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Viewpoint

Competitive energy markets and nuclear power: Can we have both, do we want either?

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ABSTRACT

In 1987, the UK Conservative Party was re-elected promising to transform the electricity industry into a privatised competitive industry and to promote an expansion of nuclear power. Fulfilling both objectives was not possible. The nuclear plants were withdrawn from the sale and plans to build new plants were abandoned, but privatisation proceeded. In 2007, the Labour government began a new attempt to build nuclear plants to operate in the competitive electricity market, promising that no subsidies would be offered to them. By 2010, the utilities that were planning to build nuclear plants were beginning to suggest that 'support' in some form would be needed if they were to build new plants. More surprisingly, the energy regulator, Ofgem, cast doubt on whether a competitive wholesale electricity market would provide security of supply. In 1990, the UK government opted for a competitive electricity market over expanding nuclear power. Now, the option of opting for a competitive electricity market may not exist. However, this might not leave the way open for new nuclear plants. The expected cost of power from new nuclear plants is now so high that no more than one or two heavily subsidised plants will be built.

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1. Introduction

In 1987, the UK Conservative Party was re-elected to government. Their manifesto included promises to transform the electricity industry into a privatised competitive industry and to promote an expansion of nuclear power (Conservative Party, 1987). Many commentators believed that these two objectives were incompatible. In 1989, in order to fulfil the promise to privatise the electricity industry, the government was forced to withdraw the nuclear capacity from the sale and abandon all nuclear expansion plans. This was interpreted by these commentators as confirming the incompatibility of new nuclear build with a competitive electricity industry. Despite this experience, in 2007, the British (then Labour) government launched a new policy to build nuclear power stations that would be built by the private sector and compete without subsidies in the electricity market. However, by the start of 2010, the utilities, which had earlier endorsed the government's nuclear plans, were becoming nervous and broaching the need for various forms of support if they were to build nuclear plants. Much more surprisingly, in February 2010, the government and the economic regulator, the Office of Gas and Electricity Markets (Ofgem), seemed to signal the likely abandonment of the wholesale electricity market.

From 2000 onwards, worldwide concern about climate change has grown and finding measures that will deal with this issue has come to dominate the energy policy agenda. Many governments have based their energy policies on a combination of revitalising the nuclear power option and introducing competition to energy markets as instruments to meet their energy policy goals. If the UK, the pioneers of competitive energy markets and one of the leading nations trying to revitalise nuclear power¹, were to have to acknowledge that this combination of policies will not work, the basis for many current national energy policies would crumble. This article examines the two attempts, in 1987 and 2007, by the UK to combine expansion of nuclear power and competitive energy markets, explains the failure of the first attempt and comments on the prospects for the second attempt.

2. Why might liberalisation and nuclear power be incompatible?

It is clear that existing nuclear power plants can be fitted into competitive electricity markets. The fact that construction is complete and a track record of reliability exists significantly reduces the economic risk and if the construction cost is already

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E-mail addresses: Stephen.thomas@gre.ac.uk, stevedt1@tiscali.co.uk.¹ The structure of the model was pioneered in Chile, but the competitive elements were largely not implemented there.

amortised, the plants may be so profitable that governments will want to recover some of these profits through a windfall tax.²

There are two simple arguments why building new nuclear power plants that had to survive in a competitive electricity market with no further assistance might not be possible. First, nuclear power costs are dominated by the construction cost and this makes nuclear power economically inflexible. If wholesale electricity prices fall, for example due to over-capacity in generation and/or low fossil fuel prices, there is no scope for nuclear plant owners to reduce their costs and if the wholesale price falls below the level needed to repay these fixed costs for more than a short period, losses will quickly accumulate. To some extent this argument applies to some renewables like wind and hydro, but, unlike these two, nuclear operating costs are not minimal. As discussed later, British Energy, the privatised nuclear generation company, collapsed in 2002 because its operating costs alone were higher than the prevailing wholesale electricity price. So while the marginal costs of wind and hydro are so low they can cover these with almost any conceivable wholesale price³, nuclear power cannot necessarily survive low wholesale prices.

