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Can the black stuff turn green?

Coal In The Environment, World Coal Institute Conference, London, 3-5 April 1991

Coal is mostly carbon. When you burn it, you turn the carbon into carbon dioxide (CO2). This simple chemical reaction has been taken for granted ever since people first burned coal. Suddenly, however, it has emerged as the gravest problem facing the world's coal industry.

The World Coal Institute, sponsored by some 20 of the world's major coal companies, takes CO2 seriously - so much so that it dominated the programme of the Institute's first-ever conference. The conference, under the rubric of 'Coal in the Environment', was attended by more than 500 delegates from 43 countries. Given coal's environmental problems, the conference might have been a sombre affair; but it was not. Instead, the mood was that of an industry preparing to meet a major challenge head-on.

Coal industry conferences tend to be hard-nosed and businesslike. 'Coal in the Environment', however, burst into life with a sprawling multimedia fanfare, a glistening slide show accompanied by thundering synthesizer chords that made the conference centre feel like a space shuttle taking off. Coal people may feel, with some justification, that coal has too long been taken for granted - that the time has come to proclaim its neglected virtues. Subjected to this audiovisual onslaught, however, an onlooker could not help musing 'Methinks the industry doth protest too much'. Fortunately, the proceedings that followed largely dispensed with glitz and hyperbolic self-congratulation, and concentrated on the gritty realities of coal in the environment of the 1990s.

Opening the proceedings, Britain's Secretary of State for Energy, JohnWakeham, wasted no time in making his own position clear. 'Coal was instrumental in forging the world's first industrial revolution here - the 'dark Satanic mills' of William Blake. . . ' - not perhaps the happiest of images to evoke, however apt to the theme of the conference.

'As new evidence about the threat of global warming has mounted ... coal burning has now come to be increasingly widely perceived as one of the most damaging of all sources of world environmental pollution ... In future we are going to have to find improved means of adapting coal to our environment rather than the other way around. The world coal industry cannot evade this issue - nor, to its credit, has it tried to do so.'

A World Climate Convention is due for completion by June 1992, with 'major implications for both coal and other fossil fuels'.

'The future for coal now seems likely to turn increasingly on the development of ... clean coal technologies ... I believe there is now an overwhelming case for substantially increased global collaboration in the funding and development of clean coal technology, including a bigger and more commensurate role for technology transfer.

'If coal is to maintain its position as the world's leading fuel source I am convinced that it now has little option but to try to meet the challenge of reducing carbon emissions head on - through the development of genuinely cost-effective, clean coal-burning technologies.'

Wakeham's words bore, to be sure, little relation to the actions of his own Department in the UK, whose support for clean coal technology has been belated, reluctant and meagre. But they set the scene for the conference, framing concisely the technical, economic and political labyrinth through which coal must henceforth find its way. It starts, of course, from a position of some strength, as Helga Steeg of the OECD International Energy Agency stressed. Coal provides 21% of OECD energy, up from 18% in 1973. OECD member governments see this gradual increase continuing to 2000. But 'the main pressures on coal are readily identifiable as environmental issues and competition from other fuels' - competition itself made sharper by environmental issues. Helga Steeg likewise endorsed the key role of clean coal technology. But 'greater efficiency on the part of consumers, greater use of less carbon-intensive fuels and greater efficiency in coal-burning plant all point to lower future coal demand projections than currently envisaged'.

After the downbeat reflections of Wakeham and Steeg, Robert Gentile of the US Department of Energy treated delegates to a visionary panegyric calling for a 'new technological order' for the world, with the USA creating 'a clearing-house for the export of coal technology' to 'provide information to international buyers on the economic, environmental and technical advantages offered by clean coal technologies' - those, that is, from US manufacturers. Gentile also insisted that if the initiatives of the US government's new National Energy Strategy are implemented 'we believe it will be possible to reduce US emissions of greenhouse gases to at or below 1990 levels - with no need for counterproductive carbon taxes or government-directed fuel choices'.

