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**Fuels for Electricity Supply
After the UK Coal Review**

**Peter Pearson (editor)
with papers by Antony Baker, Nigel Evans,
Peter M.S. Jones and Colin Robinson**

May 1993



**Department of Economics
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PREFACE

This Discussion Paper contains four papers on the theme *Fuels for Electricity Supply after the UK Coal Review*. The papers arose out of a seminar on this theme, held at the University of Surrey in early April 1993, following the publication in March of the Government's White Paper, *The Prospects for Coal*.¹ The Government's coal review - and the two Select Committee reports that preceded its publication - was the result of the political upheaval which followed the announcement on 13 October 1992 of the proposed closure of 31 coal pits. The authors of two of the papers reproduced here, Anthony Baker and Colin Robinson, also spoke at an earlier Surrey Energy Economics Centre Seminar, *The Economics of Pit Closures in the UK*, held in December 1992. Their views at that time may be found in an earlier SEEC Discussion Paper.²

The first paper, *Fuels for Electricity Supply after the UK Coal Review*, by **Colin Robinson**, presents a mixed judgement of the White Paper. Robinson concludes that it has avoided some of the worst pitfalls of such reviews and has done, "half a job" quite well - better than the January 1993 Report of the Trade and Industry Select Committee. In Robinson's view this latter report shows little understanding of the problems of regulating the energy market in the manner that it suggests.

The second paper, *Black Fuels and the White Paper*, by **Anthony Baker**, seeks to clarify a number of the underlying issues and examines, from a UK coal industry viewpoint, the developments in fuelling for electricity generation that may now occur. Baker discusses British Coal's projected electricity supply industry fuelling balance and examines both factors that may hinder and factors that may assist British Coal's efforts to sustain its market.

The third paper, *The Future of Gas*, by **Nigel Evans**, examines two alternative views of the future of gas following the White paper. View A, suggests that given the already very large commitment to combined cycle gas turbine (CCGT) generation in the UK, there may be no need for new capacity of any type for some time. Even if there were, we

should not assume that gas will necessarily be the only option for new generating plant. View B suggests, however, that the development of CCGTs will continue, with new commitments amounting to several Gigawatts being made over the next three to five years. Evans examines the arguments that can be made to sustain View B, concluding that the attractions of gas as a power sector fuel mean that this view cannot be discounted.

The final paper, *Nuclear Power and the Coal Review*, by Peter M.S. Jones, argues that the White Paper does not alter nuclear power's position in the overall UK energy mix - but that this was in some ways inevitable if the promised 1994 (but now 1993) nuclear review was not to be pre-empted. Jones, therefore focuses on the future and examines a range of issues that are likely to arise in the nuclear review. He argues that there is a number of reasons in favour of maintaining a different mix of energy sources from that which the operation of market forces might produce.

Peter Pearson
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I FUELS FOR ELECTRICITY SUPPLY AFTER THE UK COAL REVIEW

Colin Robinson, University of Surrey

1 INTRODUCTION

In December of last year, I pointed to some dangers in the Coal Review which the Government had ordered on 21st October 1992, after declaring a moratorium on closure of 21 of the 31 threatened pits (1).

2 DANGERS IN THE COAL REVIEW

The essence of my argument was that, since there was plenty of coal-burning generating capacity available, it would be easy to devise means of keeping that capacity in use by continuing to protect the British deep-mined coal industry - coal imports could be restricted, nuclear stations could be closed, gas-fired power station proposals could be vetoed, electricity imports from France could be reduced or opencast production could be limited.

However, instead of adopting a protectionist arithmetic approach - thinking of the number of pit closures which would be 'politically acceptable' and then maintaining the amount of protection which would just keep in being the necessary tonnage of deep-mined coal - I suggested the Government should attack the fundamental distortions in the British energy market: it should privatise coal, complete the liberalisation of the electricity market by making generation more competitive and end subsidies for nuclear power. The aim would be to create privatised coal and electricity markets in each of which rivalry existed among actual and potential suppliers.

3 JUDGING THE WHITE PAPER

Belatedly, the Coal Review White Paper emerged at the end of March 1993 (2). How should it be judged? Perhaps the fairest statement is that it has avoided some of the worst pitfalls of such exercises and has done half a job quite well. It seems to me a much better document than the January 1993 Report of the Trade and Industry Select Committee (3) which, as usual with such documents, shows little comprehension of the problems of regulating the energy market in the ways it proposes.

The bad news - and the reason why only half a job has been done - is that there is no sign of a fundamental review of the electricity supply industry. The good news is that the Government has resisted a number of temptations. There will be no attempt to force taxpayers or electricity consumers to pay for the continued use in power generation of large amounts of expensive deep-mined coal. Output support will be for a limited period and for a limited amount of British-produced deep-mined coal (including coal from private mines) which will be subsidised so that it is competitive with imports. There is also evidently to be some reduction in opencast output and in the use of Orimulsion.

4 'LONG TERM POLICIES' AND THE ENERGY ADVISORY PANEL

Nor has the Government been taken in by the self-interested pleas for 'long-term co-ordinated energy policies' which always appear on occasions when the energy industries are under review: the only minor concessions in that direction are the commitment to publish an annual Energy Report and to establish the Energy Advisory Panel. If experience with the 'Seven Wise Men' who advise on economic prospects and policy is anything to go by, the Government may well be anticipating that the Panel will be riven with such dissension that it will be able either to dismiss the Panel's reports altogether or to draw from them justification for whatever it wanted to do in the first place.

5 REDUCED POLITICISATION

Considering the good news in more detail, one of the claimed benefits for privatisation is that it should reduce politicisation of decisions in the industry concerned. The electricity supply industry before privatisation was one of the worst examples of politicisation: indeed, British Governments of both major parties carried out their 'energy policies' behind closed doors primarily by inducing the CEB to burn more coal than it would freely have chosen and to invest in British-designed nuclear plant, and by imposing a *de facto* ban on the use of natural gas in generation. Fortunately, it is now much more difficult to pursue such backdoor policies. During the Coal Review, the generators proved very resistant to Government efforts to persuade them to take steps which they felt were not in the interests of their shareholders. If only generation were a genuinely competitive industry, one could wholeheartedly welcome the reduction in politicisation.