The second factor is the poor record of nuclear power in meeting forecasts of construction cost, construction time and reliability. Even if nuclear power appears economic in an investment appraisal using these forecasts, if there is a significant risk that costs will be higher than planned, it represents a risky investment that financiers will be reluctant to support.

3. The failure to privatise nuclear power in 1990

Britain had a very unusual stock of nuclear power plants in 1987 (MacKerron, 1996). It had nine nuclear stations of the so-called Magnox design, the first-generation designs, all of which were completed in the period 1963–1971; and seven advanced gas-cooled reactors (AGRs), five of which were ordered in the period 1965–1968 and two in 1979. The only plant of a design widely used outside UK was a 1200 MW pressurised water reactor (PWR) on which construction had then just started (Sizewell B). When this was planned in 1979, it was to be the first of 10 units of this design but by 1987, the programme had been cut to just four units, the so-called ‘family of four’.

In 1987, the Conservative government was returned to power promising that government would: ‘go on playing a leading role in the task of developing abundant, low-cost supplies of nuclear electricity’ (Conservative Party, 1987) and to privatise and introduce competition to the electricity industry. The plan for the latter was only later elaborated and involved dividing all the generating plants into two packages, with a larger package including the existing nuclear capacity going to a company subsequently called National Power and the smaller package going to Powergen. National Power would have an obligation to build the four new nuclear plants then planned.

It was not until July 1989 that the government publicly acknowledged there were problems in privatising the nuclear capacity when it announced that the Magnoxes would be withdrawn from privatisation. Then in November 1989, it announced the withdrawal of the other nuclear plants. Two new government-owned companies, Nuclear Electric and Scottish Nuclear, were created to run all the nuclear plants and a

moratorium on new nuclear plants was imposed until a review had been carried out, scheduled for 1994. Privatisation of National Power (without the nuclear plants) and Powergen proceeded. Subsequently, it was decided to allow construction of Sizewell B by Nuclear Electric to continue and the plant was completed in 1995. A consumer subsidy paid to Nuclear Electric, the Fossil Fuel Levy (FFL), was introduced and it was set at whatever annual level was needed to ensure that Nuclear Electric would remain solvent.⁴ The FFL raised about £1bn per year and, in 1990, comprised about half Nuclear Electric’s income.

This failure to privatise the nuclear industry in the UK in 1990 was more complicated than being a simple demonstration of the general incompatibility of energy markets and nuclear power. There were essentially three specific obstacles to the privatisation of the nuclear plants:

- The nine Magnox stations were all beyond their design lifetime and their operating costs alone were about double the expected wholesale price for electricity;
- The seven AGRs were hopelessly unreliable with an average availability of less than 40 per cent. Two of the stations had been in service for about 10 years and their performance was poor but tolerable but three of the other stations had been in testing phase for about five years and it seemed unlikely they would ever work reliably. As a result, the average operating costs of the AGRs were also about double the expected market price. The two newest AGRs, then just being commissioned, were expected to suffer from similar problems to the older plants;
- The obligation on National Power to build a small family of four PWRs was seen as particularly commercially risky given the plan to transform electricity generation from a monopoly to a competitive market. Not only could operating performance be poor but also construction cost and time could overshoot leaving the plant owner with large additional costs that, in a competitive market, could not be passed on to consumers.

