

## A grim future

Despite the recent publication of two authoritative reports, from the Renewable Energy Foundation (Electricity Prices in the UK, May 2008) and Fells Associates (A Pragmatic Energy Policy for the UK, August 2008), there are few signs that the seriousness of future electricity shortages is appreciated by the Government. Yet both reports spell out the same alarming message of electricity shortages from 2012 to 2020, as some coal-fired stations are closed down under the clean air requirements of the EU Directive and as older nuclear stations are withdrawn from service, if new capacity is not built in time. Fells suggests a total of 23GWe (30% of generating capacity) will need to be replaced by 2020. The REF quotes higher figures from EDF and E.ON UK as 32 GWe and 26 GWe respectively, to be replaced by 2015. (30GWe would represent a loss of 37% of present capacity). The Department of Business, Enterprise and Regulatory Reform (BERR) is more optimistic maintaining that only 20 GW will be retired by 2020. Since the Government always insists that electricity supply is the responsibility of the industry it would be sensible to assume that the higher figures from EDF and E.ON are more probable. This leaves a gap which can only be filled by electricity from new coal, gas, renewables, nuclear power, cable connections to the continent, or by reducing demand to match the reduced supply. There are as yet no clear indications as to how, or even if, this gap will be filled.

## Nuclear

It seems to be generally accepted that site work for a first new nuclear station in the UK will not begin before 2013, although the actual construction for an established design can take only some five years. The delay in starting is said to be largely due to the need for the Nuclear Installations Inspectorate II to approve the designs so as to reassure the British public that the stations are safe; the Generic Design Assessment of three nuclear reactor designs is not due to be completed before 2011. But it is only too probable that, to justify their time and effort, the NII will come up with some modifications or alternatives that they believe would offer improvements. Are we then to go back to another one-off British PWR, as with Sizewell B? Will EDF and the other electricity companies be willing to accept changes that would

lose the benefits of replication and increase their costs? And if not the nuclear opponents would almost certainly mount a legal challenge leading to further delays. It is then unlikely that a new nuclear station can be commissioned before 2018 and so will not contribute to solving the shortages likely to arise in the years from 2012 onwards.

Under these circumstances the present closure programme, under which 7.4 GWe of nuclear capacity is due to close by 2020, should be re-examined. The limited resources of the Nuclear Inspectorate could be more usefully applied to assessing the safety case for such a life extension than in re-examining designs which are already being built or licensed in Europe and elsewhere. Fells considers that life extension for four of the nuclear stations due to come off-line between 2010 through to 2023 could provide 3 to 4 GWe. The REF is more pessimistic and concludes that the run-down of existing nuclear capacity is imminent and inevitable.

There has indeed been a continuous decline in British Energy's nuclear output since its 'reconstruction' from 63.5 TWh in 2000/01 to 50.3 TWh in 2007/08 due to unplanned shutdowns and other loss of output. Is it possible that this decline might be reversed following the takeover of British Energy by the experienced nuclear operator EDF? But there could be an immediate threat to supply. The National Grid has warned of possible power cuts this winter if Hartlepool and Heysham (2.4 GW)e are not brought back into service by the end of this year; BE has now announced that these plants will not be back on line until early 2009. We must hope for a mild winter.

## Renewables

The Government places its hopes on a large expansion of windpower with the target that 10% of electricity will be generated by renewables by 2010. This is clearly unattainable. Wind now generates only 1.3% of electricity supply; the greater part of the present 4.9% of supply from renewable electricity comes from landfill gas and hydropower, neither of which can be expanded significantly. Nor can intermittent renewables replace base load. A report for the REF from James Oswald using Met Office and Ofgem data claims that power swings of 70% within 12 hours are to be expected in winter. This will require individual generators to go on or off line frequently, thereby reducing the utilisation and reliability of large

centralised plants. These reductions will lead to increases in the cost of electricity and reductions in potential carbon savings.

