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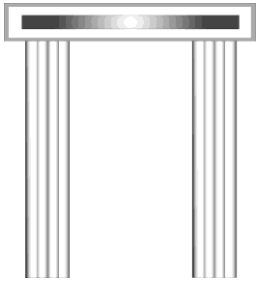
Nuclear Options

Powering the Future

Editor
Sheila Lawlor

POLITEIA

A FORUM FOR SOCIAL AND ECONOMIC THINKING



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Foreword – After Hinkley, What Next for Nuclear?

Sheila Lawlor

Energy is now the focus of political debate at Westminster. Both government and Opposition have promised to cut its costs. But how? The Coalition plans to ease some 'green' obligations and so reduce costs for companies and their customers; Labour proposes a freeze on energy costs for 18 months.

Ensuring affordable energy, however, needs to be linked to two other goals: ensuring a secure energy supply, and – so as to make this security genuine – providing a mixture of sources from which the country can draw.

However, achieving these goals may be undermined by external forces: global conditions, such as unstable producer regimes, price fluctuations or indeed sudden discoveries of new supplies, e.g. gas fields or shale. There are also the changing priorities of rulers both in the EU and UK, and the cocktail of legal and other constraints imposed by Westminster and the European Union, designed to influence what energy we use. In particular, the UK has a legal obligation to cut CO2 emissions by 80 percent by 2050, with an interim target of 34 percent by 2020.[1]

The cost, supply and security of energy, is therefore subject to changing circumstances, some imposed by government, others the result of external forces.

For nuclear energy, other factors are also important: the high cost of replacing reactors, uncertainty in policy and decades of mixed official signals, from political standoff, to economic laissez-fare, to current interventionism. As a result of official policy, or its absence, the proportion of electricity currently generated in the UK by nuclear power (currently c.20 per cent), will shrink dramatically as all existing nuclear power stations are due to be decommissioned during the next decade.

The authors of *Nuclear Options: Powering The Future*, Professor Roger Cashmore, Dr Simon Taylor and David Mowat MP wish the decline to be reversed. They therefore broadly welcome the recent announcement of a new reactor at Hinkley Point C under the aegis of the French company EDF and supported by Chinese investment. Despite some doubts about its parts, e.g. the type of reactor, the delays and over-budget costs which characterise other similar

[1] The 2050 target became law in the Climate Change Act 2008 and the interim target was made legally binding in the April 2009 Budget.

projects, they see the proposed new reactor at Hinkley Point as a first step, and want it to be followed by a fuller programme.[2]

Dr Simon Taylor, a Cambridge economist and lecturer in finance, traces the change from a market approach to a policy of central planning, where under current circumstances government support was necessary for nuclear to remain part of the UK mix. Professor Roger Cashmore, Chairman of the UK Atomic Authority, explains the importance of rebuilding nuclear energy capacity on economic and scientific grounds, as well as to produce energy; he sets out the obstacles to be overcome and the opportunities now to be seized. David Mowat MP, a former global energy partner of a technological and consulting firm, analyses the context of current energy policy and its weakness, urges his party to commit to nuclear as part of the UK's energy mix at present levels with a four-point plan on which all parties can agree.

This is the first publication in Politeia's *Energy Series*, in which academics, industry leaders and specialists from Westminster and Whitehall explore the role of different sources of energy for the UK's energy mix and consider whether this country should continue to be bound by the current framework and policy.

Sheila Lawlor, Director of Politeia

[2] The type of reactor used is the European Pressurised Water reactor, EPR and Simon Taylor refers to the problems affecting similar EPR projects elsewhere in Finland and France, while David Mowat warns against being limited in future to negotiating with a single consortium.

I

Going Nuclear

Roger Cashmore

Introduction: Nuclear Energy, Government Policy, and the Future

An agreement has now been reached over the 'strike price' for the electricity generated from the projected new reactors at Hinkley Point C, near Bristol. This is a major step forward in the United Kingdom's aspirations for new nuclear development and for nuclear generation of electricity to take its place in the nation's portfolio of energy sources for the rest of this century. This process, however, still needs to be completed, with the final decision from EDF yet to come to make its capital commitment supported by Chinese investment. This could then herald the regeneration of a nuclear supply chain in the UK, including both the companies and, more importantly, the scientists, technologists, engineers, and skilled workers to support such aspirations. But much more needs to be done to guarantee a true nuclear revival. Not only must a vision be created; but the right practical policy from the drawing board to the grid must be proposed to cover all aspects of nuclear power from 'cradle to grave', to reinforce the vision and give the population confidence that the government is committed to a coherent course.