6 PRIVATISING COAL

The renewed commitment to privatise coal and to ease restrictions on existing private miners are welcome news: both are long overdue (4). The long period of uncertainty since coal privatisation was first announced in 1988 has been very bad for the industry: it has known neither when nor how it would be privatised. Offering to the private sector pits which British Coal believes it cannot operate profitably is another move which we have long advocated; in effect, it is the first step in privatising the industry (5). It is quite wrong that British Coal should be the sole arbiter of a pit's future: if others wish to try to operate it, they should not be prevented from doing so.

7 SEPARATING BC'S MINING AND REGULATORY FUNCTIONS

The absurdity of placing a nationalised corporation in a position in which it could determine whether or not it would allow competitors into the market (and charge them royalties if it decided to do so) was pointed out many years ago (6). The White Paper recognises the problem and proposes to establish a new Coal Authority as the licensing body.

8 MORE FLEXIBLE WORKING ARRANGEMENTS

Although productivity in British deep mines has risen sharply in recent years, the industry has been hampered by the restrictions on working hours in the Coal Mines Regulation Act of 1908 which, according to the White Paper, the Government now proposes to remove (by statutory instrument). It is also expecting to modernise the safety regime after advice from the Health and Safety Commission.

9 AID FOR LOCAL COMMUNITIES

Another piece of good news, in my view, is the increase in aid for mining areas. It has always seemed to me that, in place of support for production of coal, British Government should have concentrated on helping those adversely affected by the rundown of the industry (7).

10 THE BAD NEWS

Buried in the White Paper are one or two statements which make one pause. How, for example, should one interpret the paragraph (13.23) which tells us that the Government " . . . will be taking forward its consultations with the generators about stocking arrangements for 1993/94 as a matter of urgency . . ."? I have serious doubts about Government interference with stock provision in a private industry. Though an argument can be made that security has some public good

aspects and therefore Government has a role in determining stock levels, in practice interference with stocks can lead to widespread meddling for reasons of short term political expediency.

A more general cause for concern is the Government's continued failure to admit that it made mistakes in privatising electricity and that these errors now need to be corrected - in particular by reducing the market power of National Power and PowerGen and liberalising the generation market. Everyone appreciates the embarrassment which any move in this direction would cause. Obviously, the Government is hoping that the Office of Electricity Regulation - which has been forced to use its resources in supervising the generators because of the lack of competition in the industry - will gradually manage to liberalise the market as Ofgas did in the case of natural gas.

But electricity is much more difficult than gas. Furthermore, the longer the Government delays the more the British coal industry suffers from the market power of the two big generators and the less there is to privatise. It has been obvious for years that an attempt to privatise coal when substantial market power exists in electricity generation is bound to cause problems (8). Though coal privatisation could still be accomplished, mines will be much less attractive to potential investors than they would be if there were more power generators with demands for coal.

The standard answer to suggestions that the Government should, by one means or another, liberalise generation is that such a move is not 'politically possible'. But, only a few years ago, coal privatisation was regarded as 'politically impossible'. So was privatisation of the major British utilities. Indeed, looking back, virtually every proposal ever made to move towards a liberalised energy market in Britain has been greeted initially with the 'politically impossible' cry. Progress has been slow but many of the 'impossible' steps have now been taken. So I look forward to the day - probably not far distant - when break-up of the generators can at least be contemplated.

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II BLACK FUELS AND THE WHITE PAPER

Anthony Baker, British Coal

1 INTRODUCTION

The White Paper 'The Prospects for Coal'¹ has finally emerged: the Government's Coal Review is concluded, but the underlying coal review goes on in less public view. There are many questions left unanswered about future fuelling of the electricity industry and the future of the UK coal industry. These are early days and it is impossible to be definite or prescriptive. Instead, this paper seeks to clarify some of the issues and to suggest from a UK coal industry view point what development in fuelling for electricity generation may now happen. In a sense it continues the story from a paper² to an earlier seminar in this series.

2 PRICE MOVEMENTS IN ELECTRICITY AND COAL

It is instructive to look at the movements and the real price of electricity to consumers over the last few years:

Figure 1 shows that the industrial sector in general has done quite well, with price reductions of 20% over the last 7 years, though it conceals recent upward movements in price for large industrial consumers who have expressed their vocal discontent. The domestic consumer on the other hand has apparently seen little benefit. The index that has really declined has been that of the price of coal to the generators, a steady drop of over 30%. While it would be naïve to suggest that the generators and RECs could reasonably have completely matched that performance in their price, two points stand out:

Electricity & Coal Price Indices

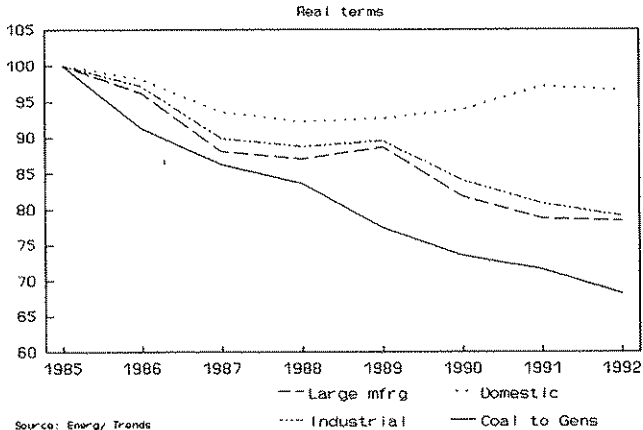


Figure 1

- a) As Figure 2 below shows, some of the gap has gone to fuel the increased profit of the privatised electricity industry
- b) As the recent Select Committee report³ commented 'The main contributor to lower electricity prices appears to have been the still nationalised British Coal'

British Coal has been able to offer these lower prices by the significant cost reductions in coal that have been proceeding for some years - this is not something that has been suddenly sparked off as some have implied by the crisis last October. Figure 3 over the page shows how costs have reduced significantly and also indicate how we expect them to reduce still more in the future.

