion of electricity will be produced from fossil fuels, mostly from natural gas, and also from coal.

The scales of Russian power generation is characterized by the following data (bracketed are 1990 figures where electricity generation was at the max. level) [2].

	1994	(1990)
TPS Installed capacity, GW	210	(213.3)
Electric generation, bln. kWh/y	876.6	(1082.2)

Power reserve in 1994 was 15% on the average. Nevertheless, some regions remained energy-deficit ones.

Electricity per capita production was 6190 kWh/y.

The installed capacity breakdown with reference to types of power plants, are (see also Fig.1):

	GW	%
Total	210	100
Fossil-fuelled,	145.6	69.3
including		
condensing plants,	65.6	31.2
cogeneration plants	80.0	38.1
Nuclear power plants (NPP)	21.2	10.1
Hydro-power plants	43.2	20.6
Other	0.04	-

Remark

Below, thermal efficiency data are calculated using low heating value (LHV) of fuels; in all cases, volumes in "m^3" are for standard conditions (if otherwise not especially indicated); masses (weight) are in metric tonnes; pressure and pressure drops are in Pa, kPa, bar and MPa

The fossil-fuelled plants generated 602.8 bln kWh (68.8%), NPP, 97.8 bln. kWh (11.2%), hydro-power plants, 175.3 bln. kWh (20.0%). The cogeneration plants supplied 613.2 mln. Gcal (713.2 bln. kWh) of heat. Specific fuel consumption at TPS was 310.3 g/kWh with the average efficiency (taking account of combined heat and power generation*) of 39.64%.

For electric and heat generation 383.2 mln ton of standard fuel (tfe) was consumed considering LHV of 29.3 MJ/kg (7000 kcal/kg), including: (Fig.2)

Name	mln. tfe	%
Natural gas	244.5	63.8
Coal	98.5	25.7
Fuel oil	40.2	10.5
Total	383.2	100.0

The generating capability is based on condensing TPS employing 200, 300, 500 and 800 MW units, and cogeneration plants with 50-80, 100, 180 and 250 MW turbines. Starting from 250-300 MW, the units are designed at supercritical (24 MPa) steam pressure. In general, 85% of electricity is generated at TPS using high-pressure steam (≥13 MPa).

Russia is located in high latitudes at the territory with severe climate. Of great importance is heating of residential, industrial and public premises. The required heat loads and supply of industrial enterprises with heat and steam are traditionally centralized and are from large boilerhouses and cogeneration plants. The total capacity of such plants is about 80 GW or more then half capacity of all TPSs. More than 80% of the heat supplied to consumers from power stations is produced on steam turbine extracted steam. Considering the fact that over 60% of electricity in these TPS is generated in combined mode (it is about 34% of the total fossil-fuel TPS generation) their average efficiency is 46.5%, with specific fuel consumption of 265 g/kWh.

The structure of fuel balances in various regions differ greatly. The larger portion of electricity in the Western Siberia, Urals and European part of the country is generated using natural gas, in the Central and East Siberia the resourses are hydro and coal, and in the North-West and the Far East, are nuclear power and coal, respectively. The consumption of coal was 133.4 mln. t. with average heat value of 16.5 MJ/kg and ash content of 27.9%.

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*) Specific fuel consumption (b) in cogeneration mode is generally derived from the following expression: $b_e = (Q_f - Q_h)/(N_e \times K)$. Here, Q_f is fuel heat, Q_h is part of fuel consumed to produce heat, N_e is electrical output, K is coefficient matching units of measurement. The equivalent efficiency $\eta = 123/b_e$.

Below, are some data on coal condensing power units (Fig.3):

Unit capacity, MW	800	500	300	200	150
Number of units	2	7	27	36	17
Average load, MW	—	400	220	150	110
Efficiency, %:					
best TPS	—	36.9	36.3	35.9	35.0
worst TPS	33.2	36.2	30.1	30.4	34.0
Share of coal in the fuel consumed, %	97.0	97.7	77.5	70.0	70.5

Coal is also fired at many cogeneration plants.

Its share is in these cases of 20-50%. At numerous condensing and cogeneration plants coal is used as seasonal fuel.

Power units up to 200 MW and equipment for cogenration plants using 640-670 t/h boilers are designed at subcritical parameters. 200-215 MW condensing units and cogeneration unified units of 180 MW, 13 MPa, 540/540°C, cogeneration plants with boilers and turbines of smaller capacity - mostly rated 60-80 and 110-115 MW - at 10-13 MPa, 555°C. Most cogeneration plant turbines extract steam for staged heating of not water. The extraction steam pressure for that purpose ranges from 0.5 to 2.5 bar.

The condensing 300, 500, 800 MW units and cogeneration units of 250 MW unified with 300 MW units are designed at supercritical steam parameters: 24 MPa, 540°C/540°C.

The total capacity of such units is about 45 GW. Their capacities and parameters are standardized. Supercritical power units with 1000-2650 t/h once-through boilers operate reliable and efficiently firing various fuels. The annual net efficiency of the best TPS with such units firing gas and fuel oil is 39%, and in the case of coal, 37%. The design of equipment is continuously upgraded: 4-5 modifications of turbines and boilers for such units have been manufactured.

Electric power manufacturing industry of the former USSR produced all kinds of equipment required for electric power stations: steam boilers, steam and hydro-power turbines, associated electric generators, transformers, auxiliary mechanical and electrical equipment, components and materials [1]. Brief characteristics of the thermal power station equipment used in Russia can be found in Section 1 herein. The equipment in many respects meets the world's standards and ensures high reliability and economic efficiency.

The manufacture and operation of electric power equipment was based on domestic R&Ds, metal, electronics, chemicals, etc. TPSs were constructed by large specialized organizations having all necessary equipment and facilities. At the same time, there was a certain lag of the Soviet, and later Russian industry in the development and manufacture of GTs, automatic control systems, gas cleaning systems and equipment.

The Russian TPS are typical of low rate of equipment renewal [4]. Now, life expiration of the equipment is 5-7 times ahead of addition of new capacities. Just today, about 40 GW TPS capacities has expired the design life. It is considered that by 2000 the figure will increase to 90 GW. Among the units operated about or over 200 thousand hours there are 20-30 units of 150-160, 200 and 300 MW each; some 150 MW units had been in operation over 270 thousand hours each. New units of 800 and 1200 MW operated less than 100 thousand hours.

Many steam turbines and boilers at cogeneration plants have been operated even longer than condensing units.

Naturally, in many cases the life of TPS can be extended.

However, it should be considered that many existing TPS constructed 30-40 years ago have obsolete equipment which does not meet the modern requirements in efficiency and environmental impact. Continuation of their operation becomes unreasonable. Frequently, it is very difficult technically or rather costly to repower such TPS to improve the performance.

A more attractive way is radical changes using new technologies. The adequate economical substantiation of constructing efficient TPS with advanced equipment is next to impossible in Russia now.

1.2 TPS Environmental Impact

TPS, especially coal fired, are larger environment polluter [5].

For new TPS, the maximum permissible concentrations (MPC) near ground-level of the major pollutants have long been met in the USSR by emission scattering through tall stacks.

Now, the State Standard has been prepared oriented on the today's level of power engineering and gas cleaning equipment (up to 2001) and more stringent requirements after 2001. The norms of the Standard are given in Tables 1, 2 and 3 [7].

2. THE POWER INDUSTRY DEVELOPMENT FORECAST for RUSSIA

The essential goals of the Russian energy strategy are to promote social and economic revival of the country and increase the GNP and income, life standard and its quality and reduce the man-made load on the environment [21].

The priority lies in increasing energy efficiency and conservation.

In 10-15 years a more effective use of natural gas and larger share for it in domestic consumption are scheduled. The quality of coals will be perfected by producing smaller amounts of high-ash, high-sulphur coals and using their washing and benefication.

While preserving the United Power Grid of Russia the development of the regions is planned, in order to ensure their self-sufficiency in electricity and heat, and, wherever possible, in fuel.

If economically justified, smaller sources of electrical energy and heat will be provided as close as possible to the consumers. It will be based on economically efficient and ecologically clean technologies, in particular, for coal TPS.

Coal is and will remain, in the near future, the basic fuel in Siberia and the Far East, and also a very important fuel in the Urals and in the European part of the country. Coal consumption for power generation shall be doubled and constitute over 200 mln. tfe/y in the future.

The prospects of the evolution of the Russian power industry are now uncertain.

The revival of the Russian economy is predicted in a long period of time. By various estimates, electric generation will reach the 1990 level in 2000-2010. In the near future, no high-investment construction of large TPS is planned.

The main attention is being paid to the radical reconstruction of the existing TPSs and the preparation of using up-to-date technologies. The worn-out and obsolete equipment, which have an overall capacity of about 90 GW, will be put out of operation.

The analysis of energy use in Russia made by several independent Western and Russian organisations indicates that:

* even without the decommissioning of some NPP and
* provided that existing TPS will expire their service life there will be considerable power deficit in Russia, if new capacities are not put into operation.

The deficits are as follows:

Calendar year	2000	2010
Power deficit, GW	24-56	149-174

About 80% of the deficit is attributed to the European regions and Urals which have no sufficient fuel resources.

The deficits can be partially covered by a life extension of the existing equipment together with the replacement of the worn-out components. The remaining deficit will be covered by construction of new power units instead of those decommissioned at the existing TPS (in the same main building or at the same site), and by the construction of new TPS both cogeneration and condensing ones. TPS retrofitting/repowering will be implemented along with increasing efficiency (in particular, by increasing the share of combined heat and electricity generation) and decreasing environmental impact.

Further growth of electric generation will depend on the rates of restoration of the country's economy. If they will be decelerated, and the energy saving be realized at a large scale and efficiently, a small number of relatively low-capacity new condensing plants will suffice, together with cogeneration plants, including those of low and medium capacity.

At higher rates of energy use, construction of some large condensing K-A and Kuzn. coal-fired TPS in Siberia, the Urals, and maybe in the Volga River region will be needed. For such TPS, the use of 300-500 MW units is under consideration.

Along with cogeneration plants, a significant fraction of the heat required for consumers will be generated in the boilerhouses (district heating plants). The steam capacity of the boilers installed there will be from 1-2 to 160 t/h, while that of hot-water boilers, up to 200 Gcal/h (230 MW). Now, many of them are of low efficiency and operate with considerable SO_2, NO_x and fly ash emissions. The boilerhouses could also be the places, where clean coal technologies could be applied.

The Energy Strategy is based on the fact that the coal industry will play the important role supplying the country with fuel, electricity and heat.

The strategy is to terminate the drop of coal production, stabilizing it at 250-270 mln. t/y level, continue the restructuring of the coal industry with the greater share of the open-cut coal production and the closing of unprofitable enterprises by the year 2000. In so doing, the following options of coal production evolution are considered.

	Calendar year				
Coal annual production	1990	1993	1995	2000	2010
Maximum: mln t	396	306	270	290	340
mln tfe	257	196	172	185	210
GJ	7530	5740	5040	5420	6150
Minimum: mln t	—	—	260	250	300
mln tfe	—	—	166	160	190
GJ	—	—	4860	4690	5670

In the European part of the country the coal production will tend in general to decrease, while that in the Kuzn. and K-A fields will increase to supply the regions of Siberia and the Urals where these coals will be fired at TPS. The remaining regions will, to a greater extent, use local coals. The brown coal production is supposed to be increased in the Eastern region of the country in the Irkutsk district, Zabaikalie, Primorsk and Khabarovsk regions from about 50 mln.t/y (17 mln tfe/y) produced at present to 90 mln.t/y (30 mln.tfe/y).

The problems of transporting the cheap K-A and Kuzn. coals to industrialized regions of the Urals and the East of the European part of the country are rather acute. It is clear that the handling of a greater portion of coal to raise its heat value prior to transportation will be required along with possible development of special transport means and systems.

Economical estimates provide evidence about competitiveness of Kuzn. and K-A coals as fuel for TPS in the Urals, Volga River region and, may be, in the areas to the East from Moscow. For interregional transportations mostly Kuzn. coal or processed, for example, briquetted, K-A coal will be involved. The demands in solid fuel for the Eastern Siberia and Far East will be covered by local production and shipment of K-A coals. The Peach. coals will be used in the Northern regions, and the coals from the Eastern Donnas, in the South of the European part of Russia.

The properties and amount of coal fired in Russian TPS are illustrated in Table 4 [3].

The coal production conditions are most favourable in the K-A field, where large, tens of meters thick horizontal seams are located near the surface. The field is in a easy-to-access area with acceptable climatic conditions. The coal is produced by the open-cast method at rather low cost.

The geological conditions in the Kuzn. field, which is most developed, now are rather complex. The industry environmental impact here is high in many areas and the infrastructure is inadequate.

In the European part of the country the coal is mined underground which makes its cost very high. The geological conditions of the long operated areas (Eastern Donb., near-Moscow field) are unfavourable. The Pechora coal field is located in a severe climatic area.

The Eastern regions of the country supplies mostly low-grade, high-moisture and high-ash local coals to be fired at power stations. Many old coal fields are exhausted and vast territories are energy-deficient.

3. BASE OPTIONS of ADVANCED COAL THERMAL POWER PLANTS

As base options, projects are considered being winners of the competition when the State Program "Ecologically Clean Power Generation", Section "Clean Coal Technology" was announced [35, 36].

Basic parameters of TPS employing various coal technologies are shown in Table 5.

It should be noted that it is difficult to compare the technologies by economical parameters because they had been designed at coals differing in properties and cost, areas of TPS location, modes of operation, etc., under the conditions of unstable and economically not fully justifiable prices of equipment and TPS construction.

Specific costs relate to TPS with most cheap 500 MW units fired Ekib. bituminous coal. Somewhat higher cost of TPS with brown K-A coal fired 800 MW units could be explained by considerably larger furnace dimensions (see section 2) designed at low-temperature combustion to prevent slagging. The lack in of Russia own experience in flue gas $DeSO_x$ and $DeNO_x$ systems gave conservative estimates of the cost of relevant systems and equipment and overestimated costs of TPS using the above equipment. Just on the contrary, the specific cost of CFB boilers - also due to lack of own experience - seems optimistic.

3.1. Project of Brown K-A Coal Fired 6.4 GW TPS with 800 MW units

As a base option, 6.4 GW TPS was selected firing brown coal from the Berezovo field and employing 8×800 MW steam supercritical units.

The principal features of the P-67 boiler at the Berezovo TPS-1: dry-bottom tangential fired furnace, low active combustion zone heat release rate, low flame temperatures (1300-1400°C max.), early ignition and intensive p.c. burnup at the initial distance were remained.

Specifics of the coal mineral and organic matter enabled NO_x and SO_2 reduction and attain the required ecological parameters (NO_x and SO_2 at 200-300 mg/m^3 level max.) without special $DeSO_x$ and $DeNO_x$ systems [7, 28, 37].

For NO_x reduction the following technological methods will be applied: fuel preheating to 650-850°C, staged low excess air combustion, using combustion gases for fuel drying in the pulverizing mill fans system. The raw coal from the hopper is fed to the gas drier to be dried there with moisture content reduction from 33% to 13% by combustion gases at 590-650°C. Further, the fuel is directed to the mill fan and therefrom to coal dust concentrator when the coal stream is separated into high and low concentrated flows. Part of the coal-air mixture is fed to the muffle burner and is used for thermal treatment of the main stream in the p.c. preheater. To ensure complete combustion and reduce slagging of boiler furnace heating surfaces, simultaneous reduction of coal particle size from R_{90}=40-60% to R_{90}=20-30% and R_{1000} <1.5% is envisaged.

Low-temperature combustion allows for sulphur capture in the furnace up to 50% by the coal ash calcium. Fabric filters are used to clean the flue gases of fly ash. Additionally, sulphur is captured in the deposit layer on the filters surface. Also the feed of the activated ash to the furnace and convective path is provided.

The pilot test results showed that in firing Berezovo coal with S $\leq$ 0.4-0.5% the $SO_2 \leq 200$ mg/m^3 concentration requirements can be ensured by the above methods of SO_2 capture in the boiler gas path and on the fabric filters. The flue gas cleaning efficiency of fly ash in the fabric filters is sufficient to meet ecological requirements specified in the project at 50 mg/m^3 max.

When TPS operates on coal with average ash content of 7%, the yield of ash and slag wastes will be 1.5 mln. t/y.

Because the K-A coal ash contains CaO provision is made for its granulation by treating with acid waste water of the make up treatment system to improve saleability properties and prevent environmental impact when land filling.

