THE SEVERN BARRAGE DIGEST

POST SHORT LIST CONCLUSIONS.

In line with the UK's commitment to reduce carbon emissions from electricity production, the Government have recently (Jan 2009) made two announcements that underpin the seriousness of their intentions. The first was the deadline for the nuclear industry to nominate sites for the next generation of power stations by the end of March.

"Nuclear power can improve energy security and help the drive to low carbon energy supplies. Alongside renewables and cleaner fossil fuels, it will help us meet our climate change goals as well as ensuring the future supply of energy for the UK."

The second was the publication of the shortlist of schemes under consideration to produce power from the massive tidal range of the Severn estuary.

"The huge renewable resource of the Severn estuary tides is a means of generating nearly 5% of UK electricity. It can contribute to meeting the UK's renewable energy targets and the progressive decarbonisation of our electricity supply. Tidal power development in the Severn estuary has benefits, costs and risks."

Of all the schemes still under consideration for generating power from the Severn estuary's tidal range, the barrage on the Cardiff to Weston line remains front runner as it goes furthest towards producing the renewables capacity that the Government needs to achieve. Choosing any of the other options on the shortlist would mean a greater reliance on other projects elsewhere in order to meet Britain's 2020 emissions targets. Yet there is a rising tide of evidence concerning its viability in terms of cost, funding, uncertainty and risk, as well as environmental questions that seem to rule the project out of any strategy for the future delivery of UK power supply.

Although frequently touted as capable of providing 5% of UK electricity supply it would be extremely costly to build. For comparison, the first European Pressurised Reactor now under construction in Finland is currently running three years behind building schedule and 50% over budget yet it will still only cost £4billion to build and generate annual electricity outputs of 13 Terrawatt hours. Best predicted outcomes for the barrage are a ten year build costing £21 billion, for the eventual production of 17 Terrawatt hours per annum. If these figures are accurate how could the Government expect to attract the private investment from the electricity companies needed for this poor cost effective project? It is the only short-listed project which would, according to the PricewaterhouseCoopers study paper, Financing and Ownership, need the risks inherent in the project underwritten by Government.

"*It is difficult to envision a party other than government who would take the risk associated with the integration of the various construction packages required for a scheme of this scale.*"

The other projects, Shoots barrage, Beachly barrage and the two land based lagoon schemes may compete with nuclear on price, costing £3-4 billion, but their outputs are feeble in comparison with annual outputs of between 2.31tw/hrs and 2.77tw/hrs.

Independent research reveals that unless there was a trebling of electricity prices the Government would be required to subsidise the big barrage project for 70% of its total cost, now put at just under £21billion. A comparative analysis of generation costs between the proposed barrage and other large- scale generation technologies commissioned by the Bristol Port Company in March 2008 revealed that Severn Barrage power would be three times more expensive than nuclear energy. Electricity produced by a Severn Barrage would cost in the region of 11 pence per kilowatt hour as opposed to 3.7 pence for nuclear. Wind, coal and gas costs are 6.8, 5.1 and 5.0 pence respectively. It is not only more expensive but it is also far less efficient, the difference in output between the barrage and competing technologies ranges between factors of 1.6 and 2.9.

Power generation from the barrage would be predictable but also hugely variable, ranging from a spring tide high of 40 Giga watt hours per day, down to a low Neap tide output of 15 Gwh/day. Being governed by the tidal cycle makes electricity production that is actually synchronous with need impossible, and during the winter the barrage would make an almost zero contribution to peak demand during spring tides. It is during the neap tides, which are far less productive, that coincidence with demand is met.

The intermittent output of the barrage would have a significant effect (increased wear and tear, extra maintenance costs.) on the more conventional plant powering the National Grid because of the process of load following that would have to take place to smooth out the peaks and troughs of barrage generated supply. The project costs identified by the Sustainable Development Commission are based on capital and operational costs but do not include ancillaries like transmission network upgrading or the increased maintenance associated with balancing the system.

The actual power generating units on the barrage will be massive turbines producing around 40mega watts each and their predictable performance is absolutely integral to assessing the plant's load factor. It has been inferred that barrage technology is proven and that turbine reliability will be comparable to La Rance barrage in France which has been generating since 1966 with very little downtime. But the comparisons bear little scrutiny. Unlike the river powering the French barrage, the Severn estuary is absolutely laden with silt, a great proportion of which is highly erosive sand.

