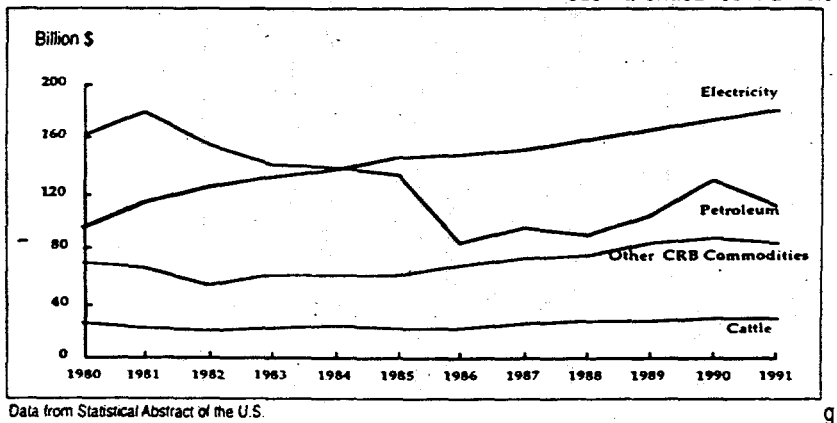
Demand for Electricity Drives Competition For Low Prices

Having established that electric technologies are directly linked to past and future economic performance, it would be entirely reasonable to expect that electricity itself would become the dominant energy commodity. Not only is electricity the dominant energy commodity, it is also the dominant basic commodity in the U.S. marketplace. As *Figure 13* shows, the purchase of electricity, when viewed against other commodities—not just energy commodities—is now the single largest commodity in the U.S. marketplace. The market consumes nearly $200 billion of electricity a year. As for other energy commodities, the totals are about $70 billion for natural gas and less than $60 billion for gasoline. The largest non-energy commodity is cattle at about $30 billion/year.

Figure 13
Total Annual U.S Commodity Purchases



Data from Statistical Abstract of the U.S.

The role of kilowatt-hours as a commodity is the underlying economic factor driving increased competition in the electric generating sector—and the creation of new markets and exchange systems to treat kWhs as a commodity. One obvious indicator of this new reality is the creation of formal commodity exchanges for electricity and the appearance of power marketing trade associations populated not just by electric utilities, but by traditional commodity-type brokers and Wall Street firms. (See the Technical Appendix for additional details on the commodity characteristics of electricity, and for details on the anti-inflationary indicators implied by declining electric rates.) The creation of a commodity business in electricity will have and is already having dramatic effect on the electric utility industry. The primary focus of interest from the perspective of regulators and popular media and legislative attention has been on the benefits to consumers of reduced electric bills. To be sure, competitive pressure promises to bring about declining electric rates, and lower electric bills for many consumers. In some regions of the country, the effect will be very significant.

However, a focus on the customer electricity bill misses the primary impacts of the increased role of electricity and declining prices arising from competition. The electric sector is not just about the bill at the end of the month—kWh and the technologies that use kWh play such a critical central role in the economy that the impact reaches far beyond that simple bill.

The important impacts of lower electric prices will be to:

- **Boost the economy**
  Lower cost electricity stimulates greater demand for electricity. Greater electric demand is a direct measure of the greater use of electric technologies, which will through their productivity benefits, boost the U.S. economy.

- **Moderate inflation**
  When any commodity is projected to have stable and declining prices, economists predict low inflation. Since electricity is the nation's biggest commodity—three times the size of the second largest commodity—low and declining electric rates will moderate inflationary pressure for years to come thereby protecting the integrity of savings and investments.

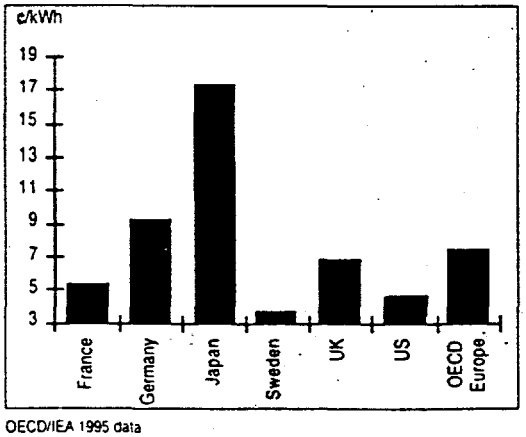
- **Increase U.S. competitiveness**

  Electrotechnologies dominate the productivity growth of an economy. Low prices stimulate greater use of electric technologies. The U.S. position of world economic dominance will be powerfully reinforced and protected by an economy with low-cost electricity.

Given the fierce and growing competition in world markets, this last factor may be the most important effect. Because of the direct connection between electricity/ electrotechnologies and the cost of electricity, the potential for continued dominance of the U.S. economy in world markets is directly related to the relative price of a kilowatt-hour.

Figure 14 shows that even before the effects of the competitive environment take hold, the U.S. already holds a dominant position in low-cost electricity for the industrial sector. Of the major industrial countries in the Organization of Economic Cooperation and Development (OECD), only Sweden has lower industrial electric rates than the U.S. This competitive advantage is reinforced by the importance of and growth in electric-based equipment, as illustrated earlier in *Figure 6*. Low-cost electricity not only leads to lower operating costs for electric-equipment-dominated businesses, but also encourages investment in new highly-productive electric equipment. Compared to the OECD Europe overall (a collective economy about the same size as that of the U.S.), U.S. industrial customers pay nearly 40% less for electricity.

Figure 14
Industrial Electric Rates

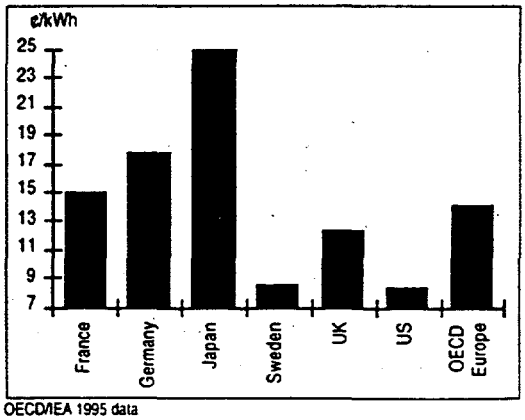


OECD/IEA 1995 data

In some respects, electric rates are more important for small businesses and homes. In the U.S., the 381,000 small manufacturing establishments produce over one-half of all U.S. manufacturing output. [Modernization Matters, May 1996, The Modernization Forum.] And manufacturing exports make up over 60% of all U.S. exports. Thus, as small manufacturing becomes more dependent on electric technologies and electricity, their electric rates become increasingly relevant to international competitiveness of the nation overall.

As *Figure 15* shows, only Sweden is close to the U.S. in providing low-cost electricity to the small business (and residential) sector. Unlike the rates for large industrial customers (shown in *Figure 14*), Swedish small business rates are slightly higher than U.S. rates. Compared to overall OECD Europe, the U.S. small business sector pays 41% less for electricity.

Figure 15
Small Business & Residential Electric Rates



OECD/IEA 1995 data

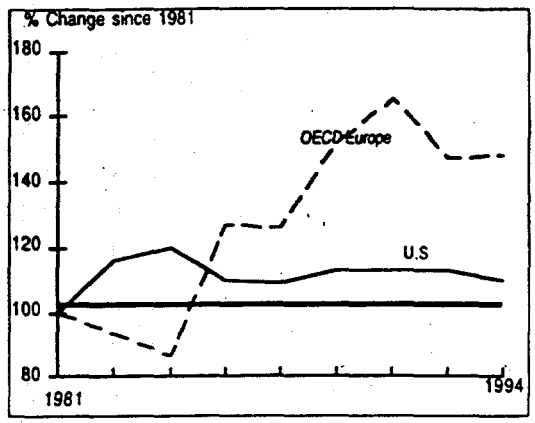
The current advantage that the U.S. enjoys in low electric rates is likely to continue and indeed will very likely grow, with recent trends showing the change in electric rates over the past decade (see *Figure 16*) with the U.S. far lower than OECD Europe.

One reason the U.S. enjoys such a large and important advantage in electricity is related to how electricity is produced, and the low cost of the fuel used to make that electricity.

It is not a technology issue. From an engineering perspective, the U.S.'s industrial competitors clearly have the ability to build comparable power plants (indeed, the manufacturers of major power plants are multinational). The central advantage for U.S. electricity users is that electricity-producers pay less for fuel to make electricity. (The reason that Sweden is able to meet or beat the U.S. is that over one-half of all Swedish electricity comes from relatively old, low-cost hydroelectric facilities.)

Of the 10 lowest-cost electricity power plants in the U.S., all are coal-fired. None of the power plants with the 10 best heat rates (i.e., best combustion technology) made it onto the list of 10 lowest cost producers. While there are obviously other factors which have an impact on the cost of electricity, the primary factor is unquestionably cheap fuel. *Table 8* shows that coal is a primary fuel source for electricity production in four of the six major industrial nations in the OECD. *Table 8* also shows that the U.S. cost for coal is about one-third that of competing nations.

Figure 16
Changes in Electricity Costs



OECD/IEA

Table 8
Largest Source of Electricity & Cost of Fuel for that Source

Contry	Fuel	Share	Cost ($/toe) Fuel
France	Nucl.	78%	-
Germany	Coal	57%	$227
Japan	Coal	19%	$152
	Oil	20%	$200
	N.Gas	21%	$161
Sweden	Hydro	51%	-
UK	Coal	52%	$113
US	Coal	54%	$57
OECD	Coal	39%	$80

toe= tons-of-oil-equivalent

Data from OECD

Low-Cost Power Anchored by Coal

It is easy to see that the primary reason the U.S. enjoys stable low-cost electricity is the dominance of coal-fired power plants. Over one-half of all current electric supply comes from coal-fired plants. The prospect of continuing to have low and lower cost electricity is thus primarily related to the future of coal prices and the future use of existing coal-fired power plants. These two factors, as the chain of connections in this study shows, are thus also a major determinant of the competitiveness of the U.S. economy in world markets.

The factors that relate to the role of coal in this story of connections are straightforward:

- Coal is the dominant source of electricity today
- Coal-fired power plants dominate low-cost electricity supply
- Coal fuel is the cheapest fuel and trends show costs declining further
- There is lots of coal available in the United States
- There is lots of additional coal-fired capacity available—with no new construction of power plants

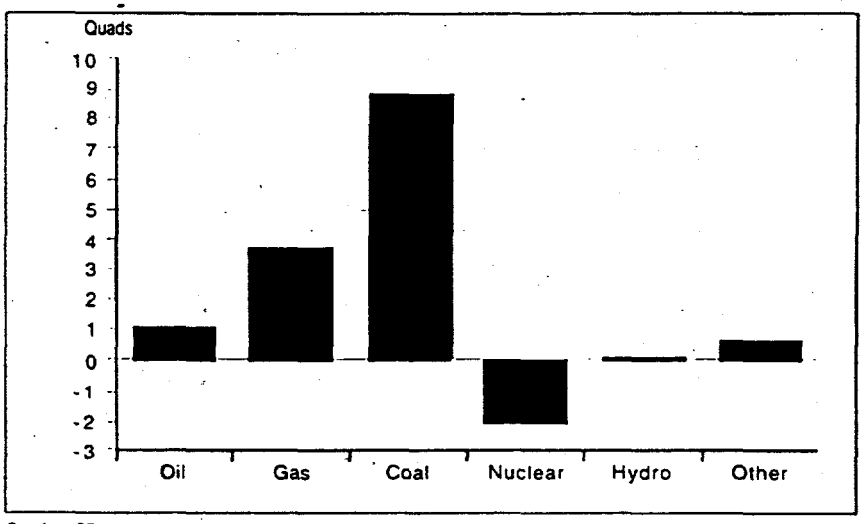
This last point is the dominating factor for assessing what sources of electricity will meet future demand. According to the Gas Research Institute, over 60% of all *new* electricity will come from coal-fired power plants. See *Figure 17.*

The GRI projection states:

"The major share of increased electricity demand over the next 20 years will be met by increased generation from existing plants, not the construction of new ones."

Since the major share of generating capacity is coal-fired, this is a direct affirmation of the increased use of existing coal-fired power plants. There is a clear

Figure 17
Sources of Additional U.S. Electricity through 2015



Data from GRI

economic advantage from increasing the utilization of existing 320,000 MW of coal power plants, compared to the capital expenditure associated with building new power plants.

