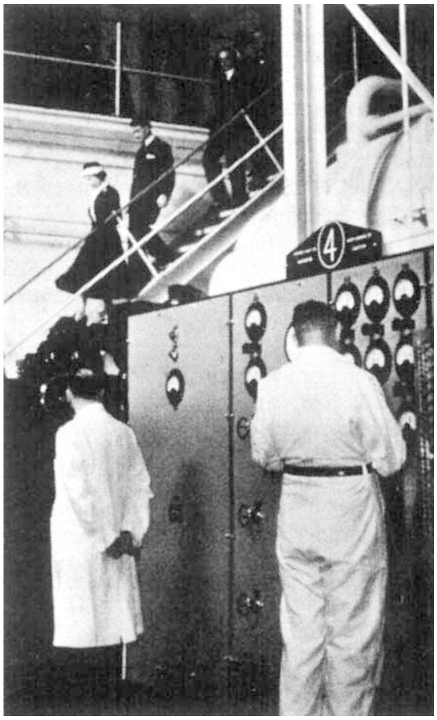
UKAEA: boom or bust?

Two years after the establishment of the United Kingdom Atomic Energy Authority 25 years ago, the Queen was opening the world's first full-scale nuclear power station at Calder Hall (see right). But these early boom years of British nuclear power are over. Energy forecasts are drastically lower, and uncertainty about the future of the industry has led to the loss of key staff. The fast breeder design team, for example, has been virtually disbanded. So even if the new government wished to re-invest in the nuclear industry — as the Prime Minister indicated at the recent summit meeting in Japan — it would first have to re-establish confidence in the industry itself. So while Britain's new energy ministers, headed by Secretary of State David Howell, consider the formation of a new energy policy for Britain, we asked **John Surrey** of the Science Policy Research Unit at the University of Sussex to give us his view of the future of nuclear power in this country. On a following page, **Paul McDonald** considers the difficulties facing another major energy option — conservation.



How the UKAEA might survive

LONG-term forecasts given at the UK National Energy Conference in June 1976 pointed to a future 'energy gap', due to rapid growth in demand and rapid depletion of British North Sea oil and gas reserves. They indicated that without major investment in coal and especially nuclear power, the UK would have to rely on increasingly large and expensive oil imports after about 1990. Only the gas industry challenged the forecasts, arguing that North Sea supplies would last until at least 2000. For the other fuel industries, high demand forecasts promised security and expansion.

Coal's target capacity for 2000 was set at 170 million tonnes — the maximum attainable given the need to replace a large proportion of current capacity and the long lead times for major projects such as the development of the newly discovered coal-fields at Selby and Belvoir. The same climate encouraged the UKAEA (Atomic Energy Authority) to present a 'reference' programme which envisaged 104,000 MW of nuclear power in operation by 2000, including 33,000 MW of fast reactors. These were to be preceded by a 1,300 MW demonstration plant, originally codenamed CFR-1 and later CDFR. The 'reference' programme would require about 6,000 MW of nuclear plant to be built *each year* — somewhat more than the total nuclear generating capacity in service today.

A recent consultative document, the 1978 Green Paper on energy policy, contained much lower demand estimates for 2000 — 450-560 mtce (million tonnes of coal equivalent). For comparison, the mid-point of the 1976 forecasts was 558 mtce and the top of the range was 760 mtce. The 1978 official forecasts were very close in several respects to those published by Chesshire and me shortly before the Green Paper appeared. The two sets of estimates were very close for final energy consumption and, in the 'high' case, for primary energy. But in the 'low' case the Green Paper estimate of primary energy demand was 115 mtce higher than ours (see Table 1). Given the other similarities, this big difference can only stem from an assumption behind the official forecasts that electricity consumption, and therefore conversion losses, will be much greater than we estimated under the 'low' case. The discrepancy simply illustrates that the prospects for electricity are one of the biggest uncertainties in energy planning — which is of key importance for coal and nuclear power, given their dependence upon electricity generation.

Until nuclear power stations can work satisfactorily and economically under highly variable load conditions, the scope for nuclear power will be limited to base load generation. In the UK, it is further restricted by a large plant surplus, including a large amount of plant still under construction. Furthermore, electricity is expensive relative to other fuels: in the industrial market the price ratio of electricity is 5.4 relative to gas, 6.1 relative to coal and 3.8 relative to oil.

