Cabinet Office PIU Project on Energy Policy

Submission from the United Kingdom Young Generation Network (YGN)

Affiliation of the YGN

The Young Generation Network (YGN) was founded in 1995 as part of a European Nuclear Society (ENS) initiative to focus on producing the next generation of nuclear specialists. The aims of the group are to encourage young professionals who wish to pursue careers in nuclear related fields and promote continuous learning and exchange of knowledge. The United Kingdom (UK) branch of the YGN is affiliated to the British Nuclear Energy Society (BNES). YGN groups can now be found worldwide in many countries with a sizeable nuclear industry.

Introduction

Any energy policy derived for the UK must be specific to the needs of the UK and its ability to meet those needs. Energy is considered to be predominantly the production or use of electricity. The methods within the energy policy are either methods that will reduce the required electricity production or methods by which it can be ensured that the generating capacity meets demand.

Energy generation must be reliable and be able to match consumer demand profiles. The difficulty in implementing wind, tidal and solar technologies is that their output is determined by climatic factors whilst social and economic factors determine what time the electricity is required. For instance the energy surge that could be anticipated and prepared for with conventional energy sources when the general public wishes to watch an international football match could not be as easily handled by say wind power on a calm day.

Many claims and emotive arguments made by the advocates of renewable energy sources are that they are pollution free and environmentally friendly. However to harness these sources in a reliable manner guaranteeing the near 100% availability demanded above requires the use of comprehensive battery storage systems for load levelling[1]. These systems are currently based predominantly on lead acid cells that have a finite life and thus have a disposal issue associated with them. Even the lesser developed battery systems, like Vanadium Redox Batteries (VRB's) utilise heavy metals with unknown long-term toxicity.

The relatively poor sunlight conditions within the UK mean that solar energy sources would be severely challenged to meet any major electrical need. Recent reports have confirmed that solar energy is unable to power parking meters in some areas of the country[3]. Hydroelectric power is limited to large rivers and dammed valleys. The scope for expansion of this is limited and recent analyses have indicated that there is a large environmental effect on the associated river systems particularly in extreme weather conditions such as drought or excessive rainfall.

It is recognised that fossil fuel sources have the highest direct impact on the environment. All areas of its production and use have an effect from the mining and drilling to produce it, the losses during transport and separation and finally the carbon dioxide, nitrogen oxides and sulphur dioxide produced from burning. The disposal of ash from coal fired units is also a major effluent that impacts on the environment.

Nuclear power has been shown to have a much lower impact than any fossil fuel and if compared fairly using environmental and social impact criteria they will yield the result that nuclear power is relatively benign. In terms of emissions, consumption of natural resources and impact on human health, only wind and wave power can compete with nuclear which is generation terms is almost emission free.

In addition, nuclear power stations are more efficient and as has been seen earlier more reliable in the production of power than renewable technologies. It is significant in a country with limited land available for construction of power generators that nuclear reactors require a much smaller amount of land (e.g. Wind 10MW/km^2 – Nuclear 5000MW/km^2)[4]. If the wind farm is placed in rural areas then the usage of the ground beneath them can be taken into account increasing the theoretical production per square kilometres. However the density of the turbines cannot be increased posing a limitation to the overall output of a farm.

If these facts and figures were taken in isolation nuclear power would be the electricity generating method of choice were it not for the disadvantages associated with the long-term management of nuclear waste. Producing a waste is common throughout all electricity generating technologies and all have disadvantages. Dependence on a single source of electricity could expose the UK to restrictive price fluctuations associated with either pressures from the producer or from the raw material source. In reality, we need a balanced approach to electricity generation with an appropriate mix of energy sources to provide long term stability and security of supply.

This energy review is been carried out in an era where current thinking dictates that a 65% reduction in the world's carbon dioxide emissions is required to combat climate change. Such a reduction in the UK would simplistically require replacement of virtually all of the existing coal and oil fired power stations with renewable technologies and nuclear power. Of these, nuclear power stations represent the only large scale emission free technology for electricity generation.

Doubts over the economic viability of nuclear power in a commercialised electricity trading arena has been quoted as one of the main reasons for the lack of recent orders for new reactors in the UK. More recent economic analyses and improved design utilising standardisation of components has shown on paper that current available designs for new reactors are economic[5]. There would certainly be no doubt about the economics of nuclear if other large scale generators were also forced to internalise their costs to include, for example, waste management and decomissioning. There are international examples of countries that rely heavily on nuclear power where consumers pay less for their electricity than in the UK. Nuclear power can be economic and there is no real reason why this should not be true at home as well as abroad.