Ed Rubin of Carnegie Mellon University called global climate change 'clearly the most significant long-term threat to the use of coal' - 'it would be naive to think that coal will not be singled out as a villain in the global climate debate'. 'Proposed carbon taxes to mitigate greenhouse gas emissions would fall most heavily on coal and could cripple its growth by the middle of the next century ... more innovative and efficient coal use technologies offer the best prospect for dealing with climate change issues.' He itemized elements of strategy to meet the environmental challenge: technology innovation; modernization of existing coal-use technology 'to upgrade or replace ... all the remaining antiquated and inefficient coal-processing units throughout the world'; a sharper focus for research and policy on climate; and expanded support for education and training of the next generation of coal technologies.

Speaking at the conference dinner, Domingo Siazon, director-general of the UN Industrial Development Organisation, noted that:

' ... most of the increases in carbon dioxide emissions today originate in developing countries ... In future, developing countries must not be burdened with inefficient and polluting coal-burning plant ... they are uniquely positioned to take advantage of recently developed clean coal technologies and avoid the mistakes that the richer nations have committed ... over the past 100 years ... It would be in the interests of all nations, if the developing countries were given access to the new range of clean coal technologies currently being developed and demonstrated in the industrialized countries.

However:

'the question of who pays for the higher costs arising out of an environmentally sounder approach to industrialisation in developing countries ... is crucial. Given the current debt problems and resource constraints ... and ... that most pollution to date was caused by the developed countries, the most appropriate principle would seem to be that the developed countries mobilise and provide the additional resources.'

This key issue was to resurface at length later in the proceedings.

The overviews outlined above set the tone and the focus for two days of detailed presentation on particular aspects of coal's environmental context. The greenhouse effect is by no means the only environmental issue confronting coal; in both the main proceedings and the technical sessions speakers addressed problems of sulphur and nitrogen emissions, other trace substances, water and solid waste. But CO2 was indisputably the overriding concern, and the problem most difficult to solve.

Jae Edmonds of the Pacific Northwest Laboratory, describing the sources and amounts of the various greenhouse gases, set CO2 in its historical context, and juxtaposed it with the other anthropogenic gases that may disturb the radiative balance of the atmosphere - in particular methane, nitrous oxide and chlorofluorocarbons. His paper included four solid pages of references.

'More is known about fossil fuel CO2 emission than any of the other gases. Since 1860, global annual emissions of fossil fuel CO2 have increased from 0.1 to approximately 5.7 Pg/yr (billion tonnes per year) in 1988 ... The United States, the Soviet Union and the People's Republic of China account for half of the world's fossil fuel CO2 emissions ... Global average per capita emissions of fossil fuel CO2 to the atmosphere are approximately 1 tonne C/capita/yr. United States emissions exceed 5 tonnes C/capita/yr.'

Edmonds noted the different carbon content of the fossil fuels - coal being the highest per unit of energy released. 'The fossil fuel resource base provides no constraint on future atmospheric CO2 release. The present atmospheric stock of carbon is approximately 740 PgC (billion tonnes of carbon). The estimated resource of fossil fuels is huge by comparison.' Considering only those resources recoverable under present technologies, conventional oil and natural gas represent only about 400 billion tonnes, but coal some 4 000 billion tonnes - about 3 200 billion tonnes of it in the USA, the USSR and China.

After surveying other sources of CO2, and other greenhouse gases, Edmonds considered the question of reducing greenhouse emissions:

'As of December 1990 fourteen nations (Australia, Austria, Belgium, Canada, Denmark, France, Germany, Japan, The Netherlands, New Zealand, Norway, Sweden, Switzerland and the United Kingdom) have established targets for reductions in greenhouse gas emissions other than CFCs, principally CO2. A framework convention was held ... February 4-14, 1991 in Chantilly, Virginia, USA, to discuss a process for determining if an international agreement is required and to establish a process for creating such an agreement.'