As long as the relative price is so high, electricity will not substitute for oil and coal in competitive crude heat uses, or for gas in many premium uses. Even assuming that nuclear-generated electricity will henceforth be cheap relative to oil and coal, the fact that nuclear power currently

Table 1 1978 Forecasts of UK Energy Consumption in 2000

	1977 Actual	Forecasts for 2000 SPRU[1]	Green Paper[2]
		billion therms	
Domestic	15.0	14.2—16.2	(13.6)—15.8
Transport	13.1	17.2—19.9	(15.8)—17.0
Other final consumers	7.6	6.0— 8.7	(7.0)— 9.0
Iron and steel	4.9	3.7— 8.4	(7.0)— 9.9
Manufacturing industry	17.9	19.6—28.2	(20.0)—25.4
FINAL ENERGY	58.5	60.8—81.4	(63.4)—76.8
		million tonnes of coal equivalent	
Coal	122.7	83—162	170[3]
Oil	136.6	124—224	150
Natural gas	62.8	88	50—90
Nuclear and hydro	14.3	40—102	95
PRIMARY ENERGY	338.4	335—577	(450)—560

1 J. H. Chesshire and A. J. Surrey, *Estimating UK Energy Demand for the Year 2000: A Sectoral Approach*, SPRU Occasional Paper No. 5, February 1978.

2 *Energy Policy: A Consultative Document*, Cmnd 7101, HMSO, February 1978. The figures in brackets apply to a 'low' case which is only partly specified.

3 These are estimated availabilities of indigenous fuels only. They sum to 465 mtce, in the 'high' case, leaving net imports of 45 mtce and a 'policy gap' of 50 mtce.

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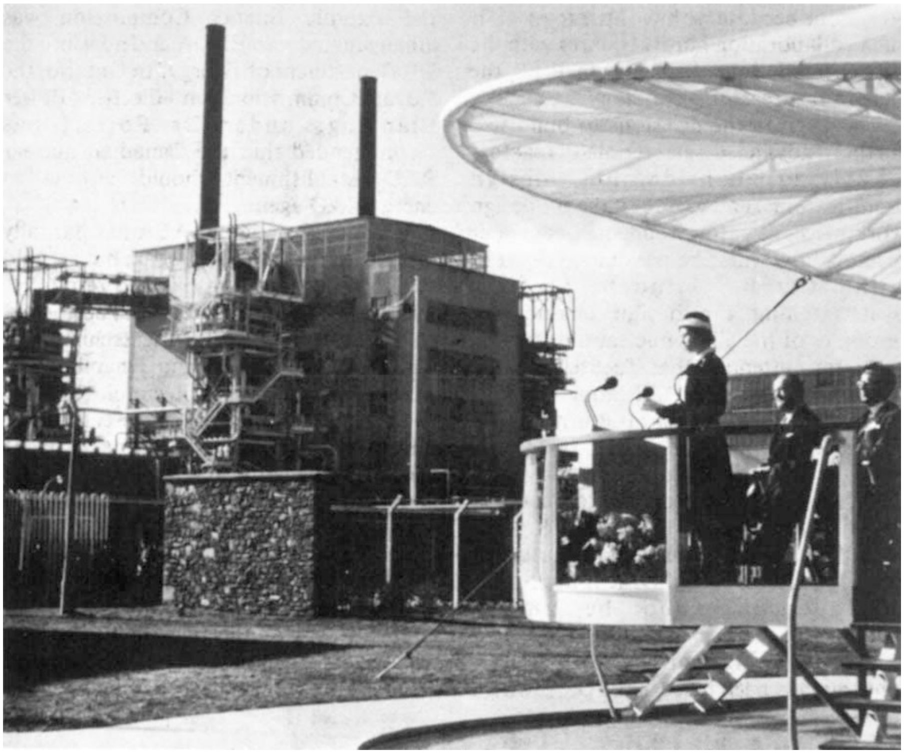

accounts for only 13% of electricity supplied to the British grid means that the price of electricity will not fall appreciably relative to the price of oil and coal until base load is supplied predominantly by nuclear power stations. That, of course, would involve a large nuclear programme to replace the fossil fuel power stations built in the 1950s and 1960s and — since two-thirds of British coal output goes to power stations — a big fall in coal demand.

One is inescapably drawn to the conclusion that electricity demand growth over the next two decades will continue to be low, especially if the supply of North Sea gas reaches 6,000 million cubic feet a day in the early 1980s and remains at that level until 2000. In these circumstances, electricity demand growth will be chiefly in certain premium uses where electricity offers advantages which outweigh its high price. Information available on domestic appliance ownership levels and industrial process applications indicates that the growth potential from these electricity-specific uses is quite small.

Compared with the earlier 104,000 MW 'reference' programme the 1978 Green Paper sees a nuclear component of 25-40,000 MW in 2000, implying the construction of only 1-2,000 MW annually from 1985. The central question now facing the nuclear industry is no longer whether it can muster the skills and resources to build a large programme, but whether it can survive a long period of low home ordering and continued difficulty in exporting.

