Energy Arithmetic: a contribution to the Energy Review

Enthusiasm for renewable energy has led to various optimistic predictions as to what percentage of UK, and for that matter, world energy supplies can be expected from renewables in the future. Shell, in 1996, produced a scenario which has been much quoted, in which renewable energy supplies 50% of world demand by 2060. Solar, wind and biomass together with a "surprise" element provide the lion's share of this market. The scenario has also been quoted by BP until recently, when more realistic predictions by The World Energy Council, IEA and the like, pointed to 20% renewable energy by around 2050 as a top figure. Over-optimistic suggestions of the role renewables might play can be dangerous. Politicians like to believe these optimistic scenarios but as a guide to action they could lead to the sort of supply problems that bedevil California or Brazil. To rely on renewable energy to replace UK nuclear energy, as stations are decommissioned and not replaced, as well as making up the short fall in indigenous gas and oil supplies, does not stand up to simple arithmetical analysis.

Take Scotland's 2 AGR nuclear stations , due to be decommissioned in 12 year's time, one possibly earlier. To replace them with wave power based on the successful Mk2 wave generator now operating on Islay would require 10,000 machines spread round the Scottish coast, not to mention a large number of expensive grid connections.

Or take wind power, both on and offshore; a central plank in the government plan to generate 10% of UK electricity from renewable sources by 2010. If all the wind farms currently operating throughout the world, 49,000 turbines, with a nameplate capacity of 18,000MW, were to be sited on the South Downs (planning consent permitting) they would supply about 10% of UK demand in 2010. One must divide the stated nameplate capacity by a factor of 3 to get the average power over a year, this accounts for when the wind is not blowing or blowing too hard; this means that the average world wind output power is 6000MW. In the UK it is 400MW which divided by 3 equals 133MW average power, that is less than 0.03%of UK electricity. If one offshore 2MW wind turbine, costing £2m, is installed off our coast every day from now to the year 2010, that is 3000 machines, they will provide an average power output of 2000MW, which is between 3 and 4 per cent of our electricity requirement.

Another major player in the Governments stategy is biomass. Wood burning power stations are the vogue, but , to put this into perspective, if the whole of Kent (about one million acres) were covered with willow to provide fuel wood, it wood provide just half the output of Dungeness B power station on the Kent coast

Once one starts to do some simple arithmetic the real potential of renewable energy becomes apparent. Statements by Greenpeace and the British Wind Energy Association suggesting that wind energy could provide three times UK electricity demand can then be seen as absurd. The recent paper by the

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executive director of Greenpeace and former ministerial adviser(Energy Savings Trust Briefing, July) in which he states that "nuclear power is not necessary, we can provide all the electricity we need from renewable sources" contains no numbers at all to justify his assertions. In addition to arithmetic one must also look at the rate at which, say, offshore wind generators can be built and installed. Jack-up rigs are required to drill offshore and to install turbines. Many more rigs will have to be built to meet the kind of offshore wind targets proposed. How many, and how much will they cost and how long do they take to build? An engineering appraisal as well as an economics-based scenario approach is crucial. This applies not only to wind energy but to all the other renewable technologies and also to the energy storage technology vital to an extensive renewables input. Where, for example, does the hydrogen come from for fuel cell systems and how expensive is it? If it is to be clean it will have to be generated from renewable or nuclear energy, if nuclear still exists, that is. These questions are crucial to providing a strategy for meeting the UK 20% carbon dioxide reduction by 2010. They are just as important when considering the energy mix for 2050.

Two neglected areas are, imported renewable electricity from Norway and Iceland, which, for some unaccountable reason, is proscribed in the latest consultation document; and the Severn Barrage which could supply 7% of UK electricity.

It appears that doing realistic calculations on deliverable renewable electricity, a figure of between 6 and 7 per cent of demand in 2010 is the best that can be achieved.

Nuclear Power

It is extremely difficult to develop an energy supply mix with a steadily decreasing carbon dioxide emission, without, at least, replacing the nuclear power stations currently operating in the UK. Closure of just the ageing Magnox stations, and replacing them with gas-fired stations will put another 15mt of CO_2 into the atmosphere by 2010, about what the climate change levy and associated instruments will save, so we will be running very fast to stand still. If all but one of the stations close by 2030, an extra 60mt of CO_2 will be emitted(twice as much if coal-fired plant replaces the nuclear stations). If the government decides to embark on a building programme to replace nuclear stations coming out of service, it will have to start the planning process immediately because of the long, ten year lead time, involved.

The industry has been developing a new generation of "inherently safe" designs, primarily light water reactors, building on very successful current technology. The Westinghouse AP600(already licensed in the US) and the larger AP1000 are ready to go. Westinghouse is owned by BNFL. There is the European Pressurised Water Reactor, built by Siemens /Framatome, the ABB Boiling Water Reactor and a number of new Japanese designs, some using mixed oxide fuel. These will be the next generation of nuclear reactors; hopefully the UK will be involved in building them, although we have almost lost that ability with the break-up of the manufacturing and design teams, after the completion of Sizewell B. Looking further ahead, the Pebble Bed Modular Reactor of Eskom/BNFL/Exelon and other high temperature reactors using helium cooling will become available.

In Russia there is enthusiasm for the fast reactor, which uses uranium 60 times more efficiently than current reactors. By 2050 uranium supply may be running into difficulty so a move to fast reactor technology could be the next logical step. Unlike fusion power, with its horrendous engineering problems, the fast reactor is up and running now. The Russian BS600 Fast Reactor has been operational for 18 years and the BS800 would be the next stage.

As always, public perception of the acceptability of nuclear power, and, for that matter, the real but limited role that renewable energy can play, must be appreciated. Although it must be said that the constant assertion that the general public will not accept new nuclear power seems at variance with the facts. A poll of readers of Time magazine last year, where the question was put "which energy source do you think is the most promising alternative to fossil fuel?" came up with 3% for wind, 12% for solar and 82% for nuclear! A universal carbon tax would make a profound difference and show real commitment to containing carbon dioxide emissions.

The Achilles heel of the nuclear industry is the problem of radioactive waste management, widely perceived as being unsolved. Although the engineering of both the reprocessing route and the dry store method is well understood the identification of dry geological structures, which can contain the waste, is still not in place. In the US continuing arguments over the Yucca Mountain site and in the UK the suggestion that there is no hurry and that waste can be stored above ground safely for 50 years, whilst a suitable site is found, are unacceptable. Finland leads the way with the approval of an underground rock facility at Olkiluoto and the near ordering of a new nuclear station.

Conclusion

The liberalisation of the energy market in the UK has delivered energy at lower and lower prices over the last decade. The new electricity trading arrangements (NETA) are expected to continue the process, although they perversely operate against renewable energy and CHP and will have to be altered. However the market does not "create competitive markets which will ensure secure, diverse and sustainable supplies of energy at competitive prices". Left to its own devices it delivers gas-fired power stations to the exclusion of coal, nuclear or renewables. The market also values the environment at zero and will pour into it whatever waste it can unless prevented by legislation , taxation or other fiscal instruments. Perhaps the most serious failure of the market is the disastrous effect it has had on R and D in the electricity sector where generic, long term research is just not done by the generation companies. This reflects the short term nature of market influence exacerbated by share holder pressure.

The market can be very powerful but must be constrained within a strategic framework which will deliver secure energy and protect the environment. Such a framework for the UK might be a prescribed electricity supply mix of 30% gas, 30% coal, 30% nuclear and 10% renewable.

It may be that the undoubted advantages of a market-led, liberalised energy market have now been reaped and we are moving to a post-market economy.

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