Severn Barrage inquiry - comments from National Oceanography Centre.
Prepared by Steve Hall sph@noc.ac.uk with input from colleagues at NOC Liverpool, 14th November 2012.

1. What contribution could the Cardiff-Weston Barrage make UK energy security and climate change objectives?

Previous investigations (most recently in 2009) suggested that the middle barrage proposal between Lavernock Point near Cardiff and Brean Down near Weston-Super-Mare would produce over 8 Gigawatts of highly predictable clean power, approximately 6% of UK demand. This is considerably less than the 15 Gigawatts possible with a barrage further to the west, but is regarded as a good compromise between cost of construction versus power generated. Other proposals within the estuary using smaller-scale barrage or lagoon and sluice systems produced much less power, a maximum of 1.36 GW.

A barrage would reduce the UK's demand on imported fossil fuels, contributing to energy security, and helping reduce the UK's greenhouse gas emissions. The lifetime of the barrage would be at least 120 years versus 40 years to 50 years for a nuclear power station, and future upgrades and maintenance could prolong the life of the structure by a considerable margin.

As well as the raw power figures, the barrage would be a highly visible statement of the UK and Welsh Government's intention to move towards a sustainable future.

2. What risks and opportunities could it pose with regard to flooding in the Severn Estuary, and how might any risks be mitigated?

Previous studies suggest that a Cardiff-Weston barrage would make a significant contribution to reduction of flood risk upstream, and that in the future the contribution will be even more important as sea level rise and climate change may both contribute to higher incidence of extreme events such as storm surges.

3. What risks and opportunities could it pose to wildlife and habitat in the Severn Estuary, and how might any risks be mitigated?

The Severn Estuary covers a very large area (approx. 7% of UK estuary space) and is an internationally important site for migratory birds and fish, wading birds and invertebrates. It is a Special Protection Area under the EU Birds Directive, a Ramsar site, a Special Area of Conservation under the Habitats Directive and a Site of Special Scientific Interest. The RSPB estimate that some 85,000 birds rely upon the unique conditions in the estuary.

After construction the conditions upstream of the barrage are bound to change. With reduced vertical mixing and less re-suspension of sediment, water clarity

will increase, allowing more sunlight to penetrate. There will be a gradual reduction in salinity, and possibly a build-up of contaminants from pollutant sources upstream – in the case of the Severn Estuary the mixture of nutrients and enhanced light penetration would increase the risk of eutrophication. There is also a nuclear power station upstream of the barrage site, which is cooled by water from the Severn.

Construction of a barrage would disrupt wildlife to some extent (mainly around the construction site, a limited area) but once complete, the reduced tidal range and greatly enhanced clarity of the water upstream would cause changes in biodiversity, favouring some species over others and leading in time to a markedly different ecosystem. With dual-mode (ebb and flow) generation, loss of mudflat habitat can be substantially reduced and a larger upstream tidal range retained after construction. This is achieved by increasing the tidal range within the basin relative to ebb mode by using the turbines as pumps to increase the head difference prior to power generation, but would increase the cost of electricity generated.

Some argue that the post-barrage situation would actually be an improvement, with enhanced water quality, higher fish population, more food for birds, shellfish aquaculture potential and a less hostile living space suitable for a wider selection of species than is possible at present, but further studies are required to confirm this.

Work by Woolf *et al* (see references) has shown that building a barrage in the Severn has implications further afield, with shifts in the amphidromic points in the Celtic Sea and reductions in tidal amplitude of the Bristol Channel that may help reduce storm surge flooding risks downstream of the barrage. Reduced bottom stress and associated velocities may permit greater bio-diversity on the seabed of the Bristol Channel.

It should be noted that climate change, sea level rise and ocean acidification will all impact the Severn Estuary over the next few centuries regardless of whether or not a barrage is constructed – the *status quo* will not continue indefinitely.

4. What lessons can be learned from the successful development of La Rance tidal barrage in France and other tidal power projects?

Existing projects have shown that tidal power is safe, reliable and predictable. The Rance power station has operated since 1966 and was only surpassed in terms of generating capacity in 2011 (by the Korean Sihwa Lake tidal power station). The French have invested mainly in nuclear power generation since then, but in recent years interest in tidal renewable energy has emerged in South Korea, Russia, the Philippines, Canada, China and India. Governments are attracted by the highly predictable nature of tidal energy (availability of peak power is known years in advance) and by the associated benefits of the barrage

such as flood protection, provision of a bridge, job creation, calm upstream conditions that can enhance leisure or conditions for aquaculture and farming. Electricity production is not necessarily the prime reason for building a barrage – these other factors may be more important depending upon the location, but the electricity is a valuable added benefit.