The 6400 MW TPS is constructed with two main buildings located on the same site. Each building accommodates 4×800 MW units each in 84 m wide bay. The overall width of the each main building over the front is 434 m and the depth, 177 m. The baghouses and the induced draft fans are located in individual buildings. A stack of 250 m high will be installed per four units.

The new technological solutions for the project in question are being perfected at the rigs and 35 t/h pilot boiler. On the boiler they investigate influence of p.c. high-temperature preheating and staged combustion on NO_x concentration, SO_x catching in the boiler path and the baghouse, and so if feeding the ash activated in the jet mill or digester to some places of the boiler gas duct.

The technologies will further be tested on a 500 t/h boiler which is under construction and will be started in 1996.

Basic parameters of TPS employing 800 MW units designed under this project are shown in Table 5.

3.2. Project of the Yuzhno-Ural Ekib. bituminous coal fired 4 GW TPS with 500 MW units

The base option is 500 MW supercritical pressure unit with conventional p.c. firing [38]. Some parameters of the unit and TPS as a whole are shown in Table 5.

As prototype was adopted the P-57, 1650 t/h, 24 MPa, 545/545°C boiler manufactured by the Podol'sk Machine Building Works in 1986 .

In case of conventional firing of Ekib. coal NO_x emissions are rather high: with P-57 boiler they are at 800-1300 mg/m^3. Two versions of the furnace have been specially designed to reduce NO_x emissions by technological methods.

The furnace with two tiers of wall swirl burners is equipped with additional straight flow burners arranged 3-4 m above the second tier.

These burners operating with SR=0.7 are supplied with 20% of fuel. Above them at 26-30 m elevation nozzles are arranged to feed 0.10-0.24 of the total air.

The tangential-fired furnace (Fig.22) employs 24 straight-flow burners arranged in three tiers on the side walls with coal-air mixture channel directed to two 1200 mm dia. circles. The burners of the 1st and 2nd tiers operate at excess air of SR=1.1, while those of the 3rd tier, with SR=0.7. About of 15% of the secondary air is fed via the tertiary air nozzles located by 8 m above the 3rd tier of burners.

The results of model and industrial tests at the Ekib. TPS-2 indicates that under the above mentioned methods of combustion the NO_x emissions in the case of P-57R boilers could be reduced to 500-550 mg/m^3.

For further decrease of NO_x emissions by selective catalytic reduction using ammonia will be applied. Considering flue gas high dust content and abrasivity of Ekib. coal 2 possibilities of catalyst location have been analyzed.

Operating conditions and some characteristics of the catalysts for the $DeNO_x$ system location before the air heater and after ESP and $DeSO_x$ are illustrated in Table 6. $DeNO_x$ system in-built into the boiler duct before the air heater is more efficient (see below).

To reduce SO_x the wet limestone system produced gypsum is used.

Among the most serious problems encountered with Ekib. coal combustion is fly ash removal. Reduction of the dust content from the reference value of 90g/m^3 to 100 mg/m^3 needs the ash removal system with 99.9% efficiency. This is difficult due to increased fly ash electrical resistivity which at gas temperatures within 140-180°C cause ESP back corona impairing ash separation.

Keeping under operation the stack gas at 95-100°C along with adequate ESP active zone gas velocity and residence time enables reaching of the required cleaning efficiency. In the case of four 8-pole ESPs with 12 m high electrodes and the active section of 197.5 m^2 in the 84 m wide bay, the velocity of the cleaned gases will be about 1 m/s and the residence time in ESP, over 30s. These conditions ensure fly ash content in the cleaned gases of 100 mg/m^3 max. ESP are equipped with changing voltage supply sources which prevent back corona and increase operational reliability.

Reduction of power unit output and efficiency due to use of gas cleaning systems is to some extent compensated for by extra generation by the steam passed to condenser instead of being extracted. This is because the part of the condensate, and in some cases feedwater are heated by boiler flue gases with less steam flow to preheaters. The temperature of flue gases shall be decreased from 160°C to 90-100°C to meet ESP operating conditions. For reduction of their temperature, the systems with low-temperature economizer or overflow (excess) of heated air have been designed. In the latter case, a larger amount of air than required for combustion is passed via the air heater, while part of the air preheated to 300-330°C recirculates heating up the feedwater and condencate.

The performance of 500 MW unit for both boiler gas duct in-built $DeNO_x$ system and $DeNO_x$ system located after ESP and $DeSO_x$ system are illustrated in Table 7. The Table also compares the data for existing Ekib. TPS-2 power unit without gas cleaning systems.

Different combustion systems have been tested to validate this project. The tangential fired furnace has been implemented at the Ekib. TPS-2 500 MW unit. As a result, NO_x emissions were decreased to 500-650 mg/m^3 as compared to 1100-1200 mg/m^3 on the other boilers, i.e. almost by 50%.

The swirl burner and simplified reburning have been tested on 210 t/h Ekib. coal-fired boiler. NO_x emissions were reduced from 1100 mg/m^3 to 520-570 mg/m^3 or by 47%.

Long-term tests of the $DeNO_x$ system catalysts have been started on real heavy dust-laden Ekib. coal fired combustion products. The blocks of the catalysts are installed on the by-pass gas duct of the existing boiler of 500 MW unit with the gas flow through the duct of about 5000 m^3/h.

A low-temperature economizer where flue gas temperature is reduced to 90-100°C is installed at 420 t/h boiler. The resultant change in the fly ash electrophysical properties increased ESP efficiency and lower fly ash emissions with 3 times.

Rig tests were conducted of the simplified $DeSO_x$ system close in the concept to LIFAC system. Sulphur capture and operational effects due to lime injection into high-temperature (800-1000°C) flue gas stream, and also sulphur capture with various methods of CaO-contained flue gases humidification were tested.

Works are under way to develop heat exchangers for $DeSO_x$ and $DeNO_x$ systems.

3.3. Project of 2400 MW TPS with CFB Boilers fired poor quality anthracite culm (AC)

For poor fuels a promising approach is CFB combustion [8, 11, 39]. Based on this technology the project of 2400 MW TPS with 300 MW units, located in the Eastern Donbass, has been developed [29, 35].

TPS employs once-through, two-furnace, 2×500 t/h, 24,5 MPa, 545/545°C CFB boiler and K-300-240 steam turbine. As fuel, poor quality AC with 36% ash, S=1.4%, 10% moisture and 4-6% volatiles is fired. The boiler features high recirculation ratio, external hot cyclones (900-940°C), and special external heat exchangers for cooling part of the ash when it is reintrained to the furnace from the cyclone.

The coal and limestone preparation system is with the common hopper and cyclones and combined feed of crushed coal and limestone to the boiler. The coal fraction composition and limestone mean particle size are 0-4 mm and 0.55 mm, respectively.

Reduction of the stack gas temperature to 100°C by the overflow air heating system, increases ESP efficiency and keeps particulate matter emission less then at 50 mg/m^3 max.

To simplify layout and operation and to reduce capital investment the deaerator is excluded from the system but two stages of LP direct-contact heaters are applied.

The once-through CFB boiler firing system consists of two modules. Each module has its own furnace, two cyclones and two external heat exchangers located under the cyclones. The combustion products from both modules are directed to the common convective section.

The amount of primary air fed via the fluidizing screen is ca. 50% of the total air required for complete combustion. The combustion gases velocity at the dense bed outlet is 6.4 m/s. In the freeboard (combustor upper part) fuel is fired using the secondary air supplied via special nozzles.

The two-stage air feed, high fly ash recirculation ratio, furnace temperature of 900°C and limestone injection ensure low flue gas SO_x and NO_x concentrations, AC complete combustion (94-97%), possible boiler load reduction to 30-50% of the nominal value without firing support using gas or fuel oil. The external heat exchangers with last stages of the primary superheater and reheater are designed at 60% heat absorption from the CFB firing circuit.

The performance of TPS with CFB boilers are illustrated in Table 5, which also compares the TPS with pulverized coal fired boilers with $DeSO_x$ and $DeNO_x$ systems, and without them. With identical environmental impact, construction of 300 MW unit employing CFB boilers under this project will be by 20-25% cheaper as a pulverized coal fired unit with $DeSO_x$ and $DeNO_x$ systems.

To validate technical solutions in designing the above boilers, comprehensive testing of Kuzn. coal and AC firing, NO_x and SO_x suppression, hydrodymanics of dust-laden flows in conditions typical for CFB duct, boiler startup and shutdown is carried out.

The highest AC firing efficiency (96%) was when supplying 60% of the total air to the primary zone. At equal flows of the primary and secondary air (50-50%) and overall furnace outlet excess air of SR=1.15-1.25 the flue gas NO_x concentration was 200 mg/m^3 max. Also, formation of NO_x is perceptible influenced by both sorbent feed to the bed and Ca/S ratio. At furnace temperatures of 740°C to 940°C 90-95% of sulphur is captured with Ca/S=1.7-2.0. With further increase of Ca/S ratio, capture of sulphur remains practically constant at about 95%.

3.4. Project of IGCC TPS with entrained flow and moving bed coal gasification

To use Kuzn. and K-A (Berezovo) coals IGCC TPS of large capacity (4.0-6.5 GW) has been designed [29, 41].

600-700 MW CCP includes two GT of 200 MW each, two heat-recovery boilers and one 240 MW steam turbine.

CCP design are based on two different gasification technologies: moving bed and entrained flow. Both systems were desic ı with air and oxygen-blown (O_2=95%) options. Technical solutions and equipment are to a large extent universal and, therefore, various grades of coal can be used, including high sulphur ones.

Gasification proceeds at about 3 MPa. In both systems, gasifiers with liquid slag removal are fed with dry coal via the lockhopper system.

To feed the moving bed gasifiers, the preliminary dried and crushed coal of <50 mm size is screened. The lumps of >5 mm are directed to the hopper, pass through the lockhopper system and via the day hopper are supplied from the top to the reactor vessel. The fines are milled, pass through their own lockhopper system and are blown into the reactor via the tuyers. The technology of production the granules of 6-10 mm from coal dust was tested which are fed into the reactor together with the screened coal.

To feed the entrained flow gasifiers the coal is milled, passes via the lockhoppers and is supplied pneumatically as high concentration dust (<0.015 kg of N_2 on 1 kg of coal dust).

As a sealing and transportation agent the coal-derived gas is used in the case of the air-blown system, and air separation plant nitrogen, when oxygen-blows system is applied.

The composition of gases produced by dried coal gasification depends but insignificantly on the elementary fuel composition and is mostly defined by the process technology, kind and temperature of blast, steam consumption.

Depending on the gasification technology the temperature of the combustible gas at the reactor outlet is 500-550°C (moving bed, oxygen-blown), 900-960°C (moving bed, air-blown), and 1300-1600°C (entrained-flow).

Preliminary cooling of the combustible gas to 900-950°C past entrained-flow gasifiers is made either in a radiant gas cooler featuring additional platen-type heat transfer surfaces, or by quenching via recirculation of cooled gas to the reactor outlet. Further cooling of the gas to 500-550°C temperature at which it is cleaned, is made in the convective gas cooler.

In the gasifier waterwall surfaces and during further cooling of the combustible gas of up to 30% of steam is produced which is later expanded in the steam turbine.

Both projects are used high temperature desulfurisation of the combustible gas at 500°C in the fluidized bed of oxides of metal, say, iron followed by regeneration of sorbents and production of H_2SO_4 from regeneration gases.

In the case of the oxygen-blown gasification, the independent air separation plant is used.

The air-blown gasification systems have two trains per each GT, and in the case of oxygen-blown design, one train is used.

In the case of air-blown gasification about 100 kg/s of air is taken past the GT compressor and its pressure is increased to 3.2 MPa in the booster compressor. Prior to being fed to it the air is a little bit cooled so that the outlet temperature of the compressor was 500-540°C max. The compressor power is 15 MW and it is drived by the condensing steam turbine with steam flow of about 50 t/h. The gasifier is fed also by superheated steam.

In heat-recovery boilers, steam of two pressures 13.8 MPa/520°C and 0.4 MPa/240-250°C is generated due to the GT exhaust gas heat. The boilers generate 205×2=410 t/h of HP steam. Besides, about 170 t/h of HP steam is supplied to the steam turbine from gasification plants. Being expanded in the steam turbine HP cylinder the entire steam is reheated in heat-recovery boilers. Steam parameters before IP cylinder are 2.2 MPa/460°C.

Part of LP steam produced at 185-210 t/h in heat-recovery boilers is used for coal drying (85-130 t/h), and the remaining steam is fed to LP cylinder. The dryer condensate is returned to the steam turbine unit.

With oxygen-blown gasification, 66,000 m^3/h air separation plant is employed to produce oxygen.

In the entrained-flow, oxygen-blown gasification CCP more steam is produced. The steam flow via the steam turbine HP cylinder increase up to 607 t/h.

Basic parameters of IGCC plant at standard ISO conditions are given below.

Parameter	Type of gasifier and oxydizer			
	moving bed		entrained flow	
	oxygen	air	oxygen	air
Two GTs output, MW	418	413	414	372
ST output, MW	188	220	233	227
CCP output, (gross), MW	606	633	647	600
Auxiliary power, MW	68	32	94	31
CCP output (net), MW	538	601	553	569
CCP efficiency (net),%	43.4	44.2	43.8	44.1
Live steam HP flow, t/h	454	532	574	551
Live steam HP temperature, °C	535	540	540	540
Fuel saving, %	10.1	11.8	11.0	11.6

Also the Table compares IGCC efficiency with that of conventional steam supercritical unit (39%).

During commercial operation the average IGCC output will be by 30-35 MW and efficiency by 1.0-1.5% lower.

The efficiency of CCP with various gasification technologies is almost the same. With oxygen blown option, it is 1.7-2.5% lower as compared to air blown.

Basic characteristics of IGCC TPS with 600-700 MW CC units using Kansk-Achinsk coal are shown in Table 5.

As a prototype for a full-scale oxygen blown IGCC plant, the demo plant with K-A coal gasification based on 100-130 MW GT has been designed with combined heat generation of 230-280 MWt [35].

Conceptual designs have been made for the gasification plant including p.c. feed system, air separation plant, gasifier, coal-derived gas convective coolers, gas/gas heat exchanger, equipment for desulfurisation used of selexol sorbent, Klauss plant, etc.

To validate technical solutions rig tests were made of kinetics of entrained-flow p.c.gasification, industrial tests of fine filter, projects of the rigs for testing of lock hopper system equipment to feed p.c. to gasifier and GT combustor for coal-derived gas.

3.5. Project of TPS with Fluidized-bed Gasification CCP

The Project of TPS with 250 MW CCP and Kuzn. coal gasification in the fluidized-bed, steam-air blown gasifier has been developed by the Central Boiler/Turbine Institute (TsKTI, St.Petersburg) and VNIPIEnergoprom Designing Institute (Moscow) [42].

The CCP featuring high degree of integration. The air to be fed to the gasifier operating on 2.0 MPa is taken past GT compressor and is additionally compressed by the auxiliary compressor arranged on the same shaft with the expansion turbine operating on cleaned coal-derived gas and auxiliary steam turbine balancing the output of the turboblock. The steam is fed to the gasifier from the extraction past the steam turbine HP section. Prior to entering the gasifier, the steam is superheated in one of the sections of the convective row gas cooler. Cooling of coal-derived gas before low-temperature wet cleaning and its further preheating are made with minimum loss of sensible heat along with production of HP saturated steam.

The gasifier reaction chamber, octahedral in section, is formed by the waterwall tube screens, switching into steam generator multiple forced-circulation loop. To make the gasifier path leaktight and provide the reliability of the gasifier external casing the steam extracted past the steam turbine HP cylinder is fed into the space between the casing and inner screens. Some gasifier parameters and characteristics are shown in Table 8.

The power generation part is based on the combine cycle with supercharged steam generator (SSG). It includes 65 MW gas-turbine unit of the KhTZ make, T-180 extraction steam turbine of the LMZ make and two supercharged steam generators of the TKZ design. The GT is connected with the SSG, arranged symmetrically from two sides, by two-walled ducts. The GT compressor compressed air is directed to the SSG over the annulus between the outer cold wall and inner pipe in which the combustion products are returned to GT. Each SSG is fed by the coal-derived gas from its own gasification train consisting of the fuel lockhopper system, gasifier, gas coolers, gas cleaning and preheating system, and turboexpander. Natural gas can be fired in the SSG which ensures operability of TPS when availability of gasification systems is loosed.