Future governments face difficult issues in the areas of energy and climate change. As the UK population increases, now projected by the ONS to grow c. 10 per cent by the year 2027 (from 63.7 million to c. 70 million) there will be an inevitable increase in demand for energy and electricity. Given the potential long term consequences of carbon dioxide emission, the government's aim now is to avoid using fossil fuels to meet such increased demand. That may allow the UK the opportunity to achieve its stated carbon reduction goals. Recent history demonstrates how hard this will be. In 2012, for example, such UK emissions increased by two per cent. If carbon reduction goals are to be met, the only choices are renewable and nuclear generation with a continuing emphasis on greater efficiency.

Obstacles and Opportunities

In the case of nuclear, even when the decision has been taken, progress will be neither quick nor simple for producing energy in moving from the drawing board to the stage when power reaches people's homes. It takes c. 10 years to approve and build a new reactor. This is then followed by c. 60 years of operation, and c. 30 years to deal with final decommissioning (the cost of which is included in the strike price). This amounts to a commitment to a 100 year programme. There are also other issues to be faced.

Overcoming the Uranium Shortage The world supply of uranium, more precisely U-235 (the primary fission fuel of the current fleets of thermal neutron reactors and 0.7 per cent of the uranium supply) is estimated to run out sometime after 2050. This is well within the 100 year time horizon and even earlier if a larger expansion in nuclear electricity generation worldwide takes place. Fortunately this serious difficulty can be avoided through the use of well known and understood fast reactors and fast breeder reactors. These were pioneered in the UK in the last century, carried forward by France and Japan, and are now being deployed in Russia, India and China. These use the plutonium Pu-239 which is generated from the U-238 in the current families of thermal reactors, or the future breeder reactors, and which can be extracted from the used fuel. The U-238 (99.3 per cent of the original uranium) is converted to Pu-239 which is then used to generate more energy in the fast reactors, giving fifty times or more increase in the energy output. This improvement is therefore a significant achievement and a far more sustainable and efficient use of the original uranium. Furthermore this reuse of 'used fuel' in fast reactors can also be arranged to 'burn up' the radioactive actinide by-products, those products which are the most troublesome and long lived components in the radioactive waste. This would change dramatically the disposal requirements, reducing both the quantity of waste and its radiotoxicity.

Unfortunately, in the early 1990s, when the UK had a large prototype fast reactor supplying electricity to the grid, this country decided to withdraw from this area of reactor research and development. If this attractive route is to be exploited in the future, the extensive experience and knowledge that had been gained must be recaptured from an ever decreasing number of experts in this highly specialised area.

Recycling Used Fuel At the same time the UK must retain its competence in reprocessing used fuel, despite it being the stated intention of the Nuclear Decommissioning Agency (the NDA) and the Department of Energy and Climate Change (DECC) to terminate this activity at Sellafield in 2018 by closing the successful THORP reprocessing plant. That decision must be reversed if the UK is now to develop its nuclear energy in a sustainable way.

A Nuclear Commissioning Agency A fast reactor future will need the scientific and technological expertise in both reactors and reprocessing and in particular it will need a new cohort of experts and practitioners who have benefitted from the UK's historic experience in these areas and can now develop the new routes the future demands. This calls for a new agency, a 'Nuclear Commissioning Agency', with a remit to look to a future which regards nuclear generation as an asset rather than a liability. This is in stark contrast to the view which underpins the current approach of the Nuclear Decommissioning Agency which emphasises

decommissioning and leads to the closure of the UK's nuclear facilities and activities. To attract into the field the necessary 'new blood' in substantial quantities will demand a well supported research and development programme as part of the grand vision. Action is now needed if the errors of the past are to be avoided.

Thorium Reactors, Fusion, and SMRs Fast reactors based on this uranium cycle are not the only way to new nuclear energy. Reactors based on thorium, a much more prolific element than uranium on the earth, may be feasible but would need time and research.