Worse is to come with the draft EU plan that 20% of final energy consumption must come from renewable energy by 2020 with financial penalties on failures to meet this target. Fells points out that the target which is based on the final energy consumption implies a well-nigh impossible 40% electricity to come from renewable sources. The costs of this would be intolerable. It has been suggested that the politicians signing up to this plan did not appreciate the difference between energy and electricity.

The Renewable Energy Foundation in a later paper "Response to the Renewable Energy Strategy Consultation 2008" of 5<sup>th</sup> September is particularly scathing of the EU draft. It claims that the targets are

1. technically and practically infeasible in the given timeframe;
2. the costs of attempts to meet them will be insupportable;
3. they are counterproductive for climate change policy;
4. for technical and economic reasons they will compound gas dependency rather than alleviate it;
5. they will create hyperprofit for investors, but suppress innovation, and drive suboptimal renewables development.

According to Fells the subsidies for renewables last year were £1 billion and he claims that if subsidies continue to be provided in the same way the cost by 2020 could amount to between £20bn to £30bn yearly. The REF argues that to avoid the EU penalty the Government would need to subsidise renewables and comes up with a similar figure of £25 billion/year. However it now seems unlikely that this EU draft target will ever be approved. The Polish Government has pointed out that with a 90% dependence on coal-fired electricity it will be quite impossible for it to be implemented in Poland.

Future possibilities may lie in the development of tidal power, but any contribution to electricity supply would only come after the critical period of 2012-2020. A Severn barrage might be able to supply up to 5% of electricity demand – but not within the next 10 years. Despite this delay Fells is enthusiastic about the longer term prospects for tidal power and the Severn Barrage, and some 40% of their paper is given over to a section "Time for Tidal Power, A renewable force for the future."

## Gas

The REF points out that "In recent years natural gas has been cheap and especially attractive if one discounts the fact that it is a finite resource. Consequently, since the early 1990s there has been a rapid growth of low-capital-cost, high efficiency, gas-fired combined cycle gas turbines (CCGT) in all OECD countries. With the notable exception of

Sizewell B, all new, central, thermal generating plant built in the UK since the commissioning of Drax 6 in 1982 has been CCGT. Enthusiasts for gas sincerely believed that its price, based on regional markets, could be de-linked from other hydrocarbons such as oil and coal and that as depletion took place, new sources would be found. However, it is increasingly clear that this is not the case, a fact that is particularly troubling given current oil price trajectories."

Gas is getting evermore expensive, and as UK gas production from the North Sea declines, we will be importing 80% of our gas requirements by 2020 at a time when international competition over supply increases. The REF claims that in just eight years time we will be looking to import between 90 and 100 Mtoe of gas; a figure that will rise rapidly as UK gas continues to decline, and by 2015 the UK could be the greatest sovereign importer of natural gas in the world but it will then be in competition with China, Japan, the USA and other European countries for possibly limited supply – a competition in which we are unlikely to succeed. If shortages develop priority may have to be given to domestic, services and industrial users which now consume 2/3<sup>rd</sup>s of UK gas supply with only 1/3<sup>rd</sup> going to electricity generation.

There are no longer any reliable suppliers. If it is confirmed that Norway's gas production will peak around 2020 Norway may seek to conserve supplies for its own use; reduce pipeline deliveries and increase LNG exports which can be sold anywhere for the highest price. LNG can and will flow to the highest bidder. World LNG import capacity far exceeds that for production suggesting that this will be a sellers market. Internal demand in the Middle East countries is also expanding with growing industrialisation and increasing reliance on water desalination. Similarly the REF report shows that although Russian gas production has risen since 1997 internal consumption has increased at an even faster rate, driving exports down. There are also signs that Russian production is now falling. The IEA forecasts a decline in Russian production of 18 Mtoe per year for the foreseeable future. Russia does not supply any gas directly to the UK, but if deliveries to Germany (over 40% dependent on Russian gas) and other EU countries are reduced or cut off the UK would also be affected.

