

National Assembly for Wales

Severn Estuary Tidal Power April 2010

This paper provides briefing on the current situation of tidal power development within the Severn Estuary.

A Welsh perspective and the views of relevant stakeholders are included.

Members'
Research
Service



The National Assembly for Wales is the democratically elected body that represents the interests of Wales and its people, makes laws for Wales and holds the Welsh Government to account.

The Members' Research Service is part of the National Assembly for Wales. We provide confidential and impartial research support to the Assembly's scrutiny and legislation committees, and to all 60 individual Assembly Members and their staff.

Members' Research Service briefings are compiled for the benefit of Assembly Members and their support staff. Authors are available to discuss the contents of these papers with Members and their staff but cannot advise members of the general public. We welcome comments on our briefings; please post or email to the addresses below.

An electronic version of this paper can be found on the National Assembly's website at: www.assemblywales.org/bus-assembly-publications-research.htm

Further hard copies of this paper can be obtained from:

Members' Research Service
National Assembly for Wales
Cardiff Bay
CF99 1NA

Email: MembersLibrary@wales.gsi.gov.uk

© National Assembly for Wales Commission Copyright 2010

The text of this document may be reproduced free of charge in any format or medium providing that it is reproduced accurately and not used in a misleading or derogatory context. The material must be acknowledged as copyright of the National Assembly for Wales Commission and the title of the document specified.

National Assembly for Wales

Severn Estuary Tidal Power
April 2010

Chris Peters

Paper Number: 10 / 011

Members' Research Service gratefully acknowledges the parliamentary fellowship provided to Mr Peters by the Natural Environment Research Council, which enabled this research paper to be completed.

Members'
Research
Service



Summary

The Severn Estuary is the most significant tidal range resource in the UK. A cross-government group led by the Department of Energy and Climate Change (DECC) has initiated the Severn Tidal Power feasibility study to consider whether the UK Government should support a tidal power project within the Severn Estuary, and if so, on what terms.

As part of the *UK Renewable Energy Strategy*, the UK Government has set targets of reducing carbon emissions by at least 80 per cent by 2050. The *EU Renewables Directive* sets a mandatory target for the UK to produce 15 per cent of its energy from renewable sources by 2020.

The *Low Carbon Revolution Energy Policy* sets out the Welsh Government's ambition for a transition to a low carbon economy through energy efficiency, security and the promotion of the economic opportunities within the renewables energy sector. The Welsh Government's aim is to generate up to twice as much renewable electricity annually by 2025 compared to current levels. By 2050 at the latest the Welsh Government wishes to be in a position where almost all of the local energy needs, whether for heat, electrical power, or vehicle transport, can be met by low carbon electricity production.¹

With regards to the capture of tidal energy from the Severn Estuary, the Welsh Government is committed to continuing to support the feasibility study presently being led by the Department of Energy and Climate Change.

At present the Severn Tidal Power feasibility study is conducting the Strategic Environmental Assessment phase which will assess the significant environmental effects of proposed Severn Estuary tidal schemes. This phase of the feasibility study will be completed in the latter part of 2010 and will be followed by a public consultation.

This paper provides a background to the Severn Estuary tidal power project, as well as a detailed discussion of the suggested socio-economic and ecological impacts of the proposed short listed tidal power schemes. Stakeholder views from within the environmental and industrial sectors are included where relevant.

¹ Welsh Government, [A low-Carbon Revolution – The Welsh Assembly Government Energy Policy Statement](#), March 2010

Contents

1. Introduction	1
2. Renewable energy policies	2
2.1. UK targets	2
2.2. Welsh targets	2
2.3. EU targets	4
3. Background of Severn Estuary tidal power	5
3.1. Feasibility study	6
4. Technology	8
5. Severn tidal power progress	10
5.1. Severn Embryonic Technologies Scheme	10
6. Proposals and short listing	12
6.1. Outer barrage (Minehead to Aberthaw) (B1)	12
6.2. Middle barrage (Hinkley to Lavernock Point) (B2)	13
6.3. Middle barrage (Cardiff-Weston) (B3)	14
6.4. Inner barrage (Shoots barrage) (B4)	15
6.5. Beachley barrage (B5)	16
6.6. Lagoon enclosure on the Welsh grounds (Fleming lagoon) (L2)	17
6.7. Onshore and offshore tidal lagoon (Bridgewater Bay) (L3d and L3e)	18
6.8. Tidal fence (F1 b)	19
6.9. Tidal reef (R1)	20
6.10. Severn lake scheme	20
7. Future plans	23
7.1. Severn Embryonic Technologies Scheme (SETS)	24
8. Stakeholder views	25
9. Compensatory habitats	30

