Oxford Energy Comment
July 2005

Nuclear Power and Renewables: Strange Bedfellows?

By Christopher Hansen and Robert Skinner

Climate change represents an enormous long term threat to global ecosystems and the world's economies. The convergence of high oil prices and climate change at the top of political agendas has resurrected many of the energy policy debates of the 1970s. Advocates of different fuels each claim to have the solution, high oil prices are prompting calls for 'urgent' action on renewables and the role for nuclear power is back in the spotlight. At this time of increased concern about climate change and high fossil fuel costs, perhaps a new approach is needed to respond to the dual exigencies of climate change and growing electricity demand. Within this evolving and complex debate, many commentators in the media have shown a poor understanding of the different sources of energy, and which fuels provide which energy services. This note aims to breakdown the interfuel debate about electricity supply and show how cooperation might be the best tactic if carbon emissions are to be reduced while maintaining reliable electricity supply.

The main area of capacity growth in the past 15 years has been gas-fired turbines, but the prospect of importing increasing amounts of natural gas in the form of LNG to fuel electricity generation strikes many policy makers as a double risk, and will not greatly reduce carbon emissions when considered on a full-fuel cycle basis. Thus, it makes sense to look for domestic sources of carbon-free fuels for electricity. Nuclear and wind are the favourite contenders.

The recent momentum favouring new nuclear power plants in both the UK and the US has been built on the confluence of two important goals for politicians and energy companies: providing reliable electricity—i.e., energy security—and reducing carbon emissions. The strategy taken by the nuclear proponents in this debate is just beginning to capture widespread public support. Nuclear proponents must confront the continuing scepticism about radiation safety and the management of spent nuclear fuel. Notwithstanding that technically viable options are emerging to address these concerns, the industry needs to convince the public. Nuclear power expansion must also manage long term costs and risks of future investments that can only be profitable with clear political signals favouring new nuclear build, e.g. carbon being priced into fossil power tariffs and government liability insurance.

In the UK, several prominent environmentalists have come forward in the past 18 months to endorse new nuclear capacity as a bridge to a carbon-free energy future. They have argued that nuclear power is the only option for a large increase in carbon-free power generation, and

have recognized the limitations of current renewable technologies to meet the growing power demand in the short and medium term. This realistic appraisal of energy technologies is a step in the right direction within the public debate and should also signal to the nuclear industry the best way to move forward: in cooperation with the green and renewable energy lobby.

Nuclear and renewable power advocates are good partners because they both supply carbon-free electricity and act to displace fossil fuels in the power grid. Nuclear power stations are built to be baseload suppliers in the power market, meaning they should run as much as possible to provide low marginal cost power to the grid. In the past two decades the nuclear industry worldwide has risen to this challenge by increasing plant efficiency and more significantly, improved plant load factors (PLF) to 90.5% from approximately 62% in the late 1980s. This has resulted in more nuclear power being delivered to consumers without increasing the installed capacity. The 105.5 GW of nuclear plants in the US accounted for 10.2% of installed capacity, but contributed 19.6% of total kWh to the grid in 2004. To put this in perspective, to generate this electricity using natural gas, the US would have to install 109 GW or 136 new, 800 MW CCGT plants (at 80% PLF) which would burn 143 billion m^3 (bcm) of gas—a volume equivalent to 20% of total North American gas consumption or most of the world's LNG trade in 2004. In the UK, the generation figures are similar in proportion with nuclear plants accounting for 15.4% of capacity and 21.5% of total electricity supplied.

The UK must address the staggered replacement of 12 GW of nuclear plant starting as early as 2010, which presents the problem of nuclear plants coming out of the system in large capacity lumps—virtually impossible to fill reliably with wind capacity. This is because, in contrast, wind and solar provide a different energy service in today's electricity supply industry, acting mostly as a fossil fuel plant displacement power source. Wind power accounted for 1% of capacity in the UK (742 MW) but only 0.35% of energy delivered in 2003 (1286 GWh), an aggregate plant load factor of 19.8%, which is about the average for all of Europe's wind power capacity. At these relatively low penetrations in the US and UK, the grid can easily absorb their output whenever it is available (i.e. "when the wind is blowing"). This is achieved not by turning off nuclear plants with their long start-up times, but by reducing the output from gas- and coal-fired plants, the real providers of flexibility in the power system.

While it may be a long-term ideal to have a power system based only on renewable sources, it simply is not possible with current or even foreseeable technology to supply both baseload and reliable peak power from renewables. As many politicians have discovered, a reliable supply of electric power is a non-negotiable requirement of voters and for the running of a viable modern economy. Thus, baseload and peaking plants must provide power when called upon; renewables are not well suited to do that and therefore contribute only after reliability is assured. Wind and solar power by their nature are not dispatchable, but this can be mitigated somewhat by harnessing their system-wide portfolio effects for available capacity. Meteorological studies have shown wind is always blowing somewhere in the UK at any given time; however, even if optimal siting of wind plants across the country can be achieved, they would still only be able to deliver 30% of their nameplate capacity in the best case scenario and will not address the resulting transmission and reliability requirements.

The ability of the grid to absorb new renewable capacity will depend on a solid backbone of baseload plants around the system. Wind and solar power will need reactive power support

and ancillary services to reliably feed into the grid, services that only baseload facilities can economically supply. Going further, it is clear from the structure of the 'in place' transmission system that large, centralised plants will have to play a role in the medium term. The aggressive plans to add upwards of 15,000 MW of new wind capacity around the UK would require many miles of new high voltage transmission lines to overcome the dispersed nature of the turbine sites and north-south congestion. This effort would require turning the present grid configuration 'inside out' to move the power from the periphery of the grid to the load centres.

With these limitations in mind, nuclear and renewable power can pool resources with each other on several fronts and form the basis for robust cooperation for both interest groups to advance their agendas. First, nuclear and renewables are not direct competitors in the generation markets because they are both used as "must run" units and act to displace fossil plants in the supply curve. Second, they can take advantage of the political momentum favouring carbon-free and reliable power that they can supply in tandem. Third, the locational disadvantage of renewables on the periphery of the grid can be partly addressed by new nuclear plants nearer to the load centres. For the renewables community, this strategy helps by adding industry support and for the nuclear advocates it accentuates the carbon emissions benefits of fission compared to fossil plants.

As for the question of reducing oil demand through renewables or nuclear, it is important to remember that less than 8% of world oil consumed in 2002 was used to generate just 7% of the world's electricity from plants running less than 30% of the time. The exception, not surprisingly is the Middle East, where load factors are highest, but still less than 45%. Thus, the 'nuclear versus oil' debate is as much a non-debate as is the nuclear versus wind.

Energy policy will benefit, not by lumping electricity supply into one homogeneous service, but by recognising that different products are being supplied by different technologies. In many ways the fuel/technology choice debate is like a clothing merchant objecting to another merchant opening a store down the street: one sells shirts and the other sells trousers. There should therefore be no conflict in the task of displacing baseload fossil plants emissions. Nuclear and renewable advocates have a variety of shared interests and should work together to reduce carbon emissions, while maintaining supply reliability.