In addition two other processes should be noted here, fusion and SMRs. The ultimate goal of energy from nuclear fusion gets ever closer with the construction of the International Thermonuclear Energy Reactor (ITER) in the south of France. In the shorter term the advent of Small Modular Reactors (SMRs), which are based on the well tried thermal neutron reactor technology, offer another route in mobilising the nuclear industry. The fact that they are small, as their name implies, and have the ability to be fabricated in a factory, can lead to lower costs, earlier development and earlier markets.

These, together with the fast reactors, offer attractive solutions to the world's, and the UK's, energy problems but they all require aggressive R&D programmes – programmes which have much in common with each other and with the areas of materials, high performance computing and simulation, processing, manufacture and remote handling. All need to be high on the national agenda. To push this agenda forward requires a concerted effort and commitment from the government, industry and academia. In re-establishing the nuclear industry in the UK, the government has a special role in providing the confidence required for investment and so making its stated Nuclear Industry Strategy a success. It will take time and the time scales are long in this area. However the scientific and technological challenges are great and every bit of available time will be needed. Urgency is of the essence to avoid squandering such a great opportunity.

Government Policy: The Next Steps

A consistent government policy must recognise that our skill and knowledge base is depleted and fragile; that unless it is regenerated, and regenerated quickly, it will be lost forever. For such a course, new nuclear build is needed, and that new build must be sustained. A revitalised UK nuclear industry will also be needed to provide career paths and prospects for those newcomers attracted both by the challenges of the new build and the excitement of the intense R&D. These will be essential to making a significant contribution to the long term future of the UK and the planet as a whole.

In particular the government needs to commit to:

- the continued use and development of nuclear power in the energy mix.
- a rolling programme of new nuclear build projects which will contain a variety of reactor systems.
- developing programmes to process used reactor fuel.
- earmarking a greater proportion of R&D and science research budget to nuclear research.

II

Nuclear Energy Policy and the UK: Learning by Doing

Simon Taylor

Nuclear power in the UK is at the sharp end of a major change, not just in policy but in the whole philosophy of government, namely the question of how far the state should intervene in the economy. This question was more or less settled from the late 1990s until the mid-2000s, based on a rough consensus that in the industrial, commercial and energy sphere the government would largely leave things to the market, while continuing to intervene in health, education and social spending.

What has changed is that the current Coalition government has agreed with the previous Labour government that nuclear, as the sole proven source of low carbon base-load power, must be kept in Britain's generation mix. This goal, together with commitments to EU policies on renewable energy, has amounted to the reintroduction of *Energy Policy*.

Given the scale, financial and engineering, and complexity of nuclear power, it is understandable that the government wants to ensure the full economic benefit of this policy for the British economy, as well as to ensure sufficient skilled people are available to harness the benefits. It also wants to help British companies prepare to exploit a potentially large export industry for nuclear services. This amounts to a revival of what, in the 1970s, was known as *Industrial Policy*, or more sarcastically in the 1980s and 1990s as 'picking winners'.

Energy policy – markets or central planning?

For 20 years or so from the mid-1980s, energy policy was, in effect, left to the market. Those parts of the gas and power industries which could be made competitive were (gradually) made so and the remaining natural monopoly network activities were explicitly regulated. This system worked pretty well, bringing substantial cost savings. It achieved, we could say, *static efficiency* gains, namely making the existing assets work better through a mixture of market forces (competition) and regulatory incentives.

The system did not have to deal with *dynamic efficiency* – investing in new plant sufficient to keep demand and supply in balance. We know from other capital intensive industries such as steel, petrochemicals and car manufacturing that the market doesn't always smoothly deliver incremental capacity increases but tends rather to surplus and shortage, with consequent swings in prices. This tendency

would be more marked in electricity because it cannot be stored. So any government might have been a little nervous about leaving the dynamic aspect of electricity and gas efficiency entirely to the market.

But we never found out. The market-based energy policy has, since the late-2000s, been subject to government central planning goals for renewable energy and carbon dioxide emission targets, arising from domestic and European policies. Some of these targets are now legally binding and in theory override any other domestic energy goals (such as affordability).

On the face of it, targets and markets don't mix. But a government that wishes to preserve the market as much as possible could minimise its intervention. It could set a price or quota of CO_2 which would deliver the desired target and leave the implied price signals to lead market participants to find the least costly way to achieve it. That at least, would be a textbook economics policy, addressing a negative externality through a tax or quota and 'correcting' the market.

But for nuclear power this policy would not have worked, even if the European Emissions Trading System had functioned effectively as a source of price signals, which of course it spectacularly hasn't, with prices at under €5 a tonne of CO_2 in December 2013, far too low to drive low carbon energy investments without further subsidy.

