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David Elliott

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Energy Regime Choices: Nuclear or Not?

DAVID ELLIOTT

Department of Design and Innovation, The Open University, Milton Keynes, UK

The energy system in industrialized countries is changing in what can be seen as an example of the technological regime change, reflecting a wider shift towards environmentally sustainable technology which may impact on all sectors in the economy.[1]

In recent years, the emphasis in the UK's power generation system has increasingly been on smaller scale power plants, combined cycle gas turbine plants and wind farms of the order of 20-100 megawatts instead of giant gigawatt coal and nuclear plants. The UK is thus moving from a system in which large centralized plants send power to users down long grid lines, to one in which smaller plants are embedded in more localized grid networks. The traditional approach had its merits, since there are economies of scale and performance with larger plants, but with power plants having reached 1.3 GW, the efficiency gains have more or less been fully exploited. What has become more important is that there are energy losses (of up to 8–9%) due to transmitting power from large centralized plants to consumers over long distances. Even more important is the very large losses (up to 70%) associated with the conventional centralized approach to the generation of electricity: the energy conversion efficiency of conventional coal and nuclear plants is only around 33%, with most of the energy being dumped as waste heat. In response, the trend is to towards decentralization, including co-generation of heat as well as power for local use (in so-called combined heat and power plants) and self generation by consumers themselves using domestic scale micro-power systems using local renewable sources.[2]

This technological regime change was central to the influential report 'Decarbonising the UK' produced by the Tyndall Centre in 2005, which, amongst other things, stressed the role that could be played by renewable energy sources.[3] A similar view had been taken in the Government's Energy Review produced in 2003, which supported a scenario in which renewables expand to supply around 20% of electricity by 2020. By contrast, nuclear power was not seen as a very strong contender, in part because of its inflexibility.[4]

However, a new Government Energy Review, completed in July 2006, came to very different conclusions on nuclear power: 'We have concluded that new nuclear power stations would make a significant contribution to meeting our energy policy goals'.[5]

Correspondence Address: David Elliot, Department of Design and Innovation, Faculty of Technology, The Open University, Walton Hall, Milton Keynes, MK7 6AA, UK. E-mail: d.a.elliott@open.ac.uk

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This guest editorial asks whether there has been a fundamental rethink over energy strategy and the need for a radical technological regime change.

The Role of Nuclear Power in the New Energy System

In the context of an energy system based increasingly on smaller scale generators meeting local energy demands often from local renewable energy sources, large nuclear plants might be seen as out of place. For example, one of the problems with some renewable energy sources is that they are variable, so there is an occasional need to balance their variable power inputs to the grid with power from other sources when needed. But nuclear plants cannot help with this variable backup requirement: for both technical and economic reasons, they have to be run continuously, supplying base load. It could be that when, and if, renewable expanded significantly, the inflexible nuclear plants' input would be seen as increasingly difficult to use. Of course, this argument can also be run the other way: with a large nuclear component, the variable renewables' inputs would also be difficult to use. The point, however, is that they can be incompatible.[6]

Certainly there could be real operational problems if the system has large elements of both nuclear and renewables. There could also be conflicts over inevitably scarce financial and technical resources. The nuclear industry has over the years always had the lion's share of any funding available, while renewables have been starved. This pattern has recently begun to change, but a new commitment to nuclear could slow the development of renewables, just when they were getting going.[7]

However, there are widely differing views as to whether nuclear power can or should make a major contribution to reducing greenhouse gas emissions. For example, quite apart from the technical and strategic incompatibilities mentioned above, there are safety and security issues to consider with nuclear power, including the issue of what to do with radioactive wastes. In parallel, there are local environmental problems associated with some renewables. And in both cases, there are also economic issues—nuclear may be expensive, but so too are some renewables. However, the simple truth is that whatever energy choices we make, the era of cheap energy is over. That will obviously present many problems, but it should make choosing amongst the non-fossil options easier. Long-term economic viability and liabilities may be important, but short-to-medium-term comparative operational costs are not the key issue. Instead, there is a need to think about what sort of energy system is required for a sustainable future.

Options for the New Energy Mix

The options are not limited just to energy supply technologies. There is an ongoing debate about the role of energy efficiency. If energy wastage can be avoided then it becomes easier to meet the reduced energy demand through whatever means chosen. Some actually see the demand side as the key, especially since it is not just electricity that is needed but also heat and transport fuels. However, there is no disputing the fact that, whatever is done in terms of reducing demand, there will still be a need for electricity.