The REF is critical of the manner in which the working of the electricity market system (BETTA) has encouraged the power industry to continue its construction of low-cost CCGTs at a time when it should have been perfectly obvious that North Sea gas was depleting and that these generators would have to be energized by possibly insecure supplies of imported gas. The UK policy of maximizing gas output from the North Sea from 1985 to 2000 when prices were low was a major factor in the "dash for gas" which pushed electricity prices down to a point where British Energy could not compete and was driven to 'reconstruction'. This early over-production

was a major factor in keeping gas prices low, and unlike Norway, the other North Sea operator, the UK spent the income received and has not built up a sovereign wealth fund.

The REF concludes “that even if gas generating capacity is built ahead of UK plant closures there is a quantifiable risk that these installations will be commissioned just as a world gas-supply crunch results in high and volatile prices and may even leave large parts of the market physically unsupplied.” Despite this pessimistic assessment the default position is to build new gas-fired stations as they can be completed in four years, but as yet only 4.5GWe are under construction. Increasing gas generation will also derail attempts to reduce CO<sup>2</sup> emissions, which will continue to rise.

## Coal

Over 80% of coal burnt in the UK is for the generation of electricity, to provide about 34% of total supply. As domestic production of coal has declined over 70% of our coal is now imported; but coal is readily available on world markets where Australia, Indonesia, Russia and South Africa are the major exporters. Although the price of coal has risen sharply in the last years following the price of oil an increase in coal plant would be an obvious choice to fill the generation gap. But an increased reliance on coal generation will conflict directly with the requirement to reduce carbon emissions. This is the dilemma now facing the Government; security of electricity supply is in direct conflict with the commitment to reduce carbon emissions; one or the other must be abandoned. This drives the protest against proposals for a new coal plant at Kingsnorth, protests that will no doubt be repeated at all other proposed new coal sites. Yet for the Government there is really no choice. As the previous Secretary of State for Business, John Hutton put it “No coal plus no nuclear equals no lights”. The economic and social collapse that would arise from shortages of electricity are imminent, within the next five years, and here at home; the effects of climate change are more remote, long term, and global. And as Fells points out coal-fired stations can be upgraded by conversion to supercritical steam operation when new stations will operate with 46% efficiency compared with the present 35%. Integrated gasification combined cycle (IGCC) coal stations are even more efficient at over 50%. Another way of bridging the energy gap would be to keep the opted-out coal-fired stations operating past 2015, in spite of EU emissions regulation. Although this would damage the UK’s “clean” image, Fells believes it may be unavoidable. Once built however any new coal stations would add to carbon emissions for the next 30 or more years. Proposals for safe carbon dioxide storage may be little more than wishful thinking. The new Secretary of State for Energy and Climate Change will be pulled in opposite directions by his conflicting responsibilities.

## Cable connections

Amongst the measures proposed in both the Fells and REF reports to ease the anticipated shortfall of electricity generation is an increase in the import of electricity through additional cable connections to other European countries. These could be built within two or three years using British technology. A link to the Netherlands, the 1 GWe BritNed cable, is already underway.

The value of such connections is plain. In 2007 electricity imports were 8 613 GWh (just over 2% of total supply) of mainly nuclear electricity from France. In comparison the total windpower generation for 2007 was only 5,274 GWh, produced at a far higher cost with support through the Renewables Obligation and providing an unpredictable and intermittent supply. At full capacity the French cable could bring in 17 TWh

The possibility of connections to countries such as Norway and Sweden and further connections to France, all countries where the electricity from hydro or nuclear power is carbon free, should be urgently explored. Even a link with Iceland should be considered. It is a country with large potential hydro power resources and the possibility of a cable connection to the UK was proposed some 20 years ago. A possible joint collaboration in developing new hydro schemes might contribute to resolving the financial problems which have now arisen between our two countries with the failure of the Icelandic banks. A country with large undeveloped hydro resources cannot be considered bankrupt.