This view is counter to a common piece of wisdom that has made the rounds in the utility industry for years: as the age of the majority of the dominant coal-fired power plants exceeds 30+ years, the plants will be retired and new power plants of some kind will be needed. **If coal units over 40 years old were actually retired, by 2015 there would only be one-third of the capacity, or 137 GW,** of the current units still on the system. **This is certainly not the view of GRI, nor is it the conclusion reached in this study.**

It is clear from all current forecasts that analysts implicitly assume that significant increased use of coal-fired capacity will occur to meet demand for electricity. *Table 9* summarizes data from recent forecasts. In all cases, coal is expected to account for about one-half of all increased need for electricity.

Table 9
Projected U.S. Electricity Growth & Coal Share of Total Supply Increase

Forecast	Total Growth to 2010 (billion kWh)	Share of New Supply From Coal %
EEI base case	970	44
EEI "high tech" case [1]	1125	44
EPA base case	740	48
EPA "high emissions" [2]	890	77
GRI	390	53
MM&A potential [3]	1500	50

[1] Data from EEI "Electricity for the American Economy 1995"
[2] Data from EPA "Revised Forecast of Electric Generation and Air Emissions Under the Clean Air Power Initiative," June 1996. The "high emissions" case assumes an enhanced price advantage for coal over natural gas, and thus higher electricity consumption growth and greater use of coal to meet that growth.
[3] Projected potential electric demand arising from demand stimulated by rapid price decreases (AD 2010 average price of 4.5¢/kWh) arising from competition and new technologies.

The Role of Existing Coal-Fired Units

In this study, we sought to validate the projection of increased use of existing coal-fired power plants from two perspectives:

1) Do the engineering fundamentals support the expectations that existing power plants, including very old ones, can be used more extensively and for much longer?

2) Based on a realistic assessment of the status and characteristics of existing coal-fired power plants, how many of them are likely to be able to operate at competitive electric rates for the next two decades?

After undertaking a literature search study, and interviews with leading engineering experts in the field, we found that the answer to the first question is clearly yes. Importantly, the answer to this question is based on the economically viable extension of the use of existing coal-fired power plants. Details on this exploration are contained in the Technical Appendix.

The answer to the second question was sought by undertaking an exhaustive analysis of the amount of total existing coal-fired capacity that could be available through life-extension and refurbishment, such that the resulting power plant would be competitive.

As an economic benchmark, our analysis used 3¢/ kWh as a maximum target price. Based on current and projected wholesale rates and contracts, a 3¢ benchmark represents a competitive price. For the analysis of coal power plants undertaken for this report by Resources Data International (details in the Technical Appendix), only those power plants that could meet or beat this benchmark were counted. In this way, the analysis identifies the magnitude of the additional coal - fired generation (i.e., post-refurbishment, life extension, or repowering) available as a competitive benchmark for 'green field' construction.

The analysis considered all coal units based on a 3¢/kWh maximum price as the acceptable delivered

power to the bus bar following any capital expenditure to extend the life of or repower old units. The analysis incorporated all of the critical performance criteria of the existing plants (e.g., age, size, heat rates, O&M trends, etc.) *Table 10* summarizes the results of the analysis. (Details are available in the Technical Appendix.) After completing the model and sorting all of the data by the key criteria, the analysis found that without building any new power plants of any kind, about 270 GW more coal-fired capacity could be operating in 2010 - 2015 than under a scenario of retiring units more than 40 years old. Furthermore, the technical capability exists to have the equivalent of 85 GW more coal generating capacity than is actually in use now, at a cost below 3¢/kWh, without breaking ground for a "green field" unit. This capacity establishes a powerful, low-cost benchmark since it represents about 50% of all the growth in supply projected to be required by 2010—and confirms the macro-economic projections or expectations in the GRI and other data presented earlier in this report.

Table 10
Total Potential Coal-Fired Capacity

CATEGORY	CAPACITY GW in 2015	
Life Extended	353.8	
Under Construction	3.6	
Return to Service	2.2	1996 Capacity
Possible Fuel Conversions	46.3	Total
Total	405.9	320 GW

Data from Resource Data International, 1996

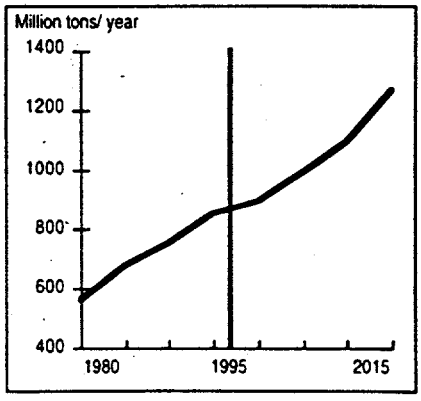
Technical note
(Fuel conversions are estimates of the potential for converting essentially unused oil-fired power plants to coal. The conversion potential in the model is based on the economic incentive to use existing capital plant with low cost fuel (coal) while achieving the model's benchmark 3¢/kWh goal. Note that any decisions to implement such conversions will clearly be dictated by plant-specific and company-specific economics. But the technical/ economic capability establishes a benchmark for competing generation sources of all kinds.)

The availability of the additional electricity generating capacity from a source (existing coal-fired power plants) at a price of less than 3¢/kWh will establish for the United States a continuing dominant role in providing low-cost electricity to the manufacturing and business sectors.

In addition to providing an abundant low-cost electric supply benchmark, the outcome of this analysis points to the probability of substantial increases in the amount of coal mined and burned. *Figure 18* illustrates the historic and projected coal consumption for electric generation.

Table 11 summarizes the increased coal consumption associated with the various electric growth scenarios included in this analysis. Without regard to which scenario

Figure 18
Projected Increase In Annual U.S. Coal Consumption
(Assumes all new generation <3¢/kWh)



ends up accurately anticipating the trends, all project a substantial growth. It is instructive to note that economic scenarios which envision higher economic growth are associated with electric projections leading to greater use of coal-fired generation.

Table 11
Projected Growth in U.S. Electricity & Coal Consumption

Forecast	Total Growth to 2010 (billion kWh)	Total Additional Coal Use in 2010 (million tons/yr)
EEI base case	970	215
EEI "high tech" case [1]	1125	250
EPA base case	740	205
EPA "high emissions" [2]	890	400
GRI [3]	390	250
MM&A potential	1500	400

[1] Data from EEI "Electricity for the American Economy 1995" Both cases assume only 22 billion kWh/year decline in nuclear generation.
[2] Data from EPA "Revised Forecast of Electric Generation and Air Emissions Under the Clean Air Power Initiative," June 1996. The base case assumes 106 billion kWh/yr decline in nuclear, the "high emissions" case assumes 135 billion kWh/yr decline by 2010.
[3] GRI assumes no significant decline in nuclear generation by 2010, but a 200 billion kWh/yr decline by 2015.

Using More Coal Reduces Emissions

While it is clear that economic forces will lead to greater coal use, a natural public policy concern is the associated potential for increases in power plant emissions. Addressing this concern, the U.S. Environmental Protection Agency has undertaken forecasts of power plant emissions arising from a competitive environment that will (in their projections, too) promote rising coal-fired power plant use. As it turns out, EPA's projections show a decline in total power plant emissions of critical regulated smog-related pollutants, even with a 25% increase in coal combustion. The EPA outcome, shown in *Table 12*, is a consequence of the improvement in the technology of combustion and emissions control.

Table 12
EPA Projected Changes in U.S. Coal Emissions to 2010
[Assumes coal use increases 25%]

Emission	Change
Nitrogen oxides	-15%
Sulfur dioxide	-37%
Carbon dioxide	+34%

From EPA June 1996 Revised Forecast of Electric Generation and Air Emmissons Under the Clean Air Power Initiative

However, while EPA does project an increase in the emissions of carbon dioxide (CO_2) from power plants-the principal gas implicated in the global warming theory there is more to consider.

Without regard to the merits of the global warming theory, the facts suggest that proponents of that theory need not worry. The effect of using more of the nation's electric infrastructure will be a net ***reduction*** in CO_2 emissions and even greater reductions in smog-related emissions than are currently projected. This reduction will occur because the increased use of electrotechnologies eliminates more emissions at the point-of-use than is created at power plants.

Details on this phenomenon are contained in the Technical Appendix. The calculations show that every 1,000 kWh used by an electrotechnology typically creates a net reduction in total societal air emissions of about nine pounds of nitrogen oxide and 3,000 pounds of carbon dioxide—the former a critical smog-related and regulated emission, and the latter a politically important unregulated and controversial emission.[1] This calculation assumes that coal provides 50% of the increased generation.

Table 13 summarizes the average results of the calculations. The emissions associated with electricity generation are comparatively uniform. For fuel-based technologies, however, there is a very wide variation in emissions from different equipment. The data in the table represents a low-weighted average. NO_x emissions for combustion-based technologies can range from as little as 0.5 lbs to over 50,000 lbs for equivalent amount of performance as achieved by an electric technology using 1,000 kWh (and emitting 1.5 lbs of NO_x).

Table 13
U.S. Emissions Reductions from Electrotechnologies
[Assumes coal provides 50% of electric supply]

Source	NO_x emissions (lbs)	CO_2 emissions (lbs)
Operate electric technology -use 1,000 kWh—power plant emissions	1.5	1,300
Operate equiv. combustion tech. to accomplish same task as above -burn fuel at point-of-use—emissions	(10.5)	(4,300)
Net decline	**9**	**3,000**

Data from "Total Fuel Cycle Implications of Increased Use of Electricity" Feb. 2, 1996, MM&A

Emissions reductions from increased electrification are evident from a systems, or total fuel-cycle perspective. The essence of this concept is the need to balance the emissions associated with producing electricity with the emissions displaced when electricity is used at a customer's site to power zero-emissions electrotechnologies.

Familiar to everyone is the electric vehicle (EV) trade-off: zero emissions electric cars (or mopeds, forklifts, tractors, etc.) lead to lower-than-gasoline-vehicle emissions at power plants for the same distance traveled. But EVs, while exciting, represent only a small part of the story.

Electrotechnology Emissions Advantage

There are literally hundreds of new and emerging electric technologies with thousands of applications in every sector of the economy.

For example, ozone-based laundry systems use electrically-generated ozone to both eliminate chemical detergent use and the associated energy/emissions from chemical processing, and dramatically reduce hot water consumption with its attendant energy costs. The energy needed to make the electricity is less than that displaced by the ozone technology.

Another example, electric induction forging of metals is emerging as a preferred technology, eliminating point-of-use combustion emissions. A more subtle example: water-jet paint stripping (achieved with powerful electric pumps creating extremely high-pressure water jets) completely displaces the use of chemical strippers as well as the energy needed to make, transport and dispose of the chemicals and the associated hazards of this process. Similarly, the growing array of electric destruction technologies for medical waste directly displaces the use of trucks that formerly carried the waste to landfills or incineration.

In many cases the energy/emissions benefits from electric technologies arise from reduced material waste because of increased precision of operation. For a manufacturer this is a clear economic benefit. From an environmental perspective, reduced material use also reduces the energy/emissions associated with both producing the wasted material, as well as disposing of it as waste.

In general, the electrotechnology offers the inherent efficiency advantage of electric phenomenon compared to combustion processes. Returning to the automobile example: internal combustion engine efficiency is less than 20% and small non-road engines are generally less than 10% efficient. And while power plants are 'only' about 40% efficient (new designs can exceed 50%), the electric motor at the customer site is 90% efficient. Thus, even counting power plant losses, the total fuel-cycle efficiency of (for example) an electric motor is about 40%, compared to a gasoline engine at less than 20%. This leads to real, not theoretical, environmental benefits.

Some examples of typical emissions reductions from switching to electrotechnologies are shown in *Table 15.*

Similar results illustrated in the table can be calculated for many other electrotechnologies. Such results can be used to roughly extrapolate an overall national outcome, as shown in *Table 14.*

Table 14
Potential Net U.S. Emissions Changes by 2010

Source	NO_x (tons)	CO_2
Emissions from generating 1,500 billion additional kWh	1 million	3 billion
End-use combustion emissions eliminated by the electrotechnologies using the 1,500 billion kWh	(5 million)	(4 billion)
Net decline in emissions	**-4 million**	**-1 billion**

If low prices (driven by competitive pressures and advancing generation and transmission technologies—

see Appendix for details) lead to an increased demand for electricity of about 1,500 billion kWh by 2010, and if 50% of that growth were met by coal, there would still be a net decline in emissions due to the offsetting impact of the electrotechnologies. The net total U.S. emissions reductions by 2010 are likely to be:

- **over one billion tons of CO2/yr,** [250 million metric tons of carbon] **and**

- **nearly four million tons of NOx/yr.**

Such results are consistent with an earlier Electric Power Research Institute report which projected some 600 billion kWh of new demand arising from 15 selected electrotechnologies with emissions reduction of 400 million tons/yr by 2010 because of those electrotechnologies and end-use emissions benefits. (Reductions that also take into account power palnt emissions.)

