Nuclear Power in Perspective

This briefing note is a revision of the first briefing prepared in 2006 as a handy reference for SONE members and the interested public. Since the original was issued the energy scene in Britain has radically altered following the Government's welcome early in 2008 for a new generation of nuclear power stations.

There is mounting evidence both in Britain and across the world of extensive preparations for a new and expanding nuclear future. To that extent, SONE appears to have won the argument, but there is much still to be done to secure the building of new nuclear power stations.

Opposition remains intense and is likely to take the form of misrepresentation and delay. These factual notes are intended to help to strengthen the case for nuclear power. They are complemented by seven other briefing notes in the series (see pg 7).

How is energy used in Britain?

In the following ways: transport – 35%; domestic sector – 30%; industry – 21%; and services – 13%.

What proportion of energy consumption goes to generate electricity?

About 30% of total energy consumption of 244m tonnes of oil equivalent is used to generate electricity.

How is electricity generated?

The share between fuels varies with market conditions but the pattern in 2007 was: coal 37.5%; gas 36%; nuclear 18%; others 4.5%; imports 2% (substantially nuclear from France); large-scale hydro – 1%; oil – 1%.

As things stand, the shares taken by coal and nuclear are set to decline sharply in the immediate future as ageing plant is retired. About a third of existing generating capacity is due to close within the next 10-15 years demonstrating two things: the perilous state of British electricity supplies medium term and the overriding importance of building replacement nuclear plant as quickly as possible.

How is electricity consumed?

Roughly equally by the domestic sector (115.5 TWh), industry (117.8 TWh), services (107.4 TWh), with a small amount (9.7 TWh) required by the energy industries themselves.

What is the most nuclear has generated in Britain?

About a third of total electricity.

How does the Government forecast nuclear will be run down?

To 18% by 2010; 10% by 2015 and 7% by 2020.

Other countries rely more heavily on nuclear power than the UK – France 83.4% (which plans to replace its capacity); Belgium 58%; Sweden 45%; Finland (which is building another reactor) 31%; Germany 29% and Spain 27%.

How many nuclear power stations are there in Britain?

Ten, as compared with 441 world-wide.

Continued over

What is the current forecast for nuclear power station closures, bearing in mind that operating lives can be extended?

Magnox (operated by Nuclear Decommissioning Agency): Oldbury 2008; Wylfa 2010.

AGR (owned and operated by British Energy): Hinkley Point B and Hunterston 2011; Hartlepool and Heysham I 2014; Dungeness B 2018; Torness and Heysham II 2023.

PWR (owned and operated by British Energy): Sizewell B 2035.

This means that nuclear's share of the electricity market is likely to be down to 10% by 2015 and, without any replacement stations, 7% by 2020 and 3% by 2023.

Are there any targets for the replacement of nuclear capacity?

No. While opening the way for nuclear's development in 2008, the Government made it clear that any decision to build nuclear was up to the market, though it recognised its responsibility to create the necessary regulatory framework. Subsidies were ruled out and, since nuclear is competitive, none had been sought.

Since then the Business Secretary, John Hutton, has become ever more enthusiastic for nuclear's development, expressing the hope that it would go well beyond replacing nuclear's existing (18%) share. A nuclear contribution of 30-35% has been canvassed in the press, roughly equalling nuclear's greatest share of the electricity market in the UK.

That is, of course, far below the proportion generated in some developed countries such as France.

Why has the Government taken so long to embrace nuclear power, given the number of ageing power stations?

The Government has kept energy policy under regular review. As late as 2003 it issued a White Paper dismissing nuclear as "economically unattractive", even though it was heavily subsidising renewable sources of energy, notably wind power, and it was likely that fossil fuel prices would rise. It then became clear that energy policy was failing on all counts.