The fuel is fed to the raw coal hoppers after coal crushing from the station-wide fuel handling system. To be gasified in the fluidized-bed, coal lumps shall not exceed 20 mm in size, and the amount of fines (<1 mm fractions), shall be 15% max. With this in view, coal is additionally crushed, using special crusher, which produced minimum fines. After that, the coal is dried to 10-12% moisture content *which is still reliable for further transportation. As a drying agent, the GT exhaust* gas is used. In the fluidized-bed dryer, fine fractions are separated, entrained with the drying agent and are later caught while drying gases are cleaned in the cyclone and further in ESP. The dust is granulated with addition of a binding substance into 3-10 mm size granules which are then predried and strengthened. The crushed coal and granules are fed to the gasifier via the lockhopper system. The pressure in this case is created by the coal-derived gas which is taken before gas heater, additionally cooled and compressed [42].

The coal-derived gas is cooled and heated in several heat exchangers. Some operational data are given below.

Nos. of gas cooler/heater	gas duct	1	2	3	4
Gas temperature, °C					
inlet	950	971	522	410	160
outlet	917	522	410	220	335

As a cooling agent, the 16 MPa, 346°C boiler water from the forced circulation loop of the SSG is used. The temperature of the tube in this case is 400-410°C max. and they can be made of low-alloyed steel.

In the gasifier itself locates only screen waterwall surfaces the primary purpose of which is to protect the outer robust casing against high temperatures and aggressive coal-derived gas. The walls of gas cooler No.1 and the gas duct connected it with the gasifier are also screened. The gas cooler path locates 3 convective sections operating under gas velocities of 6-7 m/s, ensuring self-blowing of the surfaces with no tube erosion. The 3rd section has a bundle to superheat the steam fed for gasification to 450°C. It is made of austenitic tubes. The walls of the other gas coolers operating under coal-derived gas temperatures <522°C are not screened. In wet cleaning of coal-derived gas its temperature is decreased to 160°C and after cleaning rises to 330-350°C. Whereupon the gas is fed to the expansion turbine, and further to the SSG burners. All gas coolers are located in 3.8 m outer dia. cylindrical shells ensuring preassembled transportation; their length (height) is 17-33 m.

The coarse cleaning of the coal-derived gas is made in cyclones in two stages. The first group of cyclones is installed past gas cooler No.1 (500-550°C), the cleaning efficiency is 65-70%; the second group is located past gas cooler No. 3 (210°C) and their cleaning efficiency is of about 90%.

The fine cleaning of gas so that the particle content shall be less than 10 mg/m^3 (under normal conditions) is made by washing in Venturi scrubber with cyclone mist eliminator.

The major part (70-80%) of sulphur removal is made in the fluidized-bed where together with coal sorbent: limestone or dolomite is injected. The test trains (about 5-7% of total capacity) are incorporated into the system for coal-derived gas fine dry cleaning of particulates at 410°C, dry cleaning of SO_2 by iron ore at the same temperature, and middle temperature (140-160°C) catalytic gas cleaning of SO_2 using activated coal. Upon mastering the technologies, the total sulphur capture will increase to 95% and over.

Small NO_x emissions are ensured by:

* capture of considerable part of fuel nitrogen by formation during gasification of ammonia which is removed from coal-derived gas when washing the latter;

* lower coal-derived gas combustion temperatures in SSG.

Basic parameters of IGCC-250 TPS and coal gasification system are shown in Table 5 and 8. Also given are the parameters of the CCP "industrial unit" designed by TsKTI by the same scheme but with large and more efficient GT with inlet gas temperature of 1100°C.

Investigations and validations of the project were conducted on the pilot plant of 250 kg coal/h capacity at up to 3 MPa [43] and at large-scale TsKTI test facility at up to 0.6 MPa [44].

At the above test facility the model of CCP-250 gasification system was reproduced. Gasification investigations are carried out of Kuzn. bituminous coals of WS grade at flow rates from 600 to 1100 kg/h, as well as brown K-A coals. The gasifier of the facility is a vessel of 2.2 m dia. and 10 m high with reactor itself of about 800 mm dia. with 4.5 thou.m^3/min coal-derived gas output. Gasification was conducted with steam-air blast at 900-1000°C. The plant had made it possible to reveal and eliminate many "children's deseases" in fuel preparation and handling, lighting up and maintaining gasification mode, removal of bottom ash from gasifier, ensuring nonslagging operation, etc.

At design velocities of 1.7-2.0 m/s and moderate content of coal fines, the coal-derived gas was of normal quality and fly ash take out were acceptable.

At special rigs, fuel preparation devices were mastered (cutting 10 t/h crusher, fluidized bed drier-feeder, etc.,) as well as fines granulation technology. Successful fluidized bed gasification of granules has been conducted.

4. Conclusions

Terms of Application of Clean Coal Technologies at Russian TPS

A peculiarity of power generation in Russia is wide use of as-mined high-ash coals at coal TPS.

Large amount of brown coal is produced and fired at TPS, among which the cheapest and most promising for further use are strongly slagging K-A coals.

The positive feature of the worth-while Russian coals is low sulphur content facilitating the meeting of SO_2 emission standards. At the same time, the production and use of some amounts of high sulphur coals will continue for a long period of time (from the near-Moscow, Inta and Donetsk coal fields).

In practice, the fuel standards are not met strictly. There are cases where coal ash content and heat value are beyond the specified limits. Many times the necessity appeared to change the grade of coal supplied to some TPS or units. No steam coal market exists in Russia and understanding of its inevitable appearance has far from being the generally accepted point of view.

All this demands checking up of applicability of clean coal technologies for high ash fuels, brown coals with specific ash properties and adaptability of these technologies to coal varying properties.

The climate in Russia is more severe than in the USA. It is a tradition to use centralized heating systems for residential and industrial premises. The capacity of cogeneration plants is over half of all fossil-fuelled TPS. With reference to generation their share is even higher. Many cogeneration plants are located within the cities areas and the requirements to their reliability first of all for heat supply and reduced emissions are high. Cogenerations' plants employ boilers of relatively small size and capacity (170-670 t/h).

In designing and installation of the equipment low ambient temperatures shall be taken into account; the opportunities for outdoor equipment location becomes smaller; the technologies designed for large power units shall be tested with reference to smaller boilers.

In recent years the most important task for the Russian power industry will be life extension of old TPS which shall return in line with increasing efficiency and decreasing environmental impact. Such TPS provide the largest market for the environmentally bending technologies.

Russian TPS typically locate 6-12 units of the same type in the common main building. Together with certain economic advantages, ease of construction, erection and operation such TPS layout complicates the arrangement of additional equipment during modernization to improve performance or for gas cleaning because of lack of space.

Location of the pollution control equipment and additional air, fuel and gas ducts can differ greatly from those demonstrated in the USA by CCTP. Similar difficulties appear when replacing coal-fired boilers by CFB boilers requiring larger space due to external large-size cyclones. Therefore, CFB boilers with in-gas duct built ash separators developed by B&W (USA) seem more attractive.

At this time Russia has well equipped and low-loaded power industry equipment manufacture facilities and organisations with highly qualified personnel capable of undertaking engineering in designing, implementation and operation of air pollution control equipment and systems. Traditionally, Russian power industry employed domestic equipment which meets high standards and provides for reliable TPS operation until now. Russia uses its own norms and standards. Though in some areas Russian engineering fell behind the up-to-date level (GT, CCP, environment protection, I&C systems) the decision makers: managers of power systems and TPS are mostly oriented on the Russian equipment and materials.

With this in mind, the fruitful way of transferring the CCTP-based US technologies is joint production with Russia of the equipment and employ Russian personnel to solve possible technical problems. This may require revision of the US technical documentation to comply with Russian standards, materials and manufacturing technologies, prove Russian sorbents, as well as catalysts and other materials in the technological processes, etc.

Finally, in transferring the technologies it is useful to take into account of the today's difficult economical situation in Russia. Electricity consumption dropped, only small part of capital investments needed to retrofit/repower the existing and construct new TPS can be mobilized. Financial difficulties are one of the major causes of the long times of construction.

Under these conditions, less-capital investment technologies become more attractive especially if they could be realized by stages. Designing and supply of highly shop prefabricated large blocks of equipment is desirable. For planning and organisation of construction process should be given the required attention.

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Table 1

NO_x **Specific Emission** Norms for Boilers to be Installed at TPS **before 01.01.2001**

Boiler thermal output, Q, MW	Fuel fired	Units of measurement		
		g/MJ	kg/tfe	mg/m^3 of dry gas (α=1.4)
100-299	Gas	0.05	1.46	150
	Fuel oil	0.10	2.93	290
	Brown coal:			
	dry-bottom	0.12	3.5	320
	wet-bottom	0.13	3.81	350
	Bituminous coal:			
	dry-bottom	0.17	4.98	470
	wet-bottom	0.23	6.75	640
>300	Gas	0.05	1.46	150
	Fuel oil	0.103	3.03	300
	Brow coal	0.14	3.95	370
	Bituminous coal:			
	dry-bottom	0.2	5.86	540
	wet-bottom	0.25	7.33	700

NO_x **Specific Emission** Norms for Boilers to be Installed at TPS **since 01.01.2001**

Boiler thermal output, Q, MW	Fuel fired	Units of measurement		
		g/MJ	kg/tfe	mg/m^3 of dry gas (α=1.4)
100-299	Gas	0.043	1.26	125
	Fueloil	0.086	2.52	250
	Brow coal:	0.11	3.2	300
	Bituminous coal:			
	dry-bottom	0.17	4.98	470
	wet-bottom	0.23	6.75	640
>300	Gas	0.043	1.26	125
	Fueloil	0.086	2.52	250
	Brow coal:	0.11	3.2	300
	Bituminous coal:			
	dry-bottom	0.13	3.81	350
	wet-bottom	0.21	5.97	570

Table 2

SO_x **Emission** Norms for Boilers to be Installed **before 01.01.2001**

Boiler thermal output Q, MW	Unit of measurement	g/MJ		kg/tfe		mg/m³ (α=1.4)	
		Normatired SO_x content, % kg/MJ					
	Fuel	≤0.045	>0.045	≤0.045	>0.045	≤0.045	>0.045
100-299	All solid and oil fuels	0.875	1.5	25.7	44.0	2000	3400
≥300	All solid and oil fuels	0.875	1.5	25.7	38.0	2000	3000

SO_x **Emission** Norms for Boilers to be Installed **since 01.01.2001**

Boiler thermal output Q, MW	Unit of measurement	g/MJ		kg/tfe		mg/m³ (α=1.4)	
		Normatired SO_x content, % kg/MJ					
	Fuel	≤0.045	>0.045	≤0.045	>0.045	≤0.045	>0.045
100-199	All solid and oil fuels	0.5	0.6	14.7	17.6	1200	1400
200-249		0.4	0.45	11.7	13.1	950	1050
250-299		0.3	0.3	8.8	8.8	700	700
≥300	All solid and oil fuels	0.3		8.8		700	

Table 3

Particulate Matter Specific Emission Norms for Boilers to be Installed **before 01.01.2001**

Boiler thermal output Q, MW	Unit of measurement	g/MJ			kg/tfe			mg/m^3 (α=1.4)		
	Fuel	Normatired ash content, % kg/MJ								
		below 0.6	0.6-2.5	above 2.5	below 0.6	0.6-2.5	above 2.5	below 0.6	0.6-2.5	above 2.5
100-299	All solid fuels	0.06	0.06-0.2	0.2	0.176	1.76-5.85	5.86	150	150-500	500
≥300	All solid fuels	0.04	0.04-0.16	0.16	1.175	1.175-4.7	4.7	100	100-400	400

Particulate Matter Specific Emission Norms for Boilers to be Installed **since 01.01.2001**

Boiler thermal output Q, MW	Unit of measurement	g/MJ			kg/tfe			mg/m^3 (α=1.4)		
	Fuel	Normatired ash content, % kg/MJ								
		below 0.6	0.6-2.5	above 2.5	below 0.6	0.6-2.5	above 2.5	below 0.6	0.6-2.5	above 2.5
100-299	All solid fuels	0.6	0.06-0.1	0.1	1.76	1.76-2.93	2.93	150	50-250	250
≥300	All solid fuels	0.02	0.02-0.06	0.06	0.586	0.586-1.76	1.76	50	50-150	150

Table 4

Quality of Russian Coals Fired at TPS in 1993

Coal Field/Type	Used at TPS, mln.t	Content as per working mass						Volatiles
		W, %	A, %	Q, MJ/kg	C, %	S, %	N, %	V, %
Kuznetsk, bit.	22.3	10.7	20.4	21.8	40.5 – 66.0	0.4	1.3 – 1.8	12 – 41
Kansk-Achinsk, br.	27.5	33.1	6.8	15.4	37.4 – 44.3	0.3	0.5	48.0
Eastern Donbas, AC	5.8	8.2	25.1	21.5	62.5	1.7	0.5	5.0
Pechora.,bit. (Inta)	2.2	11.6	29.1	17.0	43.9	2.4	1.5	40.0
Neryungrinsk, bit.(Yakutia)	4.2	8.3	15.8	24.85	64.8	0.2	0.7	20.0
Chelyabinsk, br. (Urals)	6.4	15.2	37.2	12.6	33.8	0.8	0.9	44.0
Near-Moscow, br.	6.0	29.6	36.2	7.9	22.2	2.35	0.4	48.0
Azeisk,.br. (East)	8.0	23.5	17.4	16.3	43.1	0.5	0.9	48.0
Kharanorsk, br. (East)	8.2	38.6	13.6	11.8	34.3	0.3	0.5	44.0
Bikinsk, br. (Far East)	5.5	38.0	28.8	7.0	22.0	0.3	0.6	53.0
Ekibastuz, subbitum. (Kazakhstan)	25.6	6.1	39.9	16.4	41.9	0.7	0.8	25.0
Gusinoozersk, br. (Buryatia)	2.5	24.7	21.3	13.1	38.3	0.4	0.6	43.0

Bit — bituminous; br. — brown; AC — anthracite culm.

Table 5

Base-Case Options of Russian Advanced Coal TPS

Parameters	Supercritical Pulverized Coal Units			IGCC Plant		Supercritical Pulverized Coal Units			Supercritical Pulverized Coal Units		CFB Unit	Subcritical Pulverized Coal Units	IGCC Plant	
	existing	$De-SO_x$–$De-NO_x$ systems	Ecologicaly clean	oxygen blowing	air blowing	existing	with $De-SO_x$–$De-NO_x$ systems LD	HD	existing	with De-SOx-De-NOx clean				
TPS capacity, MW	← 6400 →			← 6000 →		← 4000 →			← 2400 →			360	500	640
Utilization period, h/yr	← 6500 →			← 6500 →		← 6190 →			← 4000 →			← 6000 →		
Unit capacity, MW	← 800 →			← 650 →		← 500 →			← 300 →			180	250	320
Fuel characteristics:														
Coal field	KANSK-ACHINSK					EKIBASTUZ			DONETSK			KUZNETSK		
Coal grade	BROWNCOAL					BITUMINOUS			AC			BITUMINOUS		
Heat value, MJ/kg	← 15.07 →					← 14.45 →			← 17.25 →			← 22.25 →		
Ash content, %	← 7.00 →					← 45.60 →			← 36.00 →			← 21.60 →		
Moisture content, %	← 38 (33 – 38) →					← 5.00 →			← 10.00 →			← 10(12 – 20) →		
Sulfur content, %	← 0.3 (0.2 – 0.5) →					← 0.60 →			← 1.40 →			← 0.4 →		
Nitrogen content, %	← 0.3 →					← 0.80 →			← 0.50 →			← 1.50 →		
Efficiency in nominal output, %	38.50	37.60	38.70	42.50	43.50	38.15	35.90	37.20	37.60	36.80	37.30	36.30	38.50	41.90
Relative specific investment cost	1.227	1.483	1.193	1.326	1.358	1.000	1.577	1.470	1.043	1.673	1.071	1.375	1.534	1.399
Specific emissions														
NO_x, mg/m³	600	200	200	40*	30*	900	200	200	800 – 1200	200	200	900	80*	80*
mg/MJ	220	75	75	30	25	320	70	70	280 – 420	70	70	320	65	65
SO_x, mg/m³	600	300	300	3.5	10	2100	200	200	2800	200	200	1000	60*	60*
mg/MJ	220	110	110	2.5	8	750	70	70	1000	70	70	350	48	48
Particulate matter, mg/m³	150	50	50	0.7	0.7	500	100	100	500	50	50	250	2*	2*
mg/MJ	55	18	18	0.6	0.6	180	35	35	180	18	18	90	1.6	1.6

