

# **THE SEVERN BARRAGE DIGEST**

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# **THE SEVERN BARRAGE DIGEST**

## **BRIEF DESCRIPTION OF SEVERN HABITATS**

The Severn Estuary (Mor Hafren) in South West Britain divides England from Wales and spans an area that includes the city of Gloucester, the urban areas of Newport and Cardiff, Bristol, Weston-Super-Mare and Minehead. The estuary extends into the Bristol Channel and beyond that into the Atlantic Ocean south of Ireland. Its scale is vast and it is estimated that over three million people live within ten kilometres of the Severn Estuary.

It is Britain's second largest estuary occupying an area of 557 square kilometres with an intertidal area of 200 sq. kilometres. It has the second highest tidal range in the world, occasionally exceeding 14.5metres and averaging 12metres. Due to its funnel shape and high tides a tidal wave, known as the Severn Bore, occurs on the lower reaches and may reach up to 2 metres in height. The estuary is unique in Britain.

The Severn Estuary is a highly dynamic environment characterised by constant and sometimes rapid changes in features like the depth and position of channels and sand banks. Deep, narrow channels will often be running through broader, shallower areas bordered by ground that floods at high tide if not protected by embankment, as some of it is. The water of the estuary carries a very high sediment load in suspension and this is maintained by the speed of the strong currents passing through the deep channels. Sand is swept into the estuary from the seaward side on a flood tide and deposited in banks that the less powerful ebb tides cannot move again. The suspended mud mostly originates from rivers and streams eroding the ground they run through.

Contained within this environment are the inter-tidal mud and sand-flats, the salt-marsh, the rocky inter-tidal areas, sand dunes and the sub-tidal habitats. These are typically formed in areas sheltered from the action of waves to the extent that pioneering plants adapted to the salty conditions are able to colonise. Their presence aids stability by binding the sediments together and making it less vulnerable to erosion by slowing the flow of water through a network of stems. On this foundation other less hardy types of vegetation are able to establish. Other notable terrains are the transitional coastal habitats consisting of reed beds, grazing marsh and wetlands.

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The harshness of the conditions prevailing in the estuary means that the Severn terrains are not species rich. Sea floor invertebrates are particularly poorly represented. However this does not necessarily mean that there is a low bio-mass. The species that do colonise successfully tend to comprise large numbers of relatively small individuals. The symbiotic relationship of birds and fish within this environment are central to the ecological picture.

Recent studies have resulted in establishing the importance of inter-tidal habitats to fish populations. (Elliot&Taylor 1989) showed how populations in this vital area doubled that of the sub-tidal zone. Other studies have produced direct correlation between available areas of salt-marsh and the volumes of commercial fish landings from estuaries. This seems to be because of the high foraging profitability and predator avoidance qualities afforded to juvenile fish stock. This particular facility is afforded to both freshwater and saltwater species as the opportunity arises.

The estuary is a continuation of the river habitat and a corridor to the sea for migratory species. The Severn list of such species contains the Directive protected

- Twaité Shad
- Allis Shad
- Sea Lamprey
- River Lamprey
- Sea Trout
- Atlantic Salmon
- Eel.

Saltwater species also use the estuary from time to time, as a feeding ground and as a nursery, and may include species such as

- Bass
- Cod
- Flounder
- Mullet.

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Shrimps are found in abundance and are the basis of a complex food chain. They move around the estuary on a seasonal basis closely followed by their predators. They range from the mouths of the ten sub-estuaries seawards as far as Bridgewater Bay using the whole system for breeding, as a nursery and for feeding.

The Estuary is on the North Atlantic flyway for migratory birds and waterfowl. The nearby presence of the Gulf Stream means that winter temperatures are rarely low enough to freeze the mudflats and this feature makes it a key refuelling station for high numbers of waders and wildfowl. The Severn is ranked amongst the top twenty sites for absolute numbers of waterfowl and includes important populations including the Annex 1 Bewicks Swan and five other regularly occurring migratory species, the Shelduck, Dunlin, Redshank, European White Fronted Goose and Gadwall.

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## **THE TIDAL BARRAGE CARDIFF/WESTON**

The construction of the 62 million tonne structure comprising 370 reinforced concrete caissons would take place at numerous locations around the UK and even Europe. The 17 million ton hollow concrete caissons would be filled with 29 million tonnes of sand for ballast and joined to each coast by rock-fill walls comprising a further 16 million tonnes of aggregates. Around 18 million cubic metres (around 30 million tonnes) of seabed material would have to be moved to create a level foundation. The caissons would then be carefully located in position during good weather and neap tides at a rate of about two caissons per month. This would take about 84 months if all went according to schedule.

The installed capacity, or maximum output, of the Project proposal would be 8,640 megawatts or 8.64 gigawatts and would have a load factor of about 23 %. Generation would occur on the ebb tide only. Output may be augmented by pumping additional water from sea to basin when the flood tide is near its peak in a procedure known as flood pumping. The barrage would generate about 17 terra-watt hours per year in an average year or about 4.3 % of current UK electricity demand.