Earlier in this report we summarized coal use and emissions data from EPA's recent projections arising from increased competition in the electric sector. EPA concludes that power plant emissions of NOx (a smog precursor) and SOx will decline even as coal use rises.

Table 15
Net Emissions Reductions for Selected Electric Technologies Replacing Comparable Fuel Technologies
(Typical reductions per year per single use of technology.)

Technology	lbs NO_x	lbs CO_2
Automobile, electric	6	2600
Clothes drying, heat pump	1	700
Cold vaporization	10	8500
Commercial cooling	100,000	1,200,000
Commercial laundry, ozone	20	17,500
Copper melting	180	140,000
Electric moped	10	5,000
Electric steel mill	4,000	3,000,000
Fax	<1	150
FlashBake cooking	*40*	*54,000*
Forging, induction	170	95,000
Freeze concentration, dairy	50	40,000
Gas-line compressor	65,000	50,000,000
Heat pump, geothermal	6	9,700
Irrigation pump	300	27,000
Magazine ink drying, ultraviolet	20	16,000
Medical waste, Medaway	46,000	3,600,000
Microwave oven	<1	200
Mower, cordless electric	<1	60
Paint curing, infrared	50	44,000
Painting, super critical CO_2	330	92,000
Pasta drying, microwave	10	10,000
Powdered coating, infrared	*45*	*38,000*
Telecommuting	6	8,000
Train, high speed electric	23,000	17,000,000
Water-jet paint stripping	40,000	3,800,000
Welding of tube, resistance	12	9,700
Zamboni	945	60,000

Data from "A Cleaner Economy" Jan. 1995, MM&A for Edison Electric Institute

This will arise from improved combustion and control technologies. EPA also correctly notes that total CO2 emissions from power plants will rise because of substantial increase in coal combustion.

However, net national CO_2 emissions will not rise, since the additional electricity produced by the power plants will be used by end-use electric technologies that are associated with zero emissions displacing end-use combustion technologies. *Table 16* amends the EPA results to reflect the true total net fuel-cycle impacts. (Note that the net additional reductions in NO_x associated with end-use electrotechnologies are not included here.) **As the table shows, at the assumed and calculated average end-use emissions reductions of typical electrotechnologies, the net effect of the increased use of electricity will be a total reduction in carbon emissions—not an increase. Even if the effect of electrotechnologies at the point-of-use is one-half that found here, the effect of increased coal use will be to have no net increase in carbon emissions.**

[Note that these calculations do not account for trends in total carbon emissions in the transportation sector]. Electrotechnologies also frequently reduce a range of other environmental impacts, including a variety of chemical wastes, landfill use, waste water, and various of the emissions identified under the air toxics provision in *Title III* of the *Clean Air Act* amendments. For example, a new chemical-free dry cleaning technology based on super-critical carbon dioxide gas, which entails greater use of electricity to produce the CO_2, eliminates the use and emissions of perchlorethylene (PERC) the dry cleaning chemical that is highly reactive and a surprisingly large contributor to urban pollution. A cold vaporization process used by Kodak (and other firms producing low concentrations of toxic metals in a waste water stream) achieves the goal of zero waste and recovers such valuable materials as platinum and silver. The output of the cold vaporization process is drinking quality water.

Importantly, the kinds of environmental benefits outlined here will be driven by the market's appetite for the economic rewards of electrotechnologies.

Table 16
Net Projected Emissions Impact From Electricity Generation & Electrotechnology Use (2010)

			[million tons C /yr]		
EPA Forecast	Electric Growth [billion kWh]	Coal Share Total Growth	Increased Power Plant Emiss. [1]	End-Use Emissions From Electric Tech. [2]	Net Reduction.
Base case	160	48%	+162	-370	-200
High emissions	240	77%	+240	-443	-200

(note: previous tables and data are expressed in short tons, and measure carbon dioxide; the EPA data are in metric tons of carbon.)

[1] Power plant emissions from EPA analysis
[2] End-use emissions reductions are typical maximums from Technical Appendix; average of 4 lbs carbon dioxide per kWh of electrotechnology use; converted to one metric ton carbon/2,000 kWh.

[1]CO2 is the principal gas discussed in the global warming theory. Its inclusion in these calculations is not an endorsement of the theory. The research summarized here shows that for those concerned about reducing CO2 emissions, the easiest and most economically-beneficial (as opposed to financially damaging) strategy is to promote increased electrotechnology use; in other words, to support increased electrification and lower electric rates.

Conclusion

The consensus of opinion in expert circles, and the evidence found in this study, clearly point to the fact that competitive pressures in the electric utility industry will lead to increased use of coal-fired electricity. The increased use of coal as a low-cost source of electricity is driven by economic forces that arise from the direct relationship between electricity, electrotechnologies and the health of the national and regional economies. The importance of low-cost electricity derives from two key facts: first, electricity is the largest commodity, not just energy commodity, in the economy; and second electrotechnologies dominate the growth in business uses of new technologies.

In simplest terms, the nation, states and businesses thrive in an economic environment that has and that promotes access to low-cost electricity. Coal has played and will continue to play the anchor role in supporting the vital position electricity has in the economy.

This study also illustrates the fact that increased use of coal-fired electricity will be associated with decreased emissions. Critical regulated emissions reductions are expected due to factors: first, improved emissions controls on power plants will lead to reduced overall generation emissions even as the use of those generating assets increased; and second, the electricity produced by coal-fired power plants is consumed by a wide range of electrotechnologies that replace combustion-based processes, and in so doing, eliminate at the point-of-use more emissions (on average) more emissions than are created at the power plants.

Addendum

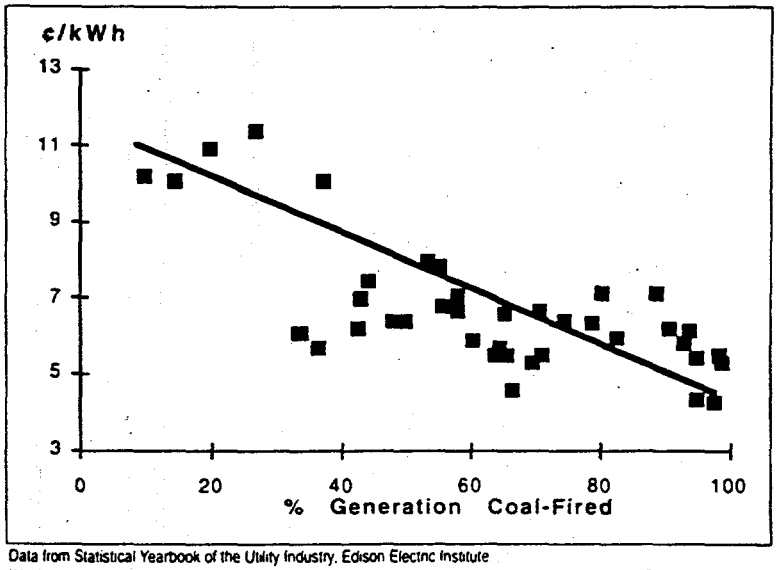
A State Perspective on Coal and Electric Rates

The graph below illustrates that there is a strong relationship between the average cost of electricity and the use of coal to generate power in a state. The data in the graph is a simple plot of the average cost of electricity in each state, and the share of that electricity which comes from coal-fired generation for that state.

The price of electricity is one of the major determinants in the competitiveness of businesses. There are two principal reasons that electric rates play an important role. First, at the fundamental level, electricity is the largest single commodity consumed by a state's economy. Changes in electricity costs thus have a larger impact on overall inflation pressures than do, for example, comparable increases (or decreases) in gasoline costs. Secondly, at the broad technological level, new electrotechnologies have come to dominate the growth in manufacturing innovation. Thus the cost of electricity has become an increasingly important consideration in helping stimulate, or depress, business interest in committing to an increased use of advanced technologies since those advanced technologies are frequently electricity-consuming electrotechnologies.

It has become a truism that manufacturers and businesses in states compete not just with neighbors in other states, but increasingly with other countries. Thus, the price of electricity in a state has a direct bearing on the global competitiveness of that state. And, again as the graph below shows, the cost of electricity is directly related to the share of state-wide electric generation that is coal-fired. From this type of evidence, and the more detailed exploration of these relationships in the preceding report, one may draw two obvious conclusions: i) higher dependence on coal improves the competitive posture for a state both compared to other states and other nations, and ii) any policies that have the intentional or inadvertent effect of reducing the use of coal-fired generation will negatively impact a state's economy.

Relationsip between share of state electricity generated by coal and average cost of electricityin each state



Data from Statistical Yearbook of the Utility Industry, Edison Electric Institute
[Note: data are for 41 of the contiguous states and exclude the six states with 0% coal generation, ME, VT, RI, DC, ID, CA, and four states with >50% generation from old hydro units, WA, OR, ID, SD]

These tables show the share of a state's electric generation from coal, along with the average cost of a kWh by state.

State Rank by cost of electricity

List in ascending order of average state-wide cost of kWh (EXCLUDES 5 states with >1/3 of generation from hydro)

State	% Coal Gen.	Avg. ¢/kWh
Wyoming	98	4.23
Kentucky	95	4.26
Tennessee	70	5.23
West Virginia	99	5.25
Utah	95	5.36
Indiana	99	5.44
Wisconsin	71	5.46
Alabama	66	5.48
Nebraska	64	5.49
Minnesota	65	5.63
South Carolina	36	5.67
North Dakota	93	5.78
Oklahoma	61	5.84
Iowa	83	5.92
Mississippi	34	6.05
Louisiana	33	6.05
Colorado	94	6.08
Ohio	91	6.19
Virginia	43	6.2
Missouri	79	6.28
Arkansas	50	6.35
Nevada	75	6.35
Texas	48	6.39
Georgia	66	6.57
Kansas	71	6.61
North Carolina	58	6.63
Delaware	56	6.78
Florida	43	6.96
Maryland	58	7.03
Michigan	81	7.11
New Mexico	89	7.11
D.C.	0	7.12
Illinois	44	7.41
Pennsylvania	56	7.84
Arizona	54	7.92
Vermont	0	9.21
Maine	0	9.63
California	0	9.78
Mass.	37	10.01
New Jersey	15	10.06
Connecticut	8	10.19
Rhode Island	0	10.24
New York	20	10.91
New Hampshire	27	11.32
OTHER NATIONS		
Japan	-	25.0
Germany	-	17.8
France	-	15.0
United Kingdom	-	12.3
Sweden	-	8.5

Alphabetical listing of states

(* indicates state with >1/3 of generation from hydro)

State	% Coal Gen.	Avg. ¢/kWh
Alabama	66	5.48
Arizona	54	7.92
Arkansas	50	6.35
California	0	9.78
Colorado	94	6.08
Connecticut	8	10.19
D.C.	0	7.12
Delaware	56	6.78
Florida	43	6.96
Georgia	66	6.57
Idaho*	0	4
Illinois	44	7.41
Indiana	99	5.44
Iowa	83	5.92
Kansas	71	6.61
Kentucky	95	4.26
Louisiana	33	6.05
Maine	0	9.63
Maryland	58	7.03
Mass.	37	10.01
Michigan	81	7.11
Minnesota	65	5.63
Mississippi	34	6.05
Missouri	79	6.28
Montana*	67	4.51
Nebraska	64	5.49
Nevada	75	6.35
New Hampshire	27	11.32
New Jersey	15	10.06
New Mexico	89	7.11
New York	20	10.91
North Carolina	58	6.63
North Dakota	93	5.78
Ohio	91	6.19
Oklahoma	61	5.84
Oregon*	10	4.6
Pennsylvania	56	7.84
Rhode Island	0	10.24
South Carolina	36	5.67
South Dakota*	36	6.19
Tennessee	70	5.23
Texas	48	6.39
Utah	95	5.36
Vermont	0	9.21
Virginia	43	6.2
Washington*	12	4.02
West Virginia	99	5.25
Wisconsin	71	5.46
Wyoming	98	4.23

Technical Addendum

Electricity as a Commodity & The Relevance to Inflation

At the wholesale level, electricity is a commodity, and it is the single largest and thus primary commodity in the U.S. economy. This reality has two broad implications: 1) as a commodity, market forces are powerfully oriented towards demanding low prices, and 2) the lower the prices the greater the downward pressure on inflation. (A corollary: any activity that either increases, or slows the decrease in, the price of electricity would be inflationary and broadly harmful to the economy.)