Engineering a machine with a long Mean Time Between Failures for such a hostile environment will be very difficult. Evidence of the sort of problems that might be expected is illustrated by the dramatic failure of Bristol Port's Impounding Pumps that are operating in approximately the same conditions as the barrage turbines will be.

These pumps were commissioned with a design period between maintenance of three years, yet within six to nine months all pumps had developed faults, due primarily, to the ingress of sand into the bearings. Operational performance is several orders of magnitude below the agreed design criteria and it is still not clear, after three years of remedial re-design, what improvements can be gained. Turbine failure on anything like this scale would dramatically reduce the output of a barrage.

If a barrage were to be built the implications for shipping into Bristol would be dire. Transit times through locks would increase the cost of freight per ton/kilometre to the point where it would no longer be economically viable for shippers to use the port.

Estimated time taken to transit the barrage could be as much as two hours in each direction and cost an additional £7,000 in ship time alone. (Large ship charter rates = £50,000 per day.) Add to this the other services required in the form of tugs, pilots and pilot boats, skilled staff and Vessel Traffic Services and the additional cost to each ship would be in the region of £20,000.

Bristol is the largest bulk cargo port in the south of England. Importers rely on it being able to accept large, deep draught ships carrying strategically important cargo at economic rates delivered close to major population centres. If trade were to shift to another port there would result a massive increase in the number of road and rail freight miles travelled to deliver imported goods to where they might be wanted.

These poor predicted outcomes assume that the highly expensive addition of a super size ship lock is included in plans for a barrage. Such a lock would need to accommodate not just the size of freighter currently trading in the Bristol Channel but the anticipated new generation of ships for which Bristol Ports are gearing up to receive. However, when Bristol Port asked the Govt. for assurances in this regard they were told no such assurance could be given. This implies the Govt. is considering constructing a barrage without the necessary navigational infrastructure to support current trade flow or to conduct future efficient maritime trade in the South West. This is entirely inconsistent with its policy of requiring active long term planning by all transport undertakers and falls well short of the standard of *Wednesbury* reasonableness required by law. This test can be applied to a decision which is so outrageous in its defiance of logic or of accepted moral standards that no sensible person who had applied his mind to the question could have reached such a conclusion.

Some of the freight handled at Bristol in nationally significant volumes includes:

1) Coal - Bristol is the second largest import facility in the UK for power coal.

2) Aviation Fuel - The port handles 27% of all imported aviation spirit.

3) Animal Feed - The port contains 30% of total UK animal feed capacity.

4) Cars - In terms of deep sea volumes handled, Bristol is the leading UK port.

Besides the £500 million container terminal there are plans for two nearby biomass power stations that would import fuel in bulk containers. All depend on Bristol Port having a big ship capability and are threatened by the barrage proposals.

THE SEVERN BARRAGE DIGEST

THE FIVE SHORTLISTED SCHEMES.

SHOOTS BARRAGE A 1.05GW scheme located just downstream of the Second Severn Crossing. It has an estimated construction cost of £3.2 billion.

BEACHLEY BARRAGE a 625MW scheme with a price estimate of £2.3 billion. Located above both the Wye and Usk estuaries.

BRIDGEWATER BAY LAGOON would produce 1.36GW by a large shore based impoundment on the English side of the estuary.

FLEMING LAGOON similar output to the Bridgewater lagoon but located on the Welsh bank and further upstream. Cost of construction £4.00 billion.

CARDIFF TO WESTON BARRAGE a massive 8.65 GW scheme with an estimated current price tag of £21billion.

In the ministerial statement on the Severn Tidal Power Feasibility Study published at the end of Jan 2009 the Secretary for State for Energy and Climate Change noted that besides the five schemes listed above

"the Government is keen to continue to consider other innovative schemes…….We hope to see these develop further with the benefit of Government financial support."