Severn Estuary Tidal Power

1. Introduction

The UK has the potential to generate at least 10 per cent of the UK's electricity demand if the tidal resources available are fully exploited. Such a large reward of renewable energy would go a considerable way to tackling both the challenges of climate change and energy security.²

The exploitation of the UK's tidal energy resources will require careful consideration of a number of factors, including environmental, social and economic impacts. The Severn Estuary contains one of the highest tidal ranges in the world and is the most significant tidal resource in the UK. A cross-government group led by the Department of Energy and Climate Change (DECC) has initiated the Severn Tidal Power (STP) feasibility study to consider whether the UK Government should support a tidal power project within the Severn Estuary, and if so, on what terms. At present the feasibility study is considering five short listed proposals for STP schemes within the Severn Estuary. The specific environmental, social and economic impacts of these projects are currently being assessed. Such a huge undertaking requires the in-depth consideration of a large number of factors to ensure that not only is the tidal energy potential of the Severn Estuary realised, but in a sustainable manner.

Combating global climate change is inherently an internationally important issue and efforts to reduce greenhouse gas emissions are high on the political agenda of many Governments around the world. The Welsh Government has set ambitious targets through the *Low Carbon Revolution Energy Policy* for a transition to a low carbon economy and the promotion of economic opportunities within the renewables energy sector.³ The potential for the tidal energy of the Severn Estuary to contribute towards these targets has intensified the need to fully investigate the options available for a sustainable energy project.

² Sustainable Development Commission, [Turning the Tide, Tidal Power in the UK](#), October 2007 [Accessed on 29 March 2010]

³ Welsh Government, *A low-Carbon Revolution - The Welsh Assembly Government Energy Policy Statement*, March 2010 [Accessed on 26 March 2010]

2. Renewable energy policies

2.1. UK targets

Through the Kyoto Protocol, the UK is committed to a 12.5 per cent reduction in greenhouse gas emissions over the period of 2008-2012 (compared to a 1990 emission baseline). Furthermore, the UK committed, in the *2003 Energy White Paper*, to achieve a 20 per cent reduction in carbon dioxide emissions by 2010 and 60 per cent by 2050.⁴ As part of these commitments the UK Government has, as part of the *UK Renewables Energy Strategy* set a target of producing 15 per cent of energy from renewable sources by 2020.⁵

The *Climate Change Act 2008* requires the UK Government to set a carbon budget over consecutive five year periods (2008-12, 2013-17 and 2018-22) with a view to achieving the legally binding long-term target to reduce greenhouse gas emissions by 34 per cent by 2020, and at least 80 per cent by 2050 against a 1990 baseline.⁶ Established under the *Climate Change Act 2008*, the Climate Change Committee (CCC), is an independent body advising the UK Government on emissions targets and reporting to Parliament on progress made in reducing greenhouse gas emissions. In the CCC's first report, *Building a low-carbon economy*, it was advised that to reach the 2050 target:⁷

It is likely that a key feature of the future optimal path will be the almost complete decarbonisation of electricity generation, and the extension of electricity to a wider range of energy end uses (in particular transport and heat). This implies that rapid progress on electricity decarbonisation is vital.