Advantages of Nuclear Power

Environmental Impact

Life cycle analyses of different electricity generating technologies show that nuclear power compares well in terms of the following: -

- Carbon dioxide emissions and emissions of other detrimental gases
- Mass of concrete required and consumption of metal per kWh
- Land required per kWh
- Waste volumes

In addition nuclear power has very low externalised costs (the cost of electricity generation that is born by society at large) because of the emphasis on waste minimisation and reduction of discharges and the excellent safety record.

In many respects, the impact of nuclear power is similar to that of renewable technologies like wind and wave power.

Land Usage

The UK has limited land resources for the introduction of new power generation. Offshore wind power and wave power offer opportunities for growth into the available sea area surrounding the coast. Wave systems are however relatively unproven and economics have only improved over recent years. The environmental impact of wave generation systems on tidal currents and beaches also remain unknown.

If the electricity usage for the UK in 2000 (an average 38500MW)[2] is taken as a base, for which nuclear provided 9000MW then the area required for a wind farm to replace it is 900km^2 assuming that wind produces 100% equivalent output. This cannot be achieved because the ability to generate depends on climatic variations. Therefore a more reasonable assumption would be 40% output where the area required rises to 2250km^2 in comparison to a small number of nuclear reactors located at small compact points throughout the UK. It should also be noted that high power outputs from horizontal axis wind turbines is achieved only with 55m rotor machines, i.e. very tall[4].

A significant point to note is that within the UK we are approaching a unique opportunity in nuclear reactor capability in which we are moving towards decommissioning of the MAGNOX reactor systems. These reactors are low power relative to the new AP600 PWR reactor available and licensed within the US. The sites are in areas where nuclear power has been accepted as part of the landscape. Replacement of an old reactor system on the same site as a new higher power unit would increase the generation capacity of the nuclear sector from these sites more than 15 fold. This provides a significant enhancement to the power generation sector with little impact on the general UK landscape.

Security of Supply

One of the main advantages of nuclear power is that it provides secure baseload generating capacity. The UK's nuclear power stations have proved very reliable. Uranium from which nuclear fuel is obtained is mined in areas of low political volatility. There is a current glut in the world market of fissile uranium derived from the decommissioning of nuclear weapons. Recent moves towards the introduction of MOx(mixed uranium/plutonium) fuel has shown that there is a recycle capability within the current nuclear energy capability and if, in the future, there is further development of the fast reactor, nuclear fuel can be used nearly 50 times before being considered spent. [6] Nuclear in the UK electricity generating market can be seen to provide long term stability in the electricity price, protecting the consumer from variations in the price of gas and oil on the international market.

Climate Change

The advantages of nuclear power in avoiding carbon dioxide emissions are widely documented. It is unfortunate that nuclear has been explicitly excluded from the Clean Development Mechanism in the Kyoto Protocol. Nuclear power is the only way to generate large amounts of emission free baseload electricity. The exclusion from the Kyoto mechanisms however, does not preclude the use of nuclear to achieve national emission reduction targets in the UK.

The energy consumption within the UK continues to grow. Currently this growth has been supplied by an increase in the consumption of natural gas (The proportion of gas has increased from near zero to 38% in 10 years)[2]. Although this produces less carbon dioxide than coal, the previously traditional baseload fuel, it still produces carbon dioxide. Any attempt to achieve targets placed in the Kyoto agreement cannot rely on the introduction of large scale wind power. It is known that where it would supply more than 20% of the total demand the variability of its supply would affect the electricity supply of the grid and thus the consumer. Few of the public would accept periods of low or no electrical power and the introduction of local load levelling battery facilities containing lead, acid and the potential for fire from the hydrogen produced during electrolysis.

There is a moral obligation to consider the lowest risk method of ensuring we meet emission reduction targets. To adopt a high risk strategy is to chance failure to address climate change. The lowest risk option will always be existing technologies and nuclear power is the only existing technology that can yield a large scale reduction in emissions.