Following Ince B, Drax B and two new advanced gas cooled reactor orders, further advance orders for power stations should be out of the question on cost grounds. It is therefore urgent to identify the resources and skills that are specific to nuclear design and engineering and to examine how they can best be organised and retained against the time that series ordering can take place. This problem must have precedence over the fast reactor question, for it would be sheer folly to develop fast reactor technology without ensuring that the design and manufacturing base is there so that nuclear power stations can be built efficiently when they are needed. If there is a solution, it is likely to require the rationalisation of the whole power plant manufacturing industry, including nuclear design and construction and large steam turbine generators.

The recognition that long lead times make it impossible to install a significant fast reactor programme by 2000 now seems to have brought a corresponding change in the reason adduced for proceeding with the demonstration plant. When CFR-1 was regarded as the first of a large fast reactor programme, it could be held that costs of the demonstration plant over and above the costs of the cheapest alternative power source (a light water reactor, for example) would be recouped from the benefits accruing from the commercial fast reactors that were soon to follow.

Since the justification was primarily economic, it was possible to argue that CFR-1 would carry no opportunity cost in terms of other R&D projects. Questions about resource allocation were answered by the claim that the programme as a whole would show a large and positive net present value after applying the test rate of discount that is applied to public sector investments. As long as it appeared tenable to argue that the cost of CFR-1 would be recouped from the subsequent commercial programme, the relevant economic questions concerned the estimated capital and operating costs of fast reactors compared with thermal reactors and the estimated long-run supply and price of uranium. Both questions involve major uncertainties and evoke widely differing views.

If, however, approval for CDFR is seen as carrying no commitment to build a programme of fast reactors before the turn of the century, the choice must be seen primarily in the context of R&D strategy. If the commitment which is sought is for CDFR alone, not for a subsequent programme, the question of R&D opportunity costs looms large — the resources must come from somewhere and something will have to be foregone. Unless it is reasonably certain that a highly economic programme will follow in the not-too-distant future, the question of economic risk becomes very important with an R&D project costing £1,500 million or more. Such a commitment to any single R&D project can scarcely fail to affect the climate of opinion and the funds available for alternative R&D options. We therefore need to be quite sure that an equivalent funding of alternative technologies (not only in the energy field, of course) will be less rewarding than building CDFR.

The argument that Britain should acquire the capability to build commercial fast reactors as an insurance against long-term uranium scarcity involves a political judgement. It requires a decision on the acceptability of the whole range of risks and the appropriate rate of social time preference, how much the present generation is prepared to forego for the well-being of future generations.

Another argument in favour of CDFR, the 'export' justification, is wholly spurious for no one can say whether there will be opportunities 20 years hence to export 1,300 MW fast reactors. So far, domestic markets in the USA, Japan and most of Western Europe have been closed to imports of nuclear reactors. Whether the developing countries can accommodate 1,300 MW generating units on their power systems is a moot point. And on foreign policy grounds it is surely unwise for the UK to appear willing to promote exports of fast reactors (and the plutonium to fuel them) before rigorous international safeguards for reprocessing and the commercial use of plutonium are agreed and implemented.

If the political judgement is that Britain should acquire the capability to build fast reactors in the future, the relevant question then is how to proceed. Several further questions must then be answered, because building CDFR is only one of the options for acquiring this capability.

Firstly, why is it necessary to scale up to 1,300 MW? Doesn't the ability to replicate and perhaps stretch the 250 MW Dounreay prototype fast reactor give sufficient insurance against the risk of long-term uranium scarcity? If there are compelling technical reasons for scaling up, why not concentrate R&D effort upon the specific, critical metallurgical and engineering problems, as opposed to building a 1,300 MW power station costing at least £1,500 million? In any case, the performance of very large conventional and nuclear generating units hardly inspires confidence that the proposed scaling-up is economically justified.

Second, since France and Germany are intent upon building demonstration plants which are broadly similar to CDFR, why not wait and license from them when their designs are proven? After all, other countries have acquired the ability to build thermal nuclear reactors on the basis of foreign licences, whilst Britain has spent untold sums in developing indigenous reactor designs. Alternatively, why not collaborate with France and Germany, learning through participation, so as to be able to incorporate any necessary modifications in an eventual British version? The argument that Britain must go it alone because we have little to offer in such collaboration hardly squares with the oft-repeated claim that Britain leads the field in fast reactor technology.

Third, given the decisions to build two further advanced gas cooled reactors (involving considerable design modifications) and to undertake the design work necessary for a pressurised water reactor, how will it be possible to proceed with CDFR without severely overstretching the design engineering resources of the ailing nuclear industry?