2.2. Welsh targets

The Welsh Government is committed, as part of the *One Wales* agreement to a target of 3 per cent annual carbon reduction-equivalent emissions per year by 2011.⁸ Further to this, the Welsh Government's *Technical Advice Note 8: Planning for Renewable Energy*, set targets for annual renewable electricity production of 4 Terawatt hours (TWh) and 7 TWh for 2010 and 2020 respectively.⁹

The Welsh Government released the *Low Carbon Revolution Energy Policy*¹⁰ statement in March 2010, which builds on the results of consultations on the *Renewable Energy*

⁴ Department of Energy and Climate Change, [Energy White Paper Our energy future - creating a low carbon economy](#), February 2003 [Accessed on 26 March 2010]

⁵ Department of Energy and Climate Change, [The UK Renewable Energy Strategy](#), July 2009 [Accessed on 26 March 2010]

⁶ [The Climate Change Act 2008 Chapter 27](#). [Accessed on 26 March 2010]

⁷ The Climate Change Committee, [Building a low-carbon economy - the UK's contribution to tackling climate change](#), chp2, p35, December 2008 [Accessed on 26 March 2010]

⁸ Welsh Government, [One Wales Delivery Plan 2007-2011](#), chp.7, p65, May 2009 [Accessed on 26 March 2010]

⁹ Welsh Government, [Technical Advice Note 8: Renewable Energy](#), July 2005 [Accessed on 26 March 2010]

¹⁰ Welsh Government, [A low-Carbon Revolution - The Welsh Assembly Government Energy Policy Statement](#), March 2010 [Accessed on 26 March 2010]

*Route Map*¹¹ and the *Bioenergy Action Plan for Wales*.¹² The *Low Carbon Revolution Energy Policy* statement sets out the ambitions for low carbon energy in Wales.¹³

In launching the Energy Policy, the Minister for Environment, Sustainability and Housing, Jane Davidson, stated:¹⁴

The statement includes a three tier hierarchy of our ambitions:-

- First, we will maximise energy savings and energy efficiency in order to make producing the majority of the energy we need from low carbon sources more feasible and less costly.
- Second, our energy needs in a modern society will remain considerable, and must be met securely from low carbon sources. We will move to resilient low carbon energy production via indigenous (and thus secure) renewables, on both a centralised and localised basis.
- Third, we will ensure that this transition to low carbon maximises the economic renewal opportunities for practical jobs and skills, strengthens and engages our research and development sectors, promotes personal and community engagement and helps to tackle deprivation and improve quality of life.

The *Low Carbon Revolution Energy Policy* statement also gives specific attention to the STP situation, commenting:¹⁵

Our aim is to test the appropriateness and cost effectiveness of steps to exploit the tidal range of the Severn Estuary. We will do this by:

- From a total sustainable development perspective, continuing to support the major study of the Severn Estuary being led by DECC.
- Ensuring both the costs and benefits of any project are fully understood and explained.
- Supporting further research of development as appropriate in the light of the study and, in particular, where new technology ideas look to have potential and could be developed within Wales.
- Considering the applicability of tidal range technologies elsewhere in Wales as appropriate.

Responding to a question on the current situation on the STP proposals in February 2010, the Minister for Environment, Sustainability and Housing, Jane Davidson, commented:¹⁶

...the Welsh Assembly Government, put in some additional funding, with the south-west regional Government, to look at new technologies to ensure that we were not missing a trick with any of the new opportunities, because this is a fast-moving field. So, there are studies of the five main proposals on the short list, plus two additional technologies, under way at the moment. All aspects are being looked at: the energy return, the economic and social aspects, the environmental aspects and the environmental obligations.

¹¹ Welsh Government, [Energy Wales – Route Map to a clean, low-carbon and more competitive energy future for Wales](#). Consultation Document, June 2005 [Accessed on 26 March 2010]

¹² Welsh Government, [Consultation on a Bioenergy Action Plan for Wales](#), February 2009 [Accessed on 26 March 2010]

¹³ Welsh Government, *A low Carbon Revolution – The Welsh Assembly Government Energy Policy Statement*, March 2010 [Accessed on 26 March 2010]

¹⁴ Welsh Government, Cabinet Written Statement, Minister for Environment, Sustainability and Housing, [The Welsh Assembly Government's Energy Policy Statement](#), 15 March 2010 [Accessed on 26 March 2010]

¹⁵ Welsh Government, *A low Carbon Revolution – The Welsh Assembly Government Energy Policy Statement*, p14, March 2010 [Accessed on 26 March 2010]

¹⁶ National Assembly for Wales, Records of Proceedings, Plenary Meetings, 10 February 2010, [The Record](#), p35, website [Accessed on 26 March 2010]