5. What risks and opportunities could it pose to local employment and community, and how might any risks be mitigated? In particular, what are the consequences for current ports, fishing and aggregate extraction industries in the estuary?

5.1 Depending upon the scheme chosen, it is reasonable to assume that the construction phase of the barrage would provide employment to a significant number of workers in South Wales and the South West of England, providing a substantial boost to the regional economy.

5.2 Raw materials can be sourced from quarries in the region, cement from the Aberthaw works near Cardiff, reducing transportation costs and carbon footprint of construction phase.

5.3 After construction direct employment by the barrage operators would not be high, with relatively small teams employed for maintenance, lock operations and other support roles. However, the barrage offers substantial opportunities for wealth creation in the following areas:

5.4 Tourism – public access/cycleway/footpath across the estuary would afford spectacular vistas across the Bristol Channel and a unique visitor experience, with opportunities for retail, catering and associated sectors, such as boat trips. Other possibilities could be an electric road-train or tram. Such a link could also be of value to commuters between Bristol and Cardiff if suitable public transport connections were available at the ends of the barrage.

5.5 Additional power generation – as well as the barrage's submerged turbines, wind turbines and solar panels can be installed on the topside of the structure.

5.6 Transportation links – the existing Severn Rail Tunnel was completed in 1886 and acts as a constraint on upgrading the rail network into Wales, particularly for freight operations where the tunnel is unable to accept double-stacked container traffic. Provision of a railway line from the start, or ensuring that the design includes foundations for a future upgrade may provide a possible replacement or back-up to the present tunnel – though a purpose-built bridge near the current Second Severn Crossing could be less expensive than adding a track to the barrage and be more closely aligned with the existing London-Swansea rail route. A road across the barrage would shorten the journey between Cardiff and the M5 but would require a more expensive barrage topside structure.

5.7 Impacts on existing ports – Cardiff, Newport and Avonmouth would be the main ports affected with some disruption to smaller operations in the Wye and Severn, including Gloucester and Chepstow and the inland canal network. Locks in the barrage would be required to maintain access to these ports. However, these are not intensively used harbours with frequent 24-hour ro-ro type activities. Sailings are already heavily constrained by the high tidal range of the estuary and locks are required at all of the major ports. The less extreme tidal range upstream of any barrage could actually improve harbour access, though queuing might be required at the locks in the barrage to coincide with correct tidal conditions downstream. Recreational sailors might find sharing a lock with a multi-thousand tonne car transporter rather daunting, but combined operations are possible and for small boat users, the conditions upstream of the barrage will be easier than at present.

Any constraints on shipping operations upstream of the barrage could be of benefit to ports at Port Talbot, Neath, Swansea, Milford Haven, and the North Devon coast, which all have excess capacity at present.

5.8 Commercial fishing activities within the estuary are at a relatively low level and any disadvantages are likely to be outweighed by the improved water quality, reduced turbidity and higher productivity (increased sunlight penetration – more plankton, more food for fish) of water upstream of the barrage. Fisheries could be managed within the upstream area to provide a strong recreational or small scale commercial fishery.

5.9 There is a reasonable concern about access for migratory fish such as salmon through the barrage. Multiple fish by-pass systems will have to be included in the structure, but it is hard to assess exact impact on wild migratory stock.

5.10 A barrage would provide a very substantial level of flood protection from storm surges for the areas upstream. In view of future climate change, sea level rise and increased risk of extreme storm surge events, this could be a benefit as important as the production of clean electricity.

6. Would the project require support under the proposed new Contracts for Difference mechanism? If so, approximately what level of strike price would be required to make the project economically viable?

No comment

7. How does the company plan to engage and consult the community in the development of the project?

No comment.

8. Are the proposals in breach of EU legislation, and if so how will this be addressed?

It's possible that the construction of a barrage could result in changes to the environment that would be in breach of EU legislation if no mitigating actions are taken. The area is designated as a Special Protection Area under the EU Birds Directive, is a Ramsar site, a Special Area of Conservation under the Habitats Directive and a Site of Special Scientific Interest. Developing a barrage is certain to contravene some aspects of these designations, due to reduction in total area of intertidal habitat and likely changes in water clarity and suspended sediment dynamics, plus disturbance during construction – all of which may affect the local biodiversity to some extent, though it has also been argued that the upstream environment could actually support wildlife in greater numbers and diversity due to removal of the high suspended sediment load from the water column.