It seems that it was the third issue that was the main barrier to privatisation. Well before the Magnoxes were withdrawn, a subsidy was planned, the FFL, which would have paid the excess costs of the Magnoxes and AGRs and funded their decommissioning so the high costs of these plants seemed to have been dealt with. A new owner could not have been held financially responsible for such a problematic set of reactors so the subsidy would have had to be set to cover all their above market costs. However, a new privatised owner would be responsible for the costs and performance of the ‘family of four’ and this was an unacceptable risk to the new management of National Power and potential investors. John Wakeham, the energy minister, explaining the withdrawal of the nuclear plants, subsequently said that: “unprecedented guarantees were being sought. I am not willing to underwrite the private sector in this way...”.⁵

4. The revival of nuclear power’s fortunes

By 1995, when the government’s review of nuclear power policy was actually carried out, Sizewell B was complete so the risk of construction cost escalation no longer existed and early operation suggested it was likely to operate reasonably reliably.

² This is the case in Belgium and Germany.

³ Note that in October 2009, the German wholesale price was negative for a whole day due to a combination of low energy demand and high wind and nuclear availabilities. See Power in Europe ‘Baseload vs wind storm brews’, 19 October 2009.

⁴ Separate arrangements were made to ensure Scottish Nuclear’s solvency.

⁵ J. Wakeham (1989) House of Commons Debates. HC Debates, 1988/89, vol. 159, 9 November 1989.

The reliability of the AGRs had improved enough that the AGRs and Sizewell B were then able to more than cover their operating costs from the proceeds of sale of their output to the wholesale market. As a result the government proposed the privatisation of the AGRs and Sizewell B. The Magnoxes were clearly unsalable on any terms and had to remain in public ownership. A new company, British Energy, was created to own the seven AGRs and Sizewell B in 1996 and was floated on the Stock Exchange with proceeds to government of about £1.7bn, about half the cost of building Sizewell B.

British Energy prospered while the wholesale electricity price remained high but when, in 2002, it fell, due to a combination of over-capacity and low fossil fuel prices, its income from sale of power was less than its operating costs and the company collapsed. The government chose to save it with a package of subsidies that it estimated would cost taxpayers in excess of £10bn (European Commission, 2005) and the company was re-launched in 2005. At about that time, the Blair government launched a review of energy policy despite the fact that it had completed its previous one only 2 years before. The verdict of the previous 2003 review on nuclear power was damning (Department of Trade and Industry, 2003):

The current economics of nuclear power make it an unattractive option for new generating capacity and there are also important issues for nuclear waste to be resolved. We conclude it is right to concentrate our efforts on energy efficiency and renewables.

Despite the fact that the estimated economics of nuclear power had deteriorated and while there was no evidence the economics of renewable and energy efficiency had got worse, the new energy policy review was widely seen as a pretext for launching a revival of nuclear ordering. In 2007, the policy was announced and it found (Department of Trade and Industry, 2007):

Nuclear power could provide significant benefits to future generations, particularly in terms of reducing carbon emissions and contributing to energy security and thereby supporting economic growth. It is likely to be more cost effective than alternative forms of low-carbon generation.

The key proviso that made this *volte face* politically acceptable to MPs who were concerned that, as with earlier UK nuclear programmes, it would turn out to be a blank cheque funded by taxpayers and electricity consumers was that no subsidies or guarantees would be given. A White Paper on nuclear power in 2008 stated (Department for Business, Enterprise and Regulatory Reform, 2008):

It would be for the private sector to fund, develop, and build new nuclear power stations in the UK, including meeting the full costs of decommissioning and their full share of waste management costs.

However, this 'hands off' approach was ambiguous. In 2009, in its Draft National Policy Statement for Nuclear Power, the government stated (Department of Energy and Climate Change, 2009):

Within the context of the overall strategic framework set by the Government, in principle new nuclear power should be free to contribute as much as possible towards meeting the need for 25 GW [15–20 units] of new non-renewable capacity.

So the government seemed to be saying, on one hand that nuclear power was necessary, but on the other, that they would

do nothing beyond a few facilitation measures to ensure new nuclear plants were built.

To facilitate ordering, the government promised to get generic design approval for several designs so that the utilities could choose between more than one design, sure that all major design issues would have been resolved. The ability to fix the design ahead of construction was expected to reduce the risk of cost over-runs during construction. The government also promised to streamline the planning process so that unpredictable delays would not arise in getting planning permission for specific sites.