So far, attention has focused on the question of whether CDFR should be built, rather than what happens if it is not built. Fast reactor work accounts for two-thirds of the scientists and engineers employed by the UKAEA on reactor development. A decision not to build CDFR will immediately call into question the future of the UKAEA. Even if CDFR is approved, this question cannot be ignored indefinitely. Sooner or later, it must confront any single-mission R&D agency. It has already been faced in the USA, where the Atomic Energy Commission was amalgamated into ERDA and now into the US Department of Energy. In Ontario, the Royal Commission on Electric Power Planning, under Dr Porter, has recommended that the Canadian nuclear R&D establishment should become an energy R&D agency.

It is true that the UKAEA has partially diversified into ancillary work; but I would like to think that its skills and resources, which are unique in Britain, can be applied on a much larger scale to other technologies with the same brilliance and dynamism that were applied to nuclear technology in the 1950s. This is not to suggest that the UKAEA must become an energy R&D agency. Its new role must be defined in the context of overall industrial and R&D strategy and the need to make the best use of all our public laboratories.

The assurance of a future rôle which is nationally and personally worthwhile will remove much of the uncertainty for the scientists and will make it less likely that a breeder is built for the wrong reason. □

'Saving it' is easier said than done

With the oil crisis in full cry and nuclear energy still an uncertain option, the UK government this week called on industrialists to make energy saving a priority. Paul McDonald assesses the potential of this new policy.

Energy conservation, according to Mr David Howell, the Secretary of State for Energy, is "now at the centre of energy policy". Faced with the task of trying to cut oil consumption by five per cent, the Government is relying heavily on industry to make significant improvements in the efficiency with which it uses its energy. However, apart from the widely publicised efforts of certain individual companies, there has been little progress in this sphere.

There are no major technical reasons why much of industry could not improve the efficiency of its use of energy substantially. Such is the inefficiency of the average industry, that its energy can usually be reduced by 10% with little or even no capital investment, simply by goodhousekeeping measures, such as insulation, or turning off machinery not in use. Savings of a further 10% are usually possible from improvements in processes; and a further 10% on top of that from major reorganizations of processing and wholesale re-equipping. The actual proportion that can be saved varies from industry to industry. The Department of Energy's estimates of potential savings vary from a total of 10% in the pottery industry to 61% in aluminium smelting.

The Department of Energy has, unfortunately, no way of assessing accurately how industry is progressing in this. The most optimistic estimates put the average level of improvement in the efficiency of industrial energy consumption since 1974 at 10%; but this is no more than could be achieved by general goodhousekeeping measures in most industries — and certainly below the level of our overseas competitors such as West Germany and Japan. In spite of an upsurge of interest in energy conservation amongst industrialists since January, there are still many factors inhibiting any major improvement in the use of energy, which are going to make the Department's target of 5% very difficult to achieve.

On the surface, there appears to be a good deal of activity: over 4,000 energy managers have been appointed; but their functions and responsibilities vary enormously, and, even in some large companies, a number of them are little more than token appointments.

A major constraint on improving energy efficiency is the lack of capital for measures designed to improve energy use, such as waste heat recovery and improving processes. This is particularly the case for the large number of industries where energy accounts for less than about 2% of manufacturing costs. There is, in any case, a preference in most industries to invest in production rather than conservation. Whilst the latter brings savings, these do not necessarily show up in reduced expenditure on energy in subsequent years, since they may easily be cancelled out by the general rise in energy prices. Given the preference for increasing output, conservation measures are often penalised by the imposition of shorter payback times than those for other items of capital expenditure.

Continuing economic recession and low levels of productivity greatly inhibit the efficient use of energy by forcing industries to work well below their full capacity. Furthermore, in a number of industries, such as food, drink and tobacco, there is a trend towards increased processing, which will increase the consumption of energy for the same level of output.

Improvements in energy use are further hindered by the slow rate of re-equipping in British industry. Many companies wait until equipment is due for rebuilding or replacement before trying to improve its energy consumption. In the case of a furnace, this is only once every 5-10 years.

Proper records of fuel consumption are vital to the sucess of any serious attempt to improve energy efficiency. In a great many companies these simply do not exist, making it impossible to set targets or monitor progress. Futhermore, the high costs of installing and maintaining adequate metering for this task will make the accurate control of energy use a continuing problem for a large number of firms.

The aim of company energy policies is not always to save energy. For certain firms operating continuous processes, security of supply may be the paramount consideration. For others, energy policy may be part of a general cost cutting exercise, and can just as easily involve renegotiating tariffs or switching to other fuels, as actually trying to reduce consumption by requiring the installation of energy using anti-pollution equipment as part of its health and safety policies. Energy conservation is clearly not going to be the easy part of the Government's energy policy.

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