At the very least, construction will legally require creation of compensatory habitat. In view of the large surface area of reduced intertidal zone (there would still be daily variation of sea level upstream of the barrage) the amount of compensatory habitat required is large, and thus difficult to source. Large amounts of low-lying land have been reclaimed on the south shore of the estuary in the last few hundred years and could provide suitable habitat, though cost of compensation to land owners (mainly this is farmland) would be high. On the northern shore the coastline is dominated by cliffs along the Glamorgan Heritage Coast as far west as the Ogwr river, with no suitable low-lying areas. There is some potential west of the Ogwr for compensatory habitat (Merthyr Mawr - Kenfig Burrows area), however, heading west the tidal range declines, reducing the quantity of available inter-tidal habitat.

9. Are any other proposals for tidal power projects in the Severn estuary currently under consideration?

In the last round of proposals in 2009 the government settled on a shortlist of 5 options :

Middle Barrage, Brean Down to Lavernock Point, peak output 8.6 GW
English Stones Barrage, peak output 1.05 GW.
Beachley Barrage, peak output 625 megawatts (MW).
Fleming Lagoon, peak output of 1.36 GW.
Bridgewater Bay Lagoon, peak output 1.36 GW.

There were an additional five schemes which were not shortlisted in part due to immature technology being proposed such as 'tidal fences' and tidal stream current devices, however, since then major companies including Rolls Royce and Alstrom have demonstrated commercial grade systems that can be scaled up to produce power without the need for a barrage structure, but with considerably lower peak electricity production potential. Typically the new generation turbines

are rated at 1.0 to 1.2 MW (examples Alstrom and MCT) so to match the 8.6GW potential of the largest barrage proposal would require an unrealistic number of generators (over 7000) to be placed in the Bristol Channel, with complex cabling and servicing requirements compared with the 'all in one row' approach of a barrage.

10. What could be the wider international implications of the scheme for UK engineering and UK low-carbon industry?

Successful development and construction of a barrage would provide UK industry with a head-start upon rivals with construction of large scale barrage projects, with good prospects for export of intellectual property and turbine systems – but we need to move quickly if that potential is to be grasped.

South Korea has already developed a tidal power scheme at Jindo Uldolmok, (90MW by end of 2013), plus a 254 MW station at Sihwa Lake, and has started construction of the 1.3 GW Incheon Tidal Power Station at Incheon Bay, due for completion in 2017, giving their engineers a strong lead over the UK.
The Russians have proposed an 87 GW site at Penzhin Bay in the Sea of Okhotsk, however there is a lack of demand from customers in that part of Russia so it has been suggested that the energy be used for the production of energy-intensive products such as liquid hydrogen rather than grid electricity and as yet no construction has started. The Canadians have long examined the possibility of building tidal energy schemes in the Bay of Fundy but so far only one 20 MW installation has been completed, in part because fossil fuel costs are low, especially with the glut of shale gas availability in North America – a plentiful resource not yet exploited in the UK. In the Indian state of Gujarat construction has started on a 50 MW project, and the Japanese are actively investigating using tidal energy to replace capacity lost since the Fukushima nuclear disaster.

References:

Wolf, J; Walkington, I.A; Holt, J; Burrows, R; "Environmental Impacts of Tidal Power Schemes" Proceedings of the Institution of Civil Engineers **Marine Engineering 162** December 2009 Pages 155-164

Burrows, R; Walkington, I.A; Yates, N.C; Hedges, T.S; Li, M; Zhou, J.G; Chen, Y; Wolf, J' Holt, J; Proctor, R; "Tidal Energy Potential in UK Waters" Proceedings of the Institution of Civil Engineers **Marine Engineering 162** December 2009 Pages 165-177

Burrows, R; Walkington I.A; Yates, N.C; Hedges, T.S; Wolf, J; Holt, J; "The tidal range energy potential of the West Coast of the United Kingdom" **Applied Ocean Research 31** (2009) 229-238

Wikipedia article at: http://en.wikipedia.org/wiki/Severn_Barrage