There is a rough consensus on what the energy supply side options are, based on scenarios produced for the Department of Trade and Industry (DTI).[8] At one extreme, it is claimed that the UK can and should expand the use of renewable energy so that, along with the use of low-carbon Combined Heat and Power (CHP) plants, around half of UK electricity can

be obtained with minimal emissions by 2050. The other half would be made up by the continued use of coal and gas, but with the resultant carbon dioxide emissions captured and stored in underground strata. At the other extreme, it is argued that new nuclear plants should be built to supply around 40% of UK electricity requirement by 2050, with renewables, CHP and carbon capture and storage making only small contributions.

The UK's long-term aim is to reduce carbon emissions by 60% by 2050. Both the extreme scenarios sketched above do that, at least in theory, while still allowing for overall growth in demand, the precise level depending on the level of commitment to energy efficiency investment. While some lobbyists argue for one or other of these energy supply extremes, much of the current debate is really about what compromise between them is best.

There is certainly a need for urgent action, but that does not imply making hasty and irreversible decisions over nuclear, when the implications of getting it wrong are so long-term—the creation of yet more wastes to guard for ten of thousands of years. While, by contrast, a programme focussing on renewables seems to hold more attractions, even then, there are many choices, within the overall decentralized approach. Do we go for relatively large-scale offshore wind, wave and tidal current/barrage technology—all of which look very promising—or for small scale solar PV and micro-power? Or a mix? And what about the demand side? And the role of carbon capture and storage?

Decision Time

To some extent the recently renewed debate over nuclear power has deflected and stalled the crucial debate over what sort of energy system we need for a sustainable future by suggesting that we could retreat back to the traditional 'big centralized supply' approach. Technical fixes like this have their attractions, but also their drawbacks, not least the fact that they are usually temporary. If the use of nuclear generation is expanded globally on a significant scale, reserves of high-grade uranium would probably only be sufficient for a few decades, after which we would have to use lower and lower grade ores, and fabricating fuel from them would require more and more energy. Given that most of this energy would come from fossil-fuelled plants, there would be increasing levels of carbon dioxide emission, thus undermining nuclear power's main attraction—no direct greenhouse gas emissions.[9] It could make more sense to invest that energy in building a truly sustainable energy system based on the use of renewable energy sources, like wind and wave power, for which there are no fuel fabrication requirements, no operational emissions and no problems with resource depletion.

Echoing the sort of claims now heard from the oil industry in response to concerns about 'peak oil', the nuclear lobby says that new sources of uranium will be found, and that even seawater could be used as source. In addition, there is renewed talk of a shift to breeder reactors to stretch the uranium resource, or the use of thorium as an alternative to uranium, or, in the longer-term, fusion, which avoids uranium use entirely. While these various 'fixes' for the uranium shortage problem may all one day be possible, for the moment, renewables are the only certain long-term carbon-free supply-side solution we have available to us and, unlike high-technology nuclear, they have the attraction of being relatively quick and easy to deploy, with no security or weapons proliferation implications. In which case, it could be argued that the UK energy review should have focussed on the issue of how to develop these technologies, rather than being sidetracked, once again, into the nuclear debate.

Some of the debate has concerned ostensibly technical or economic issues. However, underlying these is a basic dispute over the overall direction of technological development. The defenders of the status quo have sometimes employed scare tactics: 'the lights will go out if we don't have more nuclear power'. Others have appealed to similar fears more subtly. Reuters (28/6/06) quoted Tony Blair as follows: 'I think the sensible precaution is to have a balanced energy policy. You put it all in the mix. To take out of that nuclear power ... is a very, very big step for us to take and I would need a lot of convincing that renewables are going to fill the gap'. He added: 'There are people who say you can make it all up through renewables, but if they are wrong, in 15 or 20 years, we are going to have a serious problem in this country, and we will be completely dependent on imports of oil and gas from abroad. My view is that's a dangerous gamble to take'.

This debate had to be finally resolved one way or another. It may be that nuclear will still be chosen as a short-term fix in the UK (a new White Paper is promised), and that a revival of nuclear will undermine progress on, and deflect funding from, renewables and other sustainable energy options. But longer-term it seems inevitable that renewables will be developed at various scales as the main energy source for the future. With the climate prognosis worsening by the day, whether we can afford to delay the shift to a new energy regime is another question.

Conclusion

The foregoing analysis raises the issue of whether the onward progress of the transition to a sustainable energy future based increasingly on decentralized renewables has been halted or at least compromised. Implicit in many descriptions of this transition is the assumption of gradual changes in technological practice at various levels underpinned and enabled by infrastructural and institutional change. Much of the debate about the transition has been concerned with whether institutional and social changes were needed in advance to support technical change (the regime change concept) or whether they simply followed it (the disruptive technology concept). However, it was usually assumed that the overall paradigm had been at least partially established and accepted as part of the overall landscape. This assumption now may need reassessment. It was always the case that the alternative decentral paradigm was contested; it was emergent but not extant. However, it seems that the more conventional centralist paradigm still carries much force. The extent to which the drive towards a de-central future has been undermined remains to be seen. It may only be a temporary reversal.