All the UK utilities quickly took positions which would allow them to build nuclear power plants in the UK if they wanted. However, by the end of 2009, it was the three largest companies, EDF of France and the two large German companies, RWE and EON in a consortium named Horizon, which had become the front runners.

5. Progress with introducing competitive energy markets

In 1989, the UK government decided introducing energy markets was a higher priority than reviving nuclear ordering and for at least the first decade, the 'British Model' was portrayed worldwide as a successful model that should be emulated. However, since then, the high reputation of the British reforms has become increasingly tarnished.

The 'British Model' is based on creation of a wholesale market and retail competition and unbundling networks from competitive generation and retail activities. The key is the creation of a wholesale market. Unbundling is only relevant if competition is to be introduced and there is a need to ensure a level playing field in terms of access to networks for competing generation and retail companies. Unbundling is unlikely to make any difference to energy prices. Retail costs should represent less than 10 per cent of the total energy bill, so even if one company was dramatically more efficient than the rest, the savings it could offer consumers would be far too small to make it worthwhile to switch.

The wholesale market would be the arena where power would be bought and sold and where the market price would be set. This would make it easy for new generators and retailers to enter the market to challenge the existing companies. If a new generator knew it could beat the prices of its competitors, it could be sure it would be able to sell its power just as any oil producer knows it can sell any oil it produces at the world market price. A new retailer would know it could buy power from the wholesale market for no more than its competitors would have to pay, so, if it could be more efficient than the existing companies, it could win customers by offering cheaper prices or better service.

The traditional function of system planning under which a central authority would decide when new power station capacity was needed would no longer be required. If the trend of wholesale prices was upwards reflecting either an imminent shortage in capacity or the fact that the existing power station stock was sub-optimal, companies would see the 'price signals' and would choose to build new power stations to take advantage of the profits they could make from these high prices. Proponents of energy markets believe that supply security, ensuring there is enough generating capacity to meet demand, will be ensured because these market signals will be effective in stimulating new investment.

However, electricity is not like other commodities for which this commodity market model appears to work. It cannot be stored, and supply and demand must match exactly at all times if the system is not to collapse. So the price signals must be apparent sufficiently ahead of capacity need for the new capacity to be built. In addition, sufficient power stations must be

profitable for there to be sufficient capacity to meet peak demand even in unusually cold weather conditions. So, to ensure supply security, there will need to be power stations available that will not be needed in most years.

In practice, if entry barriers for new generators are not so low that there are many companies that could respond to price signals, the incumbent generators will find it much more profitable to not invest. Any shortage premium on the wholesale price will last only as long as there is a potential shortage, whereas if the incumbents do not invest and entry barriers are too high for new entrants to risk investment, high prices will be sustained. This was amply demonstrated in California in 2000–2001 (Weinstein and Hall, 2001), where an apparent capacity shortage led to sky-high prices. Arguably, the generators could have continued to make excess profits if they had not been so greedy as to cause the system to collapse and the competitive model to be abandoned.

Expressed in these simple terms, it seems implausible that the market model can deliver security of supply and it was on these grounds that Ofgem expressed its reservations in February 2010. It stated (Ofgem, 2010):

The unprecedented combination of the global financial crisis, tough environmental targets, increasing gas import dependency and the closure of ageing power stations has combined to cast reasonable doubt over whether the current energy arrangements will deliver secure and sustainable energy supplies.

And

There is an increasing consensus that leaving the present system of market arrangements and other incentives unchanged is not an option.

Ofgem is clearly trying to present this expected failure as the result of an unprecedented and unpredictable combination of events rather than it being an outcome that was bound to happen sooner or later. It was Ofgem that designed and implemented the wholesale market at a cost to consumers in excess of £1bn and to admit the failure of the market was inevitable would be to admit its guilt in wasting large amounts of consumers' money. There are other grounds for doubting the efficacy of the British Model (Thomas, 2006), but if it is unable to guarantee to keep the lights on, it is not sustainable regardless of any other pros and cons.