* — For IGCC Plants the emissions are related to m³ in standard conditions with excess air of 3.0 or O_2 = 15%

Table 6

Characteristics of catalysts for different De-NO_x locations

Name	De-NO_x location	
	before air heater	past De-SO_x
Flue gases dust content, g/m^3	70 – 100	not more than 0.15
SO_2 concentration, mg/m^3	2000-2200	200 – 300
Temperature, °C	300 – 320	320 – 350
Catalyst:		
channel size, mm	6.1 – 6.3	3.4 – 3.6
surface, m^2/m^3	430 – 470	750
relative activity	1.0	1.0 – 1.2
relative volume	1.0	0.4 – 0.5
service life, thou.h	12 – 15	24
Relative pressure drop	1.0	1.0 – 2.5

Table 7

Performance of 500 MW Unit with differ De-NO_x Plant Location

Parameter	500 MW Unit		
	Ekibastuz TPS-2	Ecologicaly clean TPS	
		$DeNO_x$ *past* $DeSO_x$	*in-build* $DeNO_x$
Additional capacity*, MW	0	4.8	1.1
Heating surface, thou.m^2			
air heater	163	252	252
economizer	12.4	12.4	17.3
heat exchangers: air-water	—	3.42	6.12
in-build air-water	—	23.10	7.50
gas-gas	—	230.00	—
Design power of draft machines. MW	10.22	20.48	13.70
ESP power, MW	2.05	3.80	3.80
Power consumed for $DeSO_x$ plant, MW	—	5.53	5.68
Increased auxiliary power, MW	—	17.54	13.15
Total fuel consumption, t/h	327.3	339.0	327.2
Boiler efficiency, %	91.09	94.37	94.07
Exhaust gas temperature, °C	159	99	100
Annual specific fuel consumption, g/kW.h	322.4	342.7	330.3
Annual efficiency, %	38.15	35.89	37.20
Relative specific investment cost	1.0	1.58	1.50

* — Power, produced by steam which was not used for feedwater preheating

Table 8

Characteristics of fluidized bed gasification system

Reaction chamber pressure, MPa	2.0 – 2.1
Fluidized bed area, m^2	8.7
Fluidized bed height, m	3.0
Combustible gas LHV, MJ/kg	4.07
Flows for one gasifier, t/h (kg/s):	
coal	60 (16.7)
steam and air	230 (63.9)
ash from bed	8 (2.2)
Consumption of oxydizers per kg of coal, kg:	
air	3.15
steam	0.67
Gas yield, kg/kg of coal	4.3
Temperature,° C:	
in reaction volume	1100
steam-air	450
gas past reactor	950
gas before cleaning	210
gas past cleaning	160
gas before expansion turbine	310
Coal characteristics: LHV, MJ/kg	23.65
Moisture, %	10 – 12
Ash content, %	13 – 21.5
Sulfur content, %	0.35 – 0.40

Buffet Lunch

REMARKS BY
JOSEPH J. YANCIK
DIRECTOR, ENERGY DIVISION
DEPARTMENT OF COMMERCE

PANEL MODERATOR
FUTURE INTERNATIONAL EXPECTATIONS FOR CCT DEPLOYMENT

After four days of outstanding papers and discussions detailing the progress towards demonstrating clean coal technologies, this panel has been given the challenge of predicting, or at least, scoping the likely prospects for the deployment of CCT's.

I have given this forecasting challenge a lot of thought, as I am sure so have the panel members which you will hear from very shortly.

Whatever is forecasted, I believe the road to success is a partnership of private companies and the government working together. Deployment will neither be easy nor guaranteed. A public-private partnership certainly would improve the chances of success.

I say this based on my experience. For over the past ten years my office has worked with energy and energy related companies that were seeking to develop international energy projects in coal, oil, gas and power generation. We worked with these companies to help them develop their project, to identify the foreign countries' key barriers to investment and regulations, and to formulate a USG advocacy effort to promote the project with host country government officials.

I would like to say that, with USG help, most of the U.S. companies succeeded in developing their energy projects, but that has not been our experience. Some projects did succeed and are shining examples of how the USG working with the private company contributed to its success. I might add that no one type of energy project, be it coal, oil, gas or power generation had a better success ratio. The bottom-line was that too often the problems in executing the project development plan could not be resolved within the time frame of the companies' expectations.

I hasten to add, the effort of both the USG and the companies in failed projects have not been wasted if both parties remember the **"LESSONS LEARNED."** I repeat, lessons learned -- lessons learned -- and these must not be forgotten in developing the public/private partnership approach I mentioned earlier.

From my experience, most project development plans that fail are the result of an inability to raise the capital at a cost consistent with the economic realities of the project. This is often due to the failure of securing the necessary financial, legal and regulatory agreements from the host government. You could view this as a classic "catch 22" situation, but it should also be viewed as a warning that the project development plan may have been seriously flawed.

So you may be thinking, what special meaning does this have for the deployment of CCT's? For openers, I suggest that CCT projects will require a much greater innovative effort on the part of developers to structure a plan that makes economic sense in an international business climate that abhors technology risks. Strong market forces alone may not encourage CCT's deployment as environmentally sustainable energy needs are weak demand engines in most of the countries where the needs are the greatest.

While a strong case is not yet evident that CCT deployment is a sure thing, I am optimistic for several reasons. First, U.S. companies are the world's leader in developing energy projects and they are fully capable of taking on the special challenge of CCT deployment. Second, multilateral banks and some private lending institutions give preference to environmentally correct energy projects. Third, our Embassies abroad, and in particular our U.S. Ambassadors around the world are now aggressively supporting U.S. companies doing business or seeking project opportunities in the host countries. This has not always been the case. Now, U.S. companies can count on the USG working hard to give them a level playing field with their competitors, especially the European and Japanese companies.

I close with a suggestion. If any company in this room does not have a personal relationship with the Senior Commercial Officer and the Ambassador in the country in which the company is doing business, I urgently suggest you to do so.

Now let's hear from our panel of experts and see if we have a consensus or dichotomy of views.

EXPORT-IMPORT BANK
OF THE UNITED STATES

CRAIG S. O'CONNOR, ENVIRONMENTAL LIAISON OFFICER
EXPORT - IMPORT BANK OF THE UNITED STATES
CLEAN COAL TECHNOLOGY CONFERENCE, DENVER, CO SEPTEMBER 5-8, 1995
TEXT of PRESENTATION

Good afternoon. It is a great honor to be here today to address the Fourth Annual Clean Coal Technology Business Conference. The potential global market for clean coal technology has now been fully recognized by the U.S. government and industry and those of our competitors. With increased worldwide demand for clean coal technology that reduces atmospheric pollution and produces energy with greater efficiency thereby expanding the customer's productive capacity, this market can only be defined as "strategic." To quote Edda Muller, German Environment Ministry, in commenting on the German government's efforts to promote environmental technologies, "What we are doing here is economic policy, not environmental policy."

Capturing a share of this "strategic" markets is highly promising for U.S. clean coal technology firms given our competitive advantage in key technologies. Yet the determining factor in realizing these export opportunities is ability to offer financing to your foreign customers. This is where Ex-Im Bank can play a major role. Created in 1934 as an independent U.S. government agency, Ex-Im Bank's mission is to create jobs through exports. Ex-Im Bank achieves the mission by offering the following programs: First, Ex-Im Bank's Loan Guarantees offer 100% coverage of principal and interest for commercial bank loans made to foreign buyers of U.S. goods and services. The Loan Guarantee protects the lender against both political and commercial risks of non-payment. Ex-Im Bank can also provide direct Loans to foreign buyers. Ex-Im Bank does not compete with private lenders, but rather accepts risks that they will not accept. In addition, Ex-Im Bank seeks to match the effect of export credit subsidies from other governments. As a result, the exporter is then able to compete fairly in these markets on the basis of price, performance, delivery and service. Second, Ex-Im Bank offers Export Credit Insurance which protects against both the political and commercial risks of a foreign buyer defaulting on payment. The Insurance Program is particularly beneficial to small- and medium-sized exporters who may not be able to afford to extend credit terms to foreign buyers nor risk the loss of non-payment.

One of the most widely used benefits of Ex-Im Bank's Export Credit Insurance is the discounting or selling of the insured foreign receivables to a bank to obtain financing. Because you're protected against non-payment, you can often arrange for more attractive financing from your bank, which in turn enables you to offer more attractive credit terms than you would without the Insurance protection. Third, Ex-Im Bank offers a Working Capital Guarantee Program which supports export-related production and marketing activities. Under this program, Ex-Im Bank provides a repayment guarantee to lenders on secured, short-term working capital loans made to exporters. Guarantees may be made for a single transaction or a revolving line of credit.

In terms of support for environmental exporters, which includes clean coal technologies, Ex-Im Bank is now proactively focused on environmental export business development. Julie Belaga was appointed by President Clinton last year to become a member of Ex-Im Bank's Board of Directors to lead Ex-Im Bank's strategic focus on proactive, increased support for environmental exports. What this means is that Ex-Im Bank works closely with other U.S. and state government agencies and private sector trade associations and firms to realize environmental export opportunities. Ex-Im Bank, along with the U.S. public and private sectors overall, possess considerable strengths to realize these opportunities. For example, the Department of Energy provides advice to many foreign governments on clean coal technology, thereby defining needs which translates into export opportunities. You, the clean coal technology industry, possess the technology to meet these needs, while we at Ex-Im Bank have the programs to finance the technology to meet the needs. Yet Ex-Im Bank finance is only important if orders are won, while orders may only be won if financing is available. The challenge for all of us is to work closely in partnership to achieve a synergy that will result in winning export orders. Along with targeted business development, Ex-Im Bank has designed a special "Environmental Exports Program" that provides enhanced levels of support, including, an Environmental Export Insurance Policy for small business exporters which provides for 95% commercial coverage - compared to the existing 90% commercial coverage - and 100% political coverage with no deductible; enhanced medium- and long-term support for environmental projects, products, and services which include local cost coverage equal to 15% of the U.S. contract price, capitalization of interest during construction, and maximum allowable repayment terms permissible under OECD guidelines.

As an illustration of Ex-Im Bank's Environmental Enhancements, in March of this year Ex-Im Bank financed the $30 million sale of Circulating Fluidized Bed boilers by Pyropower Corp. of San Diego, CA to the state-owned Turow Power Station being rebuilt in Bogatynia, Poland. Because the sale qualified as an environmentally-beneficial export, Ex-Im Bank provided a $36.5 million loan guarantee for commercial bank financing covering the export of services, some local costs, capitalized interest during construction, and an exposure fee. Ex-Im Bank has financed a number of clean coal technology projects over the years, with Turow being the latest example.

In terms of the cost of Ex-Im Bank financing, the interest rate on an Ex-Im Bank guaranteed "floating-rate" loan is based on the 6-month London Interbank Offered Rate (LIBOR) with the U.S.-based lending bank charging a fee that typically ranges from 1/4-1/2%. In addition, Ex-Im Bank charges a commitment fee of 1/8% per annum on the undisbursed portion of the loan plus an exposure fee based on the country, the borrower, and the term of the loan. The borrower may negotiate a fixed rate of interest with the guaranteed lender. For Ex-Im Bank direct loan the interest rate is based on a 1% spread over comparable maturity U.S.Treasury note rates, which for loans with repayment terms of over 8 1/2 years would be 7-year U.S. Treasury note. In addition, Ex-Im Bank would charge a commitment fee of 1/2% per annum on the undisbursed amount plus the exposure fee. Note that the exposure fees may be amortized over the life of the loan. To illustrate the approximate all-in-cost of an Ex-Im Bank guaranteed loan, take as an example a 10-year guaranteed loan to a public-sector utility in Poland. Using the current LIBOR of 5.94% plus the guaranteed lenders charge of 0.25%, adding in Ex-Im Bank's 0.125% commitment fee plus the 10-year exposure fee for Poland which equals 7.19%, the approximate cost per year based on a floating rate would equal 7.034%. For all Ex-Im Bank loan and guarantees, "a reasonable assurance of repayment" is required. Ex-Im Bank makes this determination based on the financial condition and creditworthiness of the foreign borrower. For a state-owned utility it is likely that Ex-Im Bank would require either a sovereign guarantee or the guarantee of a bank acceptable to Ex-Im Bank. For private sector buyers, Ex-Im Bank would require three years complete, audited financial statements along with supporting credit background information.

To conclude, I would encourage those firms pursuing export sales to contact Ex-Im Bank early in the process so that a complete package of technology <u>and financing</u> is offered to the foreign buyer. I can be reached at (202) 565-3939. Thank you.

EX-IM BANK
JOBS THROUGH EXPORTS

News Release

FOR IMMEDIATE RELEASE
MARCH 1, 1995
Contact: Marianna Ohe 202-565-3200

Increase Poland's Power, Reduce Pollution

EX-IM BANK BACKS U.S. ENVIRONMENTAL TECHNOLOGY SALE
Helps California Company

The Export-Import Bank of the United States (Ex-Im Bank) is financing the $30 million sale of U.S. environmental technology by Pyropower Corp., San Diego, CA, to reduce pollution at the state-owned Turow Power Station being rebuilt in Bogatynia, Poland.

Pyropower will provide U.S. engineering and project oversight services for the building of two low-emission boilers at the Turow station. The transaction is part of a $369 million project to rehabilitate two of the Turow station's ten units.

"Ex-Im Bank is committed to promoting environmentally beneficial U.S. exports," said Ex-Im Bank Board Director Julie D. Belaga. "And we are delighted that, in this case, American know-how will be used to improve Poland's environment. Increasingly, the sale of American technology and consulting is going to make the difference in U.S. global competitiveness."

Because the sale will benefit the environment, Ex-Im Bank policy allows it to provide enhanced support: a $36.5 million Ex-Im Bank guarantee of commercial bank financing covering export of services, some local costs, capitalized interest during construction and an exposure fee. Citicorp, Chicago, IL, will head a syndicate of banks providing the financing, which will be repaid in 20 semiannual installments starting Oct. 15, 1998.

Pyropower has the technology for Circulating Fluidised Bed (CFB) boilers, ideally suited to burn low heating value fuels with very low emissions of sulphur dioxide. The Turow station is located in an area extending over parts of Poland, Germany and the Czech Republic with a very high concentration of atmospheric pollution.

Ex-Im Bank is an independent government agency that helps finance U.S. sales of goods and services around the world. The Bank authorized $15 billion in financing in Fiscal 1994.

# # # #

(Editors note: The Bank follows the AP Stylebook, which states that *Export-Import Bank of the United States* is always acceptable as a first reference and *Ex-Im Bank* is the acceptable second reference.)

EXPORT-IMPORT BANK OF THE UNITED STATES
811 VERMONT AVENUE, N.W. WASHINGTON, D.C. 20571
(800) 565-EXIM (202) 565-3946 FAX: (202) 565-3380

FOURTH ANNUAL CLEAN COAL TECHNOLOGY CONFERENCE
DENVER, COLORADO
September 8, 1995

Presentation in the Buffet Lunch Panel on Future International Expectations for CCT Deployment

P. J. Adam, Chairman and CEO, Black & Veatch

Our topic this afternoon is Future International Expectations for Clean Coal Technology Deployment. When we say international, I think we must be referring to the developing world, because the industrial world, for the most part, has already implemented clean coal technology equal to our own.

Assuming we are talking about clean coal technology for developing countries, I want to raise an issue which may not play well to this audience, but needs to be said anyway. That is the issue of environmental priorities, or how clean should clean coal be in a developing country?

By way of background, Black & Veatch is currently designing coal fired power plants in seven developing countries, China, Colombia, India, Indonesia, Malaysia and the Philippines. Our views are more than just theoretical; we are actively engaged in applying clean coal technology in developing countries, and we know what it costs.

I will give you a rough idea of the added cost of clean coal technology, then give you my suggestions for appropriate environmental priorities in a developing country. And, I ask you to remember that we are talking about countries with less than one-tenth the gross domestic product per capita of the United States.

The good news is that, as a result of the billions we have spent developing and debugging these technologies, they are now proved and available to the developing world at a fraction of what we spent.

The bad news is that some of the technologies have only marginal value in any kind of cost/benefit analysis in a world which lacks basic sanitary facilities such as safe drinking water systems and sewage collection and treatment facilities.

But I told you I would give you some baseline costs of clean coal technology and let you judge for yourself. Our estimates are based on a 2 x 660 MW coal fired reference plant we are applying in a number of the developing countries.

