2E02 Energy Resources Report

Projections: Tidal Power in the UK

This report will cover the 2 different possibilities for the generation of electricity through tidal power: with a barrage, and with turbines.

Britain: Electricity Use & Targets

With a target to generate 10.4% of Britain's energy by 2010, and Britain being an island, one might initially assume that the source of available tidal energy looks promising – although the government figures differ strikingly. According to Energy Paper 62, written in 1994, the total tidal resource for the UK is 50TWh/yr, which would be 20% of electricity consumption in England and Wales. Another report identifies 30 possible sites for electricity production; Energy Paper 62 describes generation capacities (whether of barrages or turbines is unstated) between 30MW and 8GW. In 2001, the House of Commons Science and Technology Select Committee's 7th report claimed that the tidal energy at the 10 most promising sites is 36TWh/yr, which would be 35.4% of the UK's primary electricity demand in 1999 (the annual electricity consumption, according to the same report, was 329.9TWh).

There is currently no use of tidal energy in the UK. There are two small research projects, one of which is called the Seaflow project which is expected to cost £8m and may generate 4-5MW. Another project, with turbines, is under experimentation in Cornwall, but neither are generating electricity commercially.

Turbines

Turbines could work on roughly the same principle as wind turbines, and provided the masts were strong enough the two could even be built together. At first the idea was regarded with scepticism as it would only be a small percentage of each day that the tide would be flowing and move the turbines. However, the development of bi-directional turbines is now thought possible. The Executive Summary reports that if these were installed in Swansea Bay – a site more well known for its much-debated suitability for a tidal barrage – they could generate 60MW, at a cost of £79m; this divided by the installed MW capacity would come to £1.32m. This would be at a water depth of 1-5m in an area of 5km^2.

Turbines could also be installed at sea, though current thinking seems to imply that they would need to be built at a tidal stream location. Estuaries are precious ecological resources and many are at risk from current sea level rise, and judging by the fierce opposition to building a barrage in the Severn estuary this idea would probably not be popular with the public or environmental groups. At sea, no problems are mentioned in any of the government papers (most government papers do not mention turbines at all, which seems to suggest that they are not currently regarded as a potential generating resource in the near future), though many could be invisaged. For example, the depth of the sea would be greater – and variable – which would involve considerable costs in construction, transport, installation and then ensuring that it is safely installed. The rotating blades might be hazardous to wildlife, and both the blades and the masts to any ships or boats (or reckless or unfortunate swimmers!) should they come near the turbines. Maintenance would presumably involve a boat, which could be at risk from other turbines, and in some cases divers or a lot of heavy equipment.

It is worth noting, however, that the technology for this type of energy is still in its infancy – and may be a parallel with wind turbines 20-30 years ago. By this argument, it would theoretically be possible for 200MW (the current figure, according to 2E02 lecture notes) of tidal energy to be available within the next perhaps 20 years. Research for the two types of turbine could be shared. Indeed, some research has happened – it is claimed that the DTI/DE programme funding before March 1993 reached £12.1m and 150 projects, though none of these led to a commission for development. It is also claimed that Patricia Hewitt has caused £348m to be allocated to research and development over 4 years.

Barrages

The better-known version of tidal power as an electricity resource would be a tidal barrage. The oldest design of this would open the gates as the tidal power enters the estuary, close them at high tide, and release the water at the lowest tide, when the height difference and therefore head is at its greatest (11m, for the Severn Barrage) and the most electricity could be generated – this would also use turbines, and one estimate for the load factor is 23%. This would effectively flood the entire estuary, destroying a local ecosystem, and – according to a *New Scientist* article on Thursday, 24 February 05 – be a major generator of greenhouse gas, in this case methane, from decaying plants at the bottom of the basin. The effect on the local area might be adverse or beneficial. For the Severn barrage, redirecting or treating sewage effluent might cost an additional £120-230m (with a further annual running cost of £12-24m) and additional sea defence roughly £10m. Land drainage could be as much as £14-19m.

More recent thinking has envisaged a “two-basin” scheme which has been claimed to eliminate the problem of the flooded basin, and also improve the load factor. Even so, the Severn barrage was estimated to cost £800m in 1981 (Energy Paper 46), with 7% overheads cost. Projected electricity prices ranged from 7p/kWh to 14p/kWh. Energy paper 62 predicts a “limited scope for cost reduction” and is pessimistic about improving the technology. Other reports, such as Energy Paper 46 and the House of Commons Science and Technology Select Committee of 2001 disagree. The maintenance cost would be low, 0.5% of the initial capital cost; the engineering cost 0.75-1% (Energy Paper 46).

In any case, it would be a long-term investment, with little appeal to market forces and “no significant economies of scale”. No output would be generated until the construction was complete, which could take some years. More than one Energy Paper has stated that no action is intended until at least the year 2025. Further action depends heavily upon our future actions with nuclear fuel – or so it was stated in 1981; at this time, nuclear fuel was much cheaper than coal or oil. However, the barrage could be expected to last ~120 years, three times longer than most power stations.