Following the publication of the government's Energy Review in July 2006, the *Guardian* newspaper chose to editorialize that the new energy technologies needed time to be developed and that 'renewing the nuclear base will provide that' ('Nuclear Shelter', *Guardian*, 12 July 2006). However, it could be a more substantial reversal. Proops has argued that nuclear power fits in to a 'modernizing' framework that has appeal to conventional government and technocratic thinking.[10] Whether nuclear technology is indeed truly modern is of course a matter for debate. For example, it could be argued that a technology that still relies on raising steam to drive turbines is less 'advanced' than, say, solar photovoltaics, which convert sunlight directly into electricity with no waste products. But the image of modernity still clings to nuclear technology, while renewables are still often seen as an inefficient pre-industrial throwback.

Perhaps more importantly, there is the raw power of economic and industrial interests. Although it has faced retrenchment in recent years, the nuclear lobby is still well established and has the ear of government and key parts of the scientific establishment. By contrast, the renewables lobby is disparate and poorly funded, and its main source of political support, the environmental lobby, although powerful at times, is still often easily sidetracked. A case in point is the fact that the strongly 'green' evidence submitted to the 2006 Energy Review by the Sustainable Development Commission, chaired by Jonathon Porritt[11], was more or less ignored, as were the submissions by many other green leaning groups. Instead, to the extent that the issue was addressed, an attempt seems to have been made to redefine nuclear power as a 'green' energy technology.

While some environmentalists may see nuclear as better than fossil fuel, there are few that would see it as a truly sustainable option. For many of them, opposition to nuclear power is a central plank of environmental policy. For example, one of the key attractions of renewables, and indeed one of the drivers for their initial development, was that they were seen as *alternatives* to nuclear. This perspective seems unlikely to change, even given rising concerns about climate change. If the climate change threat is seen as more urgent, then, the argument goes, all the more reason to push ahead with renewables and not be diverted back to what is seen as the nuclear 'dead end'.

The continuing conflict over nuclear power is often seen as tiresome by both sides in the debate. Those from the anti-nuclear position thought that this issue had been more or less resolved, at least in the UK, by the 2003 Energy Review, and they resent going over old ground. Those from the pro-nuclear position are convinced that nuclear should be allowed back in to the mix as part of the response to the climate change threat. In the end, that case has still to be made. As the industry journal *Nucleonics Week* put it, somewhat cryptically, it may be that 'nuclear needs climate change more than climate change needs nuclear'.[12]

There may well be countries that see nuclear fission as a strategically attractive option for a variety of reasons, including nuclear weapons production, but in purely energy terms it is hard to see how this could be sustainable long term, if based on existing nuclear technology. By contrast (as reported at the International Renewable Energy Conference in Bonn in 2004, organized by the German government), renewables could supply up to 50% of total world energy (not just electricity) by 2050 and more thereafter.[13] Germany, like several other EU countries, is phasing out nuclear power and already obtains around 11% of its electricity from renewable sources with around 18 GW of wind generation capacity having been installed. Even more dramatically, non-nuclear Denmark gets around 20% of its electricity from wind. The alternative non-nuclear approach is thus being fleshed out in practice in some countries.

Whether this approach will spread remains to be seen. China and India are often seen as the key to the future. Both have nuclear programmes, but both also have very large renewable energy resources. In effect, we seem to be at an energy crossroads globally.

Launching an international roundtable discussion meeting of the 'G8' industrial nations, in November 2004, Tony Blair commented 'Over the coming decades, a massive shift towards lower carbon energy systems will be needed if we are to meet the world's growing energy needs whilst also avoiding the worst impacts of climate change. To achieve this, we will need a green technological revolution'.

In this context, the UK perhaps has a special responsibility, given that it was once a pioneer in nuclear development. Will it revive the nuclear option or support radical technological

regime change based on renewables? The UK has some of the best renewable energy resources in the world, in terms of wind, wave and tidal energy, most of it so far untapped. What the UK finally decides to do in terms of nuclear power could well have a significant influence on the development of sustainable approaches to energy technology.

Dave Elliott is Professor of Technology Policy at the Open University. He is editor of 'Nuclear or Not?', a book of papers from a recent OU conference asking whether nuclear power has a role in responding to climate change, published by Palgrave Macmillan.

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