2.3. *EU targets*

The European Union have agreed a target of 20 per cent of Europe's energy coming from renewable sources.¹⁷ The European target was disaggregated to Member States and for the UK is included under *UK Renewable Energy Strategy*.¹⁸ The European Union has additionally agreed to reduce Europe's greenhouse gas emissions by 20 per cent (from a 2005 baseline) by 2020. Furthermore, in the event of a comprehensive global agreement for a period after 2012, the EU will commit to a community objective of a 30 per cent reduction of greenhouse gas emissions by 2020 (from a 1990 baseline), provided that 'other developed countries commit themselves to comparable emission reduction and economically more advanced developing countries commit themselves to contributing adequately according to their responsibilities and capabilities'.¹⁹

¹⁷ [Decision 406/2009/EC of the European Parliament and of the Council](#), April 2009 [Accessed on 26 March 2010]

¹⁸ Department of Energy and Climate Change, [The UK Renewable Energy Strategy](#), July 2009 [Accessed on 26 March 2010]

¹⁹ [Decision 406/2009/EC of the European Parliament and of the Council](#), p137(3), April 2009 [Accessed on 26 March 2010]

3. Background of Severn Estuary tidal power

The feasibility of harnessing the power of the Severn Estuary tide has been investigated, at various stages, for almost one hundred years. More recently, in 1975 the Central Electricity Generating Board (CEGB) published a study, in collaboration with Bristol and Salford Universities, on behalf of the Secretary of State's Advisory Council on Research and Development for Fuel and Power. The council established that unless the energy situation deteriorated significantly building a barrage in the Severn Estuary would not be economically viable.

The 1979 energy crisis brought the security of future energy supply back into the public spotlight and the plans for a Severn barrage were reinvestigated by the Severn Barrage Committee in 1981. This committee was known as the 'Bondi Committee' after the Chief Scientific Adviser to the Department of Energy, Sir Hermann Bondi. Six proposed barrage locations were investigated for their suitability to supply tidal energy generation and the resulting energy paper recommended a 10 mile barrage between Brean Down and Lavernock Point.²⁰

The proposal put forward by the Bondi Committee was investigated further by the Severn Tidal Power Group (STPG) and in 1989 they calculated that the Brean Down – Lavernock Point location was best suited for tidal energy generation. They estimated that a barrage in this location would cost £8 billion (bn) to build and would generate 17 TWh of electricity per year.²¹ The STPG also concluded that the extent of environmental impact would be crucial to evaluating the viability of a Severn barrage scheme. As with the CEGB recommendations a decision to build a STP project was not considered economically viable given the then present energy situation.

In 2003 the UK Government published an *Energy White Paper* which set out future energy policies on long-term low-carbon power options. Included within this paper was a statement regarding the future possibility of a Severn tidal barrage:²²

It is clear that plans for a Severn Barrage would raise strong environment concerns and we doubt if it would be fruitful to pursue it at this stage. Tidal barrages may be capable of offering major renewable projects which will help us reach our goals and we will continue to explore opportunities.

With the rising prices of fossil fuels and the growing awareness of climate change the DECC asked the Sustainable Development Commission (SDC) to produce a recommendation on how to develop the UK's tidal energy resources in accordance with the *UK Renewable Energy Strategy*.²³ The SDC report, published in 2007, concluded

²⁰ *Tidal power from the Severn Estuary-Volume 1*. Energy Paper 46. HMSO. 1981

²¹ *The Severn Barrage Project: General Report*. Energy Paper 57. HMSO. 1989.

²² Department of Energy and Climate Change, [Energy White Paper Our energy future – creating a low carbon economy](#), February 2003 [Accessed on 26 March 2010]

²³ Department of Energy and Climate Change, [The UK Renewable Energy Strategy](#), July 2009 [Accessed on 26 March 2010]

that the development of a tidal energy power scheme situated in the Severn Estuary could potentially play a key part in the UK meeting its 2020 and 2050 CO₂ emission reduction targets:²⁴

The SDC believes that there is a strong case to be made for a sustainable Severn barrage, subject to the conditions we outline in this report:

- A Severn barrage must be publicly-led as a project and publicly-owned as an asset to ensure long-term sustainability.
- There may be an 'environmental opportunity' available by linking a compensatory habitats package to climate change adaptation.
- Much wider and stronger action on climate change is a pre-requisite for the SDC's support.