Only the day before Ofgem's statement, the British Energy Minister, Ed Miliband told the Times⁶:

The Neta system [the British wholesale market], in which electricity is traded via contracts between buyers and sellers or power exchanges, does not give sufficient guarantees to developers of wind turbines and nuclear plants. He said that one alternative would be a return to "capacity payments" – in which power station operators would be paid for the electricity they generate and also for capacity made available. The idea of such payments is to give greater certainty to investors in renewable and nuclear energy.

This statement is the clearest acknowledgement yet that the government is belatedly realising that the 'no subsidies' policy will not work. There is an arguable case to be made for capacity payments for peaking plants in a competitive market. For an electricity system to have sufficient capacity to reliably deliver power in most winters at peak demand, there must be plants available that might only be needed on average once a decade. It

is unrealistic to expect generators to keep plant available that is not usually needed and makes a loss in 9 years out of 10. So some incentive to keep such plants available in the form of capacity payments might be justifiable. If the market cannot cover the costs of a base-load technology like nuclear power, which will operate day-in day-out whatever the demand level, there is clearly something wrong with the market or the technology (or both).

6. Is nuclear power economically feasible in a competitive market?

If the economics of nuclear power were attractive, that is, if over the life of a plant, the impact of the nuclear plant would be to make electricity prices lower than if it had not been built, the fact that it was not financeable in a competitive market would be seen more as a failing of the competitive model than of nuclear power. A competitive market is a means to an end (to affordable reliable power) not an end in itself and if the market is not allowing the cheapest options to be built, the market is at fault.

Since around 2000, there has been talk of a 'Nuclear Renaissance' under which nuclear ordering worldwide would be revitalised by the qualities of the new generation of nuclear power plant designs, the so-called Generation III+ designs, now on offer. These were expected to be much cheaper, more reliable, and easier and quicker to build than earlier designs. However, new orders have been slow to materialise and by the start of 2010, there were only two units worldwide of this new generation of designs, Olkiluoto in Finland and Flamanville in France, with more than a year of construction experience.

Over the decade since the new generation of nuclear designs was mooted, the expected economics have deteriorated alarmingly. Areva NP, the French vendor of nuclear power plants, estimates⁷ that 70 per cent of the cost of a kWh of nuclear electricity is accounted for by the construction process. The construction cost part is made up of three elements: the cost of building the plant; the cost of capital to finance build; and the reliability of the plant (the more output the plant produces, the more thinly the fixed costs can be spread). Most of the operating costs are fixed because even when the plant is not producing power it has to be fully staffed and regular maintenance will be required so, unlike fossil fuel plants, in the short term, little money is saved if the plant is not operating. This paper does not examine the reliability of nuclear plants. In the past, their reliability has been much poorer than forecast, but has improved markedly in the past 20 years. So while reliability cannot be assumed, it appears less of a risk than it would have done 20 years ago and thus is less of an issue amongst financiers.

6.1. Construction cost

The first order for a new generation design, the Areva NP EPR, came in December 2003 for the 1600 MW Olkiluoto plant for which the contract price was reported to be €3bn or €1875/kW.⁸ At the exchange rates of the day (£1=€1.45), this was equivalent to £1300/kW, significantly higher than the UK government's assumption of only a year before (Department of Trade and Industry, 2003) and higher even than its 2008 forecast of £1250/kW (Department for Business, Enterprise and Regulatory Reform,

⁷ http://www.areva.com/servlet/BlobProvider?blobcol=urluploadedfile&blobheader=applicationpercent252Fpdf&blobkey=id&blobtable=Downloads&blobwhere=1246874807296&filename=Overview_June_2009percent252C0.pdf.