Such connections to other European countries could even go some way to supporting some expansion of wind power in the UK which the Government seems determined to pursue. A BBC programme of 4<sup>th</sup> September referred to the experience from Denmark which showed that the windpower production of some 20% of total generation could only be sustained by exporting the surplus, generated at times of high wind but low demand, to the neighbouring countries. The actual consumption of wind electricity within Denmark is only about 8.5% of the total generation. But there is a snag; such exports, often made at times of low demand in the recipient countries, can only command low or very low prices. The extra costs this incurs, borne by the Danish taxpayers, have been estimated at several hundred million Dkr/year. (NI February 2006)

## Energy efficiency

In the 2007 *Energy White Paper* the Government insists that “the starting point for our energy policy is to save energy” and assumes that improving energy efficiency can reduce energy demand. Yet this is contrary to experience, and the REF September report quotes Jevons’ famous postulate of 1865 that *it is wholly a confusion of ideas to suppose that the economical use of fuels is equivalent to a diminished consumption. The very contrary is the truth.* This is

the basis for the so-called rebound effect where the benefits of increased efficiency of use are taken to increase in consumption or spent on other energy uses. The REF shows UK energy consumption has increased by some 20% between 1982 and 2005, and reproduces graphs for the UK, USA and Japan showing energy consumption rising as the intensity of energy use falls. (A reduction in energy intensity is equivalent to an improvement in energy efficiency, as this means less energy is used to generate a unit of GDP.) The REF suggests that this is a consequence of improved energy efficiency which makes the use of energy less expensive, encouraging increased use, (the rebound effect). There is also an effect from the changing structure of the economy, with a decline in the energy intensive industrial sector and a rise in the contribution to GDP from the low energy services and financial sectors.

A third factor now coming into prominence with the return to fashion of Keynesian economics is the multiplier effect of injecting capital into the economy to boost economic growth. The Keynesian multiplier will also influence energy consumption so that expenditure to increase the efficiency of energy use, while always desirable, will at the same time increase, not reduce energy consumption. An example is the latest Government scheme for home insulation at a cost of nearly £1000 million. This will lead to the insulation manufacturers doing more business and paying out more to their shareholders who will buy more goods and services. The insulator installers will take on more staff who will spend more wages on food, clothes, etc. The shopkeepers selling these goods will then earn greater profits which they in turn will spend, and .. so on and ...so on, like ripples spreading through a pond. The whole economy will grow and with it the consumption of energy. This of course is the whole point of "spending out of recession", but it will not, as the Government seems to believe, reduce energy use, but increase it.

## Go ahead for PBMR

After a good deal of discussion the Pebble Bed Modular Reactor (PBMR) is to be built in South Africa. The small 165 MWe demonstration plant will be built alongside the existing Koberg site of South Africa's existing nuclear power plant equipped with two 900 MWe French designed pressurized water reactors.

The contract which has just been signed calls for a start of construction in 2010 with completion set for September 2014. If successful the plan is to build up to 30 of these plants sized about 300 MWe in South Africa.

South Africa first showed interest in the pebble bed reactor back in 1993 and the utility Eskom formed the PMBR company in 1999. The world nuclear community has watched the South African work with keen interest having previously completed a great deal of development work on the high temperature gas-cooled reactor concepts. It is a natural progression

from the advanced gas-cooled reactor and was nearly built at Oldbury B but abandoned when the then Central Electricity Generating Board got frightened by high temperatures. The Germans also undertook a large development of the pebble bed concept eventually building a 300 MWe demonstration plant but the crazy political system in that country finally scrapped the system and pulled the reactor down.

The PMBR is largely constructed in graphite, a ceramic material that can withstand very high temperatures which account for the claim of great safety. The reactor can virtually be left to look after itself if anything goes amiss and it will not reach a temperature at which any of the fuel will fail.

When we first saw the pebble bed concept in the Christmas edition of a leading magazine we thought it was a joke. A reactor core formed from a pile of ball shaped elements. But a small experimental reactor was built in Germany and operated safely at 15 MWe and temperatures up to 950 °C for many years.