Edmonds listed five ways to reduce CO2 emissions, from fossil fuels:

1. Energy conservation: reducing the energy required to provide any energy service ... Energy conservation does not mean doing without;

2. Fuel substitution ... for example from coal to natural gas or from natural gas to nuclear or renewable energy;

3. Scale: changing the scale of the overall human and energy systems, as for example by changing population, or the level of overall economic activity or simply doing without ... the fruits of energy use;

4. Activity mix: changing the composition of energy using activities ... for example ... from ferrous metals to ... plastics, or away from goods and toward services;

5. Carbon removal and recovery: removing carbon either after combustion via traditional scrubbing or tree planting, and disposing of the carbon in a permanent repository, or removing the carbon before the fuel is combusted and then disposing of the carbon.

All emissions reductions options apply one or more or the above principles.

Edmonds then assessed the potential and implications of each, noting that all pose problems, not least about costs. He cited some 50 estimates for the cost per tonne of carbon removed under various scenarios; the figures illustrated mainly the vast uncertainties involved.

Uncertainties likewise permeated the effort to assess the consequences of changes in the global atmosphere, as Sir John Mason made clear. A former director-general of the UK's Meteorological Office, he is now senior advisor to the Global Environment Research Centre at Imperial College in London. He delivered a magisterial lecture on the science of the greenhouse effect - what is known and, more importantly, what is not. He described the computer models used to track global climate, indicating how they are designed, the data they require and the data they generate. He drew particular attention to the problem of cloud cover and its effect on the global climate system - one of the key sensitivities of the models, as yet under debate. In his view:

'It is virtually certain that the troposphere is warming very slowly in response to the continually increasing concentration of CO2 and other greenhouse gases, but the signal is as yet too small to detect above the large natural climate variations, partly because it is being delayed by the thermal inertia of the oceans ... Unfortunately, the differences between the various model predictions ... are too large to provide firm guidance for major policy decisions ... It would appear that we have a breathing space of some 50 years, but this may prove optimistic; in any case, it is none too long.'

While some speakers were dealineating the dimensions of coal's environmental problems, others were proposing elements of the solutions. As the overview presentations stressed repeatedly, one key to coal's future must be the rapidly expanding catalogue of new coal-use technologies. Ben Yamagata, director of the Clean Coal Technology Coalition in the USA, reviewed the uneven history of US government support for clean coal technology. Beginning in the 1970s as a response to concern about acid rain, it has survived severe political and budgetary vicissitudes and emerged more or less intact, as a programme that now also addresses coal-related questions of air quality, energy independence, improved efficiency and climate change. The US government says that the programme represents an outlay of US$5 billion, more than half of the money coming from industry.

Lowell Miller of the US Department of Energy illustrated its scope; some 35 hardware projects are already in progress, some at power-plant scale, showing substantial promise for many different applications. But the way ahead remains rocky. The US Clean Air Act amendments, imposing stringent limits on sulphur emissions, may prompt utilities simply to opt for scrubbers, accepting the efficiency and CO2 penalty they entail, rather then pressing on to use the high-efficiency low-emission technologies that are still at the demonstration stage.

Nevertheless, the rate of evolution of the new technologies has been impressive. According to Mikko Hupa of the Abo Akademi in Finland, more than 700 fluidized-bed combustion (FBC) units are already in operation, an increase from 1000 MW in 1980 to 28 000 MW in 1989, of which some two-thirds is circulating FBC (CFBC). The largest units now in operation have capacities of more than 300 MW thermal. FBC - especially CFBC - can remove 90% of sulphur by adding limestone to the fuel, and reduce NO, to below 90ppm, although Hupa noted that minimizing one emission might make another increase.