Common Criticisms

There are four main areas where the use of nuclear power to generate electricity is commonly open to criticism. These are economic viability, waste management issues, concerns over severe accidents and proliferation risks. The following comments on these issues are submitted:-

Nuclear Economics

Currently, the profits generated by the nuclear operators in the UK are marginalised because the current electricity trading arrangements disadvantage baseload generators and the chief strength of nuclear is in providing secure, un-interrupted and plentiful baseload electricity.

Recent studies into the cost of building a new twin nuclear power station to Sizewell B, the only pressurised water reactor (PWR) in the UK have suggested that this would be uneconomic. The economics of a nuclear power station are dominated by the following factors:-

- capital cost
- discount rate

- projected generating life
- load factor

The capital cost and hence economic viability is very sensitive to delays during construction and commissioning. The capital cost of Sizewell B was inflated by the costs associated with the modifications to the original Westinghouse design and the lengthy delay in commissioning caused by the extended public enquiry after the station was built. Future build would anticipate the responses required for these public enquiries, and the reservations associated with a new build could be designed out and prepared for at an earlier stage.

In addition any new station were built in the UK would be of a different design to the Sizewell unit. A smaller station with enhanced inherent safety features would be chosen (e.g. Westinghouse AP 600). Smaller units have lower capital costs that have been shown to compete on paper with the economies derived for gas fired power units. It should also be noted that the economy of scale reduction in the build of more than one identical unit would improve the capital cost reduction achievable within new build.

Theoretical economics[5] can play an important part in the decision of a private investor to build a power station. In the current climate it is believed that for a new station to be competitive, a discount rate of around 8% is needed, together with series build (at least twin reactors), a projected generating life of 60 years and a load factor of 90%. These are viewed by many to be ambitious targets. However, international experience of PWR operation would suggest that the generating life and load factor are not unreasonable. Many reactors regularly achieve a 95% load factor. A modest carbon tax to level the playing field and allow operators to capitalise on the environmental benefits of nuclear would make a new nuclear station the cheapest option for additional capacity.

Ensuring construction remains on target could dramatically reduce uncertainties over the economic viability of new stations. Similarly, nuclear would benefit from streamlining the planning process (whilst ensuring that all interested parties still have a voice) and modifying the electricity trading arrangements so that small and baseload generators are no longer disadvantaged.

Consumers in other European countries that rely heavily on nuclear power (e.g. Sweden) pay less for their electricity than in the UK. The Finnish government has decided to embark on a project to build a new nuclear reactor because they have concluded this is the cheapest option for providing the additional electricity they require. Whilst it is understood that there are variations between economies and electricity trading arrangements, nuclear can be economic and there is no reason why this should not be true in the UK.

Waste Management

Nuclear waste is hazardous and must be treated with respect. Nuclear waste is already treated, contained, kept separate from the environment and stored at the Sellafield site with minimal effect to the public environment. The nuclear industry is the only electricity generating industry that has to incorporate its waste management costs within its electricity price.

Many efforts have been made in reducing the waste volumes derived from nuclear fuel. The effects of recycling on this production via the use of MOx fuel shows further reduction can be achieved per kg of uranium.

Additional waste generation is not sufficient reason for failing to replace our existing reactor fleet. As has been stated earlier even renewable sources create wastes that potentially have a significant effect on the environment. However, long term nuclear waste management is of great concern to the industry’s stakeholders, including those who work for the nuclear industry.

The refusal to allow Nirex permission to build a rock characterisation facility at Sellafield has effectively halted the progress in long term storage of High Level Waste, which has had a knock on effect on the perceived profitability by potential private sponsors. Thus it is important for the UK to make a decision on long term nuclear waste management policy to assist in closing the nuclear fuel cycle. It is not ethical to leave the issue for future generations.

Risk of Accidents

Globally, we recently accumulated 10,000 operating years of nuclear generation. There have only been two serious accidents in the operation of commercial nuclear power stations, the accident at Three Mile Island (TMI) within a PWR and that at Chernobyl for a Russian designed VVER.

Any new reactors in the UK would most likely be PWRs. The accident at TMI is therefore more applicable to the type of reactor we would build. As a result of this accident, there was significant damage to the reactor itself but **no release of radioactivity** to the environment and **no-one was hurt**. TMI has been described as a 'financial' rather than a 'human' tragedy because the owners could no longer operate the reactor and consequently lost their investment together with increasing the costs of decommissioning.