3.1. Feasibility study

Current concerns regarding the security of national energy supply, coupled with the ever increasing awareness of global climate change and related emissions targets, has moved the tidal energy potential of the Severn Estuary back to the top of the political agenda. In this context the DECC with support from the Welsh Government²⁵ has established the Severn Tidal Power (STP) feasibility study.²⁶ The aim of the feasibility study is to consider whether the UK Government should support a project which exploits the major energy generation potential of the Severn Estuary, and if so, on what terms.²⁷ In January 2008 the terms of reference for the study were published as follows:²⁸

Building on the work of the Sustainable Development Commission and earlier studies, the feasibility study will:

- Assess in broad terms the costs, benefits and negative effects of a project to generate power from the tidal range of the Severn Estuary, including environmental social, regional, economic and energy market impacts;
- Identify a single preferred tidal range project (which may be a single technology/location or a combination of these) from the number of options that have been proposed;
- Consider what measures the Government could put in place to bring forward a project that fulfils regulatory requirements, and the steps that are necessary to achieve this;
- Decide, in the context of the Government's energy and climate change goals and the alternative options for achieving these, and after public consultation, whether the Government could support a tidal power project in the Severn Estuary and on what terms.

In July 2008 the DECC, following input from stakeholders, considered 10 potential Severn tidal power schemes encompassing all available tidal technologies available commercially and in development. All proposals were assessed on two main criteria.

²⁴ Sustainable Development Commission, [Turning the Tide, Tidal Power in the UK](#), October 2007 [Accessed on 26 March 2010]

²⁵ Welsh Government, Environment and Countryside, [Severn Tidal Power](#), website [Accessed on 29 March 2010]

²⁶ Department of Energy and Climate Change, UK energy supply, [Severn Tidal Power Feasibility Study](#), website [Accessed on 26 March 2010]

²⁷ Department of Energy and Climate Change, [Phase one consultation, Government response](#), July 2009 [Accessed on 26 March 2010]

²⁸ Department for Business Enterprise & Regulatory Reform, [Severn Tidal Power Feasibility Study - Terms of Reference](#), January 2008 [Accessed on 26 March 2010]

The first considered the technical and economic risk and the overall affordability of the project. The second criteria considered whether a scheme that is less favourable from a technical or economic point of view, should be given further consideration due to any other reason, such as potentially lower environmental impacts or regional and social factors.