- **The development of renewable sources of energy** (wind, waves, tides, water current, solar, geothermal etc) was lagging well behind Government targets calling for 10% of electricity generation by 2010 and 15% by 2015, with an "aspiration" of 20% by 2020. Now the European Union requires 20% of its energy (and not merely electricity) to be supplied by renewables in what is widely seen as an excess of zeal in pursuit of reducing greenhouse gas emissions. This is widely thought in UK Government circles to be "testing" and by experts to be utterly impossible. The EU requirement has to be viewed in the light of renewables' current UK contribution to power supplies of less than 5%, most of which is from hydro-electricity (regarded as a fully-developed sector) and waste. After 18 years' development, wind power still produces only about 1% of the nation's electricity.
- **Energy conservation** – i.e. economy and efficiency in its use – was not reducing electricity demand, which was rising steadily on average by 1-1.5% a year.
- **Carbon dioxide (CO_2) emissions were continuing to rise** after the reduction brought about in the 1990s by the "dash for gas" – the switch from coal to gas in the generation of electricity.
- **Concerns about security of supply.** With the rundown in coal- and nuclear-generated electricity, the UK faced increasing reliance on natural gas. But gas prices were soaring and were likely to remain high. Moreover, North Sea oil and gas supplies were beyond their peak and declining. The UK was no longer self-sufficient in either and faced the prospect of relying on imports of gas from Russia and Islamic nations. Neither can be regarded as entirely reliable, given the level of terrorism in the world and the propensity of Mr Putin, the Russian leader, to turn off the taps – e.g. to the Ukraine and Georgia – for political reasons. We faced very high risks in both security and competitiveness in relying for as much as 80-90% of our energy on imported natural gas. Logically, nuclear emerged as a crucial component of UK energy policy, offering safe, secure, competitive and clean supplies of electricity.

So, in a sentence, what commends nuclear as part of the mix of electricity generation?

Nuclear is an essential component of British energy policy because it can provide safe, reliable – i.e. predictable – secure, competitive and clean supplies of power. All these qualities are urgently needed if the UK is to keep the lights on, compete in the world and discharge its international obligations to reduce carbon emissions.

The Greens claim a combination of renewables, CHP, micro-generation, carbon capture and storage (CCS), biomass and energy conservation provide an alternative way of powering Britain without coal or nuclear. Why is it not viable?

We deal with each component separately below.

Why are renewables no answer?

First, none of the range of possibilities, with the possible exception of generation from waste and methane from tips, would be on the agenda but for lavish subsidies. As dilute sources of energy, they are generally uneconomic. Wind, waves, tides and solar are all dependent on the weather or sunlight and this means their output can vary widely over short periods and solar is unproductive at night. As such, they are unreliable and have to be matched by conventional, predictable forms of power, making them uneconomic and eliminating most of the CO_2 savings claimed for them. Even the more predictable tidal power has roughly a five-hour slack period requiring expensive cover. Renewables seem unlikely ever to be more than a marginal contributor to UK power supplies, even though this island nation has theoretically vast renewable sources of energy.

Why not CHP?

As a means of securing much more useful energy from that applied, combined heat and power has much to commend it. Generally, however, CHP schemes are designed primarily to produce process heat for industry, with power generation as a secondary objective. Even so, they may well make economic sense for new buildings but finding an economic way of using the waste heat in Britain's existing 25m properties has proved elusive.

What's wrong with micro-generation?

This method of generating electricity is beloved of Green campaigners. The concept of localising power generation and distribution would make every family their own generator of the power they use and therefore directly involve them in the Green bid to save the planet.
But wind, solar and water current power are unreliable, CHP is not generally applicable to existing buildings and balancing supply and demand on localised distribution networks would become a nightmare, given the sharp variations in supply thanks to the vagaries of the weather.

Isn't biomass controllable?

Burning biomass – vegetation – is the oldest way of producing energy and electrical output is entirely predictable from biomass-firing. The problem is the amount of biomass required since it, again, stores energy in dilute form.
Vast areas of agricultural land would be required to the exclusion of food production. The problems of food shortages caused by biomass are already coming home to roost with the rush into ethanol as a "green" fuel for vehicles.

Isn't carbon capture and storage the hope for the future?

Clean coal technology at present means scrubbing out sulphur at very considerable cost to avoid acid rain. The new idea is to capture the CO_2 emitted by fossil fuel-fired power stations and inject it into disused oil wells under the North Sea. The concept is well known in the oil industry to increase the recovery of oil. On that basis, the process has staunch advocates as a means of enabling man to continue to exploit coal, notably for power generation, even though it is one of the dirtiest fuels. But the concept is not proven on the vast scale required and many think it is unlikely to be for several decades, if then. Before it can be relied upon, we have to be confident that we can capture hundreds of millions of tonnes of CO_2 from our fossil-fuelled power stations and safely and reliably lock them up under the North Sea. This means that we cannot rely on CCS for the foreseeable future. Nor do we know its cost, though the earliest estimates suggest it could double the price of electricity. It should also be borne in mind that successful power station CCS would not eliminate the major CO_2 outpouring from wider industry, commerce, the domestic sector and transport, which represent 70% of all UK CO_2 emissions.