Common sense measures like coal dust control and lining coal piles and ash ponds to protect groundwater add only about one percent to the cost of the plant and little if any to the operating cost. These are the "No-Brainers" with high benefit relative to the minor cost. We should include low cost features like these in our standard designs.

We should also design our processes to minimize the production of wastewater and solid waste. Modern processes to limit waste production often reduce cost rather than increase it.

Likewise, low NOx burners are "No-Brainers," adding less than one percent to the plant cost and very little to the operating cost.

Flue gas particulate collection systems are expensive but have a very favorable impact on air quality in the vicinity of the plant. High efficiency electrostatic precipitators or bag houses add three or four percent to plant cost and about one-half mill per kwHr to operating cost. While these costs are significant and add measurably to the cost of electricity, the benefits of a clean stack are important, even in a developing country with limited resources.

Anyone who has seen the filthy industrial areas of Eastern Europe and the former Soviet Union can appreciate the benefits of a clean stack.

Now comes the rub. This is about as far as we should go, and this is where my ideas diverge from the policies of most industrial country governments. They all seem to advocate the ultimate in clean coal technology for new power plants, even in developing countries.

An FGD system adds about 15 percent to the plant cost and one to one and one-half mills per kwHr to operating cost. Maybe this can be justified for high sulfur coal, but in much of the developing world, the available coal has sulfur content of one percent or less.

The cost of FGD for a 2 x 660 MW plant is about $180 million, and this would buy a safe drinking water system for a sizable city.

It is estimated that 20 million people die each year in developing countries due to the lack of basic sanitary facilities. If developing countries invest in FGD instead of safe drinking water systems and sewage collection and treatment systems, none of those 20 million lives will be saved.

It is said that developing countries cannot afford the water borne sewage systems used in the industrial world because they cost too much at about $1,000 per household. Well, that $180 million we want a developing country to spend on FGD would provide a water borne sewage system for nearly a million people.

Selective catalytic reduction for NOx control would be an even more foolish investment for a developing country than FGD. It costs less than FGD, adding only about seven percent to plant cost and about one mill per kwHr in operating cost, but there is no point in requiring SCR in a country which lacks basic sanitary facilities.

In the U.S., we can afford SCR even if it is of little or no benefit, because we are a rich country. We have wasted a lot of money in the name of environmental protection, but so what; electricity is still easily affordable to most Americans with GDP per capita more than ten times that of the developing countries.

But what should our policies be for environmental protection in the developing countries? As they now stand, our export and lending policies can force countries to choose the wrong environmental priorities for their people. We ask them to put FGD on power plants when that won't save lives, but basic sanitary facilities would. That is wrong, and we need to think again.

Here is a logical set of priorities for a developing country:

1. Set up a free market system and allow export industries to develop, putting the citizens to work.

2. Build the infrastructure needed to support the export industries including development of natural resources, power stations and transportation systems.

3. Apply to the production facilities and transportation systems those limited environmental controls which produce the most benefit.

4. When the people have jobs and enough food to eat, in other words, when they have enough to sustain life, look for ways to improve their health. Sewage collection comes first, then treatment, then safe drinking water systems. Then, maybe we should think about doctors and hospitals.

Notice how much a developing country needs for the health and welfare of its people before we get to FGD and SCR. Only as the GDP per capita approaches that of the industrial countries should a country begin to require the more sophisticated environmental controls.

If you think about it, the industrial world followed the same priorities in its development with technologies like FGD and SCR being applied long after the fundamental public health needs of the citizens were met.

I think you can see why I am so reluctant to encourage you to apply clean coal technology in the international market. International in this sense means developing countries. They need coal fired power plants, but they don't need and can't yet afford the ultimate in clean coal technology. Their scarce resources must be first applied to those measures which most improve the health and welfare of their citizens.

Unfortunately, for those of us with commercial interests in the technology, FGD, SCR and many other advanced environmental control technologies fail this simple test.

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FUTURE INTERNATIONAL EXPECTATIONS FOR CCT DEPLOYMENT

Robert Joyce
Ahlstrom Development Company
8925 Rehco Road
San Diego, CA 92121

Please contact author for a copy of this paper.

Financing Strategies to Promote Clean Energy Projects: Some Considerations

Kenneth Langer
Coleman Research Corporation
Advisor on Project Development and Finance
Office of International Energy Policy
Department of Energy

The following remarks were delivered at the Clean Coal Technology Conference in Denver, Colorado on September 8, 1995.

Thank you for the opportunity to speak to you today. As you just heard, I am Director of International Energy Projects for Coleman Research Corporation, a subsidiary of Thermo Electron. I am currently on assignment to the Department of Energy's Office of International Policy. My job is to work with DOE program offices, US Government financing agencies, the multilateral development banks, and the commercial lending and investment communities to explore innovative strategies to finance sustainable energy projects. These include clean coal technology (CCT), renewable energy, and energy efficiency projects. Unless otherwise stated, the ideas that I shall briefly touch on today are my own and do not represent the views of the Office of International Policy.

There are many challenges to financing sustainable energy projects, and some are more suited to areas like energy efficiency than to CCTs. So, in the short time available today, I'd like to offer some thoughts on one important area, namely how we can wean ourselves from federal funding and create a more diversified base of stakeholders.

Throughout this conference, three points have begun to echo in our ears, namely that:

- with increased competition and the unbundling of utility services, the three drivers (as Joe Kearney so eloquently stated) are price, price, and price, both here and abroad;

- the overwhelming market for CCTs is India and China, but they, like other big coal burning countries, don't have environmental standards to justify CCTs as the least cost option; and

- senior policymakers of the US Government, like governments of other OECD countries, are not waking up in the morning thinking about how they can buy down incremental costs of CCT projects.

When we throw these assumptions into the pot, stir and turn up the flame, it all boils down to a few fundamental questions: Can we, working together, identify a handful of best-prospect CCT technologies whose costs, after the initial commercialization stages have been complete, are low enough to make these projects bankable? In other words, are a select group of technologies nearly competitive? Do some have good commercial prospects based on likely future markets and achievable economies of scale? And, if so, how can we provide sufficient incentives and rewards to attract alternative investors and lenders to the table?

The institutions sitting here today -- DOE, EXIM Bank, the World Bank, commercial lenders, and private industry -- represent a powerful set of resources. I believe that we can meet the challenges that lay ahead if only we work together to combine our most creative thinking into a unified US Government/private industry strategy. A good opportunity to come together is being provided by the World Bank, which announced that it was developing a Clean Coal Initiative. The US can play a leadership role in working with the Bank and others to identify superior technology options, to cost out those options in the long, as well as short term, to define the risks, and, to work with new risk-takers to formulate innovative financial products and strategies. On behalf of the Office of International Energy Policy, I have already spoken to Assistant Secretary Pat Godley about convening a series of roundtables discussions to define a strong and unified US public/private role in the Bank's initiative. Pat agreed the time was right, and we shall waste no time in working with the Office of Fossil Energy and the Bank to organize our first sessions.

Let's take a moment to examine the kinds of efforts that might be undertaken with partners like the World Bank. Ben Yamagata in his thoughtful keynote speech suggested that the Bank's Global Environmental Facility should do more to promote CCT projects. I agree with Ben, but fear that the GEF, with its focus on buying down the costs of renewable energy and energy efficiency projects, will, at best, finance only a few advanced coal combustion projects at the margins. But Ben is right in thinking that the Bank should do more, and this may well be the right time to put forward the idea of the Bank undertaking a new GEF-like program whose sole purpose is to commercialize a select group of superior CCT projects.

Who, then, will finance a GEF for CCTs? In today's world, the US and other donor countries are unlikely to set up a $5 billion fund to buy down the incremental costs of clean coal technologies (as they did for the GEF). But perhaps the US Government, recognizing the enormous sunk costs of programs like ours, would be willing to share the burden with other CCT interested governments, industry and private investors? For example, what if a combination of US Government and multilateral development bank guarantees could be used to mitigate certain risks associated with a CCT venture capital fund to attract private investors. The fund could take equity positions in newly established companies set up to commercialize superior technologies with long-term commercial prospects. Since the US Government has little or no interest in seeking a return on its investment in international CCT projects, the government's stake (i.e., the monetary value of its contribution in bringing the technology to its current level) could be offered as shares in one or more new CCT-based project development companies at an attractive price (i.e., sold below the value of its technology investment). With a little help from our friends at Treasury, investments in such a fund might be able to offer attractive tax incentives, such as those proposed by the Clean Coal Technology Coalition. If this idea has merit, we might want to devote a World Bank roundtable discussion to issues involving venture capital formation.

And what about those CCTs that are technically mature, such as low NO_x burners and coal preparation, but can still add costs that the project sponsor are reluctant to assume? The Nature Conservancy, funded by tax deductible private donations, has been buying up old growth forests to protect them from developers. Is it time for us to think of a new Conservancy that would use the private gifts of concerned citizens to purchase shares in clean projects or in a sustainable energy fund that would invest in projects?

Another idea, which is already being explored by the Office of International Policy, is to work with host governments to add an energy efficiency component to independent power project bids. Since "negawatts" are often cheaper than megawatts, a 200 MW conventional coal project bid could be lowered by offering, say, a 50 MW of efficiency component. Moreover, since energy efficiency can be achieved in a shorter time period, such a proposal could be given extra "points" for reducing peak demand quickly. What if one were to bid a CCT project along with an energy efficiency component? The marriage of CCT and energy efficiency, however odd it may seem at first, is yet another strategy that can help bring the total project cost of an independent power producer to a level where it can compete with conventional options. Governments might even give additional points for the double environmental benefit of bids that combine CCT and energy efficiency.

In conclusion, I believe that CCT projects can become an important part of tomorrow's energy solution. To succeed, however, we will have to work with many partners to develop innovative financing strategies, combine these strategies in imaginative ways, and market them to some old and many new stakeholders. The new stakeholders will require a lot of rigorous analysis of costs, technologies, and markets. But in the end, this kind of effort, however exhausting as it may sound, will be worth our time if it helps to put CCT projects on the ground, where they should be.

Thank you and I welcome your comments.

Let's take a moment to examine the kinds of efforts that might be undertaken with partners like the World Bank. Ben Yamagata in his thoughtful keynote speech suggested that the Bank's Global Environmental Facility should do more to promote CCT projects. I agree with Ben, but fear that the GEF, with its focus on buying down the costs of renewable energy and energy efficiency projects, will, at best, finance only a few advanced coal combustion projects at the margins. But Ben is right in thinking that the Bank should do more, and this may well be the right time to put forward the idea of the Bank undertaking a new GEF-like program whose sole purpose is to commercialize a select group of superior CCT projects.

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Thank you and I welcome your comments.

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FUTURE INTERNATIONAL EXPECTATIONS FOR CCT DEPLOYMENT

William J. Meagher
Partners in Economic Reform
1730 Rhode Island Avenue, N.W.
Suite 303
Washington, DC 20036
(202) 466-3840

Please contact author for a copy of this paper.

List of Attendees

CLEAN COAL TECHNOLOGY

List of Attendees

Fourth Annual
Clean Coal Technology Conference

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ACERRA, MIKE
Vice President
Foster Wheeler Energy Int'l Inc.
Perryville Corporate Park
Clinton, NJ 08809-4000
(908) 730-4965
FAX (908) 730-4910

ADAM, P.J. "JIM"
Chairman and CEO
Black & Veatch
P.O. Box 8405
8400 Ward Parkway
Kansas City, MO 64114
(913) 339-360
FAX (913) 339-3100

ADKINS, JANIS
Sr. Associate
Technology & Management Services
18757 N. Frederick Rd.
Gaithersburg, MD 20879
(301) 670-6390
FAX (301) 670-1942

AHN, Y.K.
Mgr., Advanced Engrg. Int'l.
Gilbert/Commonwealth Int'l. Inc.
P.O. Box 1498
Reading, PA 19603
(610) 775-2600

ALIASSO, JR., ROBERT
Division Manager
The Stebbins Engrg. & Manufacturing Co.
363 Eastern Blvd.
Watertown, NY 13601
(315) 782-3000
FAX (315) 782-0481

ALTIZER, BARBARA F.
Editor, Nat'l Coal Leader
VA Coal Council
P.O. Box 858
Richlands, VA 24641
(540) 963-2779
FAX (540) 964-6342

AMICK, PHIL
Mgr., Gasification Projects
DESTEC
P.O. Box 4411
Houston, TX 77210-4411
(713) 735-4178
FAX (713) 725-4837

ANDERSON, CHUCK
Mgr., Govt. Systems
Air Products & Chemicals, Inc.
7201 Hamilton Blvd.
Allentown, PA 18195
(610) 481-8635
FAX (610) 481-2576

ANDERSON, RODNEY
Program Manager
Morgantown Energy Technology Center
U.S. Department of Energy
Office of Inst. Develop.
P.O. Box 880
Morgantown, WV 26507-0880
(304) 285-4709
FAX (304) 285-4403

ANDERSON, PAM
Clean Coal Technology Coalition
1050 Thomas Jefferson St., NW
Suite 700
Washington, DC 20007
(202) 298-1800
FAX (202) 338-2416

ANNAN, BUD
Special Asst. to Secy. of Energy
U.S. Department of Energy
7B-222/FORS
1000 Independence Ave., SW
Washington, DC 20585
(202) 586-1400

ARCHER, DOUGLAS B.
U.S. Department of Energy
19901 Germantown Road
FE-221
Germantown, ND 20874-1290
(301) 903-9433
FAX (301) 903-9438

ASHLINE, PAUL M
Vice President-Business Development
Pure Air
7540 Windsor Drive
Allentown, PA 18195
(610) 481-5094
FAX (610) 481-2762

ATWOOD, THEODORE D.
Program Manager
U.S. Department of Energy
Office of Clean Coal Technology
FE-221, 270CC
19901 Germantown Road
Germantown, MD 20874-1290
(301) 903-9445
FAX (301) 903-9438

AYAN, KATHY
Project Development Mgr.
Duke Energy
400 S. Tryon St.
Suite 1800
Charlotte, NC 28285
(704) 382-2705
FAX (704) 382-4325

AYLOR, STEVE
Technology & Management Services
18757 N. Frederick Rd.
Gaithersburg, MD 20879
(301) 670-6390
FAX (301) 670-1942

BAJURA, RICHARD
Director
Nat'l. Research Ctr.
for Coal and Energy
Evansdale Drive
West Virginia University
Morgantown, WV 26506-6064
(304) 293-2867
FAX (304) 263-3749

BAJURA, RITA A.
Associate Director
Morgantown Energy Technology Center
U.S. Department of Energy
Office of Product Tech. Mgmt.
P.O. Box 880
Morgantown, WV 26507-0880
(304) 285-4109
FAX (304) 285-4292

BALDWIN, ARTHUR L.
Program Coordinator
Pittsburgh Energy Technology Center
U.S. Department of Energy
P.O. Box 10940, MS. 92OL
Pittsburgh, PA 15236
(412) 892-6011
FAX (412) 892-4775

BARRON, MIKE
President
T.J. Gundlach Machine Co.
One Freedom Drive
Belleville, IL
(618) 233-7208
FAX (314) 436-5221

BAYENS, C.A. (CHUCK)
President
Shell Synthetic Fuels Inc.
P.O. Box 2099
Houston, TX 77252
(713) 241-7423
FAX (713) 497-7749

BEALE, LATAUNJA R.
Associate Editor
Coal & Synfuels Technology
1616 N. Ft. Myer Drive
Arlington, VA 22209
(703) 816-8641
FAX (703) 528-4926

BECHTEL, THOMAS F.
Director
Morgantown Energy Technology Center
U.S. Department of Energy
P.O. Box 880
Morgantown, WV 26507-0880
(304) 285-4931
FAX (304) 285-4292

BELL, DENIS
General Manager
Pyropower Corporation
8925 Rehco Road
San Diego, CA 92121
(619) 458-3096
FAX (619) 452-6158

BELL, HENRY
Engineering Manager
The AES Corp.
1001 N. 19th Street
Arlington, VA 22209
(703) 522-1315
FAX (703) 528-4510

BELL, TERRI
Pyropower Corporation

BEVC, FRANK
Mgr., Emerging Technologies
Westinghouse Technologies
MS 205
4400 Alafaya Trail
Orlando, FL 32826

BHAGAT, BINDU
Process Engineer
AirPol Incorporated
32 Henry Street
Teterboro, NJ 07608
(201) 288-7070
FAX (201) 288-6441