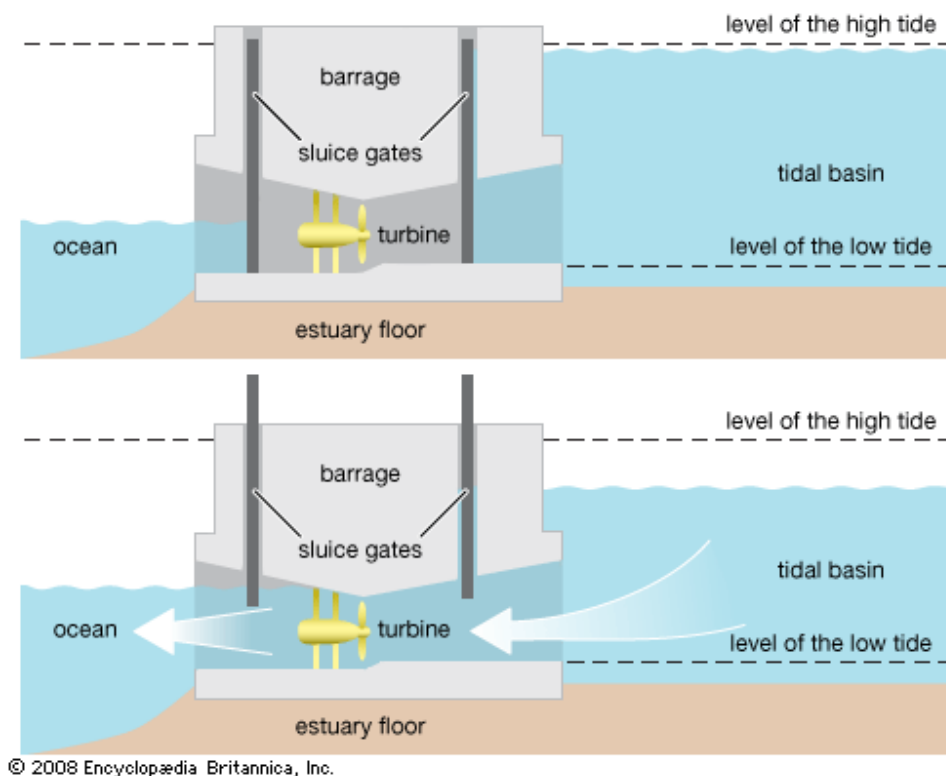
4. Technology

There are two types of tidal technology proposed for use within the Severn Estuary. These are tidal range and tidal stream.

Tidal range technology utilises the difference in height between high and low tides and generates electricity by creating a difference in the water height (head) on either side of a structure and then allowing the passage of water through turbines. The tidal range schemes proposed for the Severn Estuary will generate power only on the ebb tide, which is the flow of water seaward out of the estuary. Water from the incoming tide is allowed to pass through sluice gates in the barrage, but is impounded behind the barrage as the tide goes out. Once water levels on the seaward side of the barrage are low enough, the water behind the barrage is released through a series of turbines thereby generating electricity. Tidal lagoons work on the same principle but capture areas of water rather than having a barrier across an entire estuary. Lagoons can be completely offshore or semi-circular with both ends connected to the land.

With the large tidal range in the Severn, and the relative advanced state in development of tidal range technologies, the STP feasibility study is focusing on these as opposed to tidal stream proposals.²⁹

Figure 1: Tidal range mode of tidal generation (Ebb flow)³⁰



²⁹ Department of Energy and Climate Change, [Phase one consultation, Government response](#), July 2009 [Accessed on 26 March 2010]

³⁰ [Tidal range generation, Encyclopædia Britannica](#), [Accessed on 26 March 2010]

Tidal stream in comparison to tidal range is a relatively young technology which utilises the movement of the water from the naturally occurring tidal currents and generates electricity on both the ebb and flow tides. Tidal stream technology is not regarded as an established tidal power technology and as such was not considered in the original list of STP proposals.³¹

Figure 2: Three different varieties of tidal stream turbines³²



³¹ Department of Energy and Climate Change, UK energy supply, [Severn Embryonic Technology Scheme](#), website [Accessed on 26 March 2010]

³² Sustainable Development Commission, [On Stream: creating energy from tidal currents](#), p6, July 2008 [Accessed on 26 March 2010]

5. Severn tidal power progress

Six specific criteria were used to identify whether a proposal was feasible in the context of the study:³³

- **Impact on the energy market and security of supply** (including grid implications and impact on financing of other low carbon options)
- **Technical risk** (risk that the technology may not work as planned, confidence levels around costs and yields, likely operation dates and the risks/impact of sedimentation)
- **Cost and amount of energy** (is a proposal sufficiently competitive with other forms of renewable energy and/or carbon abatement that a developer would build it; what contribution could it make to our energy goals)
- **Affordability and value for money** (the capital cost, the role that Government, taxpayers and consumers would need to play in taking on cost and risk and providing a subsidy)
- **Environmental impact** (including carbon dioxide savings, impact on species/habitats and likely requirements under the Birds and Habitats Directives)
- **Regional level economic and social impacts** (including employment effects and potential impact on ports and recreational and commercial fishing)

Analysis of the 10 tidal power proposals using the above criteria resulted in five projects being short listed. The UK Government released the long and short list of schemes for public consultation in January 2009 as part of phase one of the STP feasibility study.³⁴ As a result of public comment regarding the exclusion of tidal reef and tidal fence technologies from the short list, an addition was made in the form of the Severn Embryonic Technologies Scheme.

