The case for coal

Discussions of coal as a viable energy source of the future usually end with cries of concern about its environmental impact. However, these discussions take a different tack when a generating company of the 21st century considers the many factors that affect the cost of producing power. These include the choice of fuel, changes in technology that alter emissions, and the costs of offsetting carbon dioxide (CO_2), sulphur dioxide (SO_2) and other pollutants. Those in the power business who make informed investment decisions and are environmentally concerned should question the premise that, under all conditions, coal is dead.

Many have long considered coal the least desirable fossil fuel because of its environmental impact. It causes acid rain and contributes to global warming. Some concluded that nothing could improve its status. Then came the US Clean Air Act Amendments of 1990. Emissions trading and the economic viability of low sulphur coal, sulphur scrubbing, and nitrogen oxide (NOx) controls have altered the belief that the only way to eliminate acid rain is to reject coal as an energy source. But this offered only a temporary respite in the belief that coal was dead. Low gas prices bolstered the argument that there was a clean and cost-effective alternative to coal.

After an extended bull market in gas prices, however, and an energy crisis in California, things are changing. Power plant investment decisions are far more complex today and must account for the costs associated with environmental compliance.

Under what conditions might coal-fired generation remain attractive in the face of strict environmental constraints? To answer this question, we examined the economics of new power plant construction in a manner that creates a special new class of hypothetical power plants: the emission-neutral plant. We assume a new power plant must fully offset its emissions of SO_2, NOx and CO_2 via assumed cap-and-trade systems. Analysis of the emission-neutral plant reveals some interesting and surprising conclusions about fuel choice and environmental costs.

For example, assume a utility must choose among the following alternative investments for a new power plant: coal; gas combined cycle (CC); gas combustion turbine (CT); wind; and solar. Assume the features of each plant reflect the most efficient and clean technologies that are commercially available.[1] The coal and CC plants are run as baseload units (ie they produce 85% and 80% of potential annual production, respectively). The GT plant runs at peak demand with a low capacity factor (15%). The wind and solar plants are smaller in capacity and are assumed to operate at 30% of capacity.

We assume a natural gas cost of $4.00/million BTU and a coal cost of $1.21/million BTU, (today's prices). Table 1 presents the assumed prices for emission allowances.

The emission rates for each plant type (presented in Table 2) reflect a coal plant that uses low-NOx burners and selective catalytic reduction technologies to control NOx (and mercury), and has wet limestone SO_2 scrubbing (95% effectiveness). The CC gas plant also uses low-NOx burners and selective catalytic reduction technologies to control NOx while the CT plant uses steam injection.

Table 3 presents the capital and operating/maintenance costs reported in the March 1998 EPA study cited in footnote 1. Capital costs are spread evenly over 20 years. The fifth column shows the total cost per megawatt-hour of electricity produced by each emission-neutral plant assuming a CO_2 price of $5/ton. The last three columns indicate which plant type can produce power at the lowest cost for various CO_2 prices (including $0/ton).

The chart shows power generation costs ($/MWh) for each of the five plant types for various CO_2 prices, assuming gas prices of $4.00/million BTU. Under our fuel price assumptions, total production costs at an emission-neutral coal-fired plant are below those of a CC gas plant when CO_2 prices are below $10/ton.

In another scenario we find that a $5.00 gas price makes a new emission-neutral coal plant less costly than a CC gas plant if CO_2 prices are below $21. Conversely, a $3.00 gas price would make a CC gas plant the cheapest option. Naturally, volatility of gas prices increases the riskiness of gas plants.

In the hypothetical scenario of emission neutrality for new fossil-fuelled power plants, wind-power is the least-cost option. But, while new technologies are making wind power cost-competitive, even without comprehensive emission offset requirements for fossil plants, it may not be feasible to meet demand growth exclusively with wind facilities. Their production is inherently variable and they are not feasible in all locations. At the best sites, however, wind plants can be expected to achieve a capacity factor of over 30%, which reduces the cost per hour of generation.[2]

In essence, power generators in the 21st century face indifference curves when choosing to build new power plants. Various combinations of fuel prices, emissions prices (and rules) and technologies will yield identical costs of production. A clean-burning gas plant facing high gas prices may have no cost advantage over a coal plant that faces low fuel costs but high environmental costs. Fully-offset coal plants can be the least-cost option in locations such as the western US (eg Montana) where power plants can be built right on top of abundant coal reserves.

New coal-fired plants are a viable option under some circumstances, even when their emissions are fully offset. It is also clear that the choice among alternative plant types is quite complex. For example, our model assumes technology is constant and does not include emissions associated with coal extraction.

With US public policy encouraging reliance on domestic energy and sophisticated private sector investment decisions, we may see more coal-fired power plants in the near future.

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1 *Analyzing Electric Power Generation under the CAAA*, Office of Air and Radiation; US EPA, March 1998

2 American Wind Energy Association

Table 1. Environmental compliance cost ($/ton)

Commodity	Price
CO_2	$5, $10
SO_2	$160
NOx	$1,500

SO_2 and NOx figures reflect market prices. CO_2 price based on projections and early trading experience

Table 2. Emission rates of newly built power plants (lbs/MMBtu)

Plant type	CO_2	SO_2	NOx
Coal	207	0.08	0.1
Gas	117	0	0.024
Wind/solar	0	0	0

Source: Clean Coal Technology Compendium, EPA, DOE

Estimated total production cost/MWh for emission-neutral power plants

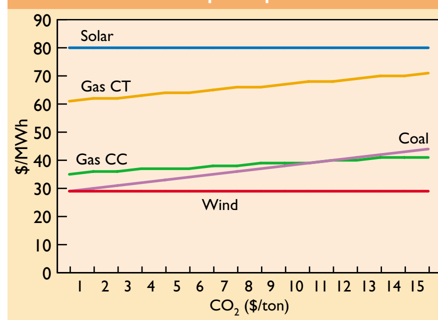

Table 3. Cost estimates for emission-neutral power plants ($/MWh)

Plant type	Levelised capital cost: over 20 yrs ($/MWh)	O&M costs (variable and fixed) ($/MWh)	Total fuel price ($/MWh)*	Total cost† ($/MWh) ($CO_2$ = $5)	Rank 1 (CO_2 = $0)	Rank 2 (CO_2 = $5)	Rank 3‡ (CO_2 = $10)
Wind (50MW)	19	10	–	29	2	1	1
Coal (400MW)	9	7	11	34	1	2	2
Gas CC (400MW)	4	4	27	37	3	3	2
Gas CT (80MW)	14	2	44	64	4	4	3
Solar (5MW)	77	3	–	80	5	5	4

* Coal price = $1.21/million BTU (about $25/short ton), gas price = $4/million BTU; † Includes CO_2, SO_2, NOx costs (see table 2)
‡ The costs for operating a coal unit and a CC are approximately equal at $10/ton CO_2