Nuclear power does not meet the criteria for a normal competitive private industry that would smoothly adjust to market price signals. In its current large scale form a new nuclear power station is not a small incremental investment, it is currently almost impossible to finance through normal private capital markets, the construction risk is uninsurable, and there are very few credible players.

So to keep new nuclear power as part of UK power generation in future, the government has been forced to go much further and adopt specific price interventions designed to encourage – we might say bribe – private players to build new stations.

The interventions come in the form of: (i) a fixed price guarantee (in the form of a contract for difference) for the power sold by the new nuclear stations, to provide some revenue certainty and a (partial) guarantee to cover the risk of construction over-runs; and (ii) a debt guarantee. Given the dreadful history of nuclear construction in the UK and more recently in Finland and France, the construction risk is enormous, and far beyond the scope of even the largest private companies to take on. (Reactors under construction in Finland and France in recent years have seen cost over-runs of 100 per cent or more). At least this is the argument that the nuclear power companies have made. But they have a point. It is hard to

imagine any new nuclear station being built in the UK without some sort of sovereign guarantee, for at least the first or second new stations.

Even those interventions might not have been enough. But the British government has been lucky that its enthusiasm to get new nuclear stations built has been matched by the keenness of the French power company EDF (Electricité de France) and to a lesser extent the Japanese company Hitachi, to build in the UK. EDF, as co-developer and sponsor of the European Pressurised Water reactor (EPR), is keen, one might even say desperate, to have a successful demonstration model built on time and budget in the UK. The EPRs under construction in Finland and France are badly behind schedule and hugely over budget, which has damaged EDF's competitiveness in the emerging global nuclear power station market.

So we have had until recently a bilateral negotiation between the government and EDF – a game of poker. Both sides truly want a new station to be built but have haggled about what price promise and guarantees the government would need to provide. Since the Treasury's June policy paper 'Investing in Britain's future', that haggling stopped. In October 2013 the government confirmed that it had agreed with EDF the building of two European Pressurised Water (EPR) nuclear reactors at Hinkley Point. The 3,200MW reactors will contribute around 7 per cent of the UK's power needs by 2023.

We can now be reasonably confident that EDF's planned Hinkley Point C twin EPR station will be built.

Nonetheless, the deal is controversial in a number of ways: it depends on a 35 year power price guarantee by the government to EDF; it also grants the project company a British government guarantee on the debt raised, for a fee; and there are many people who just don't like nuclear or see it as competing against other low carbon power sources. Perhaps Hitachi-GE's Wylfa plant (or at least the first stage) will follow. But further new build looks more problematic. EDF's commitment to more plants is less clear. If it has one that works, thereby achieving its export demonstration potential, then others will depend entirely on the economics. But the prospect of long term lower gas prices across the world makes the economic case for nuclear quite difficult, and puts it squarely in conflict with the government's goal of affordable energy.

Industrial policy

A British civil servant who went to sleep at the end of the 1970s and awoke now would find a surprising degree of consistency in government industrial policy. In 2011 we had a National Infrastructure Plan, which was updated in 2012. April

2013 saw a raft of documents, including a Nuclear Industrial Strategy, which envisages lots of new committees, consortia and coordination between government and the private sector. Such language and institutions are highly reminiscent of the corporatist days of the 1970s.

But there are two differences. First, many of the policy levers are no longer available to government, since so many of decision makers are in the private sector. The Central Electricity Generating Board, while undoubtedly something of a power in itself, reported, at least officially, to the government. Now its components are all in the private sector, accountable to shareholders and customers. Second, the amount of actual funding backing the Plan and Strategy appears minimal. The goal remains in practice to get the market to do the work and pay for it, though perhaps at the customers' expense.

One wonders in particular just how the Nuclear Industrial Strategy will actually work, clearly well intentioned though it is. We can only hope that the new, enthusiastic technocrats in Whitehall have spent a little time reading the history of government policy in the 1960s and 1970s to find out just why 'industrial policy' became a discredited term. The UK has not had a happy record in science-based technology policy, for reasons that are disputed but include the training of civil servants, the lack of cross party consensus on policy goals, a turbulent macroeconomic environment and perhaps an over-powerful Treasury.