Changes in commodity prices are considered a key indicator of inflationary trends. Despite the fascination with oil (and its unquestioned importance in the transportation sector and international markets), it is not the pre-eminent energy or general commodity indicator.

When the commodities "basket" was created in the 1950s, electricity was a small input to the nation's economy; in fact, the U.S. economy spent twice as much on oil as electricity in 1950. Since 1950, demand for oil has increased 2.5-fold; electric demand has grown 10-fold.

Trends in overall commodities prices are monitored for their pressure on inflation. The Commodity Research Bureau (CRB) index of futures prices incorporates 21 commodities (cattle, hogs, bellies, gold, silver, platinum, coffee, cocoa, sugar, orange juice, crude oil, cotton, copper, unleaded gas, heating oil, lumber, corn, wheat, soybeans, soybean oil, soybean meal).

The table below lists the typical national annual expenditures on these various commodities, with electricity and natural gas added to the list for comparison. The current CRB commodity index does not include either electricity or natural gas. Note that electricity is the largest commodity with over three times as much money spent on kilowatt-hours as gasoline or natural gas, and six times as much is spent on electricity as on the largest non-energy commodity (cattle).

Typical Total U.S. Annual Commodity Purchases
(1995 data from Statistical Abstract of the United States)

Commodity	Billion $
Electricity*	190
Natural Gas*	75
Unleaded Gasoline	60
Crude oil	50
Cattle	30
Corn	20
Soybean	12
Pork bellies	10
Sugar	7
Coffee	7
Heating oil	6
Wheat	6
Lumber	6
Cotton	5
Copper	4
Gold	3
Cocoa	1
Silver	<1
Platinum	<1

The CRB establishes an overall price index for the entire basket in order to measure basic inflationary pressure exerted by changes in commodity prices. Relatively small changes in the index are believed to have a large multiplier effect on inflationary trends in the economy. It is possible to reformulate the index to include electricity, and thus how kilowatt-hours impact the inflation-predicting commodities index.

Recasting the CRB price index to include electricity yields some dramatic results. (The analytic techniques and assumptions for this modeling are described in *Does Price Matter? The Importance of Cheap Electricity for the Economy*, Mills•McCarthy & Associates Inc. for Western Fuels Association, January 1995.) Using an electricity-modified CRB index, one finds the inflationary impact is the same for <u>each</u> of the following individual price increases (all other prices held constant):

0.4¢/kWh of electricity
32¢/gallon of gasoline
$2/bushel of soy beans (over a $5.60 base)
$323/ounce of gold

Technical Addendum

Analysis of additional generating capability of existing coal-fired power plants.

The results in this analysis come from a joint effort of Resource Data International and Mills•McCarthy & Associates Inc. *RDI* served as a data provider, compiler and analyst with analytical direction provided by Mills•McCarthy & Associates, Inc..

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The purpose of this investigation is to assess the overall supply impact arising from life extension of existing coal-fired power plants. A forecast for the year 2015 is presented here that reflects the maximum potential amount of additional electricity generation available from existing coal-fired generation.

Approach to Analysis

The general approach employed operating performance and cost data as well as design characteristics for every existing coal-fired unit. The critera examined include age, size relative to the system in which the unit is dispatched, average annual heat rates, operating and maintenance costs, and capital costs.

Using a filtering technique, each unit was categorized based on one of the following actions which appeared most feasible:

- Retirement - Unit is retired sometime between 1995 and 2015.
- Extended Use - Existing coal unit which could be run more intensively, raising its capacity factor up to 80%,
- Simple Life Extension - Unit continues to operate with minimal O&M increases and efficiency decreases beyond 30 years of age.
- Low Cost Refurbishment - Unit is maintained and overhauled as required to increase its service life and efficiency.
- Capital Intensive Repowering - Replacement of boiler usually to a fluidized-bed or combined cycle technology.
- Return to service - Units in cold standby or out of service, but may be re-activated with some expenditure to update or retrofit the equipment.
- Fuel conversion - Most oil steam units are capable of burning some type of pulverized coal or slurry. Existing idle and operating capacity are examined for possible conversion.

To estimate the potential capital expenditure for each unit associated with any of the above actions, a market clearing price of 3.0 ¢ /kWh is assumed. By estimating 2015 production costs, the difference between the market clearing price and the production cost forecast represents an amount which can be used for capital costs associated with life extension activities.

Overview of Findings

The analysis finds some 406 GW of potential coal-fired capacity for the year 2015 (see Table below), compared to 329 GW available today. The 'new' coal capacity arises from life extension of all but the smallest and oldest coal units, re-activation of idled units, and conversion of other existing steam units to coal. No planned or forecasted capacity additions are included; only units now under construction are counted.

Potential Coal-Fired Capacity (2015)

CATEGORY	CAPACITY GW
Life Extended	353.8
Under Construction	3.6
Return to Service	2.2
Possible Fuel Conversions	46.3
Total	**405.9**

Explanation for categories of coal capacity

Life extension: The belief that large coal-fired power plants 30-40 years old are due for retirement is based on a flawed assumption that an amortization or planned operating life is a determinant of an actual physical or engineering life.

Most highly engineered facilities have a large degree of design margin built into them, mainly for reliability and safety reasons. Under normal operating conditions, this means that many of these components and systems have the capability to operate well beyond the economic life of the facility. Other components and systems may have to be replaced, but at substantially lower cost than building a new facility.

The consensus of expert opinion found in the literature and in interviews undertaken for this study is that utilities will have a wide variety of options to further use the fully amortized, and high-value installed coal-fired capacity.

Return to service: The return of 2.2 GW to service is a potential source of additional coal capacity, although it is difficult to assess the cost effectiveness of this because of a lack of cost and operational data on these units.

New capacity: In order to portray a conservative estimate with regards to new capacity, only units under construction in 1995 have been included.

Fuel conversion: Fuel conversion of steam units to coal-firing is technically possible at a reasonable cost in many combustion systems. All of the non-coal steam units are candidates for fuel conversion should the relative price of coal and the cost of conversion imply lower average production costs over the life of the plant.

Data Sources used for this analysis include:

EIA Form 767 : Steam Plant Design and Operation.
EIA Form 860, Generator Unit Reference File.
NERC Form OE-411, Coordinated Bulk Power Supply Report.
EIA 759, Monthly Power Plant Report
FERC 423, Monthly Report of Cost and Quality of Fuels for Electric Plants
REA 12, Annual Operating & Financial Report (Rural Electric Utilities)
EIA 412, Annual Report of Public Electric Utilities
FERC Form 1, Annual Report of Major Electric Utilities, Licensees, and Others
EIA 860, Annual Electric Generator Report
FERC Form 1 (for investor-owned utilities)
RUS (formerly REA) 12 (for cooperatives)
EIA 412 (for municipal utilities).

Key Assumptions

Capacity factors: All units are assumed to operate at 80%. This is done to represent a maximum technically feasible generation level for coal-fired capacity.

Heat Rate: This are assumed to remain constant throughout the period. Obviously if some of the performance improvements were to be made the heat rates would drop correspondingly.

Costs: Fuel prices are RDI's 1995 plant-by-plant delivered coal price forecast. These are based on a particular demand for coal at each plant.

Capital Costs: These are based on the 1994 book value of the plant. For plants less than 30 years old, a capital charge is included in the 1994 busbar cost.

Operating and maintenance costs: These are assumed to be constant in real terms out to 2015. It is possible that many plants' O&M costs will increase with age as more maintenance and materials are needed to operate older units, although some refurbished plants will experience a decline in their O&M costs. For those companies which do not report plant costs, an O&M cost of 1.5 cents/kWh has been assumed.

Discount rate: This along with the cost of capital is assumed to be 10%.

Estimated Allowance for Capital Investment: This is based on a market clearing price of 3.0 cents/kWh in the year 2015. The difference between the market clearing price and the 2015 busbar cost represents the potential capital portion. The $/kW amount is estimated assuming an 80% capacity factor and that any capital expenditures would be amortized over a 20-year period at the discount rate stated above.

ENVIRONMENTAL ISSUES AFFECTING CCT DEVELOPMENT

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Legislative Assistant to
Representative Sidney R. Yates (D-IL)
U.S. House of Representatives
Washington, DC

Legislative Issues Relating to CCTs

While no final legislative schedule has been set for the new Congress two issues with strong environmental ramifications which are likely to affect the coal industry seem to top the list of closely watched debates in Washington - the Environmental Protection Agency's proposed new ozone and particulate matter standards and utility restructuring.

EPA's Proposed New Ozone and Particulate Matter Standards

Background

On November 27, 1996, the EPA proposed new encompassing air quality standards for ground-level ozone (smog) and particulate matter (soot), based on evidence of harm to human health and the environment.

Compared to the existing standards, these new standards are much more stringent. The EPA believes these new standards are necessary in order to meet the Clean Air Act's requirement that air pollution not adversely affect public health.

EPA and a board of independent scientists have reviewed 86 particulate matter related health studies, covering millions of people, that showed harmful effects from breathing particles at the current standard. Another 185 of the latest ozone-related studies on human health were also reviewed. All of them showed harmful effects from ozone at the current standard, including 1.5 million incidences a year of significant respiratory problems.

The proposal is based on a thorough review of the best available science and the EPA expects to hear from a wide range of interested parties, from scientists and environmentalists to industry experts, small business owners, doctors and parents, in order to receive the broadest possible public comment and input on this important issue. Stricter limits for urban smog and soot would

prevent as many as 20,000 premature deaths each year and relieve the suffering of millions of Americans afflicted with asthma and respiratory diseases.

Public Comment

There will be a 60-day formal comment period for each of the rules being proposed. The purpose of the comment period is to reach out to all stakeholders in order to obtain the best information available for determining the appropriate final standards. There will also be an EPA sponsored public hearing.

Congressional Review of Regulations

Once a final regulation is issued, it will be among the first major environmental rules reviewed by Congress under the new Small Business Regulatory Enforcement and Fairness Act. Under this legislation, enacted in March 1996, federal agencies promulgating major rules must submit to each House of Congress and the Comptroller General a copy of the rule and the cost benefit analysis of it. Before the rule can take effect, Congress is given 60 legislative days to pass a joint resolution of disapproval. A resolution of disapproval would prevent the EPA from implementing the new standards or from issuing them in substantially the same form. Such resolutions are subject to the presidential veto power and it would take a two-thirds majority in each chamber to prevent the implementation of new standards. Basically, Congress gave itself veto power over new regulations. Many stakeholders are opposing the new standards, claiming they are expensive, unnecessary and hurtful to the economy. Already stakeholders are making appeals to Congress to intervene. Aggressive and expensive lobbying efforts are in place.

Other Legislative Options

As the administrative rulemaking process proceeds, Congress can conduct oversight and consider use of the appropriations process to influence the EPA. The FY97 appropriations conference report for the EPA contained language expressing the committees misgivings concerning new particulate matter standards even before the EPA proposal was released. Congress could also revisit the Clean Air Act and enact amendments to it that target the ozone and particulate matter standards. That process would occur in the authorizing committees - Senate Committee on Environment and Public Works and House Committee on Commerce.

EPA has reached out to Congress to get their views on the proposed rule. Briefings have already been held on Capitol Hill with staff and it is expected that the EPA will continue to be forthcoming during this process. All comments by stakeholders will be addressed and since this is a very complex process it could take some time. It remains to be seen whether or not the entire matter can be resolved during the 105th Congress, particularly in light of the symbolic legislative changes pertaining to promulgating federal rules.

Utility Restructuring

The House Commerce Committee and the Senate Energy and Natural Resources Committee are both involved in another intense debate in Washington - Utility Restructuring. At issue is the right of every consumer to choose their own provider of electric power. Some people contend that competition in the electric power industry is coming, just as it has for the telecommunications industry.

The House and the Senate have both been working on legislation that gives consumers choice of electric service. The Clinton administration began holding hearings around the country on competition and is currently drafting legislation. Many states have already announced plans to implement some degree of consumer choice.

Democrats strongly believe we should develop our energy resources in ways that will not cause harm to the environment, the consumer or the taxpayer. Conservation is a critical element of our energy policy.

According to the Senator Dale Bumpers of Arkansas the ranking member of the Energy and Natural Resources Committee, "Properly handled, greater competition in the electricity industry should lead to greater customer choice and lower electricity prices -- just as competition has in the long-distance telephone business. Improperly handled, it could lead to higher prices for some customers and the loss of some customer services."

The bottom line is that any legislation Congress passes must benefit the public as a whole and not just the utility companies and their largest industrial customers.