Partly the cost reductions come about by closing higher cost collieries, though at the continuing collieries there has been an enormous drive in increased productivity (nearly 20% in the last year alone) and other ways of exploiting resources more intensively. The recent Boyd report⁴ is not the source of these ideas of productivity improvement: Boyd have

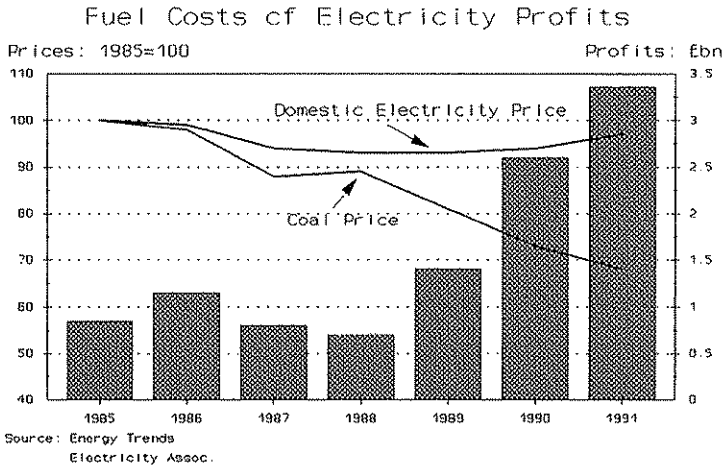


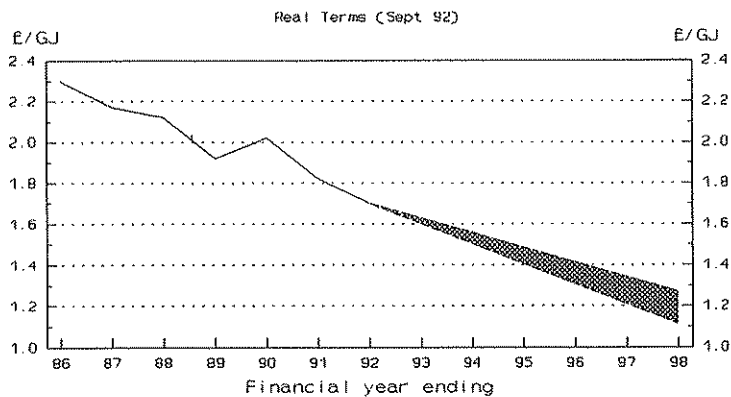
Figure 2

simply confirmed that British Coal's proposals are right and the projected improvements are believable. Indeed, we hope to perform even better than Boyd's projections, given a reform in regulation to permit different working procedures, including fewer but longer shifts.

It has to be conceded that the prices of British Coal cannot match those of world coal trade at present. The essential reason for that is not one of form of ownership, management enthusiasm or worker co-operation - important as those all are. It is that newer coal fields of the world have got much easier access to large quantities of high quality coal in thick seams. Moreover, the current world coal trade, though growing vigorously in volume terms, is outpaced by supply, and is a business for the most part of very low margins, with producers hanging on in some desperation, in the hope of better days and better prices.

BRITISH COAL PERFORMANCE

Colliery Costs per Gigajoule (net)

*Figure 3***3 THE DEVELOPMENT OF ESI FUELLING**

The projected ESI fuelling balance given in British Coal's evidence to the coal review is shown in Table 1.

The figures are not intended to be a precise projection, but they demonstrate:

- The growth of gas-fired and nuclear output.
- The sharp reduction in the next few years of the black fuels market.

TABLE I

ESI FUEL INPUT

Mtce	1993/4	1995/6	1997/8
ESI fuel Input	111	112	115
Supplied By:			
Nuclear	22	24	24
CCGT	10	28	33
French Link	6	6	6
Scottish Link	2	3	3
Available For Black Fuels	71	51	49
Supplied From:			
Fuel Oil/Orimulsion	7	5	5
Coal Imports	9	11	8
UK Licensed Mines	4	5	6
Coal Stocks	11	0	0
BRITISH COAL	40	30	30

- That the penetration of coal imports is most likely to be modest.
- That demand for British coal supplies is likely to be around 40 million tonnes this year and 30 million tonnes in subsequent years. This significant drop (compared with the 65 million tonnes contracted sales in 1992) was of course the root cause of the crisis over colliery closures.

The size of the decline of the black fuels market has been driven largely by issues of structure and rivalry in the electricity industry, rather than by primarily competitive economic forces. CCGT construction, though no doubt desirable to some degree has gone too far, and the nuclear and the French link continue to enjoy protected positions secure from market forces. If British Coal is to be exposed to the cold winds of the market place, why not the others too?

British Coal had therefore hoped that the outcome of the Government's review might bring some proposals for decline in the gas contribution, a refusal to extend further the lives of the elderly Magnox station and arrangements for a more neutral use of the French interconnector. Thus, a further 15/17 million tonnes input fuelling might be available to the black fuels market. If so, British Coal might have competitively taken 10/15 million tonnes by 1998 giving a total British coal burn of 40/45 million tonnes in 1998. The Select Committee seemingly supported our analysis, though its prescriptions were hesitant, apart from a clear recommendation to operate the French link in a neutral way. A proposal for 'subsidy' was also made by the Select Committee.

4 THE WHITE PAPER

The Government has however chosen not to seek changes in the fuelling balance which have pre-empted the black fuels market for reasons it sets out in the White Paper. However, it concedes that the cost of UK coal are declining sharply and there should be further support in the next few years while the market size is tested.

The coal review and the White Paper have provided some help to British Coal:

- By concentrating minds of the various parties involved to sign base coal contracts for 40 million tonnes in 1993/4 and 30 million tonnes for each of the next 4 years at prices which are a 20% decrease in the first year and a further 12% over the next 4 years.

- The Government is committed to bring forward legislation and generally to remove barriers to improved working practices in mines. This would give flexible shift patterns and other changes in organisation, all of which can be achieved without risk to safety.
- It gives a thrust towards privatisation and a greater freedom for the coal industry to operate as a business. The form of privatisation will of course be important. A fragmented coal industry would be in an even worse position to resist the demonstrated power of the generator duopoly, and to retain sufficient cash surplus for the continuing investment required in an extractive industry.

Lastly, the Government, while not intending to reverse market pre-emptions, will provide a temporary subsidy to enable British Coal to undertake a 'market testing' process, effectively to see how far coal imports/oil can be displaced from the market, and a larger market preserved as UK coal costs are reduced further. It is important to remember that this subsidy will be avoidable to all UK coal producers, including the operators of any mines offered for licensing instead of closure.