Some over-estimation in the public mind of the actual scale of the barrage output has been caused by failure by the media and elsewhere to distinguish between the terms electricity and energy. Electricity demand is about 19 % of UK energy consumption. The barrage output would be equivalent to about 0.8 % of current UK 'final' energy consumption, around 2,050 TWh/y in 2005.

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## **IMPACTS**

If plans to build a Severn Barrage on the Cardiff-Weston line go ahead the impacts on the environment and the bird and fish populations will be massive. The ebb flow technology proposed means that a constant head of water will be impounded in the upstream basin covering 60% of the current inter-tidal area, permanently submerging 46 square miles. To help maintain the necessary high water levels in the basin the present tidal cycle will be changed. The residual inter-tidal area would suffer a damaging reduction in submersion time- possibly an hour or more a day.

Spring tides that inundate and thus sustain the rare and protected salt-marsh every 28 days would be reduced in frequency and extent as the tidal surge will be moderated by nearly two metres. There is certain to be erosion and loss. The world famous Severn Bore could be significantly affected by flood pumping operations. Tidal current speeds will be reduced allowing scoured sediments, presently held in suspension, to form deposits that would soon be colonised by marine life. This potential “enriching” of the area’s biology could bring benefits to some habitats and species but the general change in features and composition away from those that make the site unique are not desirable.

It is estimated that 85% of British Estuaries have lost 80% of their inter-tidal areas through agriculture, port development, industry and housing. On top of this, sea level rise and the development of “hard line” coastal defences combine in an effect known as coastal squeeze. This latter phenomena alone accounts for a loss rate of 2% per annum for a habitat type with a wide range of key functions including flood defence through the diffusion of wave energy, nutrient and carbon storage and the removal of atmospheric particulate matter. The Severn Estuary represents 7% of all UK estuarial assets.

The estuary is vital to internationally important populations of protected birds which would be displaced by a barrage and could not be accommodated elsewhere in south-west England or Wales.

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As with some species of birds, migratory fish using the estuary are at very fragile levels. Tidal power generation would be likely to have a significant impact on seven species in particular. Fish using the estuary as a conduit to the sea would have to pass through either sluices, turbines or fish passes at least twice in their life cycles. Studies from similar projects have revealed shocking mortality rates of between 10 and 60 per cent for fish passing through turbines. While some of this is caused by strike damage when fish collide with the fast moving turbine blades much damage can come from sudden pressure change which ruptures the swim bladder. It is known that some species will pass to and fro several times during the course of their journey thus multiplying losses. Salmon, for example, would suffer a 44% destruction rate after one pass through a turbine, 78% for three passes rising to 92% for a fifth passage.

The mincing machines of the barrage are not the only hurdles for fish on the move to overcome. Changes in current flows, sedimentation and directional clues will all add to the perils of migration with disoriented fish becoming vulnerable to predators as a result. Birds would be the main culprits here but seals will also learn to profit from concrete dams by penning or corralling fish against the sides of the structure. It has been known for seals to take up residence actually in fish passes.

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## **BACKGROUND TO THE CURRENT PROPOSALS**

The Government created the Severn Barrage Committee in the late 70s following the oil price crisis to determine the technical feasibility of a Barrage and the contribution that such a structure would make to the future security of electricity supplies. The miner's strike and the Chernobyl incident further provoked thought on security of supply and in 1986 the Secretary of State for Energy commissioned a £4.2 million study to be jointly funded by the Government, the Central Electricity Generating Board and the Severn Tidal Power Group.

The STPG was formed in 1984 after the Severn Barrage Committee endorsed the concept of a tidal barrage. They are a consortium of Britain's six leading power generation and construction companies and have been entrusted with the development of the project ever since. Membership is as follows:

- 1) Sir Robert McAlpine Ltd.
- 2) Balfour Beatty Major Projects Ltd.
- 3) ALSTROM Hydro Ltd
- 4) Rolls Royce Power Engineering Ltd
- 5) Taylor Woodrow Construction Ltd
- 6) Tarmac Construction Ltd

In 1997 Margaret Beckett MP, President of the Board of Trade and John Battle MP the Energy Minister, invited the STPG to discuss the project in the light of new Government targets for sustainable development and renewable energy. The outcome was the STPG's "New Appraisal", published in 2002 that took into account the changes in the electricity market, changed attitudes to environmental issues and the PFI experience of public/private sector ventures.

In 2006 pressured by evidence on climate change, rising fuel prices, fuel security issues and the commitment to reduce emissions, the government decided to further

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examine the possibilities of carbon free electricity generation offered by the vast tidal range of the Severn estuary. They commissioned the Sustainable Development Commission to report (Jonathan Porritt chair Andrew Lee<sup>1</sup> director). This was duly delivered in the autumn of 2007 and concluded that a barrage on the Cardiff Weston line had the potential to deliver 5% of the UK's electricity requirements but that in order to meet the principles of sustainable development it would have to comply with the environmental legislation currently in force, namely the Habitats Directive. It insists that Government has to carry out "appropriate assessments" to fully understand all the impacts and that the project should be Government led and publicly owned.

