Nuclear Power: cul-de-sac or saving grace?

*Renewables, technologies and energy efficiency gains need time to mature or be deployed and will not be able to meet all our energy needs. Nuclear power will be required too, as part of an integrated electricity generation policy, says Dr Feroze Duggan**

Cutting the knot

This piece is the third curtain raiser to a pioneering multidisciplinary meeting being convened at the Geological and Royal Societies in October and November this year. Entitled *Challenges and Solutions: UK energy to 2050*, a two-day meeting at Burlington House will first attempt to look at all elements in the energy equation, and to produce answers - in a report to be published during a half-day event at the Royal Society one month later. For further details and a First Circular, please go to the Events Section of *www.geolsoc.org.uk*.

The conference is the brainchild of former President Richard Hardman CBE and has been in planning for over a year. Other major players are Bryan Lovell (inspiration behind 2004's highly successful meeting *Coping with Climate Change)* and Hamish Wilson, who chairs the conference's external relations committee. The conference will have sessions on demand, fossil fuels, nuclear power, renewables, and impact; the latter session asking how, as we strive to meet the targets in the White Paper, the consequential changes in energy production can be made culturally and politically acceptable in the UK.

All those attending the two-day session in Burlington House will be entitled to attend the public meeting in the Royal Society.

UK electricity generating policy is at a crossroads where many inappropriate avenues, narrowing path-ways and cul-de-sacs meet - and where we also see one bright highway that is currently being ignored – the nuclear option.

The 2003 Energy White Paper (www.dti.gov.uk/energy/ourenergyfuture.pdf) envisaged a low carbon future with renewables and no new nuclear stations, unless required in future, to meet our carbon targets. Therefore a nuclear programme[1] underpinning this policy is a necessary precaution. Giving renewables a high profile is laudable; but on the ground, I believe our expectations are not likely to be met. We started too late, and we are making unrealistic demands on immature technologies in a short time.

Figure 1 shows nuclear generating capacity reducing, from 23% (2002) to zero (~2035). Both renewables and deployment of energy efficiency measures would have to grow phenomenally fast to fill this gap. To put it baldly, unless nuclear capacity is replaced, reductions in CO_2 emissions will not be achieved.

Renewables output is intermittent (variable), depending on time of day, weather and seasons. In Figure 2 electricity demand is matched against energy generated by renewables.

As other studies have also suggested, renewable energy supplies are not in line with, and appear unable to meet, our fluctuating electricity demand throughout the year. Demand reduction by energy efficiency requires substantial cultural changes and is a slow process that will not be achieved in time.

Furthermore, reliable electricity grids require that installed capacity exceed peak demand. Figure 3 charts this excess - which is reducing, falling from 27% (2001/2) to 20 % (2002/3).

The intermittency of renewables makes them unsuitable for replacing baseload generation. Continuous and reliable supplies require either new nuclear reactors, or fossil fuel plants. The latter option suffers two limitations: increased emissions, and depleting oil and gas output from ~2010-20. Once again, nuclear is indicated, to work alongside renewables. Fusion is still a few decades away[2]. Our reliance on nuclear power is inescapable - the necessary milestone decision will have to be made.

Unlike oil, gas and coal, uranium has no real value except in electricity generation. An objective evaluation considering capacity, cost, reliability, safety and environment[3] indicates that we need to re-start new nuclear build rapidly[4,5].

A Europe-wide opinion survey found that nuclear power is publicly acceptable if the long-term nuclear waste management was safe[6]. Acceptance of nuclear within the UK has also increased[7].

So can existing science & technology deliver safe long-term waste management? Technically a worldwide consensus exists[5]: risk of 10^{-6} over 10^{6} years to reduce radiation exposure from waste to natural background, with containment of vitrified (glassified) waste in heavy duty containers, in a multi-barrier engineered repository, in ubiquitous stable geosphere. Further options include shallow burial, the ability to retrieve and relocate, and phased repository closure.

The empirical evidence is good: radionuclides are constrained naturally by the geosphere, as in the "natural reactor" at Oklo. Ancient glass artefacts show virtually no degradation.

The UK waste inventory: replacing nuclear with new nuclear build only causes 10% increase[5] in total high and intermediate level wastes, and about 3% for low level. Anyway we can't walk away from the legacy inventory.

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Decommissioning: dependent on adopted strategies, this costs between 0.6p – 0.13p /kWh. That figure is relatively static, so is not an "Achilles heel".

Cost: Electricity is cheaper in France than in the UK because of that country's ~78% nuclear capacity. This saves French industry[3] £1bn/y. The Royal Academy of Engineering's study[8] shows nuclear new build is as cheap as for gas. Renewables are expensive, but we should not count the pennies until the technologies mature. Nuclear will allow time for that to happen, and for the deployment of energy efficiency measures.

Finally, despite safety improvements, public perception of nuclear energy does not match reality. The technological facts are coloured by their defence pedigree, the cold war, memories of nuclear power stations as state-sponsored virility symbols, and so on. Unsurprisingly this has left the public ill-informed, confused, and suspicious. Currently the public is likely to jump to extreme, invalid emotionally charged judgements about civil nuclear power.

The fact that the nuclear industry is one of the most regulated of all should inspire confidence, rather than suspicion. We also need sociological tools to understand and unblock these perceptions[9].