5 IMPLICATIONS FOR FURTHER UK COAL USE IN POWER GENERATION

Table 1 above, the illustrative electricity fuelling balance for the next few years, gives some clue about what could happen. If anything, the figures probably understate the amount of nuclear output and gas burn that may now happen and overstate the oil burn. Much obviously depends on future nuclear performance, including the operating costs of the ageing Magnox plant and the ability of Sizewell B to perform as well as promised. Moreover, the White Paper gives every encouragement for

further gas plants to be constructed. On the other hand, it seems unlikely that large quantities of fuel oil will be used in future and orimulsion use is discouraged by a combination of taxation proposals and environmental controls. For the mid 90s, it is probably the projected 8 million tonnes of import that represent the upper limit of British Coal's ability to increase its market above 30 million tonnes or 36 million tonnes for all UK coal in the mid 1990s. Even to displace 8 million tonnes of imports will prove a considerable challenge, given the attractions of coastal power stations and the generators' desire for continuing fuel diversity.

6 HELPS AND HINDRANCES

Some things may hinder British Coal's efforts:

- There are already 45 million tonnes of coal stocks, mostly owned by the generators, which they are understandably anxious to reduce. This will prove an immediate barrier: imports, stocks and UK coal will be in aggressive competition with each other. The generators should have plenty of scope for future price reductions to the consumer!
- Further CCGT plant will be encouraged by the Government and the electricity regulator. Our earlier expectation that CCGT capacity might settle at 10-11 GW may well be an under-estimate.
- Environmental regulations. They pose no problems in the next 5 years, but the threat of increasing the stringent standards for SO₂ and NO_x control are likely to pose barriers around the turn of the century. CO₂ emissions from the electricity sector will undoubtedly decrease - beyond that suggested in the Government's Energy Paper 59⁵. In that sense, CO₂ should *not* be a

problem. However, changes in the electricity sector may be a more popular means of enabling the Government to meet its commitment than further attacks on the transport sector, even though transport is the main cause of CO₂ increases.

Other things may help:

- Electricity demand may grow faster than we, and others, have projected, though that seems unlikely in the light of VAT imposition on domestic energy, and the general pressure for conservation, including growth in CHP schemes outside central generation.
- The price of imported coal may well rise. Despite the chronic oversupply and availability of cheap sources, freight rates of international shipping may strengthen, and fluctuations in exchange rates may make imports less attractive. Already the sharp changes in exchange rates after the UK's exit from the ERM has made some difference.
- The cost of UK coal may reduce even more quickly than I have suggested in Figure 3, as different working practices and organisation release new management energy at collieries.
- Despite the present indulgent attitude of the Regulator, RECs may not be allowed to pass through future likely increases in gas prices within independent CCGT schemes. IPP investors, including the RECs, may have to incur the risks themselves, which may reduce the attraction of further CCGTs.
- There might be opportunities for special deals of coal sales to large companies for electricity generation. The White Paper hints at encouragement for such deals.

7 THE CHALLENGE TO BRITISH COAL

British Coal has, not surprisingly, accepted the challenge to use the Government's support to seek increased coal sales beyond the base contracts now in place. Consideration of the various hindrances show that it not going to be easy and that the scope is not great. We have another few issues to handle in parallel:

- To consult about and manage the inevitable closure programme.
- To arrange to license other closing mines to others to operate. Our past experience with several mines (eg Monktonhall) suggests this is no simple task.
- To consult employees about changes in working practices.
- To restructure British Coal's corporate base.
- To prepare for privatisation in the Government's intended form, once that is known.
- Meanwhile, to encourage and enable collieries to achieve even greater productivity and lower costs.

Some of these issues are likely to be intensely time consuming and demanding for British Coal's management. The challenge to increase sales and to test the market thoroughly will however, not be ignored - it will be pursued with vigour and skill.

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III THE FUTURE OF GAS

Nigel Evans, Caminus Energy

1 INTRODUCTION

During 1993/94 the installed capacity of generating plant in England and Wales, excluding new gas fired capacity, will be of the order of 51 GW (after consideration is taken of the recently announced closures of National Power's West Thurrock and Padiham stations). In addition to this, 10.5 GW of new combined cycle gas turbine (CCGT) plant is committed, over 4 GW of which will be operational by the end of the year (PowerGen's Connah's Quay is included in this figure following recent government approval for the station).

The reasons for the development of this large quantity of CCGT capacity in such a relatively short period of time have been well rehearsed. They include:

1. The economics of new CCGT stations are attractive when compared with other new plant options.
2. The Regional Electricity Companies (RECs) were keen to encourage new entrants into the generation market (all of whom favoured CCGTs) because of concerns with regard to the dominant market position of National Power and PowerGen. (In the event, almost half of the new CCGT capacity has been developed by the two major generators.)
3. Greater gas use has helped to diversify the fuel mix in power generation. In 1991/92, coal use in the power sector in England and Wales was some 75 million tonnes (Mt), approximately 70% of total fuel input. By 1997/98, the corresponding figures could plausibly be 45 Mt and 40%. Gas use in this market in 1997/98 may be of the order of 33 Mtce, approximately 28% of total fuel use.

4. The environmental case for gas use in high efficiency CCGTs is compelling.

The case against gas use has also been made. It rests principally on the argument that the costs of generation from existing coal-fired power stations are less than the all-in costs of new CCGTs. The response to this point has been made by, amongst others, OFFER and the Government in its White Paper¹. Both have argued that prices rather than costs represent the appropriate basis for comparison and that RECs cannot be expected to buy electricity at some notional low price if no generator is prepared to offer contract cover at such a price.

2 ALTERNATIVE VIEWS FOR THE FUTURE

In the light of the White Paper, I believe that it is appropriate to consider 10.5 GW of CCGT capacity to be committed. As to the future there appear to be two alternative views:

View A

Given the very large commitment to CCGTs, there is no need for new capacity of any type for some considerable period (perhaps five years or more). Even then, given the recent furore over coal, we should not assume that gas will automatically be the only, or even the preferred option for new plant.

This is a view which many in the coal industry believe (and, of course, hope for). However, it also seems to be the view of many gas suppliers.