⁸ Agence France Presse 'Areva, Siemens sign deal to build nuclear reactor in Finland' December 18, 2003.

⁶ The Times (2010) 'Labour prepares to tear up 12 years of energy policy' February 1, 2010.

2008). Construction started in August 2005 and Olkiluoto was expected to take 4 years to build but after 4 years of construction it was still about 4 years away from completion and the expected cost had nearly doubled in Euro terms to about €3500/kW (Schneider et al., 2009). At 2009 exchange rates (£1 = €1.10) this is equivalent to £3200/kW, two and a half times the UK government's 2008 assumption.

The Flamanville plant, under construction since December 2007, is of the same design as the Finnish plant. It is being built by Electricité de France (EDF), the leading utility proposing to operate nuclear plants in UK. EDF has already built 58 nuclear reactors of modern design in France, more than three times as many units as any other utility in the world and if any company can build nuclear power plants efficiently, surely it should be EDF. However, after a year of construction, EDF acknowledged it was more than 20 per cent over budget at £2100/kW⁹ and in January 2010, there were press reports that it was two or more years late.¹⁰ Experience at only two sites is too little from which to draw unequivocal conclusions on the qualities of the Generation III+ designs, but it is the only experience there is and it is uniformly bad, far worse than even the most determined critics of nuclear power would have forecast.

Outside France and Finland, electric utilities in the West with plans for new nuclear power plants are only at the stage of talking to suppliers, identifying sites and estimating costs. In 2008, EON, a company hoping to build new nuclear plants in the UK estimated that the cost of building a plant in the UK would be 70 per cent higher than the UK government was assuming.¹¹

In the USA, the US government is also trying to revive nuclear ordering, but in their case by offering very large public subsidies for a few demonstration units. Estimates are emerging from some of the utilities who plan to build plants there. The utilities' own cost estimates have increased markedly in the past 3–4 years and seemed to clustering around the \$5000/kW or about £3000/kW in 2009 with every expectation that prices will increase further as the estimates are firmed up (Schneider et al., 2009). A cost of \$5000/kW is more than three times the UK government's estimate (Thomas and Hall, 2009).

6.2. Cost of borrowing

In the past, financing the construction of new nuclear plants has never been a problem because the electricity industry was a monopoly. If costs over-ran or the plant was not reliable, the utility simply put electricity prices up to pay its additional costs. So, to a banker lending money to a utility, a nuclear power plant was a low-risk loan because it was underwritten by consumers. As a result, the cost of borrowing was correspondingly low. This was a huge, but arguably unfair advantage for a technology for which the costs are dominated by the cost of construction.

However, after the opening up of electricity to some form of competition, far from perfect as argued above, the financial risk moves from the consumer to the utility. In a competitive market, if the cost of a company's product is too high, it goes out of business. This was clearly illustrated in 2002 in the UK when the nuclear company, British Energy, went bankrupt because its operating costs were higher than its income from electricity sales. British Energy could not unilaterally raise its prices to cover its costs; it had to take what the market offered. Those that owned

shares in British Energy lost their money. Had the company been building a nuclear power plant, the banks providing the loans would have also lost their money.

The banks that lent money to the Finnish utility building Olkiluoto will be biting their nails to see if the utility can absorb the huge additional costs it faces and survive. If it does go under, and there is a serious risk now that it will, the banks that lent to it could lose a significant part of their loans not covered by loan guarantees. Banks will therefore have their belief that nuclear investment is highly risky reinforced and the cost of borrowing will reflect this.

6.3. Overall economics

Even if the construction costs for new plants turn out no to be higher than about \$5000/kW, which seemed to be the central value in 2010, and if we assume a cost of borrowing of 12–15 per cent, the cost of nuclear electricity is likely to be much higher than the alternative low-carbon options, especially energy efficiency measures. If nuclear power was an immature technology, it might be expected that the normal processes of learning, scale economies and technical change would significantly reduce costs over time and there might be good arguments to persist with the technology. But nuclear power has been around for more than 50 years and during that time, real costs have consistently gone up. This is despite the nuclear industry claiming for decades the cost curve for nuclear would start to go down as past problems were solved by the latest generation of nuclear designs.

