



E3G

Is Nuclear Inevitable? Policy and Politics in a Carbon Constrained World

The Environmental Law Foundation David Hall
Memorial Lecture.

Tom Burke, CBE

May 17th 2007, The Law Society, London.



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Is Nuclear Inevitable?

Policy and Politics in a Carbon Constrained World

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Thank you very much for the invitation to speak to you this evening. I am honoured and pleased to have received this invitation. I am honoured to have been included in the distinguished company of the previous givers of this lecture. I am pleased to have been given a reason for remembering David and reflecting on his life and accomplishments.

These days many more people are called visionaries than actually warrant the honour. David was one of those who really earned it. He had remarkable foresight, looking long and hard for the paths to an energy future that would press more lightly on the planet.

He had a remarkable store of knowledge about the role renewable energy could play in meeting human needs. But he wore his knowledge lightly, with good humour and great enthusiasm. That made him a much more effective advocate than many of the environmental community's more ponderous true believers.

He would have been glad to see that the renewables are taken much more seriously now than they once were, but sad to see that we were still far from reaching their full potential to improve human well being.

I now want to do something rather innovative. It is normal at this point for lecturers to reframe the question in their title to answer the one they would have liked to have been given. I am simply going to answer the question. Is nuclear inevitable? No. What is more, it is irrelevant to both climate security and energy security.

We could, of course, stop here and go directly to the drinks. But this would short change the promoters of the lecture and pass up too good an opportunity to poke fun at some favourite targets of mine. So, instead, we are going to take a journey for a while through the fascinating, but sometimes bewildering, worlds of climate and energy policy and nuclear power.

Climate change is a bad problem that is getting worse. For the moment, it remains a manageable problem. But it is now clear that within the next few decades it will become an unmanageable problem unless we act decisively.

Bad as it is, climate change is a problem that is well within the envelope of our technical and economic competence to solve. If we fail it will be because we have failed to muster the political will to apply the knowledge and resources we have to tackling the problem. This would be a moral failure on a scale unmatched in history.

Some people have compared the magnitude and complexity of climate change to the Cold War and argued that we need to mobilise our energies and resources on a similar scale if we are to defeat it. I prefer another reference from history. Winston Churchill, looking at the threat to civilisation posed by Adolf Hitler, warned of the gathering storm.

He was talking about a threat that might have adversely affected the lives of tens of millions of people. Climate change is a threat that we now know with great certainty will undermine the prosperity and security of many billions of people.

Churchill once remarked that 'If something be not done, it will do itself, and in a way that pleases no-one'. If we leave the climate to 'do itself' we will be roundly, and rightly, condemned by our children for our feckless disregard of their future.

It is a striking paradox that a problem which – unlike any other – will directly affect the well-being, security and prosperity of literally every single one of the six and a half billion people on the planet should produce such rancorous division between and within nations.

Where there should be a pulling together in the face of a common threat, there has been a pulling apart. Blame, denial and finger pointing have occupied the space that should be filled by concern, collaboration and imagination.

We will not get far in meeting this challenge successfully for ourselves and our children until we recognise that what we face is a shared dilemma. All of us need to secure reliable access to energy for our economies in order to maintain the growth necessary for social cohesion and, ultimately, political stability. For China, India, Europe and the United States, as well as the rest of the world, that is going to mean the continued use of fossil fuels.

Energy security considerations mean that this will include continuing to expand the use of coal in our economies for the foreseeable future. If we continue to use fossil fuels, including coal, with present technologies, there is now no doubt that the climate will change rapidly and soon. If that happens, then the very social cohesion and political stability we are burning the fossil fuels to maintain will be put at risk.

The point of a dilemma is that neither of the choices is acceptable. We do not want to give up either the use of fossil fuels or a stable climate. The problem with a dilemma is that you risk being gored by both of its horns if you take too long to decide what to do. Then you have the worst of both worlds.

The trick is to resolve the dilemma not to make false choices. We now urgently need to become much better at sharing the effort, both between and within nations, that will be needed to resolve our shared climate dilemma.

The shape of the climate horn of this dilemma is now clear. Let me illustrate this with some key numbers.

There is a growing body of both political and scientific opinion that recognises a 2°C rise in global average temperature as the threshold of the dangerous climate change. The EU leaders reaffirmed their desire to stay below this threshold at the spring council earlier this month.