View B

Under this view the development of CCGTs continues, if not apace, certainly at a steady rate, with a number of new commitments amounting

to several GWs being made over the next 3 to 5 years. How can such a view be sustained against the background of plant over capacity? There are a number of arguments that can be made to support this view:

1. Gas use in the power sector remains one of the few areas of gas demand in which significant growth can still be contemplated. Industrial, commercial and domestic demand are all likely to exhibit relatively modest growth which, at times of low economic growth and mild weather, can even become negative. From the gas producers' perspective, therefore, there may still remain strong incentives to try to develop the market further. The alternatives for the producers are to concentrate on meeting that component of demand associated with the decline of existing mature fields, or to leave the gas in place for some future period (and in the meantime, focus on production opportunities in other provinces). Both remain real options for the producers. However, the former will depend on the precise depletion rate of existing fields, something about which considerable uncertainty exists. And the latter will only appear attractive if the producer believes the gas has greater value by being left in the ground, something which depends on views of future gas prices and on the producer's discount rate.
2. Further power sector gas sales may have an importance to producers over and above that associated with incremental sales on which a margin may be made. As the UK gas market becomes increasingly competitive, so the markets into which producers sell are changing. British Gas is no longer the dominant purchaser. Increasingly producers will be selling gas to marketing companies, direct to their own customers, and to the power sector. Within this context, this latter market (the power sector) is likely to be important because of the diversity it provides to the producer's portfolio, as well as for the volume of gas sold. And even if a gas producer is only able to sell perhaps as little as 40% of the output of a new field into the power market, it may be sufficient to justify the development of

the field, particularly for a producer developing a successful presence in other markets.

3. The attitude of the RECs to the encouragement of additional CCGT capacity is also likely to be changing. The desire to provide an alternative to National Power and PowerGen may persist, but for each REC it is likely to be a secondary consideration to obtaining low price electricity appropriate to the needs of its portfolio of customer demand. This is because of the ongoing regulatory scrutiny associated with Condition 5 of each REC's licence (the economic purchase obligation) and, perhaps more importantly, the likely introduction of some form of yardstick regulation for the RECs' supply businesses. Such yardstick control would penalise any REC which paid too much for a CFD from a new CCGT plant compared with the alternatives available (including Pool purchases). On the other hand, it may also provide an incentive to RECs to continue pursuing options which will lead to lower costs than purchasing CFD cover from National Power and PowerGen. Low cost CFDs from new CCGT plant are still one of the options being pursued by some RECs.
4. It is even possible that National Power and PowerGen will continue to pursue the CCGT option in the near term (witness PowerGen's Connahs Quay plant, admittedly a station on which development work was started some considerable time ago). One of the continuing attractions to the two major generators of these stations is their low (non-fuel) operating costs compared with conventional coal-fired plant. For companies whose dominant focus is on reducing avoidable costs, significantly in the area of staffing costs, CCGT stations hold great appeal. They also ensure that environmental constraints, particularly with regard to SO₂ can be comfortably met, even if more stringent emissions targets need to be adopted.

5. This leads to a more general reason why further CCGTs may be developed in the near term. The commitment by the UK government to returning CO₂ levels to those of 1990 by the year 2000 is a difficult and demanding target, particularly given the apparent difficulty of tackling the important transport sector. Indeed, it appears likely that more than 5 GW of additional CCGT plant (over and above the 10.5 GW already committed), will need to be operational by the end of the century if the UK is to comply with its Rio obligations on CO₂.

3 WHICH WAY FORWARD?

It is too soon to make any definitive statement as to which of the two views discussed above is likely to be realised over the next five years. It is possible to say, however, that the attractions of gas as a power sector fuel are sufficiently compelling that View B certainly cannot be discounted.

It should also be remembered that CCGT is not the only technology available whereby gas can be converted to electricity. The announcement on 25 March 1993 by the President of the Board of Trade at the launch of the White Paper gave the go-ahead not only to Connah's Quay, but also to two substantial gas-fired CHP schemes. Given the attractions of such schemes in terms of overall economics (including the ability, in appropriate circumstances, to avoid transmission and distribution charges, uplift and the fossil levy) and their environmental impact, it is perhaps not surprising that a growing number of similar projects are now progressing to the development stage. Gas-fired CHP schemes are generally favoured by environmentalists and proponents of competition alike. They were also endorsed by the DTI Select Committee². Unfortunately for mineworkers, they represent a further threat to an industry already under siege.

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IV NUCLEAR POWER AND THE COAL REVIEW

Peter M S Jones, Independent Energy Consultant and Author

1 INTRODUCTION

It is difficult for someone dealing with the nuclear sector to know what to say in the wake of the Government's White Paper on The Prospects for Coal¹ and the preceding report from the Trade and Industry Committee² on the same topic; particularly when following on from the coverage given by the authors of the other papers in this Discussion Paper.

At first sight, neither document has altered nuclear power's position in the overall United Kingdom energy mix, and the position and representations of the nuclear industry, with regard to the operation of existing plant and the completion of Sizewell-B, have been accepted.

The White Paper has, however, been confined to the immediate position of the UK coal industry and a reiteration of the basic philosophy underlying the Government's energy policy. In some ways this was inevitable if the promised 1994 - now 1993 - review of nuclear power was not to be pre-empted, and a prescribed future energy mix defined; something that is clearly contrary to present Government policy.

This contribution will therefore concentrate on the future and some of the issues that will arise in the forthcoming nuclear review. It will raise a number of questions and point to a number of problems. It will not attempt to provide definitive answers.

2 THE COAL REVIEW AND EXISTING NUCLEAR CAPACITY

Nuclear fuelled electricity in the United Kingdom is produced predominantly by the two publicly owned nuclear generators, Nuclear Electric and Scottish Nuclear, with smaller contributions from British Nuclear Fuel's Magnox plants and, for a further year only, from AEA Technology's Prototype Fast Reactor at Dounreay.

It is accepted that the total electricity generation costs, including capital charges, operating costs and provisions for future de-commissioning and radioactive waste management, are higher for existing Magnox and Advanced Gas Cooled Reactor (AGR) plants than for most existing coal-fired and gas combined cycle plants. Their current accounting costs of operation are shown in the Nuclear Electric accounts as 4.3 p/kWh for Magnox and 3.6 p/kWh for AGRs. However, it is also accepted that this is not an appropriate criterion for decisions about their future operation.