Civil servants and politicians might wish to review the fiasco over the choice of reactor type for Dungeness B in 1965 or the long forgotten but unfortunately all too important 'reactor wars' of the 1970s. Each of these was marked by conflicts within government and the public sector more broadly over what was best for energy policy versus what was best for exports and employment. In each case the result was a costly decision that failed on both counts.

Both the National Plan and the Nuclear Industrial Strategy contain language that suggests over-confidence about planning, and excessive certainty about the future of nuclear power, especially in the international market. There are good reasons to believe a global boom in nuclear power could happen, and there are areas where the UK could contribute, but we can't be sure.

The outlook

Government plans for CO_2 reductions after the 2020s look a little fanciful at present, as they depend heavily on a large expansion of nuclear power. From where we start it would be quite an achievement even to preserve nuclear's current market share in generation, given that most of the older stations are scheduled to close in the next ten years. We must also wait to see what is the

momentum of other countries' policies. At present the UK and EU appear to be going it alone on CO_2 emissions, at least rhetorically, and public support for an expensive policy that makes little global difference is unlikely to last. But we may yet see some major changes in policy in China and the US which could re-motivate climate change policy and bolster public support for power that is likely to be expensive on a narrow economic view for a long time to come. Cheap gas may even *allow* expensive nuclear, by keeping the overall base-load power costs down.

And, as far as the current plan for the new nuclear station at Hinkley Point goes, it should not be forgotten that the EPR (European Pressurised Water Reactor), the design chosen for Hinkley Point C and for another potential station at Sizewell, has its critics. It is large and expensive and the two other plants under construction in Europe, in Finland and France, are vastly over time and budget. Two EPRs under construction in China, with EDF's prospective partners in the Hinkley Point project China General Nuclear Power Group (CGN) and the China National Nuclear Corporation, are said to be on time and budget, but I've been unable to get any firm evidence on why this is the case.

There are other nuclear technologies that some of my engineering colleagues in Cambridge believe would be cheaper, such as the GE-Hitachi Advanced Boiling Water Reactor (ABWR). That reactor, which is already operating in Japan and Taiwan and is licensed for the US, may yet make an appearance in the UK but needs a separate licence from the Office of Nuclear Regulation, which can take several years.

The optimistic case is that we will, through learning by doing, achieve large falls in construction costs with later EPRs. Perhaps the Chinese, currently achieving much cheaper and faster construction of EPRs, can help. They may be willing to fund new stations too, though western companies should be realistic about the potential for selling into a protected Chinese market longer term.

In sum, we can now look forward to two, perhaps three large nuclear power stations starting construction in the UK in next few years. That seems quite an achievement compared with where we were only five years ago. But to bring about a wholesale replacement of aging UK nuclear stations, let alone to increase nuclear's market share to the level needed to de-carbonise the UK power sector in the next thirty years, is going to be much more difficult, in the absence of a huge rise in hydrocarbon prices. Affordability may turn out to be the key political constraint.

III

Nuclear Energy and Government Policy: Acting for the Future

David Mowat

Introduction – Hinkley Point: Necessary but not sufficient

The recent decision to give the go ahead finally to Hinkley Point C is welcome – even if 20 years overdue. The two new reactors will supply around six per cent of current UK electricity needs, more than all the on- and offshore windfarms currently commissioned. Equally important, the power will be continuous and reliable.

Hinkley C is necessary but not sufficient. Currently, we get 20 per cent of our electricity from nuclear energy. However, all existing stations will be decommissioned in the course of the next decade. In addition, 50 per cent of electricity is currently generated from coal but that too is now in sharp decline on account of official policy in the UK and EU favouring cleaner energy production. The EU Large Combustion Plant Directive (2001) mandates that these too will no longer be usable after 2017.

The problem therefore is clear. The UK's old stations, which produce around 70 per cent of current electricity, need to be substantially replaced over the next decade. Furthermore, if all goes to plan, more and more of our energy must, in future, come from electricity. In particular, the decarbonisation of transport will need a shift from oil to electricity. This means that yet more electricity will be needed for the future. Of course we must also try to use less energy, whatever the source, but it is difficult to see how total electricity use over time will do anything apart from rise.

This chapter considers the role that nuclear energy can play in the future. In particular, it considers how nuclear can help meet the three imperatives of energy policy:

- decarbonisation
- cost
- security

Each will now be considered in the context of current policy.