However we have already observed a 0.7°C rise since the beginning of the 20th Century. Such is the nature of the climate system that even if we were to halt all further emissions of greenhouse gases today, there would still be another 0.7°C before temperatures stabilised. You do not need to be a better mathematician than I am to agree that 1.4°C is awfully close to 2°C.

The best estimates we currently have suggest that to be confident of staying below this threshold we need to keep the concentration of greenhouse gases below 400 parts per million (ppm) carbon dioxide equivalent. That is the measured carbon dioxide plus the effect of all the other gases we are adding to the atmosphere expressed as their carbon dioxide equivalent.

The hard carbon dioxide concentration is today 380 ppm, up from the pre-industrial 280ppm. But the carbon dioxide equivalent number is already 425ppm. Each year adds another 2ppm carbon dioxide and about 3ppm overall. And that rate is increasing. The odds of being able to stay below the 2°C threshold may now be worse than 3 to 1 against.

My intention in reiterating these, by now well known numbers, has been simply to underscore how little time there is before we are impaled on climate horn of the dilemma.

The other horn of the dilemma is the world's growing demand for energy. The most recent projections from the International Energy Agency (IEA) envisage world primary energy demand growing by more than 50% between now and 2030. Fossil fuels will account for more than 80% of that increase and, as a result, carbon dioxide emissions from energy use alone will be more than 50% greater than they are today.

Last year, Nick Stern produced a groundbreaking report on the economics of climate change. He set out very clearly where we must get to if we are to resolve our shared dilemma. And just how big the risks of failure might be. His report has been vigorously criticised by some of his fellow economists.

I have not been impressed by the contribution the economics profession has so far made to the debate on climate change. I am not just being rude. Let me give you just one example. A major focus of the professional criticism of Stern was that he had chosen the wrong discount rate. By setting it too low, they argued, he had artificially, and some said, deliberately, understated the real costs of dealing with climate change.

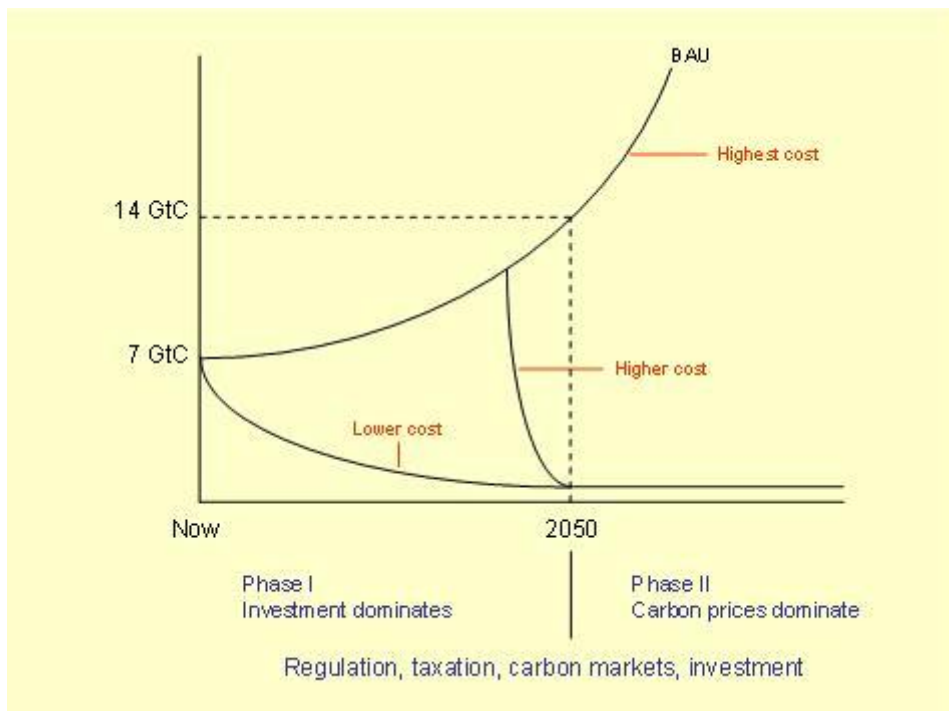
Imagine what might have happened had the same economists been arguing with Churchill in 1938 about the right discount rate to apply to the cost of building Spitfires. This would have been a part, of course, of arguing about the costs-benefit analysis of appeasing Hitler. Had those economists had their way I might now be speaking to you in German.