The fuel in fact consists of uranium enriched to about 10% — somewhat higher than the 4% to 5% of a light water reactor giving it the potential for high burnup. It is contained in small pellets coated in silicon carbide which makes it very secure. The pellets are imbedded in a sphere of graphite about 6 cm in diameter — nearly the size of a tennis ball. Each pebble contains about 9 gm of uranium and a full core of around 450 000 pebbles makes a load of about 4.1 te. Fuel pebbles are continuously added at the top and removed from the bottom. The reactivity of the pebbles is measured at the bottom and if sufficient it is recycled to the top. But when after about six passes through the core the fuel is used up it is diverted to spent fuel storage vaults below the reactor. There are ten of these each with a capacity 600 000 pebbles which means that they can hold the lifetime fuel of the reactor. At the moment the intention is to store the used fuel for eventual disposal.

The reactor is contained in a graphite structure inside a steel pressure vessel — 88 ft tall and 20 ft diameter. High pressure helium gas coolant enters at the top at some 500 °C and exits at the bottom at temperatures up to 950 °C. (We are not quite sure why this figure but it is always quoted) At this temperature the very hot gas can drive a turbine to generate electricity. It can also be used for a range of process heat applications which is another reason for the keen interest in the system.

The reactor is controlled by rods inserted into the graphite surrounding the core but the Germans have demonstrated that in larger reactors rods could be inserted directly into the core of pebbles.

It has to be said that the main difficulty can be expected by the system for handling the very high temperature gas but the South Africans have undertaken a large programme of development and can be expected to succeed. Countries that should have been in there helping them included Britain for a while but we sold that opportunity to the Japanese when we got rid of British Nuclear Fuels plc (BNFL).

Who is in charge?

The answer seems to be no one. The Government insists that electricity supply is entirely a matter for the industry. Yet this is plainly not the case. The Government through the negative power of veto can, by refusing planning permission, ensure that only those projects of which it approves can go ahead. In addition the imposition of the Renewables Obligation compels the generating companies to build the specified renewable energy capacity, whether or not they consider this to be a sensible investment, or else pay the buy out penalty. The generating companies are thus inhibited in the way they can plan for the future. And competing with each other under the rules imposed by Ofgem the emphasis is on the lowest short-term costs. The National Grid is now a private company operating in the USA as well as the UK and no longer has any responsibility for seeing that generating margins are maintained. This free-for-all is a recipe for disaster.

The only consolation is that if we can struggle through the next ten years our nuclear future should be assured.

What about the waste?

The European Environment Agency put the total electricity generation in the EU for 2004 as some 300 TWh, of which nuclear provided 31%, coal and lignite 29.5%, and gas 19.9%. According to the EU Nuclear Illustrative Programme report of 10.1.2007 the nuclear share of electricity generation produces some 40 000 m<sup>3</sup> of radioactive waste each year. The greater part of this radioactive waste originates from day-to-day activities at the power stations and other nuclear installations, and is classified as low-level and short-lived. Most of this is disposed of in surface or near-surface facilities

High level and long-life wastes, mostly as spent nuclear fuel amount to only some 500 m<sup>3</sup> per year, in the form of either irradiated fuel or vitrified waste from reprocessing. This is something around 1000 tonnes a year depending on how it is processed. For the high-level and long-lived waste deep disposal in a stable rock formation is the preferred option by nuclear operators although near-surface storage in order to make surveillance and potential recovery easier in the future, if required, could be an alternative. Since spent nuclear fuel still contains over 95% of uranium as well as plutonium and other actinides it can be expected that these will be recovered and used to extend uranium resources and as fuel for future advanced and fast reactors. Mixed plutonium/uranium oxide fuel is already being used in increasing quantities in present reactors. The amount of waste for final disposal will then be considerably less than the 1000 tonnes/year, perhaps no more than a few hundred tonnes a year for the whole of the EU.

Nuclear waste disposal is however seen by the public as a major obstacle to nuclear power. The 2005 Eurobarometer survey showed that the EU public is

not well informed on nuclear issues, including possible benefits in terms of mitigating climate change, and the risks associated with the different levels of radioactive waste. It also found that out of a majority of citizens having questions about nuclear, 40% of those opposed to nuclear energy would change their mind if solutions to nuclear waste issues were found.