Barbara Wainman
Assistant to the Chairman
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Washington, DC

First a little background about myself. I have been with Mr. Regula since 1981-- some of you have been working on these issues since the 70's, but to have been on the Hill 16 years is a very long time. So, I have seen a variety of approaches to our energy policy over the years.

Anyway long enough to have been around during the last Speaker of the House that had problems, Jim Wright. Speaker Wright used to tell a story about energy and how one of his constituents came up to him and says "Jim, I'm really worried about energy, we really have to worry about it." He says, "You know we can't keep burning coal, coal is dirty. It's not a good thing to keep burning coal. We can't keep using oil, because oil is in the unstable Mid-East, and I'm worried about that. We can't keep sending our troops over to fight to protect oil. Nuclear's just not safe, we can't use nuclear." So the Speaker said well Joe, what do you think is the answer. His answer: "We just have to use more electricity."

Well that would be funny, if it wasn't pretty reflective of what a lot of people know about our energy policy. A lot of people unfortunately have a limited amount of knowledge about energy and the issues that all of us in this room care about. Some of them are of our Congressman and their staff and it's not that they're not interested, but Congress really tends to be crises oriented and there is currently no energy crisis. There hasn't been in recent memory. So it's not something that's really on the congressional radar screen. And if you look at this Congress, speaking about staff being younger, I start looking every year to see how many members are younger than I am. And this is a very young Congress. Young in terms of experience and a lot of them young in terms of age, and there are many people up there who may not remember well the crises of the 70's. I remember the energy crises of the early 70's, because I had just gotten my drivers license and I always got to take the family vehicles on the odd days when you could get gas depending on license plates odd or even and filled them up. And some of these guys weren't even driving, they don't even have that exposure.

So we really have a job to do in terms of trying to focus on how do we deal with the energy issue, absent a crisis. Congress is looking at budget crises and Medicare crises and those kinds of things, and their philosophy is "if it ain't broke then don't worry about it." So we have to think of how we are going to deal with the Congress in that context.

I think that to some degree what it means is the way we're going to deal with energy policy is going to be incremental. I don't think we're going to see big sweeping energy policy acts or even utility deregulation in the next two years. I think it's going to be an incremental process.

Now what does that mean for all of us. I think it means that what every one of us in this room, what you all need to be doing--and those of us like Maura and I who are more familiar with these issues, need to be helping you to do--is "Education." I think it's very important that you get out and start talking to your Congressmen and your Senators and their staff about what issues are important to you. Talk to them in ways that they can understand. Make it relevant to their State, their district, and their constituents

I've learned a lot today, but there's a lot that I hadn't a clue what was being talked about, and I'm pretty familiar with these issues, so I think you need to get out there and talk about these issues so that those of us who don't spend our whole lives working on this, which is most of the Congress, can really understand and understand why it's going to be important to them. Why it's going to affect their district. Tom and I were talking at lunch, about, the impact if you throw half of this country into non-attainment. You're going to have a real crisis. But most members don't know that, they don't know what non-attainment is and so you need to be starting now. Get out and really start the education process because we're going to be dealing with these issues, not next week, not next month but over the next period of years, and it's very important to not just go and say here's what I want you to do for me, but here's what I want to tell you about this issue. I think that's very important and it's never to early to begin this education process.

What does all this have to do with the impacts for clean coal technologies. I really find that I agree very much with what Linda said earlier. When we established the Clean Coal Program, I can say we because I was around at the birth of the Clean Coal Program so I'm very interested in how it finishes up. But I remember what I call the "3 E's." The program was founded because it was going to make these technologies more *economical*, it was going to make them more *efficient*, it was going to make them more *environmentally* friendly. I think right now two of those issues are very central to current debates and that is economics and the environment. The two issues of utility restructuring and changes in the whole Clean Air Act will both affect the future of the clean coal projects, but I don't think that necessarily has to be negative. I think that we should not look at these changes as "stumbling blocks" but as "stepping stones", and how can we use these to make the Clean Coal Program the true success that it can be. I think it is very important that all of you continue very aggressively to work on deployment, to have the most options to respond to whatever Congress comes up with in terms of new regulations or deregulations. You can't sit in this room and know what Congress is going to do. I think these issues, like you said, are going to be necessarily dealt with in the 105th Congress, maybe the 106th or 107th, and we don't have a clue as to what those are going to look like. We just have to be ready with the best suite of options.

A classic example of where an industry failed to do that is one that we're dealing with in another area of DOE. When some groups saw a Republican Congress elected, they thought "heck" now we can go in and not worry about getting our appliances more efficient. I'm glad to hear refrigerators are really efficient, because that helps the company that I'm interested in, but DOE

thinks they need to be more efficient. So, a lot of the industry just sort of sat back thinking the Republican Congress is going to save us from having to make these refrigerators more efficient. Now they are scrambling to meet anticipated new standards. So you don't want to sit back trying to anticipate the lay-of-the land, because the lay-of-the-land can change every two years. It's important to get out there and keep working on getting these technologies into the market, get them sold, get them demonstrated and be very aggressive on that front. Because we don't know what Congress is going to do. We can't predict from day-to-day. But I think we need to look at these issues as positive opportunities and to be working to have the most options available for the coal industry to make sure that coal continues to play the important role in our economy and environment that we all know it can.

Thank you very much.

Panel Session 4

Issue 4: CCT Deployment From Today Into the Next Millennium

A Utility Perspective on the Deployment of CCTs Into the Next Millennium

Michael J. Mudd
Principal Engineer
AEP Energy Services

ABSTRACT

The successful Clean Coal Technology projects which are being discussed in this conference are all a testament to the positive advancements that can be made with environmentally superior technologies when the government and industry cooperate in the context of a properly funded and a well thought-out program. Many of the technologies developed in the Clean Coal Technology Program have taken a competitive position in the marketplace, and many others are on the verge of being competitive in the marketplace. Based on the success of the Clean Coal Technology Program, one would expect that they would be ready for full deployment in the marketplace as we approach the next millennium.

This is not happening. There are several hurdles that impede their deployment. Some of those hurdles, such as the higher first-of-a-kind cost and technology risk factors that accompany not-yet mature technologies, have existed since the initiation of the Clean Coal Technology Program. However, several new hurdles are impeding the market penetration of Clean Coal Technologies.

Those hurdles include the radically different marketplace due to the restructuring of the electric utility industry, a soft market, the difficulty in financing new power plants, low natural gas prices, and lower-cost and higher-efficiency natural gas combined cycle technology.

I. INDUSTRY RESTRUCTURING

The restructuring of the electric utility industry is being reviewed in detail at other sessions. Therefore, I will not discuss that aspect in detail here. However, at the same time, it is important to acknowledge that the restructuring of the industry from cost-based prices to market-based prices will have a great impact on the commercialization of CCTs in the domestic electric utility industry. This is because the pending change in the electric utility industry has resulted in the deferral of construction of new plants in the United States into the next decade or beyond. Until the rules of the newly restructured marketplace are known, electric utilities are not likely to add new base-load coal-fired capacity.

II. MARKET FOR NEW PLANTS

The market for new base-load, coal-fired plants in the United States is stagnant. Sales of coal-fired plants are few and far between. The load growth of electricity is lower than was projected twenty years ago when the electric utility industry was adding significant capacity to the grid. As a result, there is ample base-load capacity to serve our nation's electric system in most areas of the United States. Currently, the average capacity factor of the 720 GW of generating capacity installed in the United States is 49.6%. Most of the projected load growth for the next 10 to 15 years can be absorbed by increasing the capacity factor of existing power plants, decreasing reserve margins, and by life extension of existing capacity. It will not be met by adding base-load solid-fuel power plants.

III. FINANCING OF NEW PLANTS

In a regulated environment, utilities based decisions to erect new facilities on prudency, life cycle costs, and the regulatory compact, whereby utilities were allowed to recover the cost of prudent investments provided the facilities were used and useful, and a reliable source of electricity was provided to the ratepayers. In the deregulated environment, the key to building a new power plant is financing. One of the keys to financing is to obtain a Power Purchase Agreement. A Power Purchase Agreement is dependent on the ability of the generator to provide reliable power at competitive prices. The utility, (or GENCO or IPP or any producer of electricity by any other name) would seek a Transmission Company, Distribution Company, customer, or power broker to sign an enforceable long-term contract for the electricity produced by the new facility.

Absent a Power Purchase Agreement, the plant would be a "merchant" facility (eg. the plant is built without any assured purchaser of the power) which entails considerable financial risk. Usually, it is difficult, if not impossible to finance such a facility with project financing (using lower-cost debt to finance the project). A merchant plant would likely be financed with mostly equity (which typically is more expensive than debt).

Let's look at whether or not a Clean Coal Technology Plant could provide competitive power in today's market. Most studies which project the market price for power in the 2000 to 2005 time frame point to an average market price for energy in the range of 20 to 25 mil/kWh, and 30 to 35 mil/kWh when capacity is included in the cost. With natural gas at less than $2.00/million BTU, a Natural Gas Combined Cycle Plant can be competitive with that price level. Most new solid-fuel plants, whether a conventional or a Clean Coal Technology Plant, cannot provide power at that price. The reasons for that follow.

IV. NATURAL GAS

Since 1988, approximately 75% of new generation has been gas fired. The dominance of natural gas in recent years can be attributed to economics associated with the price differential between natural

gas and coal, the efficiency of natural gas combined cycle plants, and the decreasing capital cost of combustion turbines.

Natural gas has historically commanded a price-premium factor of 2.5 to 3 (on a BTU basis) over coal. That premium reached a low of 1.25 within the past five years, and has remained well under 2 over the past several years. It is because of this historical price premium that coal-based technologies have been competitive with natural gas technologies despite their higher capital cost. With the lower price premium, coal-based technologies tend to lose out in an economic comparison. Will natural gas prices increase in the future relative to coal prices? Current conditions do not indicate such a trend. Known natural gas supplies have increased by 30% over the last decade. The abundance of reserves, coupled with advances in extraction technologies and competition in the natural gas industry, have reduced natural gas prices by 15% in real dollars in the past five years.

At the same time, the efficiency of gas turbines has been steadily increasing. The efficiencies of the latest fleet of high-temperature gas turbines is approaching 40% for a simple-cycle configuration, and 50% for a combined-cycle configuration. The DOE projects efficiencies of 60% in advanced turbine systems by the next millennium.

Finally, the capital cost of gas turbine combined cycle plants has declined dramatically. The current cost of a Combustion Turbine Combined Cycle Plant (on a $/kW basis) is about one-half the price of a pulverized coal-fired plant.

The combination of lower fuel prices, higher efficiency and lower capital cost has resulted in lower projected life-cycle costs for NGCC Plants compared to coal-fired plants -- both conventional designs and Clean Coal Technology designs.

There are many other issues which impact the evaluation of whether or not a utility should build new generation, and what type of generation should be used. Some of them include environmental considerations, location of plant relative to the availability and cost of fuel, system stability requirements, system needs (peaking, intermediate, or base load) to name a few. There will be selected niche markets where a coal-fired plant is the economic choice. However, in the short term, I believe that natural gas will dominate new plant construction.

V. CLEAN COAL TECHNOLOGIES

Where does this leave CCTs in relation to the domestic electric utility industry? I do not believe that there will be a viable wide-scale market for solid-fuel, base-load power plants -- whether clean coal or conventional in the United States until the need for base-load power reenters the marketplace, and coal can reestablish its competitiveness compared to natural gas.

At the same time, CCTs continue to be good technologies. They have cost advantages, efficiency advantages, and environmental advantages compared to conventional technologies which must not

be sold short. They have the potential to provide the higher efficiency and lower capital cost to bring coal back to the forefront for new electric generation. But before CCTs can be competitive with natural gas, they must complete their path along technical and cost maturation curves.

In the long run, coal-based generation must continue to be a viable and important part of our nation's future generating needs. Coal is a natural resource which must not be ignored. Coal is an important aspect of our country's energy security. I believe that the dominant market for new generation in the foreseeable future will be in smaller-size generating stations. Fluidized-bed combustion boilers, especially CFBs, can continue to serve this important market niche, especially where low-grade fuels and alternate fuels (such as pet coke and biomass) are economically available. At the same time, this smaller-size market is where the competition between coal and natural gas will be the greatest. Both PFBC and IGCC technologies could be the "swing" choices for new generating facilities, which could allow coal to capture a large share of the intermediate-size power generating stations in the future.