BICKI, ZBIGNIEW
President
Polish Power Grid Company
Chair, CENTREL
, POLAND

BIDDLE, TONY
Vice President
Chase Manhattan Bank N.A.
1 Chase Plaza
New York, NY 10081
(212) 552-3956
FAX (212) 968-7485

BLACK, CHARLES
Vice President
Tampa Electric Company
P.O. Box 111
Tampa, FL 33601
(813) 228-1767
FAX (813) 228-4802

BLACK, JAMES B
Project Manager
NOXSO Corporation
2414 Lytle Road
Bethel Park, PA 15102
(412) 854-1200
FAX (412) 854-5729

BLASZCZYK, BERNARD
Vice Minister-Air Protection
Ministry of Environmental Protection,
Natural Resources and Forestry
POLAND

BOETTGER, KARL W.
Proposal Specialist
Babcock & Wilcox
1562 Beeson Street
Alliance, OH 44601
(216) 829-743
FAX (216) 829-7324

BOLLI, RITA
Marketing Manager
NOXSO Corporation
2414 Lytle Road
Bethel Park, PA 15102
(412) 854-1200
FAX (412) 854-5729

BOUMAN, ROBERT W.
Research Manager
Bethlehem Steel Corporation
Bethlehem, PA 18016
(610) 694-6792
FAX (610) 694-2981

BRDAR, DAN
Product Manager
Morgantown Energy Technology Center
U.S. Department of Energy
Office of Product Tech. Mgmt
P.O. Box 880
Morgantown, WV 26507-0880
(304) 285-4666
FAX (304) 285-4403

BRADY, ESQ., EDWARD J.
Asst. General Counsel
American Electric Power Service
1 Riverside Plaza
Columbus, OH 43215
(614) 223-1608
FAX (614) 223-1687

BRECHER, LEE E.
V.P., Engineering
Western Research Institute
365 North Ninth St.
Laramie, WY 82070
(307) 721-2244
FAX (307) 721-2345

BREEN, BEN
President
Energy Systems Associates
300 Gateway Two
Pittsburgh, PA 15222
(412) 392-2380
FAX (412) 392-2393

BROWN, WILLIAM R.
Mgr., Syngas Conversion Sys,
Air Products & Chemicals, Inc.
7201 Hamilton Blvd.
Allentown, PA 18195
(610) 481-7584
FAX (610) 481-5833

BUSH, STUART A.
Sr. Engr., Generation Div.
Tri-State G&T Assn., Inc.
P.O. Box 1149
Montrose, C0 81402
(970) 249-4501
FAX (970) 249-2585

CAIN, DAVID A.
Director Process Engineering
Kennecott Corporation
P.O. Box 11248
Salt Lake City, UT 84147
(801) 322-7322
FAX (801) 322-7225

CARPENTER, LARRY
Director
Morgantown Energy Technology Center
U.S. Department of Energy
Major Projects Division
P.0. Box 880
Morgantown, WV 26507-0880
(304) 285-4161
FAX (304) 285-4403

CHEETHAM, DEREK
Station Manager
West Burton Power Station
National Power PLC
Nr. Retford
Nottinghamshire
UNITED KINGDOM DN22 -9BL
44 1 427 88043
FAX 44 1 427 88034

CHEN, CHIH-LIEN
Sr. Research Engineer
Taiwan Power Company
84, Ta-An Rd. Shu-Lin
Taipei, Taiwan
REPUBLIC OF CHINA
02-681-5424
FAX 02-682-2793

CHERENSON, RUTH
Deputy Program Mgr., UPP
U.S. Energy Association
Washington, DC

CHILDRESS, JAMES M.
Gasification Technologies Council
1110 N. Globe Rd.
Suite 610
Arlington, VA 22201
(703) 276-0600

CORBETT, RON
Project Manager
Pittsburgh Energy Technology Center
US Dept. of Energy
P.O Box 10940, MS. 920L
Pittsburgh, PA 15236
(412) 892-6141
FAX (412) 892-4775

CRAIG, BILL
Bechtel
1015 15th Street, NW
Suite 700
Washington, DC 20005
(202) 828-5200
FAX(202) 785-2645

CRAWFORD, CLEGG
V.P., Engrg. & Operations Support
Public Service Co. of Colorado
1225 17th Street
Denver, CO 80202
(303) 294-8000
FAX (303) 294-8815

CREMER, GREGG A.
Venture Manager
Shell Synthetic Fuels, Inc.
P.O. Box 2099
Houston, TX 77252
(713) 241-2914
FAX (713) 241-2212

CRIKELAIR, DAVID C.
Vice President
Texaco, Inc.
2000 Westchester Avenue
White Plains, NY 10650
(914) 253-7692
FAX (914) 253-7744

CROUCH, EDITH
Mgr. Creative Services
Tampa Electric Company
P.O. Box 111
Tampa, FL 33601
(813) 228-4389
FAX (813) 228-4259

DAVIS, BOB
Sr. Staff Scientist
Radian Corporation
8503 MoPac Blvd.
Austin, TX
(512) 454-4797
FAX (512) 345-9684

DOANE, ELLIOTT
Kerr-McGee Coal Corporation
123 Robert S. Kerr
MT-2201
Oklahoma City, OK 73125
(405) 270-3736
FAX (405) 270-2967

DOYLE, JOHN
Sales Engineer
Babcock & Wilcox Company
7401 W. Mansfield Avenue, Suite 410
Lakewood, CO 80235
(303) 988-8203
FAX (303) 485-1842

DRAKE, CAROLYN
Director, Washington Office
Southern States Energy Board
P.O. Box 34606
Washington, DC 20043
(202) 667-7303
FAX (202) 667-7313

DRIVER, BRUCE
Special Counsel to the Energy Project,
Land and Water Fund of the Rockies
2260 Baseline Road, Suite 200
Boulder, CO 80302
(303) 417-1350
FAX (303) 417-1351

DYAL, STEPHEN D.
Govt. Liaison
Macfarlane, Ausley, Ferguson & McMullen
P.O. Box 391, 227 S. Calhoun St.
Tallahassee, FL 32302
(904) 224-9115
FAX (904) 222-7560

DeLALLO, MIKE
DOE Programs Manager
Gilbert/Commonwealth, Inc.
2675 Morgantown Rd.
Reading, PA 19607
(610) 885-2675
FAX (610) 885-2384

EBERT, BERNIE
Vice President
Shell Synthetic Fuels Inc.
P.O. Box 2099, Two Shell Plaza
Houston, TX 77252-2099
(713) 241-3152
FAX (713) 241-0842

ELLER, BARRY D.
Staff Research Engineer
Southern Company Services, Inc.
SCR Project, Gulf Power Crist Plant
P.O. Box 1151
Pensacola, FL 32520
(904) 478-5900
FAX (904) 444-6229

ENGELHARDT, DON
Project Manager
EERC
1345 N. Main, P.O. Box 153
Orrville, OH 44667
(216) 682-4007
FAX (216) 684-2110

ESKINAZI, DAVID
Sr. Washington Rep., Generation
Electric Power Research Institute
2000 L Street, NW, Suite 805
Washington, DC 20036
(202) 293-7515
FAX (202) 293-2697

EVANS, JACK
Assistant Treasurer
Air Products & Chemicals, Inc.
7201 Hamilton Blvd.
Allentown, PA 18195
(610) 481-8692
FAX (610) 481-8692

FEELEY, III, THOMAS J.
Project Manager
Pittsburgh Energy Technology Center
U.S. Department of Energy
P.O. Box 10940, MS. 922-316B
Pittsburgh, PA 15236
(412) 892-6134

FELDMANN, HERMAN
Project Engineer
Illinois Clean Coal Institute
P.O. Box 8
Carterville, IL 62918
(618) 985-3500
FAX (618) 985-6166

FERNALD, WILLIAM E.
U.S. Department of Energy
19901 Germantown Road
Germantown, MD 20874-1290
(301) 903-9448
FAX (301) 903-9438

FERRITER, JOHN P.
Deputy Executive Director
International Energy Agency
OECD, 2 rue Andre Pascal
75775 Paris, Cedex 16, FRANCE
45- 24-98-80
FAX 45-24-90-41

FOLSOM, BLAIR
Sr. V.P.
Energy and Environmental Research
18 Mason
Irvine, CA
(714) 859-8851
FAX (714) 859-3194

FRANK, NORMAN
Consultant
Ebara Corporation
717 Curtis Road
Greensburg, PA 15601-1613
(412)
FAX (412) 838-0279

FREDERICK, JAMES P.
Project Manager
ENCOAL Corporation
P.O. Box 3038
Gillette, WY 82717
(307) 686-5493
FAX (307) 682-7938

FRIEDMAN, MICHAEL A.
Senior Associate
Combustion Systems Inc.
1404 Kalmia Avenue
Boulder, CO 80304
(303) 440-9820
FAX (303) 440-9819

FUJINO, TETSUYA TERRY
Manager, SCR Systems
Mitsubishi Heavy Ind. America, Inc.
660 Newport Center Drive, Suite 1000
Newport Beach, CA 92660
(714) 640-5442
FAX (714) 640-6945

GAJERSKI, EDWARD
Managing Director
Energoprojekt
POLAND

GAYNOR, JOHN
Technical Manager
U.S. Gypsum
125 S. Franklin Street
Chicago, IL 60606
(312) 606-3735
FAX (312) 606-5516

GEILING, DONALD W.
Project Manager
Morgantown Energy Technology Center
U.S. Department of Energy
Major Projects Division
P.O. Box 880
Morgantown, WV 26507-0880
(304) 285-4784
FAX (304) 285-4403

GELLE, KEN
Executive Director
NRG Energy, Inc.
1221 Nicollet Mall
Minneapolis, MN 55403-2445
(612) 373-5304
FAX (612) 373-5430

GERSE, LAJOS
Deputy Head of Section
MVM Rt.
Development of Power Plants
HUNGARY

GIDEZ, CHRIS
Assistant for Vice President
Texaco Inc.
2000 Westchester Avenue
White Plains, NY 10650
(914) 253-6170
FAX (914) 253-7744

GILLING, JOSEPH
Sr. Energy Economist
World Bank
1818 H Street NW
Washington, DC 20433
(202) 473-3230
FAX (202) 477-0558

GODLEY, PATRICIA FRY
Asst. Secretary for Fossil Energy
U.S. Department of Energy
1000 Independence Ave., SW
Washington, DC 20585
(202) 586-6660
FAX (202) 586-5146

GOETZ, GARY
Director
ABB
1000 Prospect Hill Road
Windsor, CT 06095
(203) 285-2082
FAX (203) 285-2565

GOTTLIEB, PAUL
Asst. Gen. Counsel
U.S. Department of Energy
Tech. Transfer & Intellectual Property
6F-067, FORS
1000 Independence Ave., SW
Washington, DC 20585
(202) 586-3439

GRAHAME, THOMAS J.
Senior Policy Analyst
U.S. Department of Energy
Office of Coal Technology
FE-20, FORS
1000 Independence Ave., SW
Washington, DC 20585
(202) 586-7149
FAX (202) 586-7085

GREEN, STUART L.
Senior Engineer
BHP Minerals
300 W. Arrington
Suite 200
Farmington, NM 87401
(505) 325-4336
FAX (505) 325-3574

GREENE, VICTORIA
Director-Business Develop.
Custom Coals International
100 First Avenue
Suite 500
Pittsburgh, PA 15222
(412) 642-2625
FAX (412) 642-2643

GRISHAM, JOHN C.
President
Buckeye Industrial Mining Co.
P.O. Box 389
Lisbon, OH 44432
(216) 337-9511

HAHN, BRADLEY
Dir., Business Development
Air Products & Chemicals, Inc.
7201 Hamilton Boulevard
Allentown, PA 18195-1501
(610) 481-3955
FAX (610) 481-2393

HAJNY, AMOST
Head of Department
CEZ
Power Plant Pocerady
CZECH REPUBLIC

HAMILL, PHOEBE
Envir. Specialist
U.S. Department of Energy
FE-22
19901 Germantown Rd., 270/CC
Germantown, MD 20874
(301) 903-9439
FAX (301) 903-9438

HANGER, JOHN
Commissioner
Pennsylvania Public Utility Commission
P.O. Box 3265, Room 107
Harrisburg, PA 17105
(717) 787-1031
FAX (717) 787-5813

HARBISON, EDMUND J.
Manager of Development
Air Products & Chemicals, Inc.
7201 Hamilton Blvd.
Allentown, PA 18195
(610) 481-8528
FAX (610) 481-7298

HARNETT, WILLIAM
Deputy Director
Environmental Protection Agency
Air Quality Strategies & Standard Div.
OAQPS (MD-15)
Research Triangle Pk., NC 27711
(919) 541-4979
FAX (919) 541-0804

HARRISON, KENNETH E.
V.P. - Engineering
Custom Coals International
100 First Avenue, Suite 500
Pittsburgh, PA 15222
(412) 642-2625
FAX (412) 642-2643

HARRISON, CLARK D.
President
CQ Incorporated
One Quality Center
RR 2, Box 2113
Homer City, PA 15748
(412)
FAX (412) 479-4181

HAYASHI, SHIGEKI
E.V.P.
Sumitomo Heavy Ind. Inc.
65 E. 55th St., Suite 2302
New York, NY 10022
(212) 223-1863
FAX (212) 223-0399

HAYWOOD, RON
Director of Engrg.-IPG
Rolls-Royce IPG Adv. Engineering Ctr.
Shields Road
Newcastle upon Tyne
UNITED KINGDOM NE6 2YD
44 1912742900
FAX 44 192752909

HEBB, JERRY L.
Project Manager
Pittsburgh Energy Technology Center
U.S. Department of Energy
P.O. Box 10940, MS. 920-L
Pittsburgh, PA 15236
(412) 892-6079
FAX (412) 892-4775

HEITKAMP, THE HONORABLE HEIDI
Attorney General
State of North Dakota
600 East Blvd., First Floor
Bismarck, ND 58505
(701) 328-2210
FAX (701) 328-2226

HEYDORN, EDWARD C.
Develop. Mgr.
Air Products & Chemicals, Inc.
7201 Hamilton Blvd.
Allentown, PA 18195
(610) 481-7099
FAX (610) 481-5833

HINTON, SCOTT
SCR Project Manager
Southern Company Services, Inc.
SCR Project
Gulf Power Crist Plant
P.O. Box 1151
Pensacola, FL 32520
(904) 478-5900
FAX (904) 444-6229

HORTON, ROBERT S.
Sr. Staff Engineer
Texaco, Inc.
Alternate Energy Dept.
2000 West Chester Ave.
White Plains, NY 10650
(914)
FAX (914) 253-7744

HUNT, TERRY
Professional Engineer
Public Service Co. of Colorado
5900 East 39th Avenue
Denver, CO 80207
(303) 329-1113
FAX (303) 329-1003

HURA, HARJIT S.
Sr. Project Engineer
Energy Systems Associates
300 Gateway Two
Pittsburgh, PA 15222
(412) 392-2375
FAX (412) 392-2393

HYLAND, MICHAEL J.
Vice President
Snamprogetti USA Inc.
2950 North Loop West
Houston, TX 77092
(713) 956-5300
FAX (713) 956-8153

HYLAND, PATRICIA
2950 North Loop West
Houston, TX 77092
(713) 956-5300
FAX (713) 956-8153

IDEMURA, HIDEO
Executive Advisor
Chiyoda Corporation
12-1 Tsurumichuo
2-chome
Tsurumi-ku Yokohama, JAPAN 236
81-4-521-223
FAX 81-45-506-720

IRBY, SHELLY
UPP Program Coordinator
U.S. Energy Association
Washington, DC

JACKSON, CHRISTOPHER E.
Gilbert/Commonwealth, Inc.
P.O. Box 1498
Reading, PA 19603
(215) 775-2600
FAX (215) 775-0608

JARABAK, ANDREW J.
Manager, Program Development
Westinghouse Electric Corp.
1310 Beulah Road
501-3B28
Pittsburgh, PA 15235
(412) 256-2881
FAX (412) 256-1948

JECHOUTECK, KARL
Chief
The World Bank
Power Development, Efficiency and Household
Fuels Division Industry and Energy Dept.
Washington, DC 20433
(202) 458-2872
FAX (202) 477-0542

JEWELL, DOUG
Project Manager
Morgantown Energy Technology Center
U.S. Department of Energy
Major Projects Division
P.O. Box 880
Morgantown, WV 26507-0880
(304) 285-4720
FAX (304) 285-4403