This refers to options put forward in the feasibility study call for evidence that are not yet sufficiently developed to be evaluated properly. The statement continues;

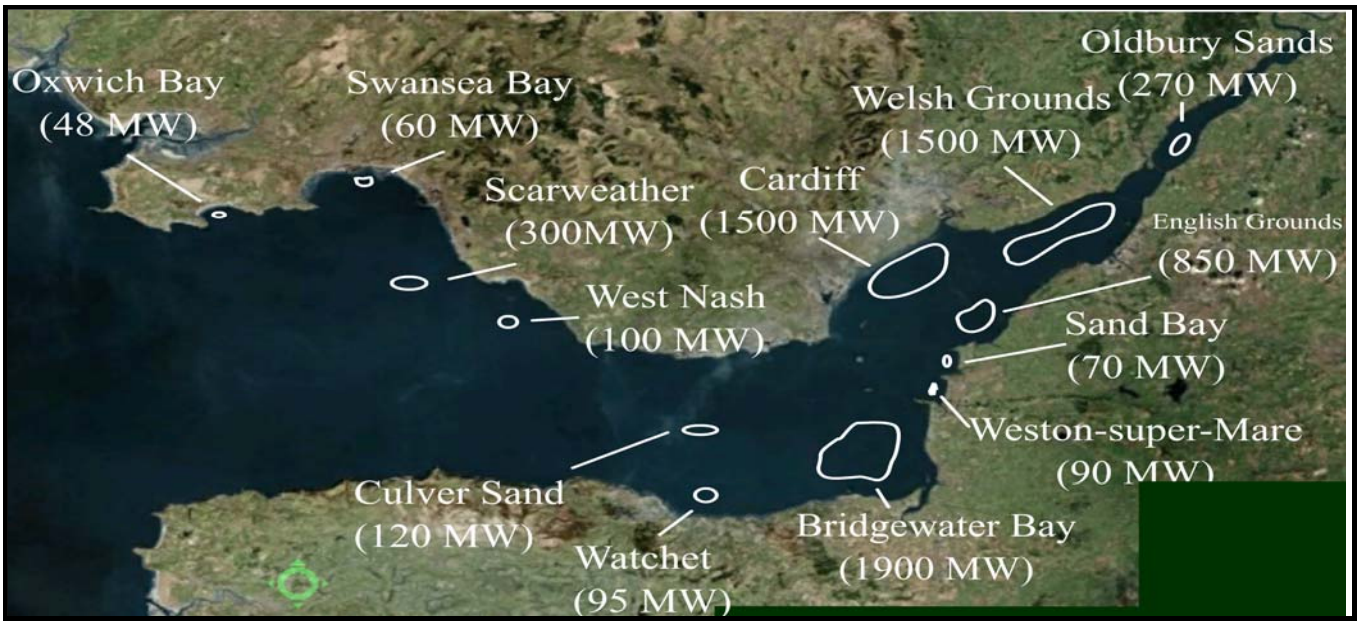
"the Government will consider their progress alongside short-listed schemes before taking decisions on Severn Tidal Power Generation."

Although not specified, he is referring to a further two proposals:

A SERIES OF OFF SHORE CIRCULAR IMPOUNDMENTS (Lagoons) could be built in a ribbon development in different bays along the coast from Oxwich Bay on the Gower Peninsula to the road crossings. They are **not** the same as the generic lagoon layouts on the short list.(See next page.)

THE TIDAL REEF is an innovative and adaptable engineering proposal designed by Evans Engineering and located along a line between Aberthaw in Wales and Minehead in the West Country.

PROPOSED LOCATIONS FOR TIDAL ELECTRIC OFFSHORE IMPOUNDMENTS



TIDAL ELECTRIC LAGOONS

The off shore impoundment technology being pioneered by Tidal Electric could theoretically eclipse the output of the big barrage and produce a massive 10% of UK electricity demand. Its own calculations have been independently verified by consultants WS Atkins and the difference in capacity explained by the lagoon's ebb and flow modes of operation, using the full tidal range. This is distinct from the barrage's ebb only generating capacity. Remarkably this output could be generated by impounding far less water that the 185 square miles of the barrage. The Tidal Electric scheme requires a mere 50 square miles and avoids penning up water in less productive yet eco- sensitive inter- tidal areas and would not be an impediment to migratory fish or to navigation.

Another advantage of developing a string of these tidal lagoons is that they can be constructed sequentially. Impacts could be assessed and understood before moving on to build more or larger lagoons. With the Cardiff- Weston barrage it is all or nothing and any shortcomings (such as mechanical failure of turbines due to erosion) in the scheme will only be discovered after commissioning.