In contrast to the minimal quantities of radioactive waste, the coal power stations, generating some 1000 TWh, only a slightly smaller share of EU than the nuclear stations, would, assuming carbon emissions of 800 gm/kWh, discharge about 800 million tonnes/year of carbon dioxide generation. But to meet concerns over climate change it is being proposed that some part of this carbon dioxide should be separated from the flue gases and buried underground. The nuclear waste is in solid form as a ceramic or as vitrified waste, both of which are resistant to water erosion, as well as being encased in metal containers. The possibility that buried underground any radioactive matter would ever return to the surface is remote. After a few hundred years most of the radioactivity would decay to levels that are common in our surrounding environment. Carbon dioxide does not decay and would have to be stored for ever – an impossible requirement given that under pressure it would probably be as liquid which, with any water intrusion, would give a slightly acid solution that would, over time, attack the surrounding rock and eventually find its way to the surface. When released it would, heavier than air, blanket the surroundings and smother all life.

If the public has doubts over the safe storage of less than one thousand tonnes a year of nuclear waste will they ever be likely to accept the underground disposal of several million times more carbon dioxide which if released could cause an immediate, not a long-term danger.

Carbon capture and sequestration

With the expectation that oil and gas supplies will become evermore expensive as available supply decreases while world demand for electricity continues to grow, there will be an increase in the need for coal-fired electricity generation. In March last year, with the expectation that the share of fossil-fired generation will increase, the European Council announced that all new power plant should be fitted with carbon capture and storage CCS by 2020. It also endorsed the construction and operation of up to 12 commercial-scale demonstration plants in the EU by 2015. Carbon separation and storage is seen as the only means of meeting the requirement to reduce carbon emissions.

To meet this situation the Environment Agency has now issued a Position Paper on CCS, capturing the carbon before or after combustion and storing it underground. It claims that CCS is technologically feasible, and that a fully integrated demonstration

plant could be built using existing technologies that are economic under certain conditions. This might apply to the capture process, although the presence of sulphur and nitrogen oxides might be a complication and restrict the process to only certain coals, but it does not address the storage problem. It also points out that CCS can only be used at the large point sources – which in the UK are responsible for 35 per cent emissions. Any new coal stations built before CCS is an established solution – by 2020? – will also tie us into a high emissions path over the lifetime of the plant of about 30 years – unless these plants are designed so that CCS can be retrofitted, and it is suggested that the Government should use its powers under the Electricity Act to ensure that this is done. Whether this condition would be accepted by the private power companies remains to be seen. With the imperative to ensure an adequate supply of electricity the Government is not in a strong position. It is possible that carbon capture could be technically feasible, but the main problem will be in finding sites which can contain the vast quantities of carbon dioxide to be stored securely and for ever. The Environment Agency suggests sites could be found in depleted oil and gas fields, coal seams or deep saline aquifers. But there will be widespread, and justified, opposition to any sites on land which would rule out depleted coal seams. It has been suggested that carbon dioxide could be injected into the depleting North Sea oil and gas fields to increase the recovery. Carbon dioxide is indeed a powerful solvent and its injection into depleting oil fields is used to increase recovery, but in this case the carbon dioxide will return to the surface with the recovered oil. Storage in saline aquifers would come up against the problems of acidification.

In the face of these problems the Agency asserts that the regulatory framework must reliably safeguard the capture, transport and storage of CO<sub>2</sub> to reduce the risks of slow or catastrophic leakage to the local environment; that storage sites must be carefully chosen and managed to ensure their environmental integrity over hundreds of years (or rather for ever), and it admits that many of the sites currently identified for potential future storage may not, therefore, be suitable. On the other hand it suggests that large-scale projects using the Sleipner aquifer in the North Sea and the Weyburn oilfield in Canada show that it is possible to store CO<sub>2</sub> safely and monitor its movement reliably, but this experience is for only a few years of storage, longer term effects cannot be known in advance.