If PFBC and IGCC can continue down their paths of commercial demonstration and cost reduction, these technologies should offer the opportunity to use coal in medium-size facilities which might otherwise be fired with natural gas. The challenge remains to continue the development of these important technologies despite the fact that the near-term market for new generation, especially coal-fired, is bleak. This is why, absent opportunities in the domestic market, it is so important to continue to focus on developing these technologies overseas.

VII. INCENTIVES

The Clean Coal Technology Program has been the model of the type of incentives that were required in the mid 1980's to assist in the commercialization of CCTs. I believe that the incentives should remain in effect to allow those projects to be completed. At the same time, it is important to acknowledge the context in which the CCT program was initiated. Natural gas prices were declining relative to coal prices, however it was expected by many analysts that would be a short-term situation. The Clean Air Act Amendments were being discussed, but were not yet enacted. Deregulation was being talked about, but it was far from a reality. The cost-sharing provided by the federal government was often tied to enhancing the cost-recovery of the project by the utility through rate consideration.

As previously discussed, conditions are significantly different now. At the same time, incentives are still required to assist the completion of the commercialization of Clean Coal Technologies. Proper incentives are still required to ensure that not-yet-mature CCTs are commercially deployed as opportunities become available. Those incentives must make these not-yet-mature CCTs cost indifferent to the customers. If the only market for CCTs is overseas, and if incentives are required to ensure that Clean Coal Technologies can be proven in this market, then it is better to pursue an international cost-sharing program than to simply claim that we should not spend CCT funds on overseas projects, and lose the momentum gained through the CCT Program.

VIII. CONCLUSION

Our nation has invested a lot of effort and money in the development of Clean Coal Technologies -- in excess of $7.5 billion. Electric utilities have played a major role in that development, having been involved in a significant percentage of the Clean Coal Technology projects. This is a testimony to the importance that electric utilities place in the development of Clean Coal Technologies. Our industry and our customers cannot overlook the environmental, efficiency and economic benefits of Clean Coal Technologies. Industry and government must continue to work together to ensure that Clean Coal Technologies are ready to be used in the next fleet of power plants by being an economic choice compared to other alternatives in the future.

A CHICKEN IN EVERY POT
A NEW BOILER IN EVERY POWERPLANT
A NEW POWERPLANT AT EVERY INDUSTRIAL SITE

Robert D. Bessette
President
Council of Industrial Boiler Owners (CIBO)
Burke, Virginia

For those of you who do not know, the Council of Industrial Boiler Owners (CIBO) is a broad-based association of industrial boiler owners, architect-engineers, related equipment manufacturers, and university affiliates consisting of over 100 members representing 20 major industrial sectors. CIBO members have facilities located in every region and state of the country. We have a representative distribution of almost every type boiler and fuel combination currently in operation. CIBO was formed in 1978 to promote the exchange of information within industry and between industry and government relating to energy and environmental equipment, technology, operations, policies, laws and regulations affecting industrial boilers. Since its formation, CIBO has taken an active interest in the development of technically sound, reasonable, cost-effective energy and environmental regulations for industrial boilers. One of our prime objectives is to support and promote the industrial energy base of our country, a foundation of global competitive power.

What you do and are talking about at this conference is directly in line with our objective to promote the industrial energy base of our country. In that context, I want to begin with a quote from Jesse Jackson's remarks to the Democratic National Convention in Chicago:

"What is our vision tonight? Just look around.

This publicly financed United Center is a new Chicago Mountaintop. To the South, Comiskey Park, another mountain. To the West, Cook County Jail, with its 11,000 mostly youthful inmates.

Between these three mountains lies a canyon.

Once Campbell's Soup was in this canyon. Sears was there, and Zenith, Sunbeam, the Stockyards. There were jobs and industry where now there is a canyon of welfare and despair.

This canyon exists in virtually every city in America."

If we look at where the companies which once thrived in the canyon have gone we may not like the answers we find. When we talk about boilers which support the companies which produced these jobs, they are not being built in this country today. When is the last time you saw a major new manufacturing plant being built or considered for any major city or non-attainment area? They are not. The canyon of welfare and despair will never be revitalized without a rebuilding of American industry. Even Mr. Jackson knew this, as he ended his speech at the convention with the following:

"In the Canyon, we must have a plan to rebuild and redeem our cities, to reinvest in America.

I suggest we have at least as much sense as a honey bee, which knows enough to repollinate her flower.

After World War II, we helped rebuild Germany-- the Marshall Plan. We helped rebuild Japan - the MacArthur Plan.

Now we must rebuild America."

Today I want to share with you my thoughts on a problem which all but prevents us from doing this. This problem has increased the complexity for the individual or business to create its own future. There is a perception, throughout the country, which binds our hands as we look to create a better future for our children -- whether they are in the city or suburb.

What is this perception? "Energy Awareness!" There is "no" energy awareness! We as a people take energy for granted. We forget it takes energy to do anything, to provide any product or service. I challenge you to touch something in this room, or where ever you happen to be, which doesn't have energy connected to it in some way. Even touching takes energy.

As we look to the future, our nation's energy awareness will be the determining factor in how and what we are able to do. I do not know what that will be. Right now we have great "Environmental Awareness." To balance the future, we must have an equally strong "Energy Awareness." In a sense, it is now backwards. I believe people, in general, feel energy happens (made by God, used by man), and environment is created (made by man, used by God). When you think about it, in reality, the environment happens and energy is made. Everyone agrees we must be environmentally conscious as we build our future. However, without energy there is no future as we think of it today.

If we stop and take a look at where we are today, to say the "times-are-a-changin" may be an understatement. EPA's regulatory activity is at its highest level in recorded history. Utility deregulation and competitive sourcing are opening new alternatives resulting in new complexities (including additional environmental complexities), for our day-to-day operations and long-term development considerations. Corporate re-engineering is changing the face of every industrial company in the United States, if not the world. What we see two years from now will not be anything like what we saw two years ago.

Each industry grows, or changes, as a result of the pressures it experiences. If you are to be successful you have to look at what these pressures are and how to address them.

What are the pressures on the industrial boiler owner today which will affect how he meets his energy needs?

- CHANGES IN OPERATOR KNOWLEDGE AND EXPERIENCE
  Retirements and Loss of Naval Training

- INCREASING ENVIRONMENTAL REGULATIONS AND COMPLEXITY
  NAAQS Integration, ICCR, FERC, OTAG

- INCREASING GLOBAL COMPETITION
  Cost of Goods Sold, Regulation Difference, Profitability

- DEMANDS FOR INCREASED ENERGY EFFICIENCY
  Global Climate, Cogeneration

- DEGRADATION OF FUEL SUPPLY QUALITY AND CONSISTENCY
  Waste Fuels

These pressures have created a new environment in which the industrial power plant must operate. The ability of the industrial company to compete has been seriously complicated. The goods and services which are produced to maintain our standard of living and to provide the social benefits to the people of the United States are becoming more expensive primarily due to the increasing burden of regulations, environmental and others. Talking primarily about environmental regulations, these regulations are generated without significant positive benefit. We forget it takes energy to clean up the environment or do anything.

As a result of these pressures, especially the environmental regulations, we see some major trends which may be indicative of what the future will hold.

- Industrial development is now mostly in other countries and not in the United States.

- There are very few people who know how to burn coal or fuels other than natural gas in an efficient, environmentally acceptable way.

- The question of who should own my powerplant is given serious consideration. As more companies proceed down this path, the financial plant, definition and labor problems will be worked out for others to follow.

- Staff reductions and travel curtailments are commonplace to meet the ever increasing globally competitive pressures and the demand for short term profits by investors and management. Capital for powerplants vs. production.

- Environmental regulations have forced rapid development of technologies without a plant operation infra-structure.

- Regulations emanating from the implementation of the Clean Air Act Amendments of 1990 are being generated on all fronts at the same time without sufficient time to determine the true costs and benefits. However, all affected parties are beginning to talk to each other.

- We are beginning to see a trend where savings are being generated through team efforts. There is a greater acceptance of owner/vendor/engineer groups working together. A new way to work out projects.

- Natural gas is the primary industrial fuel of choice.

The single most important question to come out of our annual meeting in October was: "what is the future of industrial energy needs in a deregulated utility market?" We are going to try to work this out and develop a program to specifically address this issue over the next year.

Today's situation is one of complexity and multiple energy/ environmental issues forcing companies to look at the increasingly complex solutions with increasingly smaller staffs.

I must say, I do not believe there is anyone in this room who does not want a clean and safe environment for our children and our grandchildren. This has become a top priority in everyone's mind. It is like buckling seat belts when you get into a car; where once there was resistance, now there is a natural acceptance.

Where do I think the industrial powerplant will be in the next 10 to 20 years?

- The industrial powerplant may not necessarily be owned or operated by the users of the steam and power. The powerplant will be considered a profit center.

- Powerplants will be built to generate electricity based on a process steam load to capitalize on the system efficiencies. The "steam only" system may become extinct.

- There will be a drive for effective and efficient increased consumption of any waste which can be used as fuel, if not completely banned by the EPA, under a radical combustion strategy and maximum achievable control technology (MACT). Large Wholesale Electric Generation's (WEG) will be located at mine sites or where there is low cost fuel.

- The next generation of electric powerplants will be smaller (40 to 240 MW) systems located at or near the major industrial energy users, taking advantage of the increased efficiencies of cogeneration.

- Environmental regulations will be generated with real and valued input by all interested parties. These may provide a sense of realism and benefit for the costs incurred. The Industrial Combustion Coordinated Rulemaking (ICCR) and Ozone Transport Assessment Group (OTAG) are examples of this.

- The environment will be cleaner; and people will be better educated. They will not be scared like "Goosy Lucy" listening to "Chicken Little" when they hear words like endocrine disrupters, ozone hole, alar and radon.

- Clean coal tehnology programs will have a more important place in everyday decision making.

The above projections are based on a sense of optimism that there will be sufficient energy awareness to balance the environmental awareness which exists today. If this happens we will be able to replace our aging industrial energy base and provide the support for an increased national productive capacity. If it does not happen, I am afraid to consider the possibility that we will become a nation of service providers to the world and importers of goods. Of course, this is what some would like to see -- a return to the primitive times.

"In Order to be Successful, Technology Must Adapt to the Changes in the Marketplace"

James C. Houck
General Manager
Alternate Energy Department
Texaco, Inc.

First, let me tell you how proud Texaco is to be a part of the team which contributed to the success of the Polk Power Station IGCC -- the cleanest coal power plant in the world. I also want to commend our friends at Tampa Electric Company for their vision, their energy and their spirit that were critical to bringing this plant on line -- and on schedule. Finally, I want to thank our DOE hosts for organizing this fine conference.

Texaco has been in the gasification business for more than 50 years, and the only "constant" we have seen in the marketplace is change. The marketplace is no longer a set of neat and distinct boxes. It is hard to discern the lines between the utility and non-utility sectors; and between the power and the refining and chemical sectors.

In the same way that marketplace distinctions have evolved, technology distinctions have evolved. In adapting gasification to the marketplace, we have learned not to view gasification as strictly a "power" technology, or as strictly a "coal" technology. It is, however, a "popular" technology because it is so many things to so many people. Thus, the emphasis of my remarks are on "technology that meets marketplace needs," not on "clean," or "coal."

A little perspective on where we've been and what we've learned will help us understand where we're going. Gasification was first used in the late 18th century to "cook" coal to produce gas for street lamps. Over the next hundred years it was primarily used to produce town gas. During the 1920's gasification was first used by the chemical industry to synthesize chemicals. During World War II and for several years thereafter, gasification was used to produce liquid fuels from coal and natural gas.

Texaco entered the gasification market during this time period, and we licensed our first commercial plant in 1946. At the start, the gasification technology appealed to the chemical industry, followed later by the refining industry, where it was used to produce hydrogen from oil and natural gas.

With the energy crises of the 1970s, America decided to become energy self-sufficient and since our most abundant energy resource was coal, it was clear that coal-based, energy self-sufficiency had to be balanced with environmental concerns. Hence, the creation of the Synfuels Corporation and later the Clean Coal Technology Program. As has been thoroughly documented at prior CCT conferences, it is important to note that these programs did indeed contribute to advancement of technology, including commercialization of technology, in the power sector. (And Texaco is

proud to have played an important role in the Clean Coal Technology Program.) It is equally important to note that some of these technologies have been, and continue to be, adapted from other, more traditional, marketplace applications.

The lessons we learned from history is that the gasification of 1996 is a far cry from the gasification of 1796. In fact, the only point of commonality is the name itself.

The marketplace, both here and abroad, has changed dramatically since the Clean Coal Technology Program was first legislated. In the United States, the Electricity Market is undergoing the most profound change since Edison first invented the light bulb. Overseas, the electricity markets are growing at a much more rapid pace than total energy demand.