Lagoon power would also be easier to integrate into the National Grid. A series of lagoons could smooth their overall output and shape it accurately to demand, unlike the output of the barrage which is effectively tied to the tidal regime.
It is quite possible that with a little more political support a privately funded prototype lagoon could have already been built in Swansea Bay. Tidal Electric claim successive govt. departments, starting with the DTI, have been hostile to these proposals referring to lagoons as dead end technology and discouraging the company from applying for expensive consents.

In October 2006 the House of Commons Welsh Affairs Committee attempted to address the DTI's hostility in their report Energy in Wales.

"*Regardless of the merits and economic viability of the scheme we have concerns about the DTI's handling of it and the damaging effect this has had on investor* *confidence and potential commercial development. We are pleased that the DTI has now withdrawn its technical objections to the scheme, but errors made by their officials have undermined and delayed a highly promising project. We recommend that the DTI takes urgent steps to address the damage it has caused, and to set out clearly its strategy for rebuilding investor confidence."*

Since then the Department for Trade and Industry has mutated first into the Department for Business, Enterprise and Regulatory Reform and lately the Department for Energy and Climate Change. It remains to be seen whether the latest promise of support for "*innovative schemes……..not sufficiently developed at this point for more detailed evaluation."* announced in Ed Milliband's Ministerial Statement will allow this serious contender for power extraction from the Severn to compete with the big barrage plans.

TIDAL REEF

"The main objective of the tidal reef project is for it to be environmentally benign but still generate very significant quantities of renewable energy for the UK. From the outset the needs of wading birds, sea mammals and migratory fish have been taken into account. In addition, the need for unhindered navigation, flood alleviation and low visual impact have been considered paramount. Evans Engineering argues that the *Big Barrage* approach starts with the large engineering components such as the water turbines and then considers the environmental impacts in the form of mitigation measures afterwards."

The reef is a far more adaptive piece of engineering than the Barrage. The scheme has the potential to generate more electricity than a barrage while keeping environmental and financial costs to a minimum. A recent report from independent engineering consultants Atkins, commissioned by the RSPB, concluded that the reef structure could produce 20TWhrs per year against the barrage's 17TWhrs and would be economically competitive.

The starting point for the reef's design is to obtain a consensus of informed opinion on how to satisfy the environmental criteria around which all engineering will be designed. These criteria include minimising damage to fish passing through the structure and preservation of the valuable inter tidal habitat. It also includes minimising disruption to shipping. The alignment from Minehead to Aberthaw has been chosen to maximise power generation, ease navigation and provide maximum flood protection to the low-lying areas of Somerset. Visual impact is also considered. Whereas the Cardiff Weston barrage would have to be constructed with enough concrete to hold back forty foot of water plus adequate freeboard to protect its roadway and superstructure, the reef impounds a mere six foot and would require far less concrete as a result. Most of the structure is underwater.

The reef consists of one continuous line of relatively small 5MW turbines as opposed to the smaller number of large 40MW turbines in the proposed barrage. The advantage of this is that it will not radically alter the water flow patterns in the estuary with the attendant risk of silting, scouring and erosion. They can also be easily removed for servicing and replaced with ready to go units, thus cutting time spent off line.

Another important benefit is that migratory fish will be able to pass safely through the reef because of the turbine design. These will be slower running, low specific speed turbines, of fixed geometry and with a low number of blades. In order for fish to move through turbines without injury it is necessary to have wide clearances, smooth surfaces and a lack of pinch points. The low differential of a mere two metres means their swim bladders would not be ruptured as would be the case with barrage turbine technology. All of the schemes on the Government shortlist have been identified as substantial barriers or impediments to the free movement of migratory fish species and thus are a threat to their future well being and even survival.

Loss of precious inter-tidal habitat due to altered tidal range is also largely avoided because the working head (height of the water held back) is so much smaller. Almost all environmental and navigational concerns associated with a barrage are as a direct result of the high differential head resulting from the long “dwell” at high water. The absolute priority of the reef designers is to reduce this “dwell” to around two hours, just sufficient time to produce the two metre head.

The advantages of a reef over a barrage system seem apparent from every aspect. Old fashioned barrage technology creates more problems than it solves, it impedes navigation to the detriment of maritime trade in the area, it effectively stops the transit route of seven migratory fish species and permanently submerges huge tracts of valuable wetland habitat. In exchange it offers expensive yet inadequate compensation. The reef system offers a flexible, holistic approach to 21st century problems. It would be adaptable, cheaper, more productive and less damaging and could be producing clean renewable electricity in harmony with the environment within a few years of inception.