The truth about climate change is that the only real choice we face is whether to build Spitfires or Hurricanes or both and how many of them to build, by when.

This is an issue on which we cannot afford policy failure. There is no rewind button on the climate. There is very little scope for trial and error. Nor is a stable climate readily traded-off against other desirable goals which themselves will become unattainable in a rapidly changing climate.

As Stern himself recognised, the analytical toolkit that economists bring to a problem of this nature and scale have their limitations. The core value of his work is that it confirms conceptually what the scientific community has long been saying empirically, that the cost of resolving our climate dilemma will be far outweighed by the cost of not doing so.

Stern was very clear about what we must do if we are to avoid the greatest risks of climate change to our security and prosperity. Let me illustrate this with a graph I call Stern on a page.



He points out that our energy system currently adds about 7 Gigatonnes (GtC) of carbon to the atmosphere a year. By 2050 on a business as usual basis this will have risen to 14 GtC.

To avoid the worst risks of climate change we need to keep the concentration of greenhouse gases in the atmosphere below 550ppm – well below if possible. This would give us a reasonable chance of keeping the eventual temperature rise to below 3°C.

We currently add just over 10 GtC of carbon to the atmosphere each year – 7 from the combustion of fossil fuels and the rest largely from agriculture, deforestation and other land use changes. The oceans and vegetation between them absorb about 4 GtC of carbon annually though there are increasing concerns that rising temperatures and increased carbon dioxide concentrations are reducing this buffering capacity.

This means that to avoid the greatest risks of climate change we need to make our energy system carbon neutral by the middle of the century. Since there is no politically available route to a stable climate that does not involve increased use of fossil fuels, coal in particular, this means we must move very rapidly to the deployment of carbon sequestration and storage for electricity generation and hybrid vehicles for road transport.

These are by no means the only things we must do. We also need to hugely improve energy efficiency and greatly increase the deployment of wind, solar and other renewable energy technologies. The relative role of each carbon neutral option will vary from place to place but what we are looking for from all of them are very rapid step changes as we make a transition to a low carbon energy economy that must be completed in about four decades.

Which brings us neatly to energy policy and more particularly to energy security. There can be no doubting the importance of this issue. Modern economies simply do not function without secure supplies of affordable energy.

Reading the headlines you could be forgiven for thinking that the world was on the very edge of a energy resource crisis. The reality is rather more complicated. We do not have an energy resource problem. Not yet anyway. We do have an investment problem. Actually, we have four different investment problems and a geopolitical problem.

Much attention is currently given to the IEA's projection that to meet the world's rapidly growing need for energy – and thus to ensure energy security – we need to invest some \$21 trillion between now and 2030. For those concerned with climate security shifting the trajectory of that investment on to a carbon neutral pathway is an urgent priority.

But large aggregates can conceal more than they reveal. Journalists and politicians alike talk lazily about energy security as if our energy resources were all the same. They rarely bring out the differences between oil, gas, coal and electricity and they hardly ever mention efficiency at all.

In fact, the energy security, and thus, investment, challenges are different for each of them.

Oil, inevitably, attracts the most attention. For all the talk of peak oil, however, there is no immediate likelihood of a fundamental resource shortage, though the era of oil being cheaper than water may be over soon. This good news for our economies is, of course, bad news for the climate.

Our problem with oil is the concentration of the remaining reserves of cheap oil in a small number of places and the increasing desire of the owners of those reserves to have them developed by national oil companies rather than the giant international companies with whom we are so familiar.

National oil companies have a long record of not investing sufficiently to develop the reserves fully or efficiently. This is partly because the governments that own them use the revenues for other social purposes and, in some cases, simply steal them. Thus the wells produce less than they otherwise might.

This is both an investment problem and a geopolitical problem. It matters because oil is by a very long way our dominant transport fuel. Without it, not only are we not able to fly to our holiday of choice but, as the lorry drivers taught us a few years ago, you cannot get food from the warehouses to the table.

The only way to solve this problem is to reduce our dependency on oil for transport which could be good news for the climate. Though, as the rush to biofuels is demonstrating, not necessarily good news for the environment.