There is the additional problem of carrying the carbon dioxide from the power stations to the storage site. This can only be though a network of CO<sub>2</sub> pipelines, themselves a potential source of leakage and extremely costly, although the Agency suggests that the Government should work out a framework for funding and building them, with further work to map the suitability of prospective storage sites. But with

the risk of ‘lock-in’ to high emissions pathways from new coal plants it is suggested that they should be built as close as possible to a suitable storage site. But finding an acceptable storage site may take years, time we cannot afford to meet the coming electricity supply crisis.

Public concern over the far smaller and potentially less hazardous disposal of nuclear waste suggests that this will be the major problem with finding acceptable CO<sub>2</sub> storage sites. The Agency then urges that as soon as possible the Government must provide clarity over the regulatory framework to reduce developer uncertainty and improve public confidence; the regulatory responsibilities of different Government departments, devolved administrations and agencies, (particularly where CCS activities extend offshore), will need to be clearly defined: rigorous criteria for site selection is a priority, and research is needed to understand the potential environmental and safety risks of transport and storage. These risks the Agency suggests include the problems of low levels of CO<sub>2</sub> exposure on surrounding ecosystems. This seems a gross understatement; the concern is not over *low* levels of exposure on *ecosystems* but on the potential threat to all life forms of a massive escape. If a significant leak were to happen the whole concept would probably be abandoned.

Carbon capture and storage may prove to be only a comforting illusion to justify the prompt construction of the new coal plants that will be required to avoid the more damaging shortage of electricity that will otherwise occur.

## India

At its second meeting on the topic, at the beginning of September the Nuclear Supply Group finally, and with some reluctance, agreed to accept the India-USA nuclear trade agreement. Among the countries which are reported to have delivered statements to clarify their views on how the NSG’s policy on India should be implemented were: Austria, China, Germany, Ireland, Japan, the Netherlands, New Zealand, Norway and Switzerland. They urged that India should accept a nuclear test moratorium pledge and take further non-proliferation and disarmament measures, including “entry into force of the CTBT and a termination of fissile material production for weapons.” But these statements are only expression of opinion and are not included in the final text of the agreement. Other objections, mainly from US critics describe the Agreement as “a non-proliferation disaster of historic proportions that will produce harm for decades to come.” They draw attention to the fact that unlike 179 other countries, India has not signed the Comprehensive Test Ban Treaty; it continues to produce fissile material and expand its nuclear arsenal. And they claim that India’s political promises on non-proliferation and a voluntary test moratorium are not in any way equivalent to the legal

obligations and commitments made by the member states. These objections however carried no weight and after approval of the US Senate the Bill was signed by President Bush on 8<sup>th</sup> October.

On the other hand in the light of the large expansion of nuclear capacity in many countries with forecasts from the IEA and IAEA that world capacity could double by 2030 it can be expected that, as a large rapidly expanding economy, India will seek a significant share of this expansion. The US then expects that the agreement will open a large and lucrative market for their own nuclear industry, and the other major potential supply countries of fuel and equipment will also seek a share. But as the critics point out although nuclear fuel sales to India for Indian power reactors will help increase India's energy output, it will at the same time free-up India's limited domestic uranium supplies to be used for bomb-making.

The nuclear trade need not however be a one-way exchange. Specialised Indian companies can expect to take a share of the international market in nuclear equipment, notably pressure vessels, heat exchangers and other heavy components which might otherwise be a limitation on the rate of expansion of the world nuclear power capacity.

Although the India-USA agreement is a clear divergence from the existing non-proliferation regime it is a pragmatic acceptance of India as a nuclear weapon state. It suggests that the non-proliferation treaty has now ceased to serve its purpose. Why should any of the non-weapon states continue to accept the restrictions of the NPT when they see that these are not applied to India – a clear nuclear proliferator. It now appears that the main restraint on nuclear hostilities has been the MAD principle of mutual assured destruction rather than the NPT. Most weapon states are locked into specific, counterbalancing targets Russia/USA; India/Pakistan; and China/USA or even China/Russia. Israel is a worrying unconstrained exception in that its missiles threaten the Arab world which is unable to offer any nuclear retaliation. France and the UK, without having any obvious potential targets to aim at, are what might be seen as in a state of national psychosis, driven by a free-floating anxiety – or more probably by the prestige and military might they believe that possession of a nuclear deterrent confers.