Decarbonisation Targets

UK policy today rests on the assumption that the country must progressively decarbonise and takes account of the overall direction of the science. Whatever the respective merits of abatement versus decarbonisation, the need generally to

reduce carbon usage worldwide is accepted. It is however worth noting that the UK remains the only country in the world with a legal target as onerous as that which became law in the 2008 Climate Change Act. It is also worth noting that in 2012 the UK was responsible for just 1.5 per cent of global emissions.

	Renewables (percentage of total energy – 2010)[3]	**Tonnes of carbon per capita (2011)[4]**	**Tonnes of carbon per unit of GDP[5]**
Ireland	6%	12.8	350
Netherlands	4%	11.8	351
Germany	11%	11.2	376
Belgium	5%	11.1	370
Poland	10%	10.7	1275
UK[6]	3%	8.8	293
France	12%	7.6	275
EU(27)	12%	9.2	392

There can be no serious dispute that if carbon is to be reduced, nuclear must play a growing role. One of the myths which characterises the decarbonisation debate is that the policy should focus on renewables. However, the challenge for the UK is how it can use less coal.

Take the example of Germany, which, though it leads Europe in terms of deploying renewables, still produces far more carbon than the UK (20 per cent more per unit of GDP and 25 per cent per capita). Why? Because Germany's energy relies heavily on coal. To make matters worse the Germans have recently

[3] Renewables 2012 Global Status Report: http://www.ren21.net/Portals/0/documents/activities/gsr/GSR2012_low%20res_FINAL.pdf

[4] European Environment Agency, *Greenhouse gas emission trends and projections in Europe 2012: Tracking progress towards Kyoto and 2020 targets*, Copenhagen, EEA, 2012; p92-158

[5] Ibid.

[6] DECC National Renewables Statistics: https://restats.decc.gov.uk/cms/national-renewables-statistics/

decided to build yet more unabated (non-Carbon Capture and Storage) coal stations, and according to Bloomberg, three new coal plants will be brought online in December by the energy companies GDF Suez SA, Trianel GmbH, and Steag GmbH. But Germany is not alone. Countries such as Holland, Belgium, Ireland and Poland all emit far more than the UK does. In fact, the UK is amongst the lowest of carbon emitters in Europe relative to both GDP and population.

If decarbonisation is to be achieved without imposing crippling cost rises on customers, the existence of a carbon hierarchy must be recognised and taken into account. Coal and oil would sit at the bottom of this hierarchy as the fuels which emit the most carbon; wind, solar and other renewable sources sit at the top. However, the section which could make the biggest contribution is the one in the middle, which includes gas and nuclear.

However, policymakers across the world have for too long focused on replacing the bottom tier of the hierarchy with the top tier, renewables. This is very difficult to achieve given the scale and the cost. Countries such as Germany and Japan have embarked on a policy of replacing nuclear with fossil fuels. This is in direct conflict with existing carbon reduction commitments and is seen by many in the developing world as further evidence that a number of developed countries refuse to take their obligations seriously, while lecturing other countries.

The Green lobby meanwhile has focused on the wrong problem, lobbying heavily to increase renewable generation in a bid to cut carbon, rather than concentrating on the eradication of coal-fired power plants. Some of the more sensible commentators (George Monbiot is one) have made the point that, whilst not perfect, nuclear power is the only viable technology to replace the scale of current coal-fired generation. He suggests nuclear should be exploited as a stepping stone to a carbon-free future, an appeal that implies that green opposition to nuclear seems self indulgent.

Security

There is considerable concern that the UK could experience power shortages before the end of the current decade – a concern with which I am familiar as a former Global Managing Partner at Accenture, the technology and consulting firm, and still in touch with the industry. For 20 years, the UK has failed to invest in energy infrastructure. The consequence now is that, at times of exceptional demand, this country runs perilously close to its limits.

Unfortunately, at the same time, the UK has signed up to EU directives which require the country to close many of existing coal-fired plants. Given that up to 7 Advanced Gas-Cooled (AGR) reactors and a magnox reactor as well as 13 coal-fired power plants are due to reach the end of their operating lives during the

current decade, the UK will need to replace nearly 20GW of generation capacity by 2025.

Replacing capacity of this scale could, in theory at least, be done with renewables. However, the cost, both financial and environmental, would be ruinous to an economy still in recovery. By contrast, Hinkley Point C will on its own be capable of generating up to 3.2GW[7] – more than can be produced by every single wind turbine (onshore and offshore) in the UK combined.