Because their capital costs are sunk and their decommissioning costs and historic waste liabilities are unavoidable, their continued operation, and the completion and operation of the Sizewell-B Pressurised Water Reactor (PWR), should depend on their respective avoidable incremental future costs. These costs have been calculated to be 1.2 p/kWh for Magnox plants, 1.5 p/kWh for the tranche of Magnox capacity operated by Nuclear Electric, around 1.3 p/kWh for the AGRs of both Nuclear Electric and Scottish Nuclear and 1.4 p/kWh for Sizewell-B. The figures were independently audited for the Department of Trade and Industry by Ernst and Young.

These avoidable costs are below the operating costs of other fossil - fuelled plants connected to the UK grid (Table 3), and are only bettered by the Scottish hydroelectric plants; a resource that regrettably has little scope for expansion.

Both the Government and the Trade and Industry Committee have recognised the economic rationale underpinning the use of avoidable cost criteria, which is analogous to the arguments for continuing to run existing coal plants whose operating costs are below the incremental

costs of building and operating new gas fired capacity. Others have been confused by the existence of the fossil fuel levy and the, albeit rapidly improving, overall costs published by the nuclear generators in their annual reports.

The difference between the avoidable costs and the total operating costs, which include the creation and maintenance of the provisions against future liabilities, would still have to be found if the nuclear plants were shut down, either from the consumer, as at present, or from the taxpayer. In addition higher costs would be incurred for replacement electricity from non-nuclear plants. This would not be a good deal for the consumer or the taxpayer, and it would certainly not liberate funds as some erroneously have imagined.

A point will soon be reached with the Magnox plants when their continued operation will require some refurbishment and, ultimately, refurbishment of the associated spent fuel management facilities at Sellafield. At this point there will be a step increase in their avoidable costs, considered either singly or as a tranche. At that stage the extension of their lives will be subject to similar considerations. It will only be worthwhile proceeding if the net income that can be earned from their continued operation, allowing for incremental provisions for spent fuel management, will repay any required capital investment, and an appropriate rate of return on that capital. The White Paper notes that the Government will look carefully at the case for life extension when it is made, subject presumably to the caveat that the nuclear utilities are still in the public sector.

3 FUTURE NUCLEAR DEVELOPMENT

The electricity output from the existing Magnox and AGR plants is expected to increase as efforts continue to improve their performance by reducing both planned and unplanned outage times to the minimum consistent with comprehensive maintenance and safe operation.

Additionally the new Sizewell-B plant will be coming on line in 1994, adding nearly 1200 MWe to nuclear capacity and some 7 Terrawatt-hours to nuclear electricity output.

This together with the planned gas combined cycle capacity and the small tranche of additional renewable capacity targeted under the non-fossil fuel obligation, would be sufficient to fill all the baseload capacity requirement for the United Kingdom, assuming the plants all operate on baseload.

This is a logical role for nuclear and renewable plants, which have very low fuel and operating costs. It is less logical for gas fired plants, whose marginal fuel and operating costs are high. However, where gas has been purchased on a take-or-pay basis and there is no provision or outlet for its resale, then gas plants too will have low effective incremental operating costs. It will then pay their owners to run them until the minimum gas quota has been consumed. The details of the gas contracts have not been revealed, but a number of the plants being constructed by "independent" generators are believed to be in this category.

The major generators, on the other hand, have interruptible supply contracts with British Gas, and are not operating on take-or-pay terms. Their plants are therefore at some risk of being deprived of fuel at times of peak demand and would not normally be bid into the Power Pool at prices below their short run marginal costs.

Nevertheless, there is a very real prospect that coal-fired plants will be pushed off baseload in the late 1990s and confined largely to mid-merit operation. Additional baseload capacity will only be needed to match any growth of demand and to replace existing baseload capacity as it becomes uneconomic to continue maintaining it in operation. The gross overcapacity anticipated in the Autumn of last year is illustrated in Table 1. Since then plans for new gas fired capacity have been reduced to about 10GWe.

Since the Government is committed to improving energy efficiency, including the efficiency of electricity use, and with the impending introduction of value added tax on domestic energy use, it is highly likely that the growth of electricity demand will be sluggish even if the United Kingdom's economy itself attains a healthy growth rate.

Only a confirmed optimist would see any prospect for significant overall growth of demand much before the year 2000. Generators are therefore likely to set their sights on maintaining their market share in the first place, and winning additional markets from competitors by reducing the operational costs of their existing plants. Once the anomalous market conditions that have led to the dash for gas have had their effect, investment in new capacity will be difficult to justify, particularly for new entrants to the market.

For this reason most attention will concentrate on the post-2000 period and on the replacement of both nuclear and fossil-fired capacity that would be expected, on grounds of age or cost, to come out of service in the early years of the next century. The levels required are illustrated in Table 2, but take no account of effects of the recently announced VAT charges, possible carbon taxes or any upsurge in decentralised small scale generation.

For the nuclear industry, this means planning for the replacement of the Magnox capacity in England and Wales at the end of its useful working life, and, somewhat later, for the start of replacement of the longest serving AGRs in the United Kingdom as a whole.

It is on this basis that Nuclear Electric and Scottish Nuclear have been giving consideration to the available technical options, and the nuclear industry will be making its submissions to Government in the planned Nuclear Review.