We believe gasification can play a key role in the marketplace competition for power generation. National privatization and regional imbalances in projected supply/demand scenarios have created opportunities where gasification has successfully competed. Markets where the demand for power is combined with the lack of inexpensive, indigenous fuel (for example in India, Taiwan and Japan), or where the ability to use a variety of low value and/or waste feedstocks in combination with coal feedstocks, have also created opportunities where gasification has successfully competed. An interesting result from our successful efforts in the area of low value and waste feedstocks has been the importance of not necessarily characterizing gasification as a "clean coal" technology. Rather, it is a "clean, versatile" technology, with an emphasis on both "versatile" and "clean."

Against the backdrop of the recent gasification successes in the marketplace, it is important to ask "What are the challenges to future commercial success?" Let me share our thinking on a few:

1. Government -- The old attitude was that regulations must become more strict in order to foster an environmental in which gasification can succeed. The new attitude should be that government should step aside and let the market figure out how best to make this technology succeed. And that is by recognizing that a technology is only as versatile and flexible as the laws which regulate it. Gasification can do many things, and solve many problems, but only if the lawmakers are willing to advance their regulations as quickly as industry advances the technology. The EPA and other countries' environmental agencies should recognize this, as should the World Bank.

2. Perceptions -- Most of the technologies showcased at this conference are fully commercial. Gasification certainly is. So let's stop referring to these projects as "demonstration," let's stop talking about these efforts as R&D, and let's stop suggesting that these technologies need special incentives to deploy them. Similarly, let's recognize that as commercial technology, it has met the marketplace requirements for reliability and availability. Too often, as we develop technology for new marketplace applications, we are tempted to emphasize the "learning curve" issues and not give credit when those issues have been clearly addresed.

Gasification is Commercial. The commercial lending community recognizes this, as evidenced by the successful projecting financing of two IGCC projects in Italy. And the Utility market recognizes this, as evidenced by the winning bid put forth by GSK in Tokyo Electric's IPP solicitation.

3. Cost - Although gasification has enjoyed recent commercial successes, the major factors contributing to the overall costs of projects still need improvement. In particular, installed capital cost of a gasification facility continues to be perceived as a barrier to widespread commercial acceptance. The techniques for capturing and implementing reduction in cycle time, along with improvements and standardization in engineering designs are known and being used to make improvements. With the continued efforts of many of the world class technology suppliers and engineering/construction companies represented here today, we are confident this barrier will be eliminated. Overall costs can also be reduced through multiple product facilities where incremental capacity additions to accomodate more than one product result in economies of scale.

What will be the model gasification plant in the next millennium? That's tough to predict, but our current successes would illustrate the folowing trends:

1. Multiple feeds -- The feedstock versatility of gasification mentioned earlier will be more and more common. The kinds of materials we wouldn't have imagined just 20 years ago (for example petroleum coke; municipal wastes and sludges; industrial and hazardous wastes; biomass) are frequently included in project considerations. The Texaco gasification projects at the STAR Delaware City refinery in Delaware, the Texaco El Dorado refinery in Kansas, the Ube Ammonia facility in Japan, and the Quantum Chemicals facility in Texas are examples of this.

2. Multiple products -- As the walls that used to neatly define industries come down, single facilities making multiple products will become more common. With gasification's primary output being syngas, the potential for achieving greater project economies by producing fuel, hydrogen, chemicals, steam and power from syngas is significant. Texaco gasification has long been operating in the multiple hydrogen/chemicals environment. Building on the success of the SARLUX refinery based project in Italy to produce hydrogen and power, the Texaco gasification technology is now under final evaluation for several refinery/chemical facility applications, including the Shanghai Coking and Chemical Plant in China. This facility is developing a "trigeneration" project, of which two of the three legs are already operating. This single plant is designed to convert coal into methanol, electricity and town gas -- meeting three very distinct market needs -- cleanly, efficiently and with the flexibility to adapt quickly to changing market requirements.

3. Facility Integration -- Again, with the flexibility afforded by gasification's multiple feeds and multiple products potential, the ability to locate a gasification facility adjacent to, and therefore integrate the facility with, another facility (such as an existing refinery chemical plant or power plant) provides a significant opportunity for capital cost reduction and additional revenue steam generation.

4. Facility Financing -- Just as the applications for gasification technology are expected to become more complex, the methods of funding such projects are expected to be more sophisticated than the traditional model of corporate balance sheet financing. The financial community has already demonstrated its level of comfort on recent Texaco gasification power projects. Included in this success story are the financial closure of two refinery-based "project financed" transactions and one refinery-based "operating lease" transaction. Texaco is proud of its role, which included both technical assessment and commercial performance guarantees, in supporting the financial community in achieving these breakthroughs. And we clearly stand ready to continue this support for future projects.

5. Strategic Partnering -- It should come as no surprise that if the applications are expected to become more complex and the financing more sophisticated, there will need to be an evolution from the traditional project roles of owners/suppliers/etc. Teamwork among project sponsors to better manage the risk/reward profile for a gasification facility will become a must. Texaco's strategy, for example (and we know similar strategies are being initiated by other world class companies represented at this conference) emphasizes joint venture partnerships, and includes the active participation by Texaco in roles beyond the traditional perception of Texaco as technology supplier. The additional responsibilities we are pursuing when becoming an owner include responsibility for fuel supply, for operations/maintenance supervision, for establishment of maintenance programs, and for the supply of selected gasification technical support and equipment fabrication/supply. And we recognize that each of these roles must be performed to competitive standards and to bankable, contractual requirements.

The underlying theme to the facility of the future is its versatility -- using different, and multiple feedstocks to produce a host of products for different industry segments. Adapting technologies to these applications which are fully commercial will provide the most economic and efficient means of making these products from these materials, as well as being environmentally superior.

Thank you very much.

CONSOL'S PERSPECTIVE ON CCT DEPLOYMENT

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ABSTRACT

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

I. INTRODUCTION

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

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

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

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

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

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

II. FUTURE OF THE POWER GENERATION INDUSTRY

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

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

The natural gas combined cycle (NGCC) generating systems have significantly improved cycle thermal efficiency compared to simple cycle and first generation NGCC units. On a high heating value basis, the advanced NGCC generators have achieved 52 to 55% cycle efficiencies (at sea level and in new condition). The NGCC cycle efficiency is a function of elevation above sea level (cycle efficiency decreases by 0.3%/100 ft elevation), ambient temperature and age. The installed coal fired capacity in the United States has a cycle efficiency between 35 and 37%.

CONSOL R&D developed the CONSOL Coal Quality Cost Model (CQCM) to evaluate the break-even price of coal and other fuels. The break-even price is the delivered natural gas price at which the bus bar power cost is identical for natural gas and coal. For the cost comparison, a new 500 MWe pulverized coal- fired power plant, complying with the NSPS for utility boilers and

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

Effect Of NGCC Cycle Efficiency On Break-even Coal Price

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

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

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

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

III. IMPEDIMENTS TO DEPLOYMENT OF CCT TECHNOLOGIES

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

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

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

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

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

Pending Environmental Regulations

National Ambient Air Standard for SO_2
National Ambient Air Standard for Ozone
Revised New Source Performance Standard for Utility Boiler NO_x Emissions
NO_x Emission Limits Due to the Ozone Transport Assessment Group
NO_x Emission Limits Due to OTC Regulations
Nation Ambient Air Standard for PM (2.5 μm Particulate Matter) $_{2.5}$
Utility Air Toxics Regulations

The three ambient air standards could require utilities to reduce NO_x and SO_2 emissions from existing utility boilers through the State Implementation Plans. If the cost of compliance is not excessive, these regulations could create a market for the retrofit CCTs. For example, the CCT program demonstrated the performance and economics of the Pure Air , Chiyoda, and SHU FGD processes for SO_2 control; of the NO_xOUT, Selective Catalytic Reduction, and low NO_x burners for nitrogen oxide control; and wide-plate spacing ESPs for particulate control. The OTC and OTAG processes could create a market for NO_x control technologies capable of achieving emissions of 0.15 pounds-per-million-Btu. Clearly, EPA's actions will either expand the market for CCTs or, if the environmental regulations are too severe, they could reduce coal-fired generation and the demand for CCTs.

I have been informed that the utility deregulation legislation being drafted by DOE may include an environmental compliance title. It was reported that EPA is seeking significant SO_2 and NO_x emission reductions beyond Title IV Acid Rain Control levels. DOE and EPA are discussing a concept termed "environmental comparability". While the definition of "environmental comparability" is not clear at this time, it could mean that existing SIP-regulated boilers become subject to

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

Not on the list of pending regulations is greenhouse gas control. A program to limit greenhouse gas emissions without including the entire community of nations is doomed to failure. Several countries have already stated that they will not participate in greenhouse gas emission control. Many third world countries are purchasing the standard 2400 psi, 1000 F/1000 F boiler. The third world is where the growth in greenhouse gas emissions will occur. China is currently the world's leading coal consumer. The Chinese are purchasing the standard boiler package and have stated that they will not agree to greenhouse gas limitations. Reducing CO_2 emissions will limit coal and, for that matter, any fossil fuel usage. Increasing power plant efficiency will reduce CO_2 emissions per kilowatt generated, but may not reduce the total CO_2 emissions if there is compensating growth in generating capacity.

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

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

IV. NEED FOR CONTINUED FEDERAL ASSISTANCE

CONSOL believes that government involvement in the development of technology should be minimized. However, the combination of regulatory and environmental uncertainty caused by past and potential future federal actions has changed the private sector risk analysis. Typically, when a company evaluates a development project, it evaluates the market size and the cost and performance of current technology. For example, Intel knows the cost and performance of both its current generation and the competitors' microprocessors. Developing a new microprocessor has risk, but the market size and new performance requirements can be estimated with some accuracy. Compare this to developing power systems. What is the performance requirement? The EPA can alter the performance specification by imposing additional requirements that are out of the control of the process developer. If the developing design includes a 90% NO_x removal but

EPA regulations require 95%, then the development effort may be in vain. A significant uncertainty is greenhouse gas emission reduction. What is a minimum acceptable boiler efficiency that might satisfy EPA requirements? No one can answer that question.

When regulatory uncertainty introduced by the federal government has such significant impacts on technology development, then the government has a responsibility to assume a portion of the development risk. The Clean Coal Technology Program was an example of a private sector-federal program which achieved some success. Some have complained that this was a welfare program for industry. This is far from the truth. For example, CONSOL, Babcock & Wilcox, DOE, and EPA developed low capital cost, moderate SO_2 removal processes. When the Clean Air Act Amendments of 1990 were passed, Title IV (Acid Rain Control) did not favor these technologies because of the utility-wide emission allowance and trading programs. The private sector and federal investments were made obsolete by the Congress and EPA's implementation of the Act. This situation continues to exist today and probably will continue to exist in the foreseeable future. If the United States is to remain a leader in power systems development, continued federal assistance will be required to domestically deploy CCT-demonstrated NO_x and SO_2 controls and more efficient coal-based power systems such as PFBC, IGCC, the advanced supercritical boiler, the Kalina cycle, and others.