But surely energy conservation can reduce the need for power stations?

Energy conservation is theoretically immensely valuable but the savings from cutting out waste and improving the efficiency with which energy is used are more easily identified than achieved. Every year scientists, engineers and technologists improve the efficiency with which energy is used. We get more work out of the energy we put in. Improved insulation and instrumentation should also reduce demand, and both have been pursued since the last energy crisis 30 years ago. But each year electricity demand grows by 1-1.5%. The problem with energy conservation is that the money saved from less energy use often goes into buying new ways of using energy – and the self-same scientists, engineers and technologists each year satisfy the public's craving for new energy-driven gadgets of one kind or another.

So, how could nuclear contribute to security of supply?

It is a safe and reliable method of continuous generation proved over 50 years during which there has been no death in the UK recorded from a radiation accident. There is no shortage of uranium available from stable countries and long-term supplies look to be more durable than oil and gas. What is more, the uranium (96%) and plutonium (1%) recovered by reprocessing can be used in the manufacture of new fuel, reducing the need for mining uranium ore; as the price of uranium rises, this becomes increasingly attractive. The price of uranium represents only a small proportion (i.e. 15-20%) of nuclear's costs. Nuclear power can be provided at a competitive price and is admirably suited to the generation of baseload power – say, 60% of peak load.

But opponents of nuclear say there is a shortage of uranium?

Nonsense. See separate Uranium Availability Briefing Note.

Where does nuclear stand in the competitive pecking order?

Nuclear is now the cheapest generating option, especially when environmental costs are taken into account. It is the only fuel that reflects in its current price – an allowance of some 4% – the estimated cost of decommissioning and waste management. This is probably a prudent conservative value for the ageing Magnox and AGR plants. For future reactors, a figure of 1-2% is more realistic, and even less than one per cent if the working life of the reactor is taken as 60 years.

Various studies confirm nuclear's competitiveness, even without taking account of its contributions to security and greenhouse gas reduction. These studies have been done by the OECD, IAEA, Scherer Institute of Switzerland, and the British Royal Academy of Engineering. Before the recent steep increases in the price of gas, the Royal Academy found that costs were: gas 2.2 p/kWh; nuclear 2.3 p/kWh; coal 2.5-3.2 p/kWh; onshore wind 3.0 p/kWh (but 5.4 p/kWh with back up); offshore wind 5.5 p/kWh (but 7.2 p/kWh with back up). Nuclear's competitiveness has also been confirmed by a survey by the World Nuclear Association of a range of comparative cost studies across the world. In other words, wind power is anything from two to three times as dear as nuclear power.

If nuclear is competitive, why have no nuclear power stations been built for 20 years?

Until recently the Government and other political parties have been hostile to nuclear power and done nothing to facilitate its development. Instead, the nuclear industry has, for example, been subjected to the climate change levy, even though nuclear emits next to no greenhouse gases. Now the Government is moving to license the use of a new generation of reactors, identify sites for new power stations and clarify the regulatory and financial framework. It has recognised the need to eliminate uncertainties which raise the cost of capital – the major component of nuclear's costs. Over, say, a 60-year life nuclear power stations are likely to be immensely profitable, taking into account every cost from uranium mining to decommissioning and waste storage, but they have to surmount high front-end costs.

So nuclear wants a subsidy?

Nuclear generators have not sought a subsidy. Instead, they have sought fair play – in other words, a reasonably level competitive field. They recognise that they will have to compete in the market and that the future generation of nuclear reactors will be built by the private sector, not by Government agencies.

But didn't British Energy have to be rescued from bankruptcy?

In fact, the Government, through its energy regulator, Ofgem, drove all electricity generators, whatever their fuel, to the edge of bankruptcy in 2002 by seeking to depress wholesale prices. Only those with large retail arms survived the squeezing of wholesale prices by 40% by cross-subsidising their generating divisions. British Energy, the nation's nuclear generator, had no large retail arm. Since then gas prices have soared and British Energy is profitable but its profits are being creamed off by the Treasury under the terms of the Government's "rescue". The company was effectively re-nationalised on confiscatory terms. Now British Energy occupies a crucial position in the development of nuclear power, with sites for development and a skilled workforce that has won local support. It is now the subject of overtures from a wide variety of energy companies.