TABLE 1 OVERCAPACITY (As of Autumn 1992)

	1992/3	1995/6	1998/9
ENERGY REQUIREMENTS TWh	274	280	292
PEAK DEMAND (Av.Cold Spell) GWe	49	51	53
PLANT			
MAGNOX	3.6	3.6	3.6
AGR	5.9	6.0	6.0
PWR	-	1.3	1.3
LARGE COAL	22.9	22.9	22.9
MEDIUM COAL	6.4	6.4	6.4
SMALL COAL	4.4	4.4	4.4
OIL	8.5	8.5	8.5
CCGT*	3.0	17.9	22.9
OCGT	2.7	2.7	2.7
PUMPED STORAGE	2.1	2.1	2.1
EDF	2.0	2.0	2.0
SCOTTISH LINK	0.9	1.6	1.6
TOTAL PLANT CAPACITY GWe	62.4	79.5	81.8
PLANT MARGIN per cent	26.8	55.8	55.2

Note: * Since reduced to nearer 10GWe for mid-1990s

TABLE 2 REQUIRED CAPACITY POST 2000 (Units GWe)

	1996/7	2003	2008	2013	2020
ACS PEAK DEMAND	53	55	57	60	65
PLUS 20 % MARGIN	64	66	68	72	78
REMAINING PLANT	62	59	56	38	32
SHORTFALL	2	7	12	34	46

- Notes:**
- 1 Assumes 10 GWe of gas capacity and retirement of 10 GWe of oil, open cycle gas turbine and coal capacity by late 1990s.
 - 2 Other coal/oil plant life 40 years, Magnox 30-33, AGR 35-37.
 - 3 May well overstate requirement following imposition of VAT and if prices rise in the future or tranches of CHAP plant are built.

4 CAN NUCLEAR COMPETE IN THE UNITED KINGDOM?

The economic comparison between different generation technologies is not straightforward. In the United Kingdom, with direct and unique commercial competition between generators it is even more difficult. However, if a new plant is to be constructed, then the plant having the lowest costs of generation, given its intended operating mode, should be preferred and should offer the prospects of yielding the highest returns to the investor, other things being equal.

The problem is that the costs of generation are sensitive to a number of factors whose future values are matters of judgement. Fossil-fuelled generation costs are particularly sensitive to fuel prices (especially gas fired plants). These are determined by market conditions, which will be increasingly affected by world and European circumstances. They are dependent on sterling exchange rates, and could be strongly influenced by international political developments and international environmental controls. Gas prices could be affected by developments in both gas and oil producing countries.

Nuclear generation costs, on the other hand, are relatively insensitive to fuel prices, and, once built, offer more assured electricity price stability. They are, however, sensitive to the capital charges, which depend on the direct costs of plant construction, the required rate of return on capital, and on the operational performance of the plant. Critics of the nuclear industry have little difficulty finding examples of major historic cost over-runs and plants that have performed well below the targets their designers have set for them. Claims that these problems have now been overcome and that future plants will not suffer similar difficulties are inevitably and justifiably received with some scepticism.

Nevertheless, the industry has good grounds for its optimism. The performance of nuclear plants, worldwide, has been showing consistent improvement. In the United Kingdom, Nuclear Electric has been constructing Sizewell-B within the agreed budget and well ahead of its committed construction schedule. The plant is now nearly 90 percent complete. With this experience there is every reason to believe that a repeat plant could be accurately costed and built to a closely controlled timetable. Evolving international and United Kingdom experience of plant operation, given the specific design features of the Sizewell PWR, provide good grounds for confidence that high plant availabilities will be realised.

On present thinking, based on Nuclear Electric's published assessments, they are confident that they can produce electricity from a twin repeat of the Sizewell-B design, located at the Sizewell site, at a lifetime levelised cost of under 2.9 p/kWh, based on an average real

return on capital of 8 percent per annum. Overnight investment costs are estimated to be around £1300/kWe. Further improvement on this figure may be achieved as planning and thinking develop.

This represents a big but understandable reduction relative to the analogous cost for the Sizewell-B reactor. The existing plant has had to bear the full first-of-a-kind costs following the Government's imposition of the moratorium on further construction, taken at the time approval in principle was given to the Hinkley-C plant. The construction of a twin plant, following on from Sizewell-B, will yield significant replication benefits. Additionally, the new plants would achieve savings from sharing site infrastructure and some staff, which reduces both investment and operational costs.

It must be stressed that the costs claimed by Nuclear Electric are firmly based on experience and interaction with contractors, and that they include full provision for plant decommissioning and for the management of spent nuclear fuel. In practice the overall costs are very insensitive to these latter back-end costs. Although these are themselves based on sound international consensus and practical experience. In the unlikely event that they were to be exceeded by significant margins, they would have little effect on the overall generation cost estimates.

What of the competition? My estimates for new coal-fired plant, using the same basic assumptions and current world coal prices, suggest that both currently available pulverised fuel or fluidised bed technologies, or future advanced plants such as those using integrated coal gasification combined cycle technology, will be significantly dearer (Table 3). Coal would only become competitive if significantly higher average rates of return were required.

Renewable technologies have their committed advocates and some, based on the most recent figures published by the Advisory Committee, could generate electricity at costs of under 3p/kWh using an 8 percent per annum real rate of return. Their potential contribution at this price is very limited however, and confined to hydropower, some waste incineration technologies, landfill gas and a small tranche of land-based

windpower. These sources are not unimportant, because they will have low operating costs and will compete, when supplies are available, for baseload.

The main large scale competitor for both nuclear and coal generation will be gas combined cycle plant. It has appeared particularly attractive to the generators in the recent past as a result of the availability of cheap indigenous gas supplies on long term contract. Additionally, the relatively short construction times for plant and the potential for increased gas burn to reduce the gaseous emissions of sulphur dioxide, nitrogen oxides and carbon dioxide offer economic benefits either now or in the future. Reductions in acid gas emissions have to be achieved by 2000 to conform with the EEC's targets and, in the future, new plants will have to conform to the large combustion plant directive. The substitution of gas for coal burning can also contribute to the attainment of the Government's commitments to reduce greenhouse gas emissions to 1990 levels by 2000.

Table 3 also contains my estimate of future gas combined cycle power generation costs, for specified levelised gas prices. It is clear that these prices are critical to the ability of other sources to compete. At the prices prevailing in the late 1980s (16 pence per therm), gas was unbeatable for new investment. Even at current prices (23 pence per therm) it would be significantly cheaper than new coal or nuclear investment. What will it cost after the turn of the century? This depends on several factors.