Following from this the department for Business, Enterprise and Regulatory Reform together with representation from the Welsh Assembly and the South West Regional Development Agency launched a feasibility study that commenced 22<sup>nd</sup> Jan 2008. The aims of the study are to gather and examine evidence that will enable the Government to decide whether or not it could support the scheme and on what terms.

There are six key areas for the study:

- 1) Environmental - wild life, biodiversity, morphology, water quality, landscape and compensatory habitat.
- 2) Engineering and Technical – options, costs, design& construction.
- 3) Economic – financing, ownership and energy market impacts.
- 4) Regional - impacts on local business and industry
- 5) Planning and consents – regulatory compliance
- 6) Stakeholder engagement and communication.

Part of the study includes a Strategic Environmental Assessment. The SEA is a formal examination of plans likely to affect the environment. **Parsons Brinckerhoff** have been appointed to run the SEA. They (PB) lead a consortium that includes **Black and Veatch**, the **Environment Council**, **Environ**, **ABPmer**, **H R Wallingford**, **Hartley Anderson** and **George Corderoy**. **Pricewaterhouse and Coopers** have also been appointed by BERR to examine ways of financing the project.

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<sup>1</sup> Andrew Lee was vociferously opposed to the Severn Barrage when he worked for the WWF but now sees it as a vital component in the decarbonisation of Britain's electricity supply.

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The study is scheduled to run for two years and is divided into two stages the first of which has just been concluded. The first phase consisted of a call for proposals for tidal power schemes in the Severn estuary from which a long list of ten projects was assembled. It also included a call for evidence that will contribute to the assessment of schemes on the list and the SEA. A Steering Group of independent stakeholders, including panels of experts in specific areas, will provide advice and act as a peer review group. The information gathered so far will now be fed through to ministers in an internal review that will decide if there are any fundamental reasons that mean it would be pointless to proceed further with the study.

Part two – assuming a continuation of the study, will involve private and public consultations on which of the ten options should be short-listed for detailed impact assessment during 2009. It will also cover the scope of the SEA , the way the feasibility study is being conducted, the issues it is considering and how these are being approached.

The 10 projects on BERR's list are:

1. Outer Barrage from Minehead to Aberthaw - largest scale proposal to produce 12GW
2. Cardiff Weston – to produce 8.5 GW
3. Middle barrage – same as above but lands at Hinkley on the English shore.
4. Shoots Barrage - located between the two road crossings.
5. Beachley barrage – small, low impact and above both Wye and Usk estuaries.
6. Tidal Fence – To be constructed approximately on the line of the Cardiff Weston barrage but with open section to facilitate navigation. Incorporates tidal turbines to capture energy on both ebb and flow tides.
7. Fleming Lagoon – one of the previously studied Russell Lagoons from the 80s.
8. Tidal Lagoon concept – proposal for a string of lagoons.
9. Tidal reef – to include floating turbines and caissons.
10. Severn Lake scheme – a 1km scheme again on the Cardiff Weston line to include marinas and a wave generator.

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## **THE QUALIFIED SUPPORT OF THE SDC.**

The SDC report “Tidal Power in the UK” is broadly supportive of the idea of electricity generation in the Severn estuary, but it is qualified support. The Commission takes the position that it is vital for the UK to take action on climate change now and for the country to adhere to its stated policy of delivering a 60% cut in greenhouse gas emissions by the year 2050. In this context a barrage on the Severn that generated the equivalent output of two conventional power stations over the long term future seems very attractive. However, even viewed from this perspective it must be noted that a barrage would only deliver 5% of a decarbonised electricity supply and only 1% of total energy requirements for the UK.

While this contribution would be welcome, the SDC only sanctions the proposals as part of a package that would include a combination of measures designed to both reduce consumption and completely decarbonise the electricity supply. This would involve carbon pricing, the support of innovative technologies and action to remove barriers to behavioural change as a prerequisite of any decision to build a dam. They also acknowledge the pivotal importance of environmental compensation and the polarising effect it has on debate. Detractors of the scheme resolutely refuse to see any possible way of compensating for the damage to the Natura 2000 network while hard line supporters go as far as to suggest reform of, or derogation from, the Directives.

The SDC proposes a sort of “3<sup>rd</sup> way” approach to compensation which acknowledges the impossibility of replicating the hyper-tidal estuary habitats but would seek to conform to the Directives objectives by studying the long term requirements of the protected network, some of which is under threat in any case through sea level rise etc. and supporting it by creating new coastal and wetland habitats on a national scale. This would, in effect, twin the need for development and compensation with coastal protection, linking climate change mitigation measures with adapting the environment as part of a long term project funded through the income from the barrage.