Does nuclear have any other advantages?

Yes, a significant one in an overcrowded island where the Green Belt is under pressure. A modern 1000 MW nuclear power station requires the equivalent of only 10 soccer pitches whereas to generate a similar amount of electricity wind (when it is blowing) requires an area the size of Dartmoor; solar – 1.5 times the size of Dartmoor; biomass – a forest the size of North Wales; bio-oil – a rapeseed field the size of the Highlands of Scotland; bio-alcohol – Devon given over to sugar beet or the whole of Yorkshire to corn; and bio-gas – 800m chickens on a farm a third the area of Dartmoor. To keep Britain going we need not 1000 MW but at least 60,000 MW – sixty power stations, not one. This is partly why renewables have only a marginal role to play.

Anti-nuclear campaigners claim that nuclear is a "dirty" fuel – indeed, some say it is the dirtiest.

They would, wouldn't they? It is, of course, nonsense. The Government's Energy Technology Support Unit shows that nuclear is the cleanest per unit of electricity produced over its life cycle, taking into account everything from mining ore to decommissioning and disposal of waste. The figures have been broadly confirmed by the OECD. They are:

Nuclear	4 grams of carbon per kWh produced
Wind	8 g
Large-scale hydro	8 g
Small-scale hydro	9 g
Energy crops	17 g
Geothermal	79 g
Solar	133 g
Gas	430 g
Diesel	772 g
Oil	828 g
Coal	955 g

In other words, nuclear is cleaner than wind and other renewables, 100 times cleaner than gas, and 270 times cleaner than coal.

Anti-nuclear campaigners say nuclear power carries a radiation hazard?

This is how the average Britain is exposed to radiation:

	%
Radon seeping from the ground	50
Medical X-rays	14
Gamma rays from rocks	13.5
Cosmic – ie from the sun	12
Chemicals in our bodies	10
Fall-out from nuclear weapons	0.2
Occupational and largely indoor radon	0.2
Nuclear industry activities and disposal of radioactive materials – less than	0.1
Radioactive products – less than	0.1

In other words, nuclear medicine exposes the average Briton to about 140 times more radiation than nuclear power and natural radiation to 750 times more.

But what about the "unresolved problem" of nuclear waste?

The nuclear industry has been managing its waste for 50 years – ever since plutonium began to be manufactured for defence purposes and the first electricity was generated. It follows that part – but only a small part of some 2% – of the current waste arises from military not civil use. High-level waste has been stored in ponds prior to vitrification – sealing in glass in stainless steel containers. Intermediate level waste has been held where it arises, pending final disposal, while low-level waste (including that from industry and hospitals) has gone to a dump at Drigg, near Sellafield. Storage in ponds and in vitrified waste stores has allowed some of the heat to dissipate and the radioactivity to decay. If it could, the industry would send intermediate-level waste encapsulated in cement and cooled high level waste vitrified in glass to a more permanent longer-term storage. The only thing that stands in the way of doing this is a Government decision on a site for such disposal. The Committee on Radioactive Waste Management (CoRWM) has recommended deep disposal in suitable strata – a conclusion the industry reached 25 years ago.

The former chairman of CoRWM, Professor Gordon McKerron, said that there is enough nuclear waste in Britain without any long-term strategy for its disposal to fill the Royal Albert Hall five times over.

First, we have to ask whose fault it is that there is no long-term strategy. The answer is that it is government's fault. Second, SONE has queried the five-Royal-Albert-Halls-full with Prof. McKerron since we can discover only enough to fill one RHA. He did not reply personally but a document sent by his office showed that he included in his total waste that which is expected to arise in the future. This we regard as sharp practice. It devalues CoRWM, which suffered the loss of two scientists concerned about how it went about its work.
Prof. McKerron has further devalued his position by lending his name to an article specifically setting out the case against nuclear in the Observer on December 4, 2005.

The highly radioactive waste in the current inventory could be contained within a volume of 30 cubic metres. This is about the size of an articulated lorry's body.

Anti-nuke campaigners say the waste disposed of would remain toxic for hundreds of thousands of years.