JHA, MAHESH C.
President
Entech Global, Inc.
5950 McIntyre Street
Golden, CO
(303) 273-7284
FAX (303) 274-7204

JOHNSEN, KEN
V.P. & Secy. & Gen. Counsel
Geneva Steel
P.O. Box 2500
Provo, UT 84603
(801) 227-9321
FAX (801) 227-9141

JOHNSON, ROY
V.P., Business Development
NALCO FUEL TECH
1001 Frontenac Road
Naperville, IL 60563
(708) 983-3242
FAX (708) 983-3240

JONES, MICHAEL
Associate Director
Energy & Environmental Res. Ctr.
P.O. Box 9018
Grand Forks, ND 58202
(701) 777-5130
FAX (701) 777-5181

JORNLIN, LEN
International Programs
IMS, Ltd./NREL
7566 E. Warren Drive
#16-308
Denver, CO 80231
(303) 751-6160
FAX (303) 751-7616

JOSEPH, LARRY M.
Director
U.S. Department of Energy
Office of Clean Coal Technology
Washington, DC 20585
(301) 903-9450
FAX (301) 903-9438

JOYCE, ROBERT
President
Ahlstrom Development Corp.
8925 Rehco Road
San Diego, CA 92121
(619) 458-3124
FAX (619) 457-0855

JOYCE, JR., EDWARD L.
Program Manager
Los Alamos Nat'l. Lab.
Energy Technologies, MS D453
Los Alamos, NM 87545
(505) 665-6799
FAX (505) 665-2864

KATO, MUTSUO
Sr. Staff
Center for Coal Util. Japan
Technical Development Dept.
Idemitsu-Shinjuku Bldg.
2-3-4 Ohkubo, Shinjuku-Ku
Tokyo, JAPAN 169
03-5 273-3763
FAX 03-5 273-3874

KEARNEY, JOSEPH
President and CEO
U.S. Generating Company
7500 Old Georgetown Road, Ste. 1300
Bethesda, MD 20814-6161
(301)
FAX (301) 718-6910

KEEPERS, WILLIAM L.
President/CE0
KFx Inc.
1999 Broadway, #2505
Denver, C0 80202
(303) 293-2992
FAX (303) 293-8430

KELLEHER, FRANK A.
Vice President
Foster Wheeler Corporation
1701 Pennsylvania Ave., NW, Ste 460
Washington, DC 20006
(202) 298-7750
FAX (202) 342-0597

KELLER, J.B.
Engineer
Harris Group
Box 24038
Denver, C0 80222
(303) 320-0425
FAX (303) 320-0481

KERN, DOLORES
Asst.V.P. for Research, Development
National Coal Association
1130 17th Street, NW
Washington, DC 20036
(202) 463-2625

KIEFFER, RICHARD
Engr., Applications, Dev.
Prakter Surface Tech. Inc.
P.O. Box 1705
Stow, OH 44224
(216) 688-1989
FAX (216) 688-3440

KINDL, VACLAV
Director of Section
CEZ
CZECH REPUBLIC

KINSINGER, DAVID L.
Licensing Specialist
Phillips Petroleum Company
261 Patent Library Bldg.
Bartlesville, OK 74004
(918) 661-1244
FAX t918) 662-2007

KLOSEK, JOSEPH
Senior Technology Manager
Air Products & Chemicals, Inc.
7201 Hamilton Blvd.
Allentown, PA 18195
(610) 481-7871
FAX (610) 481-2247

KMET, ERVIN
Director-Heat Plant
Handlova, SE a.s.
SLOVAKIA

KORNOSKY, BOB M.
Project Manager
Pittsburgh Energy Technology Center
U.S. Department of Energy
P.O. Box 10490, MS. 92OL
Pittsburgh, PA 15236
(412) 892-4521
FAX (412) 892-4775

KRAL, STEVE
Mining Engineering Magazine
P.0. Box 625002
Littleton, C0 80162
(303) 975-9550
FAX (303) 973-3845

KRENK, JAN
Member of the Board
CEZ
CZECH REPUBLIC

LAND, GALYN
Project Manager
R.W. Beck
1125 17th Street, Suite 1900
Denver, C0 80202
(303) 299-5268
FAX (303) 297-2811

LANGER, KEN
Advisor
Coleman Research Corporation
Project Dev. and Finance, Int'l .Policy Office
950 L'Enfant Plaza Ctr. SW
Washington, DC 20024
(202) 863-2443
FAX (202) 863-9259

LAWSON, WILLIAM F.
Director, Tech. Base Program
Morgantown Energy Technology Center
U.S. Department of Energy
P.O. Box 880
Morgantown, WV 26507-0880
(304) 285-4173
FAX (304) 285-4403

LAWSON, GENERAL RICHARD
President
National Coal Association
1130 17th Street, NW
Washington, DC 20036

LEE, BERNARD S.
President
Institute of Gas Technology
1700 South Mt. Prospect Rd.
Des Plaines, IL 60018-1804
(708) 768-0504
FAX (708) 768-0802

LEISTER, PAT
Public Affairs Specialist
Pittsburgh Energy Technology Center
U.S. Department of Energy
P.O. Box 10940, MS. 922-M207
Pittsburgh, PA 15236
(412) 892-6126
FAX (412) 892-6127

LERCH, JEAN L.
Program Analyst
U.S. Department of Energy
FE-22, 4G-052
1000 Independence Ave., SW
Washington, DC 20585
(202) 586-7320
FAX (202) 586-8488

LEYSE, ROBERT
Sales
NVS
Idaho Falls, ID
(408) 257-6649

LIGHT, MAX E.
General Manager
CanadEER Ltd.
58-1271 Denison Street,
Markham, Ontario
CANADA L3R 4B5
(905) 946-1732
FAX (905) 946-8680

LOSEN MICHAEL
Strategic Dept.
VA Technologie AG
Lunzerstr. 64
Linz, AUSTRIA A-403-1
43-70 688 64001

LUCZKIEWICZ, ROMAN
Adviser to the Minister
Ministry Of Industry and Trade
POLAND

LUKASIK, MIKE
Mgr., Contracts-Proposals
Babcock & Wilcox
1562 Beeson Street
Alliance, OH 44641
(216) 829-7577
FAX (216) 829-7801

LYNCH, RICHARD W.
Assoc. Dir., Int'l. Program Coord.
U.S. Department of Energy
FE-20, 270-CC
19901 Germantown Road
Germantown, MD 20874-1290
(301) 903-2643
FAX (301) 903-1591

LYNCH, GEORGE
U.S. Department of Energy
FE-22I, 3091/270
19901 Germantown Road
Germantown, MD 20874-1290

MALI, EDWARD J.
Project Manager
Babcock & Wilcox
20 S. Van Buren Ave., P.O. Box 351
Barberton, OH 44203
(216) 860-1628
FAX (216) 860-1909

MANAVI, GHASSEM B.
Lead Engineer
Pure Air
7540 Windsor Drive
Allentown, PA 18195
(610) 481-6268
FAX (610) 481-6288

MARCHANT, SHARON K.
Business Devel. Mgr.
Pittsburgh Energy Technology Center
U.S. Department of Energy
P.O. Box 10940, MS. 920L
Pittsburgh, PA 15236
(412) 892-6008
FAX (412) 892-4775

MARKEL, KENNETH E.
Associate Director
Morgantown Energy Technology Center
U.S. Department of Energy
Office of Project Mgmt.
P.O. Box 880
Morgantown, WV 26507-0880
(304) 285-4364
FAX (304) 385-4403

MARKOWSKY, JIM
Executive VP/Engrg. & Construction
American Electric Power Service
1 Riverside Plaza
Columbus, OH 43215
(614) 223-1200
FAX (614) 223-1207

MARKUSSEN, JOANNA
Project Manager
Pittsburgh Energy Technology Center
U.S. Department of Energy
P.O. Box 10940, MS. 84-340
Pittsburgh, PA 15236
(412) 892-5734
FAX (412) 892-4775

MARROCCO, MARIO
Manager-PFBC Technology
American Electric Power
1 Riverside Plaza, 24th Fl.
Columbus, OH 43215
(614) 223-2460
FAX (614) 223-2466

MARTINELLI, BOB
Proposal Manager
Babcock & Wilcox
20 S. Van Buren Avenue
Barberton, OH 44230
(216) 860-6337
FAX (216) 860-2045

MASE, SHUHEI
Gen. Mgr., Tech. Dev. Div.
Mitsui Mining Co., Ltd.
2-1-1 Nihonbashi-Muromachi
Chuoku
Tokyo, JAPAN 103
81-3-3241-179
FAX 81-3-3241-868

MAZER, MARSHALL
Manager, Marketing Development
Babcock & Wilcox/McDermott
1525 Wilson Blvd., Suite 100
Arlington, VA 22209
(703) 351-6313
FAX (703) 351-6418

MEAGHER, WILLIAM J.
Executive Director
Partners in Economic Reform
1730 Rhode Island Ave., NW, Ste 303
Washington, DC 20036
(202) 466-3840
FAX (202) 463-7473

MENEZES, EDUARDO
Marketing Manager
Praxair, Inc.
175 East Park Drive
Tonawanda, NY 14151-0044
(716) 879-7369
FAX (716) 879-4033

MILLER, C. LOWELL
Associate Deputy Assistant Secretary
U.S. Department of Energy
Office of Clean Coal Technology
FE-22, 270 Corp.
Washington, DC 20585
(301) 903-9451
FAX (301) 903-9438

MILLER, STEVE
President
CEED
1800 Diagonal Rd., Suite 370
Alexandria, VA 22314
(703) 684-6292
FAX (703) 684-6297

MOORE, NANCY
Western Correspondent
Inside Energy
P.O. Box 6880
Denver, CO 80206
(303) 777-5760
FAX (303) 777-5750

MOORE, JOHN S.
Chief,
Illinois Off. of Coal Development
Dept. of Commerce & Community Affairs
325 W. Adams, Room 300
Springfield, IL 62704
(217) 782-6370
FAX (217) 524-4177

MOTTER, JACK
Director of Technology Mgmt.
Sierra Pacific Power Co.
6100 Neil Road
Reno, NV 89520-0400
(702)
FAX (702) 689-3047

MUDD, MICHAEL J.
Principal Engineer
American Electric Power
1 Riverside Plaza, 24th Fl.
Columbus, OH 43215
(614) 223-1585
FAX (614) 223-2466

MUZIO, LARRY
Vice President
Fossil Energy Research Corp.
23342 C South Pointe
Laguna Hills, CA 92653
(714) 859-4466
FAX (714) 859-7916

McDONALD, DENNIS
Mgr., New Product Engineering
Babcock & Wilcox
20 S. Van Buren Avenue
Barberton, OH 44203
(216) 860-6175
FAX (216) 860-2348

McKEE, BARBARA N.
Dir., Int'l Program Coordination
U.S. Department of Energy
FE-20, 270-CC
19901 Germantown Rd.
Germantown, MD 20874-1290
(301) 903-4497
FAX (301) 903-1591

McKEOUGH, WILLIAM C.
Dir., Power Gen. Alloys
Rolled Alloys
125 W. Sterns Road
Temperance, MI 48182
(313) 847-0561
FAX (313) 847-0270

McMAHAN, RONALD
President
Resource Data International, Inc.
1320 Pearl Street
Suite 300
Boulder, CO 80302
(303) 444-7788
FAX (303) 444-1286

McNEIL, CHARLES S.
President
McNeil & Co./Puron Corp.
2120 Hollowbrook Drive, Ste 102
Colorado Springs, CO 80918
(719) 593-0211
FAX (719) 593-1765

McVICKAR, MIKE
Engineer
Fossil Energy Research Corp.
23342 C South Pointe
Laguna Hills, CA 92653
(714) 859-4466
FAX (714) 859-7916

NAGY, LISA
Secretary
Pittsburgh Energy Technology Center
U.S. Department of Energy
P.O. Box 10940, MS. 920L
Pittsburgh, PA 15236
(412) 892-6140
FAX (412) 892-4775

NAGY, GEORGE
Head of Department
MVM Rt.
HUNGARY

NAKAISHI, CURTIS
Product Manager
Morgantown Energy Technology Center
U.S. Department of Energy
Office of Product Tech. Mgmt.
P.O. Box 880
Morgantown, WV 26507-0880
(304) 285-4275
FAX (304) 285-4403

NEAL, JOHN C
NOXSO Corporation
2414 Lytle Road
Bethel Park, PA 15102
(412) 854-1200
FAX (412) 854-5729

NEAL, L.G.
President
NOXSO Corporation
2414 Lytle Road
Bethel Park, PA 15102
(412) 854-1200
FAX (412) 854-5729

NELKIN, GARY
Project Manager
Morgantown Energy Technology Center
U.S. Department of Energy
Major Projects Division
P.O. Box 880
Morgantown, WV 26507-0880
(304) 285-4216
FAX (304) 285-4403

NICHOLAS, ERIN
Clean Coal Technology Coalition
1050 Thomas Jefferson St., NW, Ste 700
Washington, DC 20007
(202) 298-1800
FAX (202) 338-2416

NICKELL, ROBERT
ENCOAL
P.O. Box 3038
Gillette, WY 82717
(307) 686-5425
FAX (307) 682-7938

NOWICKI, MACIEJ
President
The EcoFund
POLAND

O'CONNOR, CRAIG
Environmental Liaison Officer
Export-Import Bank
International Business Dev. Grp.
811 Vermont Ave., NW
Washington, DC 20571
(202) 565-3939
FAX (202) 565-3932

O'CONNOR, BARBARA
Marketing Analyst
Norton Company
1 New Bond Street
MIS: 506-301
Worcester, MA 01615
(508) 795-5946
FAX (508) 795-5011

O'NEIL, BRIAN
Contract Manager
Air Products & Chemicals, Inc.
7201 Hamilton Blvd.
Allentown, PA 18195
(610) 481-5683
FAX (610) 481-2576

OFFEN, GEORGE R.
Team Manager
Electric Power Research Institute
Air Emissions & Air Toxics
3412 Hillview Ave., P.O. Box 10412
Palo Alto, CA 94303
(415) 855-8942
FAX (415) 855-2002

OLIVER, JERRY J.
Vice President and Manager
Bechtel Corporation
3000 Post Oak Blvd.
Houston, TX 77056
(713) 235-5956
FAX (713) 235-3037

OLKHOVSKY, GURGEN G.
Director
All Russia Thermal Engrg. Inst.
14/23 Avtezavodekayr Sir.
Moscow, RUSSIA
7-095-2753483
FAX 7-095-2751123

OSTERSTOCK, EARL R.
Mgr., Commercial Development
Air Products & Chemicals, Inc.
7201 Hamilton Blvd.
Allentown, PA 18195
(610) 481-5574
FAX (610) 481-2247

OWCZARSKI, BILL
Manager
McDermott/Babcock & Wilcox
Contract Res. Div., Wash. Office
1525 Wilson Blvd., Suite 100
Arlington, VA 22209
(703) 351-6314
FAX (703) 351-6418

OWCZARSKI, CONNIE
1525 Wilson Blvd.
Suite 100
Arlington, VA 22209
(703) 351-6314
FAX (703) 351-6418

PALMER, FRED
General Manager and CEO
Western Fuels Association
1625 M Street, NW
Washington, DC 20036
(202) 463-6580
FAX (202) 223-8790

PARKS, DIANNE
Program Coordinator
CEED
7853 East Arapahoe Ct., #2600
Englewood, CO 80112
(303) 694-4244
FAX (303) 694-4299

PAVNOTESCU, OCTAVIAN
Director for Engrg.
RENEL
Bd. Magheru 35
Bucharest, ROMANIA 70164
4-01 613.73.3
FAX 4-01 312.02.9

PEARL, IRA
Radian Corporation
1979 Lakeside Pkwy., Ste. 800
Tucker, GA 30084
(770) 414-4522
FAX (770) 414-1491

PENDERGRASS, MARSHALL L.
Asst. Gen. Mgr.
Tri-State Gen. & Transmission Assoc.
Generation and Transmission
1845 South Townsend Ave., P.O. Box 1149
Montrose, CO 81402
(970) 249-4501
FAX (970) 249-7710

PHILO, GARY
IL. Office of Coal Development
Dept. of Commerce & Community Affairs
325 W. Adams, Room 300
Springfield, IL 62704
(217) 782-6370
FAX (217) 524-4177

PLESS, DONALD E.
Dir./Project Mgr.
Teco Power Services
Advance Technology
P.O. Box 111
Tampa, FL 33601
(813) 228-1332
FAX (813) 228-4802