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

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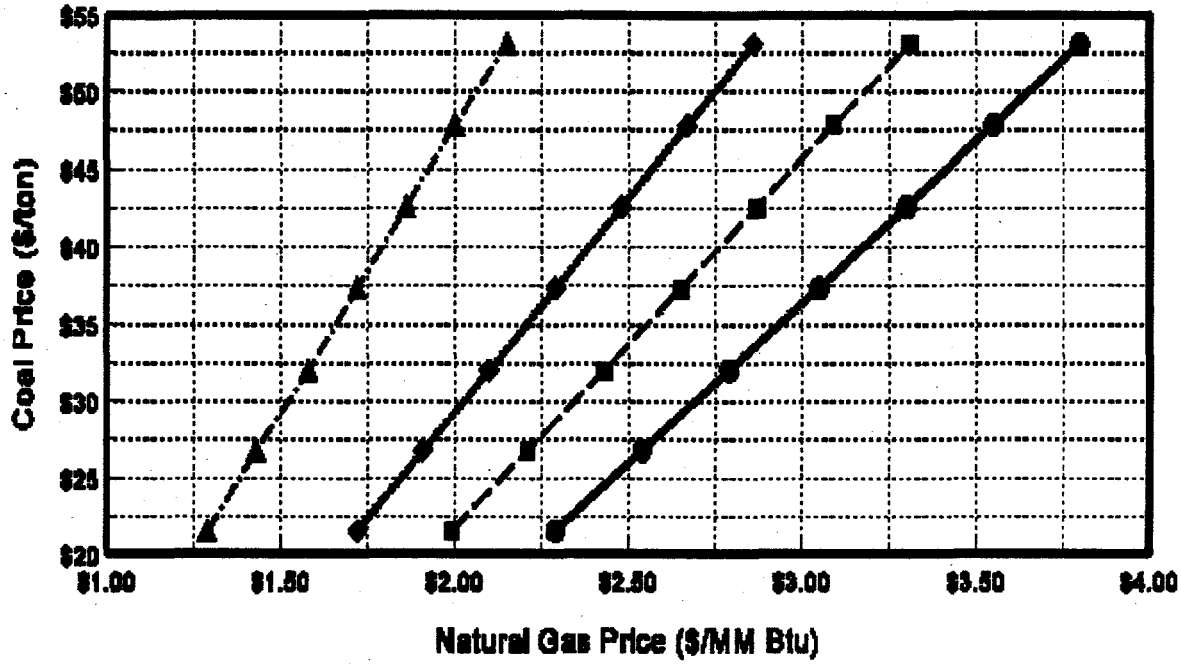
Break-Even Fuel Prices
New 500 MW Power Plant (Today's Efficiencies)
Coal @ 36.2% HHV -- Natural Gas @ 45.6% HHV



STATE PERSPECTIVES ON CLEAN COAL TECHNOLOGY DEPLOYMENT

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ABSTRACT

State governments have been funding partners in the Clean Coal Technology program since its beginnings. Today, regulatory and market uncertainties and tight budgets have reduced state investment in energy R&D, but states have developed program initiatives in support of deployment. State officials think that the federal government must continue to support these technologies in the deployment phase. Discussions of national energy policy must include attention to the Clean Coal Technology program and its accomplishments.

I. INTRODUCTION

I'm pleased to be a part of this panel to represent the states' perspectives on the future of Clean Coal Technologies. Before I begin, I would like to thank all of the state officials who took time to talk to me about their views and activities.

States have been active partners in the Clean Coal Technology Program since its beginnings. Of the 40 projects funded through the program, 15 received support from state governments or state universities. The states of Alaska, Ohio, Pennsylvania, Indiana, Illinois and New York and the universities of Georgia and North Dakota all have participated in Clean Coal projects. Ohio alone was a funding partner in six projects, and Illinois and Pennsylvania supported two projects each. States provided only about 3% of total program funding, but their participation was crucial in building political and funding support for many of the co-funded projects.

It's always been clear that the participating states perceive they have something to gain from the commercial development and deployment of Clean Coal Technologies. The states' role in Clean Coal Technology development has been a parochial one, aimed at fortifying specific economic strengths as well as providing long-term energy and environmental benefits to their citizens.

When the Clean Coal Technology program began in 1985, there was a very different culture in states than the one that exists now. At that time, a typical debate in my state legislature involved which tax to raise, how to come up with a dedicated funding stream, how much more bonding authority to approve -- basically, how to get the money to pay for more and bigger programs.

Coal development programs enjoyed strong political and funding support in a number of states even before the federal Clean Coal Program was established. In Illinois, for example, we had already cofunded several technology demonstration projects by 1985. We were embarking on a

series of industrial-scale demonstrations using advanced fluidized bed combustion systems. We were developing a demonstration of the Chiyoda scrubber at the University of Illinois. We had just received funding for a major coal R&D effort, in addition to participating in the national Clean Coal Technology program. Clean energy was a real priority in state and national programs and policies.

Ten years later, states are still interested in clean coal technologies, but there have been some fundamental changes in the type and amount of support that states provide. I'm going to briefly discuss some of the challenges states face and how they have influenced state activities.

II. CHALLENGES

Many speakers over the last few days have cited the challenges facing Clean Coal Technology deployment: emerging environmental issues, electric utility deregulation, the current excess capacity in domestic utility markets, the dynamic relationship between coal and natural gas, the costs and status of technology deployment, et cetera. All of these factors have undoubtedly influenced the decisions of all of the participants in the Clean Coal Program in some respect.

The unique differences between states make it difficult to talk about a "generic" state outlook or response. From the state perspective, it makes sense to look at these challenges in a kind of aggregate way, and you can boil them down to two central forces: The first is a kind of "uncertainty factor," related to all of the regulatory and market issues that other panelists have discussed. The second is related to the budget problems that states are experiencing. These forces together have changed how states see their role in any future technology deployment initiatives.

Everyone here understands the regulatory and market issues. As of June 30, 1996, regulatory commissions in 44 states had adopted or were evaluating utility deregulation alternatives, according to a study by the General Accounting Office. There are at least 12 deregulation bills in the works in Congress, although it's still unclear whether legislation will advance during this session. Illinois' Office of Coal Marking and Development has produced a white paper on the effect of utility restructuring on our state, with specific attention to impacts on the coal industry. The paper predicts several major changes in utility operations, including consolidation, a switch to performance-based regulations, and the development of regional power pools. It also predicts that with an emphasis on efficiency, existing coal-fired power plants will increase production in the short run due to their lower marginal generation costs. Over the longer term, however, the older, less efficient plants will be retired and replaced with or converted to natural gas. Other states have similar predictions, although there is an emerging body of experts who believe that gas-fired, highly efficient "micropower" plants will supplant utilities as we know them by the end of the next decade. In either scenario, the outlook for new coal use technologies is uncertain.

The impacts of change in environmental regulations on the coal industry are well documented. In 1985, the FOB price of Illinois coal was $30.80/ton; a decade later, the price had fallen 29%, to $21.80/ton. Mine employment dropped 67% over the same period. Electric utility purchases of

Illinois-mined coal fell 25%, from 54.5 million tons to just over 41 million tons. Ohio, Pennsylvania, Indiana, and Kentucky -- the states traditionally most active in coal research and development -- all experienced similar decreases. Meanwhile, exports to the Midwest from the Power River Basin reached an all-time high. Still to come, of course, are the impacts of Phase II of the Clean Air Act. In the environmental arena in particular, uncertainties are driven by forces that are external to state government and it's difficult for states to formulate meaningful technology policy in response.

Then there's the fiscal challenges to states. Over the last decade, states have increasingly had to cope with a structural imbalance between the rate of growth of state revenues and the rate of growth of expenditures. This imbalance has affected every state in some way and it's almost all due to increases in the costs of Medicaid, which pays for health care for the poor and elderly. From 1990 to 1995 these costs -- which are mandatory entitlements -- grew by almost 20% per year, while state revenues increased by about 5% a year.

Today, these Medicaid costs make up 20 to 30% of our state budgets. In Illinois alone, the tab is $6 billion a year. It's impossible to argue that this is not a priority, yet every single other state initiative -- education, child welfare, prisons, mental health, law enforcement, as well as energy and environment and economic development -- has been affected. In the 1990s, states have stopped looking for new ways to spend money, because we are told how we **must** spend it.

Governors and state legislatures have not been inclined to raise revenues to make up the difference. In fact, according to the most recent *Fiscal Survey of the States*, a report produced annually by the National Governor' Association and the National Association of State Budget Officers, 35 states actually decreased taxes in some way last year, continuing a trend that started in the early 1990s.

The regulatory and market uncertainties combined with serious fiscal constraints have led, directly or indirectly, to changes in state programs. In August 1996 *Governing* magazine reported that many states had closed or restructured their energy offices. In fact, Washington, New York, Pennsylvania, Illinois, Mississippi, North Carolina and Tennessee have all recently consolidated their energy programs into larger departments. In the last 6 years, the number of employees in state energy offices has fallen by an average of 14.5%, according to a survey by the National Association of State Energy Officials.

State funding for energy R&D has also declined. In 1995, the General Accounting Office looked at changes in electricity-related R&D for technologies cited by a Secretary of Energy task force as having high and medium long-term potential for meeting national energy goals, including fuel cells, coal gasification and advanced turbines as well as alternative energy technologies. The report noted that "of the 11 large (R&D) programs in the nine states reviewed, 7 have been reduced in the last three years." Overall, the GAO study found a 30% reduction in state funding for advanced power generation R&D, from $83 million to $58 million, over the two year period surveyed.

I should also note here that the federal government and electric utilities also reduced R&D funding over the same period. Overall tight budgets and the increased competition expected from utility deregulation were cited as the principal reasons for declining support.

III. STATE ACTIVITIES.

The good news is, even though programs have been downside and restructured, there is still a significant amount of state activity and interest in the support of coal and clean coal technologies. The state energy officials that I interviewed consistently cited a sharpening of goals in their programs and a feeling of greater accountability in setting economic development priorities.

In those states that have traditionally pursued clean coal technologies and coal development, the approach today appears to have shifted from big incentives for major development projects to more pragmatic, focused actions such as exploration of niche markets, promoting export opportunities, technical assistance and education.

There is one notable exception to this generalization. Mississippi, one of a handful of states projected to need new generating capacity, is undertaking a major lignite development project that will likely use an advanced, clean technology. Last year, the Mississippi state legislature expanded the scope of general obligation bonding authority and earmarked $30 million toward the development of a 400 MW lignite-fired generating plant and associated industrial complex, diverting bonding authority previously earmarked for the Strategic Petroleum Reserve. A coal company, electric utility and the state and local government are partnering in the project, which is still in its developmental stages.

In Kentucky, a state with a long history of support for coal research and technology projects, state officials have made a decision to focus their efforts on education at the elementary school level. Bill Grable, director of the Kentucky Coal Marketing and Export Council, plans to personally visit public schools throughout the state to bring students the message of the importance of coal to the state economy and the opportunities for environmentally sound coal use.

Pennsylvania has restructured its energy office and put it in the state Department of Environmental Protection. The Pennsylvania Energy Development Authority no longer exists as an active R&D organization. The new Department of Environmental Protection has become business-friendly, according to state officials, and has created the Office of Compliance Assistance to work with companies on pollution reduction. This would include assistance in planning for advanced technology retrofit projects.

In Ohio, the state is exploring niche markets for coal, including industrial projects. Ohio appears to be the only state where programs are specifically configured to promote Clean Coal Technology deployment. The Ohio statute allows state funding for up to three replications of a first-of-a-kind technology. Other states might consider such a statute to allow for participation in the deployment phase.

Illinois has a number of major projects ongoing. The state has also undertaken specific activities relevant to the deployment of Clean Coal Technologies, including the development of an interactive, computer-aided design package for State of the Art Power Plants using advanced technologies. Illinois is also supporting a series of workshops to bring together technology manufacturers and electric utility operators to share solutions to changing environmental standards. In addition, Governor Edgar has recently announced a multi-million dollar plan to expand markets for Illinois coal and improve the state's coal transportation, export and delivery systems. Our Lieutenant Governor, Bob Kustra, has formed a Coal Strategy Group to explore ways to improve the economic viability of Illinois coal. The group is made up of leaders of the Illinois Coal Association, the United Mine Workers of America and several state agencies. The Coal Strategy Group has been active in development of legislation to support the state's coal industry.

IV. THE NEED FOR LEADERSHIP

Realistically, individual states will not make much of an impact on Clean Coal Technology deployment in the near term. State energy officials are highly supportive of deployment, and they think that these technologies merit continued federal support and leadership in the deployment phase. Federal tax incentives, expedited permit protocols, targeted export assistance and graduated support for successive replications were some of the ways that states suggested to help promote commercial deployment.

It's interesting to note that one regional organization, the Southern States Energy Board, has established an effort to promote the increased use of U.S. coal and the transfer of Clean Coal Technologies. SSEB's activities include participation in major coal forums to serve as a focus for state interest in Clean Coal Technologies, facilitating discussions of market development and penetration potential for these technologies, and identifying institutional barriers to their use. Other states might want to join forces with SSEB or organize their own regional effort.

State officials also stressed the importance of raising the profile of the program at the national level. The Clean Coal Technology program has not received nearly enough credit for what it has accomplished. I'm not being critical of the federal Clean Coal program leadership, because they've done an admirable job of keeping interested parties informed about its accomplishments. States are concerned, however, about the lack of attention to this program in national policy, and beyond that, the lack of attention to any coherent policies that incorporate realistic energy goals.

Our national political leaders seem to spend a lot of time hyping things like public-private sector cooperative efforts, development of emerging markets for technologies, export opportunities, building national excellence, and promoting environmental quality. These are all attributes of the Clean Coal Technology program. It should be recognized as a model initiative and the embodiment of important national policy goals. We are taking a lot of rhetorical and actual pride in our ability to get things done, but, as far as energy is concerned, there is very little attention given to what it is we should do and why we should do it.

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