John Rackley of Babcock & Wilcox reviewed the important option of retrofitting or repowering older combustion plant with clean coal technologies, offering a lengthy shopping list of pre-combustion, combustion and post-combustion innovations. Sven Jansson of ABB Carbon reported on one of the leading contenders, pressurized FBC (PFBC). ABB Carbon and its partners have three demonstration PFBC plants now in the commissioning phase - a 73 MWe unit at Tidd, Ohio, a 79MWe unit at Escatron, Spain, and a twin-unit cogeneration plant at Vaertan, burning coal in the heart of Stockholm, Sweden. According to Jansson all the projects are proceeding to plan, and the plants performing to specification; other units are now under active discussion.

PFBC's closest rival for the next generation of utility units is integrated gasification combined cycles (IGCC). R P Jensen of Shell described the general concept of IGCC, noting the range of technologies now competing for the lead. Shell's own gasification process will be the basis for the 250MWe demonstration IGCC plant now under construction at Buggenum in the Netherlands, due to start up in 1993. Other units are also in the pipeline, and manufacturers including Texaco, Dow, Krupp-Koppers, Lurgi and Schwarze Pumpe are jockeying for position; according to Jensen, 'For many utilities the question asked concerning IGCC is not 'if' but 'when'.'

British Coal, long a leading proponent of advanced coal-use technology, wants to boost efficiency yet higher by using an airblown gasifier in a gas-turbine 'topping cycle' that could be added, for instance, to a CFBC or PFBC unit. The gasifier char would be burned in the combustor, raising steam for combined-cycle operation. Andrew Minchener described the project; it has just received a modest injection of financial support from the UK government, whose previous attitude - total lack of interest in 'clean coal' technology - may at last be changing for the better.

Until very recently all the proponents of innovative coal-use technologies appeared to be on the same side, making common cause against the forces of tradition. Perhaps the healthiest sign of the commercial potential of the technologies is that this united front is rapidly breaking down. PFBC and IGCC are squaring off with claims and counter-claims, while topping cycles, humid-air turbines, steam-injected gas turbines, fuel cells, and other advanced concepts are each making a case v all the others.

One of the advantages claimed for IGCC is that it lends itself to yet a further stage in the attack on CO2. Three Dutch papers reported on the possibility of removing CO2 from IGCC fuel gas, leaving only hydrogen to be burned in the gas turbine, and injecting the CO2 into disused underground gasfields. This would reduce fuel efficiency and raise the price of electricity - but it is clearly feasible, indeed straightforward, always provided a suitable gasfield is within reach, perhaps 100km. Research on CO2 removal clearly warrants further investigation.

The final session of the conference confronted perhaps the crucial question about coal; what will be its role in developing countries? Anthony Churchill of the World Bank outlined the scale of the problems - not merely financial or technical but also cultural - that will inhibit improved efficiency and environmental control of energy-use in the Third World. A panel discussion did not dispel the air of gloom; and the conference broke up in sober mood.

Nevertheless, it represented a significant achievement, indeed a breakthrough. Scarcely any time was wasted in attempting to deny the existence of the greenhouse problem. Participants acknowledged the problem, and accepted the imperative to do something about it. The debate concentrated on questions of emphasis and priorities among solution; but the solutions were being actively pursued, for early implementation. One startling implication in particular emerged repeatedly. Had the time not come for coal producers themselves to diversify downstream? Perhaps, henceforth, they might not merely produce and sell coal, but play a part in how it was used.

Electricity suppliers were buying into coal mines; perhaps coal producers should begin investing in clean coal power plants, to be where the coming action is.

At previous coal conferences, whenever the topic of 'environment' came up, delegates surged to the exits. At this first World Coal Institute conference the transformation was remarkable. Some diehards, to be sure, disappeared into the lobbies to continue buying and selling coal; but the majority remained in the hall, listening intently. If the issue of 'coal in the environment' continues its present trajectory, the next World Coal Institute conference in April 1993 will have delegates on the edge of their seats.

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