POPCZYK, JAN
Former President
Polish Power Grid Company
Chair, CENTREL
POLAND

RAO, KAM
Project Manager
Cooper - Bessemer
150 Lincoln Avenue
Grove City, PA 16127
(412) 458-3550
FAX (412) 458-3652

RAPPOLD, TOM
Asst. V.P.-International Coal
Norfolk Southern Corporation
110 Franklin Road
Roanoke, VA 24042-0026
(540) 985-6707
FAX (540) 985-6398

RASMUSSEN, JILL
Consultant
Jill J. Rasmussen, Inc.
P.O. Box 121
Leesburg, VA 22075
(703) 777-2899
FAX (703) 777-1141

RATH, LAWRENCE K.
Director
Morgantown Energy Technology Center
U.S. Department of Energy
P.O. Box 880
Morgantown, WV 26505-0880
(304) 285-4094
FAX (304) 285-4403

REKOS, NELSON
Project Manager
Morgantown Energy Technology Center
U.S. Department of Energy
Major Projects Division
P.O. Box 880
Morgantown, WV 26507-0880
(304) 285-4066
FAX (3 04~285-4403

RENK, JOSEPH
Project Manager
Pittsburgh Energy Technology Center
U.S. Department of Energy
P.O. Box 10940, MS. 920L
Pittsburgh, PA 15236
(412) 892-6249
FAX (412) 892-4775

REUTHER, ROBERT B.
Product Manager
Morgantown Energy Technology Center
U.S. Department of Energy
Office of Product Tech. Mgmt.
P.O. Box 880
Morgantown, WV 26507-0880
(304) 285-4578
FAX (304) 285-4403

RHEE, KEE H.
Senior Scientist
Pittsburgh Energy Technology Center
U.S. Department of Energy
P.O. Box 10940, MS. 58-M217
Pittsburgh, PA 15236
(412) 892-5913
FAX (412) 892-4152

RICCI, LODOVICO
Liaison Engineer
ENEL
405 Lexington Avenue
New York, NY 10174
(212) 599-3060
FAX (212) 557-5369

RITZ, HARRY
Project Manager
Pittsburgh Energy Technology Center
U.S. Department of Energy
P.O. Box 10940, MS. 920L
Pittsburgh, PA 15236
(412) 892-6137
FAX (412) 892-4775

RO, TAE S.
President
UC Trading Company
1317 Black Friar Lane
216) 270-9559
FAX (216) 270-1660

RODEBAUGH, PAUL
Supervising Engineer
Florida Power & Light Company
P.O. Box 14000
Juno Beach, FL 33408-0420
(407) 691-2620
FAX (407) 691-2695

ROSENDAHL, STEVE
Sr. Project Mgr.
Stone & Webster
7677 East Berry Avenue
Englewood, CO 80111-2137
(303) 741-7273
FAX (303) 741-7670

ROSS, TERRY
V.P., West Region
CEED
7853 East Arapahoe Ct., #2600
Englewood, CO 80112
(303) 694-4244
FAX (303) 694-4299

ROY, CHUCK J.
Financial Systems Officer
U.S. Department of Energy
1000 Independence Avenue, SW
Washington, DC 20585
(202) 586-8977
FAX (202) 586-0734

RUETHER, John A.
Division Director
Pittsburgh Energy Technology Center
U.S. Department of Energy
P.O. Box 10940, MS. 920L
Pittsburgh, PA 15236
(412) 892-4832
FAX (412) 892-4775

SAKANASHI, YOSHIHIKO
Chief Representative
Electric Power Develop. Co.
1825 K Street, Ste. 1205
Washington, DC 20006
(202) 429-0670
FAX (202) 429-1660

SALVADOR, LOUIS A.
Deputy Director
Morgantown Energy Technology Center
U.S. Department of Energy
P.O. Box 880
Morgantown, WV 26507-0880
(304) 285-4147
FAX (304) 285-4403

SARAN, MEHER
Business Devel. Mgr.
Ahlstrom Development Co.
8925 Remco Road
San Diego, CA
(619) 458-3000
FAX (619) 457-0855

SARKUS, TOM
Division Director
Pittsburgh Energy Technology Center
U.S. Department of Energy
P.O. Box 10940, MS. 920L
Pittsburgh, PA 15236
(412) 892-5981
FAX (412) 892-4775

SAROFF, LAWRENCE
Program Manager
US Department of Energy
Office of Clean Coal Technology
19901 Germantown Rd., FE-221
Germantown, MD 20874-1290
(301) 903-9483
FAX (301) 903-9438

SCHAAL, MIKE
Energy Economist
Argonne National Laboratory
955 L'Enfant Plaza North, SW, Ste. 6000
Washington, DC
(202) 488-2403
FAX (202) 488-2413

SCHAUB, ELIZABETH
Engineer
Air Products & Chemicals, Inc.
7201 Hamilton Blvd.
Allentown, PA 18195
(610) 481-6947
FAX (610) 481-2177

SCHEHL, RICHARD
Director, Ind. Liquefaction
Pittsburgh Energy Technology Center
U.S. Department of Energy
P.O. Box 10940
Pittsburgh, PA 15236
(412) 892-5786

SCHEIBEL, JOHN
Business Unit Manager
Electric Power Research Institute
Gas and New Coal Generation
3412 Hillview Avenue
Palo Alto, CA 94303-1395
(415) 855-2850
FAX (415) 855-2954

SCHMALZER, DAVID K.
Manager, Fossil Energy Program
Argonne National Laboratory
9700 S. Cass Avenue
Argonne, IL 60439-4832
(708) 252-7264
FAX (708) 252-4546

SCHREURS, HARRY C.E.
Novem B.V.
P.O. Box 17
6130 Aa Sittard, THE NETHERLANDS
31-46-595314
FAX 31-46-528260

SCIAZKO, MAREK
Inst. for Chemical Processing of Coal
1 Zamkowa Str.
Zabrze, POLAND 41-80-3
48 03 1715152
FAX 48 03 1710809

SHARMAN, PHILIP W.
Programme Mgr., Coal R&D
UK Dept. of Trade & Industry
ETSU, B156, Harwell
Didcot
Oxfordshire, UNITED KINGDOM OX11
4412 35432669
FAX 4412 354322753

SHELDON, RAY
Director of Engineering
Rosebud SynCoal Partnership
P.O. Box 7137
490 North 31st Street
Billings, MT 59103
(406) 252-2277
FAX (406) 252-2090

SIMMONS, THOMAS N
Vice President - Administration
CEED
1800 Diagonal Rd., Ste. 370
Alexandria, VA 22314
(703) 684-6292
FAX (703) 684-6297

SINOR, JERRY
The Clean Fuels Report
P.O. Box 649
Niwot, CO 80544
(303) 652-2632
FAX (303) 652-2772

SKINKER, MICHAEL
Attorney
U.S. Department of Energy
2H-027/FORS
1000 Independence Ave., SW
Washington, DC 20585
(202) 586-6667
FAX (202) 586-0971

SKULEC, JAROMIR
Head-Tech. Racionalisation Dept.
SE a.s.
SLOVAKIA

SMIGELSKI, JOHN
Principal Engineer
NYSEG
Kirkwood Industrial Park
P.O. Box 5224
Binghamton, NY 13902
(607) 762-8688
FAX (607) 762-7770

SMITH, RANDY
Engineer
Fossil Energy Research Corp.
23342 C South Pointe
Laguna Hills, CA 92653
(714) 859-4466
FAX (714) 859-7916

SMOUSE, SCOTT M.
Project Develop. Mgr.
Pittsburgh Energy Technology Center
U.S. Department of Energy
P.O. Box 10940, MS. 920L
Pittsburgh, PA 15236
(412) 892-5725
FAX (412) 892-4775

SOMMER, TODD M
V.P., Engrg. Services
EERC
1345 N. Main
P.O. Box 153
Orrville, OH 44667
(216) 682-4007
FAX (216) 684-2110

SORELL, JERRY
Consultant
Nickel Development Institute
49 Brookside Terrace
N. Caldwell, NJ 07006
(201) 228-0491
FAX (201) 228-0491

STEIN, VAN ERIC
Engineer
Air Products & Chemicals, Inc.
7201 Hamilton Blvd.
Allentown, PA 18195
(610) 481-6947
FAX (610) 481-2177

STEPTOE, JACQUELINE
Asst. to Coal Prog. Mgr.
UK Dept. of Trade & Industry
ETSU Building\156 Harwell
Didcot
Oxfordshire, UNITED KINGDOM OX11
4412 35432071
FAX 4412 35432753

STODDARD, LARRY E.
Mgr., Advanced Technology
Black & Veatch
11401 Lamar
Overland Park, KS 66211
(913) 339-7225
FAX (913) 339-2934

STULTZ, STEVE
Manager, Communications Projects
Babcock & Wilcox
20 S. Van Buren Avenue
Barberton, OH 44203
(216) 860-6124
FAX (216) 860-1886

STYF, DAVID
Envir. & Chem. Compliance Specialist
Northern Indiana Public Service Co.
246 Bailly Station Road
Chesterton IN 46304
(219) 787-7302
FAX (219) 787-7357

SZABO, SANDOR
Expert Thermal Mechnical Engr.
NVM Rt.
HUNGARY

TATE, ROBERT
Electrical Engrg. Mgr.
Krupp Wilputte Corporation
1370 Washington Pike
Bridgeville, PA 15017
(412) 257-8277
FAX (412~257-8344

TAVOULAREAS, STRATOS
Director
EnTEC
7722 Desdemona Ct.
McLean, VA 22102
(703) 506-0422
FAX (703) 506-0422

THOMPSON, JAMES HAROLD
Attorney
Macfarlane, Ausley, Ferguson & McMullen
P.O Box 391
227 S. Calhoun Street
Tallahassee, FL 32302
(904) 224-9115
FAX (904) 222-7560

THOMPSON, WENDY
Communications Director
CEED
1800 Diagonal Rd., Ste. 370
Alexandria, VA 22314
(703) 684-6292
FAX (703) 684-6297

TOMER, BRAD
General Engineer
Morgantown Energy Technology Center
U.S. Department of Energy
P.O. Box 880
Morgantown, WV 26507-0880
(304) 285-4692
FAX (304) 285-4292

TOMKOWSKA, IWONA
Energoprojekt
Head of Envir. Protection Dept.
POLAND

TRIGER, STACY RAY
Asst. to The President
CEED
1800 Diagonal Rd., Ste. 370
Alexandria, VA 22314
(703) 684-6292
FAX (703) 684-6297

TUCKER, BIL
Commissioner
Wyoming Public Service Commission
700 West 21st Street
Cheyenne, WY 82002
(307) 777-7427
FAX (307) 777-5700

TUSIC, VACLAV
Head of Department
Power Plant Chvaletics
CZECH REPUBLIC

UBHAYAKAR, SHIVA K.
Program Manager
TRW Space & Technology Division
One Space Park, MS 01/1081
Redondo Beach, CA 90278
(310) 813-9296
FAX (310) 814-5288

UNDERWOOD, KIM
Illinois Clean Coal Institute
Box 7295
Springfield, IL 62707
(217) 698-3049
FAX (217) 546-9707

VAILLANCOURT, MAUREEN
MJV Management Resources
P.O. Box 826
Sheridan, WY 82801
(307) 672-2934
FAX (307) 672-9318

VAILLANCOURT, JOE
President
MJV Management Resources
P.O. Box 826
Sheridan, WY 82801
(307) 672-2934
FAX (307) 672-9318

VAN EGTEREN, MARIANNE
Consultant
Transcanada Pipelines
111 5th Avenue, SW
P.O. Box 1000, Stn M
Calgary AB T2P 4K5
CANADA
(403) 267-8844

VINCENT, GREGORY
V.P., Fuel Supply & Engrg.
Tennessee Valley Authority
1101 Market Street, Mail Code LP3K
Chattanooga, TN 37402
(615) 751-4641
FAX (615) 751-6376

VYMAZAL, DON C.
Mgr., Contract & Govt. Admin.
Pure Air
7540 Windsor Drive
Allentown, PA 18195
(610) 481-3687
FAX (610) 481-2762

WEBB, RODNEY M.
Senior Vice President
Destec Energy, Incorporated
2500 Citywest Blvd., Ste. 150
Houston, TX 77042
(713) 735-4229
FAX (713) 735-4059

WEISENFELD, HARVEY
Vice President
Energetics Inc.
7164 Gateway Drive
Columbia, MD 21046
(410) 290-0390
FAX (410) 290-0377

WELLS, ROBERT H.
Mgr.-Coal Procurement Planning
American Electric Power Service Corp.
Fuel Supply Department
One Memorial Drive
Lancaster, OH 43130-0700
(614) 687-3062
FAX (614) 687-3295

WENDAHL, TOM
Project Dev. Manager
Air Products and Chemicals, Inc.
7201 Hamilton Boulevard
Allentown, PA 18195
(610) 481-7025
FAX (610) 481-5444

WESTMAN ROBERT
President
Westman Associates/DVAI
359F Quarry Lane
Warren, OH 44483
(216) 856-4149
FAX (216) 856-2564

WHITE, JOHN
Applications Engineer
Spraying System's Company
North Ave. at Schmale Rd.
Wheaton, IL 60189
(708) 665-5201

WILLIAMS, MARK C.
Product Manager
Morgantown Energy Technology Center
U.S. Department of Energy
Office of Product Tech. Mgmt.
P.O. Box 880
Morgantown, WV 26507-0880
(304) 285-4747
FAX (304) 285-4403

WILLS, JOHN
Director of Business Dev.
Rolls Royce Inc.
11911 Freedom Drive
Reston, VA 22090
(703) 318-9008
FAX (703) 318-9009

WILSON, ROBERT P.
V.P. Technology Development
Arthur D. Little, Inc.
20 Acorn Park
Cambridge, MA 02140
(617) 498-5806
FAX (617) 498-7206

WINTRELL, REG
Chief Engr. Coke, Iron & Steel
Geneva Steel
P.O. Box 2500
Provo, UT 84603
(801) 227-9214
FAX (801) 227-9141

WOLFE, HATTIE C.
Technical Editor
U.S. Department of Energy
Office of Communications, FE-5
Washington, DC 20585
(202) 586-6503
FAX (202) 586-5146

WOLK, RONALD H.
Principal
Wolk Integrated Tech. Services
1056 Hyde Avenue
San Jose, CA 95129
(408) 996-7811
FAX (408) 996-2746

WOLK, EILEEN
Wolk Integrated Tech. Services
1056 Hyde Avenue
San Jose, CA 95129
(408) 996-7811
FAX (408) 996-2746

WOODRUFF, MICHAEL R.
Gasification Business Mgr.
Destec Energy, Incorporated
2500 Citywest Blvd., Ste. 150
Houston, TX 77042
(713) 735-4159
FAX (713) 735-4059

WOODWARD, DONALD W.
Lead Engineer
Air Products & Chemicals, Inc.
7201 Hamilton Blvd.
Allentown, PA 18195
(610) 481-7479
FAX (610) 481-2247

WROBEL, BETH A
Principal, Corporate R&D
NIPSCO
5265 Hohman Avenue
Hammond, IN 46320
(219) 647-4320
FAX (219) 647-4321

WROBLEWSKA, VIOLA
Manager
Institute of Power Engrg.
Combustion Problems
POLAND

YAGIELA, ANTHONY S.
Sr. Marketing Specialist
Babcock & Wilcox
1562 Beeson St.
Alliance, OH 44601
(216) 829-7403
FAX (216) 829-7801

YAMAGATA, BEN
Executive Director
Clean Coal Technology Coalition
1050 Thomas Jefferson St., NW, Ste. 700
Washington, DC 20007
(202) 298-1800
FAX (202) 338-2416

YANCIK, JOSEPH
Director-Office of Energy
U.S. Department of Commerce
Energy Div., Rm. 4413
14th & Constitution Ave., NW
Washington, DC 20230
(202) 482-1466
FAX (202) 482-5361

YAVORSKY, KIM
Staff Assistant
Pittsburgh Energy Technology Center
U.S. Department of Energy
P.O. Box 10940, MS. 920L
Pittsburgh, PA 15236
(412) 892-6244
FAX (412) 892-4775

ZEH, CHUCK
Product Manager
Morgantown Energy Technology Center
U.S. Department of Energy
Office of Product Tech. Mgmt.
P.O. Box 880
Morgantown, WV 26507-0880
(304) 285-4265
FAX (304) 285-4403