Gas is far less concentrated geopolitically than oil but there is nevertheless, often a big gap between the locations of supply and demand. Here that has given rise to some greatly exaggerated fears of the resurrection of the Russian bear. In

fact, by far and away the largest foreign supplier of gas to Britain is that unstable and unreliable country, Norway.

Russia is important. And will be more so in the future. But what is less often pointed out in the headlines is that the Russians are far more dependent on our revenues from the sale of gas than we are on their supplies of gas. All but a tiny fraction of the huge quantities of gas that Russia exports come to Europe and thus into the European gas grid.

The gas shortage scare in 2005 that was cynically used by Ministers to justify the energy dodgy dossier – sorry, energy review – occurred exclusively in the headlines. Insofar as there was a potential problem it was caused by inadequate investment in gas infrastructure and a failure to properly implement existing European legislation on gas markets.

Despite the Prime Minister's repeated assertions to the contrary, there is no way that new nuclear build can play any significant part in reducing our dependence on gas. About half of Britain's gas is used for domestic heating – water and air. Another quarter is used for industrial heat or as a chemical feedstock. Only a quarter of our gas is used to produce electricity.

But of that quarter, a significant proportion is used for load following during periods of peak demand. Gas turbines – essentially big jet engines – can be switched on or off very rapidly. Nuclear power stations cannot be switched on or off quickly. To be economic they must run continuously. Thus, there is relatively little scope to replace gas with nuclear.

Electricity is strictly speaking an energy carrier not an energy source. We are very definitely not short of energy sources for electricity. It can be generated from coal, oil, gas, biomass, water – hydro, wave, tidal, wind, the sun, wastes and uranium. However, liberalised electricity markets of the kind favoured by this government discourage investors from early commitment to large capital projects.

This leads some people, rather than trust to the wisdom of investors and the market place, to imagine the appearance of a supply gap and to call for government intervention. The current president of the CBI, Martin Broughton, was the latest to do so. He is the chairman of British Airways so I suppose we must expect him not to understand that markets actually do work even if they do not always give you the result you desire.

To maintain secure supplies of electricity will require investment in the years ahead. To do so in a way that maintains climate security will make that investment larger. Making our energy system carbon neutral by mid-century means that we have to drive all of the gas out of domestic and commercial heating and cooling. While the carbon dioxide from centralised electricity generation can be captured and sequestered, you cannot do that with the emissions from millions of domestic boilers.

Two things will matter most in securing the necessary investment. First, a stable framework of government policy. No one could argue that this has been a marked feature of recent government energy policy. Second, an acceptance by government that the public, that is the taxpayer, must pay for the delivery of public goods. Climate security is a public good that will only be delivered if the public pays for it.

If you want to protect both climate and energy security, improving energy efficiency is by far and away, the quickest, cheapest and most reliable way to do so. Yet it is also the most neglected area of government action.

Let me give you one example. The 24 million owners of energy inefficient homes in Britain produce 27% of our carbon dioxide emissions. Raising the energy efficiency of these homes to modern European standards let alone state of the art levels would simultaneously reduce carbon emissions, increase energy security and improve personal well being. We simply invest far too little in this area to get these readily available benefits.

It would take another whole lecture of its own to explain why we have come to this sorry pass and what we can, and should do, to increase the efficiency with which we use energy in both our homes and our businesses.

So let me make just one more point. A real and understandable concern of many people about doing more on climate change is that it would harm the competitiveness of our businesses. Helping them more aggressively to improve their energy efficiency would not only reduce their carbon footprint it would also make them more competitive.

I have set out these energy policy considerations in some detail because they form the background to my more detailed answer to this lecture's question.

The whole case for a 'nuclear renaissance' is predicated on the role it can play in energy and climate security. I hope that by now you will agree that it can play no

part in solving our oil problem and practically no part in helping with gas. Furthermore, proper investment in energy efficiency could do more for enhancing the security of both more rapidly and more cheaply. So, the question boils down to is nuclear inevitable to meet our growing demand for electricity?