6.4. Can we have competitive markets and nuclear power, do we want either?

Whether building new nuclear power and competitive energy markets are incompatible still remains unproven. The failure in 1989 in the UK to fit new nuclear plants into a competitive framework may well have been influenced by the poor track record of the UK nuclear industry. In 1989, the British government chose competitive energy markets over nuclear. At that time, the consequences of introducing competitive energy markets were little understood by the UK government and privatisation/competitive markets were seen as a panacea for the failings of government energy policy. Nuclear power's reputation had been badly damaged by the revelations about how high the costs really were.

The UK government seems remarkably credulous to the claims made for the new generation of nuclear designs, but it is now beginning to appreciate that the renewed attempt of 2007 to build nuclear plant will fail unless government is prepared to provide subsidies or guarantees. However, the problems of introducing competitive markets to energy are becoming apparent and the indications from Ofgem and from the Energy Minister are that it will be the competitive market that will be abandoned. This provides an opportunity for nuclear power. There is no doubt that nuclear power plants can be built provided governments are prepared to offer large enough subsidies and abandoning the market makes it easier to provide the support needed to finance new nuclear plants.

If global warming was the major threat it is generally portrayed to be and nuclear power was the only option that could make a significant impact on fossil fuel use, then we would have little choice but to provide this support. We would have to learn from our mistakes with previous nuclear programmes and manage the programme better than in the past. However, in the UK, electricity accounts for only about 20 per cent of the energy we use and nuclear provides about 15 per cent of our electricity,

⁹ Nucleonics Week 'EDF: Flamanville-3 cost rise due to inflation, technical/regulatory changes' December 11, 2008, p. 1.

¹⁰ French Business Digest 'Unions confirm 2-year delay at EDF's nuclear project in N France' Jan 21, 2010.

¹¹ The Times 'Reactors will cost twice estimate, says E.ON chief', May 5, 2008, p. 32.

so nuclear accounts for only about 3 per cent of our energy needs. If the UK was able to triple electricity's share of energy and triple the contribution of nuclear to electricity, nuclear would still only provide less than 30 per cent of our energy. To achieve an increase in the contribution of nuclear on this scale would mean building about 60 new nuclear plants. Finding sites that are far enough away from population centres, which have appropriate geological and water characteristics, but which are not at risk from rising sea-levels would be difficult. The additional network requirements in terms of new transmission lines and reinforced distribution lines would also be formidable. On the demand-side, to use the extra power, it would, for example, need a large-scale switch to electric cars and space heating would need to be switched from natural gas to electricity. While such a switch is technically feasible, the economics of electric heating and electric vehicles are poor. Many household consumers already struggle to pay their heating bills and imposing a more expensive method of heating would have a serious impact on social welfare. So at best, nuclear can only replace a relatively small proportion of fossil fuel use and will require a massive policy effort to achieve even that.

The high costs and the seemingly inevitable construction problems mean that the capacity of new nuclear generation build will be later and far less than planned. However, while nuclear power is still a looming presence in our energy policy, it will continue to consume a grossly disproportionate share of the resources and political attention. How else can the dismal quality of the UK housing stock and the poor rate of exploitation of the UK's enviable renewable resources be explained other than because of this effect? The policy we must adopt is to remove the looming presence of nuclear power in the policy agenda and concentrate on the best options available now, and in the UK context, there is little doubt that this means pursuing energy efficiency. We also need to create options for future generations, and, in the UK context, this means putting money into developing

and commercialising renewables. The failed competitive model was chosen because it was believed it would maximise economic efficiency. Its ability to meet environmental and social objectives was not an issue. Now we have to design a model that is well suited to meeting these non-economic objectives.

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