In fact, the nuclear generation industry has an impeccable safety record, the chance of a severe accident is minute and the consequences of accidents tend to be over-exaggerated. Newer reactor designs have enhanced inherent safety features that would further reduce the probability and consequences of a severe accident.

Proliferation Concerns

The UK has been a nuclear power since the fifties. In the intervening time, fissile materials arising from the reprocessing of spent nuclear fuel in the UK have been safely managed and stored securely. Proliferation concerns are not sufficient to prevent the UK from embarking on a replacement programme for its civil nuclear reactors.

Reduction in proliferation is being aided throughout the world by nuclear power. Highly fissile concentration uranium and plutonium from weapons are diluted and then used for power generation. This dilution utilises waste uranium derived from enrichment processes thus reducing waste volumes from the process. Future plutonium burning fast reactor systems would reduce this stockpile even further.

It should be noted that the material produced by the PWR civil nuclear reactors is not of an acceptable composition for the production of a weapon. Thus it can be seen that within the UK future civil nuclear power generation can be used to assist the reduction in proliferation in the world stage rather than promoting it.

Comments on PIU Nuclear Scoping Note

The initial scoping note on Nuclear published by the PIU Energy Project team on 15th August 2001 is in general a fair assessment of the issues surrounding the continued use of nuclear power in the UK. The following comments on some of the issues put forward in the scoping note are additionally submitted:-

Paragraph 42 – Risks of nuclear accidents

The probability per year of a loss of coolant accident in a PWR of similar design to Three Mile Island is roughly one in a million. To put this figure in perspective, this is more likely than winning the UK lottery (one in 14 million) but far less likely than the chance of having a serious accident in the home each year (one in a thousand). Remembering that the TMI accident was contained within the plant boundary and no direct harm was caused to the public.

When a nuclear reactor is designed, probabilistic risk assessment techniques are used to determine the most probable causes of accidents and changes are made to mitigate these risks. Newer reactor designs would therefore have a lower risk of accidents together with enhanced safety features to mitigate the effects of a severe accident – effectively learning from experience.

In general, the concept of risk is poorly understood. Understanding of risk is distorted by perceived consequences. For example, there are people who won't drive on motorways because they perceive them to be dangerous and travel by lesser roads. The risk of an accident on a motorway is in reality far lower because there are no oncoming cars but the personal consequences of an accident could be greater.

Paragraph 56 – Nuclear fuel reprocessing

There is a vocal minority which campaigns for the end of nuclear fuel reprocessing in the UK. The majority of these organisations would additionally be opposed to new build in the UK under any circumstances. A move to direct disposal of fuel has been put forward as an alternative to reprocessing however such a decision would have to be taken with due consideration of other related issues e.g. suitability of waste form for long term management and the loss of a potential fuel source for future generations.

Paragraphs 57 – 59 – Public perception of nuclear

It is stated that 25% of the public are anti-nuclear. This figure is consistent with reported polls. It should however be noted that there is a roughly similar proportion of the population that is pro-nuclear. The debate in the national newspapers on the role of nuclear has been remarkably balanced as has the proportion of submissions to recent nuclear related consultations. The remaining 50% remain undecided, feel nuclear power is a necessary evil or have no strong feelings either way. It has recently been demonstrated in the U.S. that when electricity shortages threaten quality of life, it is possible for a swing in public perception towards nuclear energy to occur. In a recent poll, 80% of college graduates in the U.S. stated they were in favour of building new nuclear reactors. It seems likely therefore that rising gas prices and/or electricity shortages in the UK would have a similar effect.

Paragraphs 64 – 66 – Possible policy responses

The scope of the PIU energy review is to consider energy needs in the UK up to 2050. All but one of our nuclear reactors will have shutdown by this time. In order to support the construction and operation of new nuclear reactors, there must be a skills base to draw on. Similarly, the NII have stated that we will need specialist skills for decommissioning activities up until 2080. Continuity of experience when maintaining the infrastructure of an industry is important.

It is unlikely that the UK will be able to maintain an adequate expert resource for the possible future expansion of nuclear power if no replacement reactors are ordered before 2050. A neutral position towards the nuclear industry, which fails to secure the replacement reactors needed, is inconsistent with 'keeping the nuclear option open'.

References

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