TABLE 3 ELECTRICITY COSTS
(Units 1992 pence per kilowatt-hour)

EXISTING PLANTS AVOIDABLE COSTS

MAGNOX	1.2	
AGR	1.2 - 1.4	
SIZEWELL B	1.4 - 1.5	
COAL NO EXTRA FGD	1.9 - 2.4	(1.6 - 2.6)

NEW PLANTS AT FULL COST

CCGT	2.7 - 3.4	(2.6 - 3.3)
COAL (FBC)	2.8 - 3.5	(3.6 - 4.2 British Gas)
SIZEWELL C TWIN	2.8 - 3.0	(Nuclear Electric)

CURRENT CONTRACT

PRICES	3.2 - 3.6
POOL PRICES 1992	ca 2.5
CONVERGENCE POST 2000	ca 3.0

Notes:

- 1 Illustrative coal price range £1/GJ to £1.8/GJ; Gas price range £2/GJ (22p/therm) to £3/GJ.
- 2 Figures in parenthesis from Trade and Industry Committee evidence and memoranda.

The United Kingdom is likely to link in to the European gas grid, both to obtain access to the larger pool of resources available from Norway and the East, and to open up opportunities for selling British gas into the wider and more profitable markets of Europe. In the long run this should help to keep prices down, but in the medium term prices are likely to be higher as we compete for supplies with our more affluent neighbours. A recently completed, but as yet unpublished, study by OECD has indicated that OECD electricity utilities expect gas prices in the year 2000 to be about US \$3.7/GJ (in a range of 3 to 5 \$/GJ) escalating at 2.1 percent per annum in real terms (July 1991 money values), figures which are consistent with the EEC's projections of c.i.f. import prices to the Community. International Energy Agency scenarios have suggested prices at the burner tip in Europe of around 3 to 6 \$/GJ in 2000 in 1991 money values.

Clearly, actual prices are going to depend significantly on the balance of supply and demand. Expansion of supply is not easy and demand is buoyant across Europe, including the Eastern regions and the CIS, with increases in demand over the next 20 years widely forecast to exceed 50 percent.

All this presupposes market stability; something that has not been a pre-eminent feature of hydrocarbon fuel markets over recent decades. Both gas and oil supplies to Western Europe are vulnerable to political events in the major supplying regions. Indexation of gas prices in Britain to oil prices set in world markets reduces the protection afforded in the short term by the availability of indigenous supplies. Average gas prices could well prove to be higher than those anticipated on the basis of assumed market stability, just as they have been since 1970.

Another factor is the introduction of environmental taxes. Emissions of acid gases arise mainly from coal, oil or Orimulsion burning, although sour gas can also be a source. They can be controlled, at a modest price, and measures are in hand that will, if pursued vigorously, largely internalise their costs. The same is not true of greenhouse gas emissions of carbon dioxide from carbonaceous fuel combustion or methane from gas leaks and, to a lesser extent, coal mines.

If carbon release to the atmosphere were to be taxed at the rate equivalent to \$10 per barrel of oil it would add about 1 p/kWh to coal fired generation costs and 0.5 p/kWh to gas fired generation in combined cycle plants. At present there is no technical solution to carbon dioxide emissions but the application of taxes in the United Kingdom is being based on fuel price rather than on environmental impact. The EEC proposals are for a mixed energy/carbon tax, which is better, but it still penalises nuclear power unnecessarily since its external costs are already largely internalised.

The question of whether nuclear power can compete in the United Kingdom from around the turn of the century on is therefore dependent on political as well as market factors, and opinions can and will differ on the most appropriate set of assumptions.

5 NUCLEAR POWER AND THE MARKETPLACE

If nuclear power is perceived to be the cheapest source of new baseload capacity, it may still face problems with funding. Like many renewable sources it is capital intensive, and investors contemplating the financial risks are likely to want to see firm contracts in place before they are willing to commit their funds.

With the planned progressive reduction in the size of the franchise market and the planned phasing out of the non-fossil fuel obligation in 1998, the Regional Electricity Companies are unlikely to be enthusiastic about placing long-term contracts with generators (other than those for projects in which they are themselves partners). The market uncertainty thus created will lead investors to seek higher returns to cover their extra risks, adding to the prices charged to consumers and biasing the market against the more capital intensive technologies (such as renewables and nuclear).

Such a market would discount heavily the risks associated with future fossil fuel price escalation, particularly since the regulatory framework

allows such escalation to be passed on to the consumer without penalty to the generator.

It is not surprising therefore that the nuclear industry (and the coal industry and proponents of renewable energy) see merit in a more orderly market in which some of the uncertainty is removed, and in which circumstances are conducive to the negotiation of long term contracts. This could be achieved in a number of ways which still preserve a reasonable degree of competition between generators and fuel sources.

Thus, Nuclear Electric proposed to the Trade and Industry Committee that the franchise market be kept with its present cut-off and that fuels be allocated specified shares within that market (Coal 55%, nuclear 25%, gas 15% and renewables 5%). Free price based competition was proposed for the non-franchise market.

An alternative favoured by the present author would involve competitive fixed price bidding (p/kWh) to add pre-established tranches of capacity to the grid. This would avoid the construction of costly and unnecessary excess capacity in the manner we have seen in the recent past, and would oblige generators to carry the risks of future fuel price escalation or moves to internalise current externalities, thus levelling the playing field for nuclear and renewable plants, for which these factors are not significant.

The Government's reiteration of its policy principles in the White Paper would appear to rule such measures out as being too interventionist. However, the Government recognises that it has international obligations in terms of agreed and yet to be agreed environmental objectives. At present these are being implemented for acid gases through regulatory controls. Taxes that internalise external costs do not seem to be favoured, but a key element of policy is to ensure that users meet the full costs of their energy supplies. The introduction of blanket taxes like VAT do nothing to redress the balance between fuels, and at present the levels debated have no demonstrable relation to the external costs imposed on society.

Government also has responsibility for ensuring that the country's energy supplies are secure and provided at a reasonable price. It states its belief that the latter responsibility can be met by competition between and the self interest of generators. Nevertheless, it imposes rules on the level of fuel stocks at power stations. Will such rules be applied to the gas plants? It would be expensive.

The consumption of relatively short lived indigenous resources is living off capital just as the population of the Sahel have done. Unless steps are taken to replace the capital with sustainable energy sources and means of wealth production, future generations of United Kingdom citizens will have cause to rue our profligacy. Is this not something with which governments should be concerned?

There are many arguments, not all entered into here, in favour of maintaining a more even mix of energy sources than unfettered operation of market forces might provide; particularly if those forces are distorting choice to reflect self imposed short-termism and imbalances in the incidence of risks between investors and consumers.

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