I want to start by setting out the arguments I do not intend to use. My core argument is that nuclear is not only not inevitable, it is a distraction at best and, at worst a very damaging diversion from our most urgent priorities. But these arguments are peripheral to that core case:

- > **Nuclear power is unsafe.** This is a legitimate concern for many people. But our experience is that the nuclear industry by and large runs its power stations very safely, at least in the OECD countries. It has clearly taken on board the message from Chernobyl that a nuclear accident anywhere is an accident everywhere. This thought may however be less reassuring to investors than it will be to the public since a nuclear accident anywhere in the world could lead to shut downs everywhere.
- > **Radioactive waste is an unsolved problem.** This remains true and will be so for some time. However, it is a problem that exists and for which some solution must eventually be found, whatever the cost. Lord Flowers was right 30 years ago when the Royal Commission on Environmental Pollution recommended that no new nuclear power stations should be built until the problem had been solved. He remains right today. Until you solve it you cannot properly say what nuclear electricity costs to make. Just how difficult this issue is was clearly revealed by Alistair Darling's refusal, under great pressure, to specify what the government's coy commitment that new nuclear stations would have to pay their 'full share' of radioactive waste disposal costs. Clearly, if it is a share, it is not the whole lot so the question arises about who will pay the rest.
- > **A nuclear renaissance will increase the risk of nuclear proliferation.** Our current experience with Iran and past experience with India and North Korea demonstrates the validity of this concern. The truth is that no-one has yet managed to find a way of making atoms work for peace without making them available for war.
- > **More nuclear is not necessary.** This is certainly the view of both the IEA and the Energy Information Administration in the United States both of whom are projecting flat growth for nuclear out to 2030. Meanwhile the

renewables are experiencing double digit growth rates around the world. Actually, this may be over generous about the role of nuclear. Simply to keep pace with retirements will need 8 new plants a year until 2017 and then 20 a year until 2027. Compared to the 1 a year that has been built since 2000 this seems very optimistic.

- > **Nuclear is unattractive to investors.** It is difficult to see what might be attractive to investors about a very large capital investment that will produce no revenues for ten years or more and whose future revenue flows are subject to the whims of a liberalised electricity market. Furthermore, investors would be betting that governments would continue to be willing to add to the gargantuan bill for radioactive waste disposal and carry the bulk of the insurance risk against accidents.

These then are the arguments I am not going to use. Rather I want to concentrate on two other issues – cost and time. Even if you could solve all of the above problems – and that has to be one of the largest ‘ifs’ I have ever uttered - there are two reasons why new nuclear will play no part in ensuring our energy and climate security: cost and time. Nuclear costs too much, the costs are too uncertain and the reactors cannot be available in time.

There are only two honest answers to the question how much does a nuclear power station cost. The first is ‘I don’t know’. The second is ‘I’ll tell you when I’ve built it’. Anything else is a guess.

Some numbers will illustrate my point. This is the history of what happened in the USA between the guess and the delivery of nuclear electricity. Between 1966 and 67 they went up 209%. Between ‘68 and ‘69 they went up 294%. Between ‘70 and ‘71 they went up 348%. ‘72 to ‘73 was a good year, they only went up 318%. But by ‘74 to ‘75 they were back up to 381%. In 1976 they only went up 169%. But by then the American utilities had given up. They have not ordered a nuclear reactor since.

And just in case you think we do things better here, the cost of building Sizewell B went up from £1.7 billion to £3.7 billion during construction.

There are of course a new set of guesses being broadcast by the advocates of the nuclear renaissance. These include, \$1000 a kilowatt hour by GE, \$1664 dollars a kilowatt hour by France, the University of Chicago bids \$1500 dollars, the World Nuclear Association a \$1000 dollars, MIT \$2000 dollars and the US EIA \$2083 dollars a kilowatt hour. This certainly looks like ‘I don’t know’ to me.

If the nuclear hawks cannot agree what it costs you can imagine how bewildered governments and investors are. As no-one has built any nuclear power stations in most of the world so we have to look to recent Asian experience for guidance. There the estimated actual cost for 8 recent reactors is \$4540 dollars per kilowatt hour.

If this is the situation now with one nuclear power station a year being built, imagine what will happen to those costs if you try to build more in a world where the competition for any steel and concrete, let alone the specialised materials needed for nuclear power stations, is intense and prices are rising rapidly. If nuclear is cannot compete now with real interest rates at relatively low levels, imagine what will happen to its costs if interest rates rise sharply is they seem intent on doing.

What really matters here is that this huge uncertainty about what a nuclear power station might cost combined with the very large scale of the capital commitment, is the biggest deterrent to investors. For all the government's talk about having to make a big decision, the reality is that there is no decision to be made by government. The decision on whether or not to build a new nuclear power station will be made by the electricity generators.