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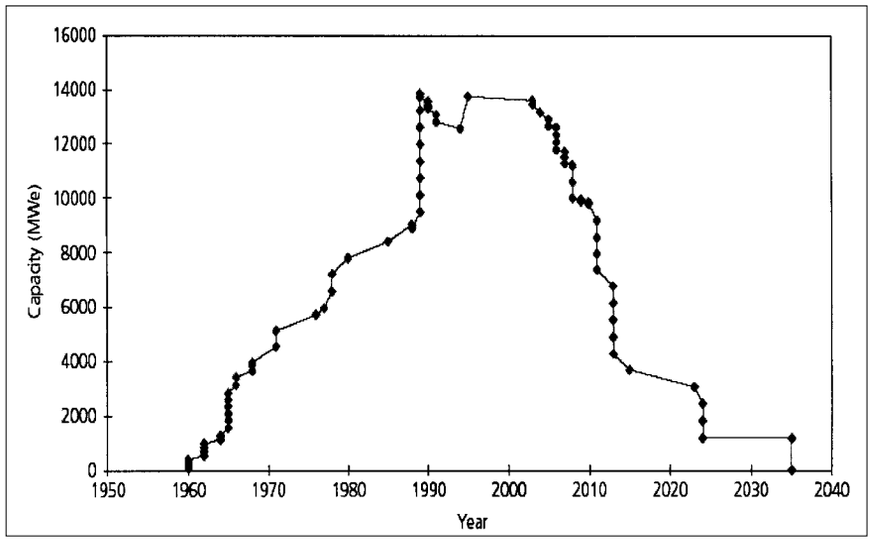

Figure 1. UK nuclear generating capacity - in the absence of new construction (Source: NAC and BNFL - Nuclear energy - the future climate 1999, Royal Society and Royal Academy of Engineering, fig. 12)

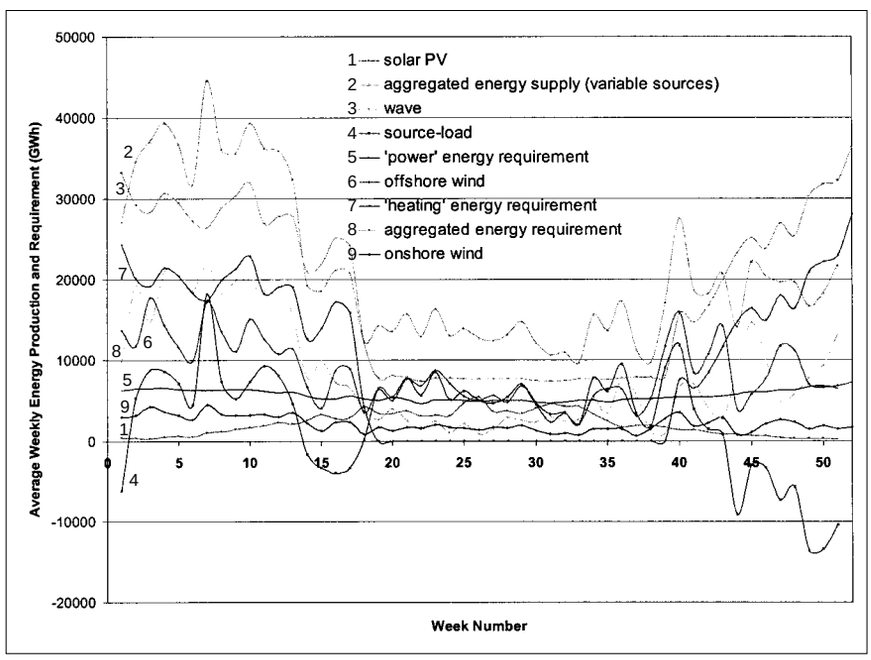

Figure 2. Average weekly energy production and requirement for UK Ca 2003 (From CREST University of Loughborough; Professor David Infield's presentation is at http://groups.iop.org/EG/03/08/030812a_e.html)

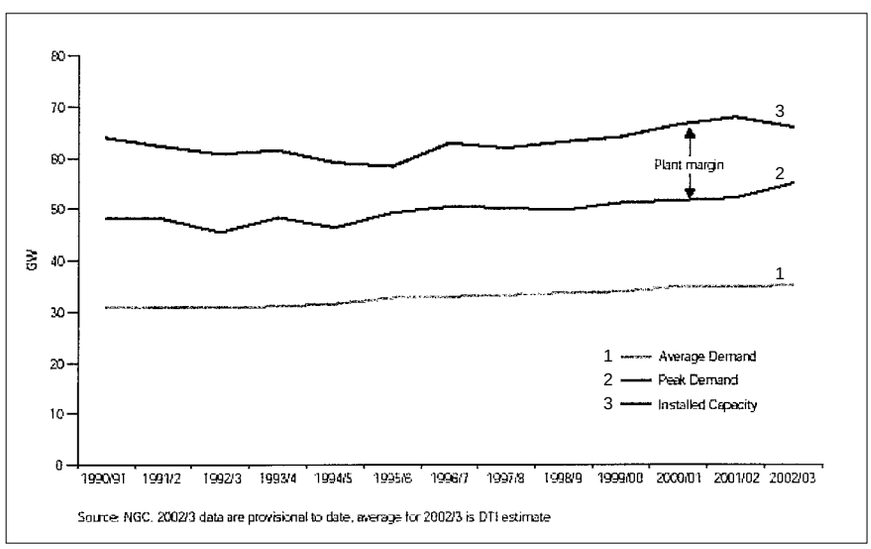

Figure 3 Installed Capacity and Electricity Demand, England and Wales (Energy White Paper, Our energy future - creating a low carbon economy, page 89 chart 6.1)