Moreover, relying on fossil fuels would leave the UK heavily dependent on Russia and the Middle East for energy supplies, which, strategically, does not seem sensible. Meanwhile, the potential of shale gas (and indeed oil) should not be overlooked.

However, it should be recognised that the obsession with renewables and the failure to replace existing capacity has left the UK heavily dependent on imported electricity at the busiest times. The irony is that most of Britain's imported electricity comes from France which invested heavily in nuclear several decades ago and is now in a position to export electricity abroad.

Costs

Not only will Hinkley C make a significant contribution to generation capacity in the UK, but to equal that capacity would require a doubling of the number of wind turbines. The number of suitable sites for offshore wind farms is limited. To replace capacity on such a scale would require an exponential increase in onshore wind generation, blighting some of our finest landscapes and at a cost which remains higher than nuclear.

One of the perverse effects of the UK's renewable subsidies is that they transfer money from the poor to the rich. If the UK were to invest heavily in onshore wind generation, the biggest beneficiaries would be the major landowners who could benefit by either selling or renting their land to the energy companies. The bill would fall on ordinary energy customers who would pay the bills.

If reliance on coal is to be substantially reduced with a view to ending it, something will have to fill that gap. Left to its own devices, the market would always choose coal as the cheapest power source available. Remove coal from the mix and the market will plump for the next cheapest source – gas. Gas still

[7] AREVA, Hinkley Point: http://www.areva.com/EN/global-offer-1477/two-epr-reactors-at-edf-s-hinkley-point-c-nuclear-power-plant-the-first-of-a-new-generation-in-the-uk.html

produces carbon, but because it burns much more efficiently than coal, it only releases about half the amount of carbon to produce the same amount of energy.

Simply replacing every single coal-fired power station with a gas-fired one would actually result in a substantial cut in our carbon emissions. This is not just a theoretical argument: the USA, which has invested heavily in shale gas, has recently recorded the lowest carbon emissions in over a decade, yet bills for consumers are low and preparations are now being made to export US gas abroad.

Shale gas, however, appears to face the same problems that have historically held back the development of nuclear technology, leaving a gap in the market that nuclear can exploit. However, the risks and costs to the private sector to build and manage a nuclear reactor make it unattractive to investors unless the government is prepared to share some of that risk. The renewable technologies available cannot produce the amount of capacity that the UK needs without adding substantially to generating costs.

While many believe the cost of nuclear paid at Hinkley was high (and is a direct consequence of the country being desperate due to the delays of the last decade or so), the cost of offshore wind is double that. The market's default option will always be coal, closely followed by gas. If nuclear is to continue to play an important role in the generation mix, then market intervention will be necessary.

Asking companies to commit to build a power plant which will take several years to construct and decades before it pays for itself is unreasonable unless the Government is able to offer some form of long term guarantee. Without this guarantee, the plant will not be built because the price of electricity has not risen to the point at which such a plant would start to make enough of a return within a reasonable time frame. If it is accepted that nuclear is necessary to help keep both prices and emissions down, then the Government must intervene in order to bring forward the investment.

Global Impact

Globally there are about 60 nuclear power stations currently under construction. The majority of these are in Asia, and predominantly in China. Despite this rate of construction, the proportion of the world's energy supply being delivered from nuclear actually fell to 15 per cent in 2012. The decision of Germany and Japan to abandon nuclear in favour of fossil fuels is likely to accelerate that trend. Whilst some countries (particularly China) are expanding their civilian nuclear programmes, the world as a whole is decommissioning or mothballing at a faster rate than it is building.

The implications for an increase in carbon emissions are severe. It was noted earlier that in 2012, the use of coal, in terms of energy produced, increased three

times more than renewables. A statistic which should give us all pause for thought Rather than looking increasingly at the 'middle tier' of the carbon pyramid to reduce carbon, countries are increasingly looking towards the top end and focusing on renewables to suggest a serious approach to reducing CO_2 emissions, whilst relying on the dirtiest of fuels to deliver the bulk of their electricity and to prevent prices rising beyond the level that their populations can tolerate. The EU focus on renewables not carbon reduction accelerates this trend.