Another splendid exaggeration. The radioactivity would have decayed to relatively harmless levels found in nature – e.g. in the form of uranium – after 500-600 years.
The only elements remaining toxic would be metals in the waste, in the unlikely event of their being eaten. Some of these metals are toxic like arsenic, mercury and lead but that has not stopped us from burying such metals in dumps that are far more accessible than nuclear repositories would be.

It is interesting that Bob Hawke, former Prime Minister of Australia, has said that Australia should volunteer to become the world's nuclear waste collector because its geology makes it ideal for the purpose as "an act of economic sanity and environmental responsibility".

How much highly radioactive waste does a 1000 MW nuclear power station produce in a year?

Only enough to fill a London taxi.

But what about the cost of decommissioning and waste management – the figure has been put as high as £72bn?

That figure includes £10bn for disposing of reprocessed uranium and plutonium, which could be used as new nuclear fuel and hence become income instead of a cost. We have a year's supply of electricity in the form of plutonium stocks. It would be economic madness to dispose of these stocks when we could usefully burn them up. That shows you how figures for decommissioning and waste management are gold plated. This leaves £62bn as the Nuclear Decommissioning Agency's (NDA) bill for cleaning up after military and civil nuclear operations. SONE has formally protested against the NDA's draft strategy because it is based on the assumption that nuclear operations are to be run down and many sites returned to greenfield status. It is nonsense to suppose that all nuclear operations – military, medical, industrial and electrical power – will cease. There is also a use for existing nuclear sites – as the sites for new generation nuclear power stations. There is no sense in returning sites required for a new generation of nuclear power stations to greenfield status. Incidentally, new, safer and more efficient designs of nuclear reactor would produce a tenth of the waste generated by current reactors.

In short, the oft-quoted massive clean up costs for the nuclear industry have no credibility. What is more, electricity consumers have already contributed – and continue to contribute – towards the cost of decommissioning and waste management through the current price of electricity. They have already paid for decommissioning and waste management.

What about terrorism?

Terrorists pose a threat the world over and security at nuclear sites is crucial. But nuclear power stations are not bombs waiting to go off. Their systems are entirely different from military weapons. And why should terrorists try to acquire highly dangerous and difficult to handle radioactive materials when they have global access to a vast array of weapons? Nuclear reactors are operated within robustly thick concrete containment vessels designed to withstand massive impact. In fact, in computer simulations an aircraft flown into a nuclear power station containment at 500 mph evaporated but the containment was undamaged.

And what about proliferation?

Clearly, the effective operation of international anti-proliferation treaties is necessary and so far those protocols have worked pretty well, with UN agencies as active watchdogs.

In Britain nuclear materials in nuclear installations and in transit are safeguarded using methods tried and tested over 50 years. The threat of proliferation cannot – and will not – stop the development of nuclear power in a world hungry for electricity and concerned to combat global warming.

The important thing is to promote the responsible peaceful use of uranium as a means of generating electric power: to make sure that an element – uranium – with no peaceful use other than to generate electricity is put to the service of man and so extends the availability of other fuels. The late Prof. J H Fremlin, a leading radiophysicist, in his book, Power Production, said: "I can see no way in which the building of further nuclear power stations in Britain can make the probability of proliferation of weapons elsewhere either greater or smaller".

As well as this briefing, SONE has published the following briefing notes:

The Looming Energy Crisis

Uranium Availability

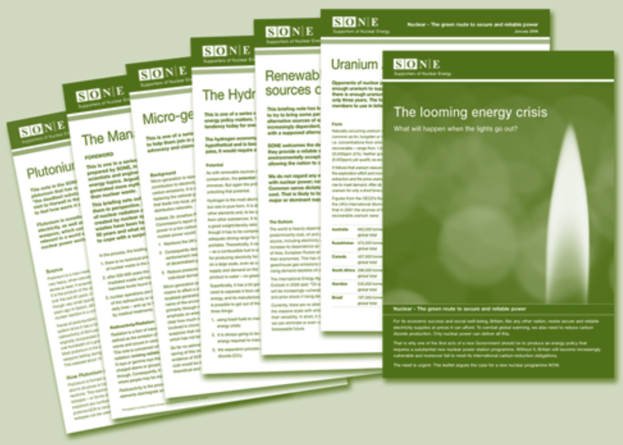
Renewable and alternative sources of electricity

The Hydrogen Economy

Micro-generation Briefing Note

The Management of Nuclear Waste

Plutonium in Perspective



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