Is an update of the Trident missile and its submarine delivery system in the UK said to cost up to £20 billion or £50 billion over its operating lifetime a wise and rational policy at this time of financial crisis. The more pressing and urgent need is for a secure energy and electricity supply; without this all military pretensions will collapse.

## Nuclear regulators

An important element in convincing the public that spent nuclear fuel is being safely handled and stored

must be confidence that the nuclear regulators are carrying out their role free from government interference. Independence of the regulators is a key issue, but also the EU regulators have to be working within the same framework.

The member states of the EU are already signed up to basic rules in these areas, and the national regulators are committed to a full exchange of information. At their most recent meeting the regulators made an important decision. By unanimous agreement they decided that it should be mandatory that IAEA peer review teams should thoroughly review systems in each regulatory body. This, however, will take some time to complete, so it was also agreed that member states would make self-assessments against IAEA standards, with the assistance of experts from other member states. The co-operative work of the national regulators is brought together in the European High Level Group on nuclear safety, waste management and decommissioning. The next move by the HLG is to begin discussions on the establishment and implementation of radioactive waste management plans in all member states. The regulators are also increasing the transparency of their work by creating a website at EU level, which will make relevant data open to the general public.

All these are important steps in reassuring the general public that safety issues are being given the highest priority by the industry, and also to give the lie to those opponents of nuclear power who are forever claiming that “there is no solution to the problem of waste management”. There are none so blind as those who will not see.

## EdF and British Energy

The furore over the failed takeover may be exaggerated.

The question is whether or not British Energy is worth more than £12 billion. Invesco and Pru, both financial organisations who think it is, know little about nuclear technology but look primarily at the present and probable future price of electricity. (are they being greedy?) EdF with its vast experience of operating nuclear power stations should be better able to assess the value of the aging Advanced Gas-cooled Reactor stations and is unwilling to pay more.

A look at BE's results over recent years suggests that EdF will be proved right. Since the reconstruction there has been an almost continuous, and accelerating decline in the nuclear output. How far and how fast will this decline continue?

	00/01	01/02	02/03	03/04	04/05	05/06	06/07	07/08
TWh	63.5	67.6	63.8	65.0	59.8	60.4	51.2	50.3

The performance of the AGRs is even worse than these figures show. The total nuclear output is boosted by the good performance over these years of Sizewell B.

It is also interesting that under the previous management, (much abused by Patricia Hewitt), before the reconstruction, BE's nuclear output was steadily increasing. The turnaround and progressive decline under the new management is striking.

	95	96	97	98	99
TWh	55.1	61.2	67.2	66.7	69.1

The AGRs seem to be suffering from specific aging problems – corrosion etc – which can be remedied at a cost. But lurking in the background is a potential generic fault with the graphite moderator. Some years ago there were reports on the monitoring of graphite samples, but we have not seen anything on this recently. EDF would, we assume, have contact with Dr Pascal Colombani, a French nuclear physicist and board member of BE who is also a director of Alsthom. Perhaps they know something we do not.

EDF might do better in seeking accommodation at Magnox sites, where the Government could lean on the NDA – if indeed the NDA still owns these sites. Or are they now under the control of Energy Solutions Inc who a few years ago advertised their opposition to nuclear power and their expertise in shutting down and cleaning up nuclear facilities?

Is there any reason why a replica of Flammanville cannot be built on the Dungeness A site, which is only a few miles across the Channel, without the need for a long public inquiry or lengthy approval by the Nuclear Inspectorate. There could be large savings with both sites under the control of EDF. And the plant could come into operation by 2015.