Advantages and Disadvantages of Tidal Energy

Tidal power has an advantage over wind in that tides are completely predictable, including spring and neap tides, and can be predicted years ahead. Within the system of NETA, which places predictability of supply at a very high level of importance, tidal power would have a distinct advantage impossible to most renewable resources: the company could sell an exactly agreed quantity of electricity and would be unlikely to be fined for fluctuations. Tides, however, do not conveniently follow the patterns of peak electricity demand. They operate every 12.5h. There would be times when the electricity would be generated when it is not needed; at peak times, it might be difficult to ensure that electricity is sold and supplied in competition with a coal-fired power station that has been relied upon for several days at the previous peak demand times whilst the tidal barrage was not active.

Projections: 2005-2030

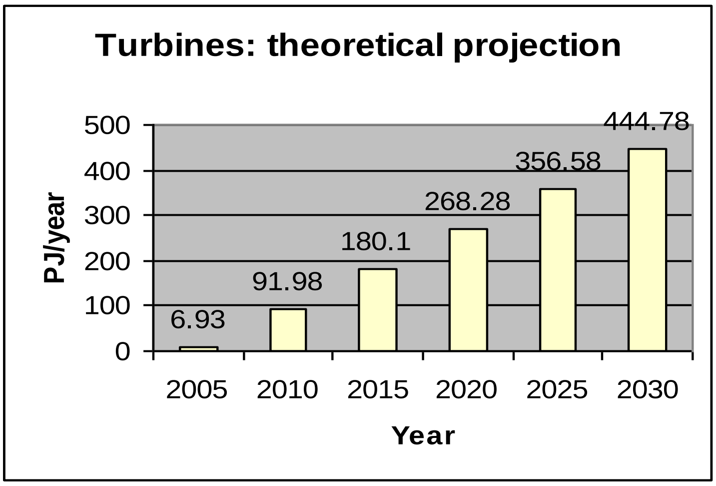
It does not appear that there is much enthusiasm for the generation of tidal power. However, success in other countries might influence Britain's thinking. One well-known tidal barrage is La Rance, in France. Its capacity is 10MW – the Severn Barrage's is expected to be 17. Its turbines are two-way, so electricity is generated both at high and low tide. It is also very popular with tourists and provides an excellent site for water sports, and necessitated the construction of a new road which is now used by nearly 26,000 motorists every day. It could be said that this project was highly successful and should have set an example to British thinking; a less optimistic view is that if this was so it would have done so by now: the barrage was constructed in 1960. (Source: http://www.edf.fr/html/en/decouvertes/voyage/usine/retour-usine.html.) Probably it is not thought economically beneficial to invest in such a scheme for a mere 10MW even if the secondary benefits were as great as they have been in La Rance.

Therefore, the most likely projection for electricity by tidal power in Britain is none – at least until 2025. Assuming construction started then, in the case of a barrage, electricity production would still be 0PJ. If the Severn Barrage was constructed and working by 2030, and generating 17TWh/year, this would be 61.2PJ, or <4% of estimated electricity demand (assuming an annual 1.7% rise in demand). If the "10 most promising sites" identified in 2001 were all put to full use, and generated 36TWh/year, this would be 129.6PJ.

Since turbines are scarcely even mentioned in any government papers, let alone any generation predicted, unless policies are radically changed or research and development is highly successful, the most likely scenario for these seems also 0PJ at any time. However, a theoretical optimistic projection has been calculated. It was suggested that 20 1MW turbines/day could be installed, each one over a period of 3-4 weeks (Keith Tovey, February 2005). Rather than assume 20 turbines a day could be installed, this calculation assumes they are done in “projects”: 20 turbines installed every 3 weeks, each “project” starting as soon as the previous one was completed.

The following table shows these theoretical projections, starting on March 1st, 2005:

Year	MW	PJ/year
2005	220	6.93
2010	2920	91.98
2015	5720	180.1
2020	8520	268.28
2025	11320	356.58
2030	14120	444.78



So theoretically, this could generate up to ~3% of UK electricity demand by 2030 (again, assuming a 1.7% annual rise in demand).

Added together, this comes to 574.38PJ. This would still be a very small percentage of UK electricity demand. It would not look insignificant among 10.4% electricity being generated by renewable fuels, but even so this scenario is highly unlikely for two reasons. Firstly, by 2030 Britain is theoretically supposed to be well on its way to producing 60% renewable energy, in which case it would equate to a small percentage; secondly, and far more importantly, it is highly unlikely that such investments would be made. According to one figure, each turbine might cost £2000 each. Even without maintenance costs included, this would come to £28,240,000 (£28m) – and this seems optimistic in contrast to the projection of 60MW at £79m, 14,120MW at an equivalent cost would come to £10,724m!

Although the initial pessimistic projection of zero electricity production from turbines or barrages even up to 2030 presently looks the most accurate, we cannot altogether rule out the future development of these technologies; when compared to the wind scenario, for example, the prospect of some electricity generated this way looks possible. Even so, the total production of wind energy is still very small, and opposition to barrages and turbines might turn out to be as bitter and intense as the opposition of some interested parties to wind turbines. It seems most realistic to believe the government papers when they forecast no action until 2025 at the earliest.