The result is that the UK is becoming increasingly isolated because it alone is making genuine efforts to decarbonise and at a faster rate than other industrialised nations. The continental style emphasis on renewable targets *increases* rather than decreases carbon emissions, because countries are offsetting the increased cost of renewable generation by producing more energy from the cheapest available source – coal. If this continues it will have serious implications for the future of manufacturing in this country as companies look to locate overseas to avoid crippling energy prices in the UK.

One attractive feature of nuclear vis-a-vis most forms of renewables is that it has a much higher UK content (i.e. produces more UK economic activity). It is disappointing to note that a typical windfarm has around 20 per cent UK content. The target for Hinkley Point C is 60 per cent.

UK Policy Needs

What does this mean for energy policy in the UK? At present nuclear is regarded by DECC as just one of a number of viable technologies. However, it has become clear that on cost, security and climate change grounds, nuclear represents the best low carbon source of capacity; and that will continue to be the case as long as DECC continues to drag its feet on the exploitation of Shale Gas.

Other forms of renewables will continue to provide additional capacity but it is difficult to see how they could provide energy on the scale necessary to give the capacity needed. There also remain issues of cost and intermittency where further progress is needed. The UK is not windy enough for wind power to be a viable option for replacing the scale of capacity that the UK requires. It will therefore be necessary to look beyond renewables to see whether other technologies can help us make the numbers add up.

Public acceptance of civil nuclear power is now high in the UK, having risen steadily in recent years. Maintaining such confidence is key for the future of the nuclear industry; continued progress on waste disposal will also be central. The two – siting and waste disposal – are linked. Both are difficult and time consuming and have previously held the industry back from investment it might have made.

The UK has lost two decades and finds itself in a uniquely difficult position now. Political will is needed to make the decisions and move at the speed that is necessary.

If the UK is to replace 50 per cent of current nuclear and coal based energy with nuclear power another half dozen Hinkley Points will be needed. It must now be clear that the UK should never again be forced to negotiate with just a single consortium: further suppliers and ventures need to be encouraged. Whilst the deal struck is reasonable, EDF had a strong negotiating position as the only company with the will and technology to invest.

The evidence is that across the world, new stations are now often smaller, more modular and more repeatable. These could be part of a UK solution, and the mistakes of the past must not be repeated when failure to standardise cost dear.

Such a policy would be based on the need globally to de-carbonise. If other countries continue to stall, the UK's entire approach should be re-evaluated. Even if all UK carbon emissions were to be completely eliminated, this would reduce global emissions by just 1.5 per cent but, if done too quickly, it could decimate the economy.

Next Steps

For at least two decades, our politicians (from all sides) have failed to provide for the country's long term energy needs. The cycle of short-termism must be broken and the Conservative Party should propose the following as the basis for future policy and with the aim of securing cross party agreement:

- Continued use and development of nuclear in the energy mix, with its present level being enshrined as a minimum benchmark.
- A rolling programme of new nuclear build projects which use a variety of systems or reactors, rather than having to go cap in hand to other countries to ask them to design and build our reactors.
- The earmarking of a greater proportion of R&D and science research budget for nuclear research.
- Acknowledgement that renewables cannot produce electricity at the scale or the cost of nuclear power for the foreseeable future, and that climate change commitments should focus on decarbonising as cheaply as possible.
- That Britain can become a world leader in the design and construction of nuclear reactors. Other countries should be begging *our* physicists and engineers to build reactors for *them*, not the other way around.

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The announcement has now been made that Britain's first new nuclear reactor in over 20 years will be built. Hinkley Point C will be part-owned by the French company EDF with Chinese investment. What should Britain's energy users who pay the bills make of the deal? Does it herald a bright future for Britain's nuclear energy industry, with cheaper cleaner energy secured for the longer term? Or does it signify that Britain is abandoning its role as producer in favour of the French, to whom the promised 'strike price' for the electricity is high.

The authors of *Nuclear Options: Powering the Future* welcome the announcement, as a first step to rebuilding Britain's nuclear energy. Professor Roger Cashmore, Dr Simon Taylor and David Mowat MP explain that after decades of neglect, a first new reactor and further ones are now more likely to go ahead. How many will depend on what policies are adopted. The authors explain the steps needed for reviving the industry and the advantages this would bring.

A properly revived British nuclear industry would allow the expertise and experience of British scientists and engineers to benefit Britain's wider economy; it would help safeguard future energy supply; and it would allow Britain to meet its legally binding carbon reduction targets more effectively and efficiently than can be done with 'green energy'.

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