There is nothing to stop them making that decision now. Except the costs. For all their apparent enthusiasm, what the generators are really looking for is precisely those government subsidies that have so far been ruled out.

Under the Prime Minister's prompting the government is leaning over backwards to make it easier for new nuclear build both by publicly weakening nuclear reactor regulation and by abolishing the democratic safeguards provided by the planning system. Privately, I suspect considerable effort is now going into finding a way to cheat on the 'no subsidies' pledge. So look out when the Energy White Paper is published for the somewhat obscure words that will conceal the intention to go back on the promise of no nuclear subsidies.

Even if they cost too much, is there not an argument that it is worth paying that price for the prize of low carbon electricity? As I pointed out earlier achieving climate security is time dependent. It not only matters where you get to, it matters when you get there. Which brings us to the vexed question of how long it takes you to build a nuclear power station.

The question how long does it take you to build a nuclear power station has the same problems as asking about the costs. Honest answers are hard to come by.

Average construction times have ranged from 60 months between 1965 and 1970 to 116 months from 1995 to 2000. Recently, it has improved greatly, it now only takes 82 months on average to build a nuclear reactor.

That is global experience. Britain's is rather worse. The Advanced Gas Cooled reactors that we built in the '70s and '80s had a projected construction time of 78. Their actual average construction time was 170 months.

Of course, that is only the construction time. To this must be added several years for the detailed design work and the regulatory approvals. On past experience, the time from firm order to delivered electricity, all going well, will be at least ten years and possible a lot longer.

Just in case you think that we will do much better now let me tell you what is happening to the much touted new Finnish nuclear power station. When ordered in August 2005, its projected construction time was 48 months. By March 2006, this had risen to 54 months. By July of the same year it had increased another 6 months. And by October, 6 more. In other words, in a little over a year the construction time had increased 37.5% and the rate of increase was itself increasing. Don't hold your breath.

All this matters because the non climate argument for new nuclear build rests on the fact all but one of our existing nuclear power stations will be coming out of service before 2020. Furthermore, a number of our existing coal fired power station will also be decommissioned in the next few years.

This prospect is so serious, according to one recently quoted 'Whitehall insider', that the lights could go out in 2015 'unless we act soon'. He clearly had not been listening to Vincent de Rivaz, the head of Electricite de France in Britain, one of the loudest of the nuclear renaissance hawks. Just the week before he had optimistically expressed the view that if an order was placed at the end of 2007 electricity could be delivered by 2017.

It is quite clear from simple mathematics that even if you could solve all the other problems satisfactorily, and even if you could find investors willing to take the risk, that new nuclear build in Britain cannot occur in time to replace the nuclear and coal fired power stations that will no longer be available.

So we will have to do something else. And if we are to do something else that does not involve increasing our dependence on gas, we will have to use coal or do even better than we are currently planning to do with the renewables. If we

are going to use more coal in the carbon neutral energy system that we must have by 2050 – and remember we are going to have to increase our overall use of electricity greatly – then we will have to do so in a carbon neutral way. That is by using carbon sequestration and storage.

If we have a viable way to use coal in a carbon neutral way in the next few years, why do we need nuclear power, with all its risks and unsolved problems, at all?

We need that carbon neutral coal anyway. China has the most ambitious nuclear power programme anywhere in the world. They are proposing to build 40 nuclear power stations by 2030. Even if they do so, and there is very fierce competition in China for the materials and skills that would be necessary, this would still only supply 6% of their electricity.

Most of the rest will be supplied by coal. China is currently building coal fired power stations at the rate of more than one a week. Unless these stations, and those like them that will also be built in India, the USA and Europe, there is no chance that we can keep global temperatures below 3°C, let alone 2°C.

Carbon capture and storage is an imperative not an option if we are to have any hope of maintaining climate security. Nuclear power is simply a dangerous diversion from that task, here and in the rest of the world.

Over the last fifty years, we in Britain have invested over £80 billion in nuclear power to supply less than 20% of our electricity. We have to spend at least the same amount again to pay for the radioactive waste we have already created.

Imagine what David Hall could have done with that £80 billion. Imagine how much more secure our climate would be, and how much more competitive our economy, if he had been able to do so.

The Prime Minister may be having another bad dream, this time about a nuclear future, but there is no reason for us to join him in it.