5.1. Severn Embryonic Technologies Scheme

The Severn Embryonic Technologies Scheme (SETS) was set up to support the development of new Severn tidal power technologies as an alternative to conventional barrages and lagoons and to deliver a technology development route map, charting the means, timescale and costs of taking promising technologies to deployment stage.³⁵ There are three proposals within the SETS remit:

- Severn Tidal Fence Consortium – a tidal fence scheme which works by installing an estimated 500 – 800 tidal stream turbines in a line across the estuary at either the Cardiff - Weston or Minehead - Aberthaw sites.
- VerdErg Tidal Fence – a tidal fence scheme which is considered by some to be a radical new fence design.³⁶ Whilst it will still make use of the tidal stream, this proposal will utilise a fence structure, formed by a series of horizontal and

³³ Department of Energy and Climate Change, [Severn Tidal Power – Phase One Consultation](#), January 2009 [Accessed on 26 March 2010]

³⁴ *ibid*

³⁵ Department of Energy and Climate Change, UK energy supply, [Severn Embryonic Technology Scheme](#), website [Accessed on 26 March 2010]

³⁶ VerdErg press release, [SMEC Tidal Fence selected by SETS Group for Severn Estuary study](#), 21 August 2009 [Accessed on 26 March 2010]

vertical tubes, and create a pressure difference which will increase the tidal flow to drive turbines and generate electricity. This action occurs on both incoming and outgoing tides.

- Rolls Royce – Atkins Low Head Barrage - is similar in structure to a conventional barrage but with a new type of turbine which draws upon both tidal stream and tidal range technologies. The turbine would generate electricity on both the incoming and outgoing tides and operate at a lower depth and water level difference than conventional barrage turbines. This turbine is not yet developed at scale.

Table 1: Short listed SETS proposals³⁷

Tidal Power Option	Annual average electricity output	Contribution to UK electricity supply	Estimated cost of construction
	<i>TWh/yr</i>	<i>Per cent</i>	<i>£bn</i>
Severn Tidal Fence Consortium	3.5	0.9	3.5
Severn Tidal Fence: VerdErg	13.74	3.6	9.9

Note. The Rolls Royce – Atkins low head barrage scheme incorporates a turbine that is not yet developed to scale and as a result of this, estimates for construction cost and average electricity output are unavailable.

At the conclusion of the scheme the UK Government will:

- Assess proposals against the criteria used to determine the current short list.
- Any scheme meeting the criteria will be assessed for impacts in the same way as the other short listed schemes
- Consider as part of any final decision at the end of the feasibility study, in light of technology route maps, scheme assessment, and the strategic case for Severn tidal power, whether to wait for these technologies.

³⁷ Department of Energy and Climate Change, UK energy supply, [Severn Embryonic Technology Scheme](#), website [Accessed on 26 March 2010]

6. Proposals and short listing

A list of 10 proposals was originally considered for short listing. The full list of proposals, including the reasons why certain projects were short listed and others were not are discussed below. The SETS projects are not included as, pending the completion of the scheme, they have not been considered for short listing.

Figure 3 shows the locations of all the STP proposals within the Severn Estuary and Bristol Channel. References to figure 3 are included in the tables e.g. Outer barrage (B1). Further details of predicted impacts for the short listed proposals are included in the Severn Estuary Tidal Power: Supplementary Information research paper.

6.1. Outer barrage (Minehead to Aberthaw) (B1)

The longest barrage proposal on the original long list, option one had an estimated electricity generation equivalent to 7.3 per cent of UK demand and was estimated to cost between £31-£34.7bn. The location between Minehead and Aberthaw is considered to be the site where the maximum tidal energy can be acquired.³⁸

Table 2: Outer barrage³⁹

Option	Pros	Cons
1. Outer barrage (B1) (Minehead to Aberthaw)	<p>Major contribution to carbon dioxide savings and security of supply</p> <p>May protect low lying areas of Somerset from tidal flooding</p> <p>Proven technology</p> <p>Significant employment opportunities during construction</p>	<p>Loss of 28,000 hectares of intertidal habitat</p> <p>Impact on migratory fish</p> <p>Over £11bn increase in capital costs and higher unit costs of energy compared to Cardiff-Weston</p> <p>Possibly higher technical risk than Cardiff-Weston as generating equipment</p>

Option 1 was not recommended for short listing as it was deemed to be unaffordable, with a large proportion of the estimated construction cost likely to fall on taxpayers.⁴⁰

³⁸ Black & Veatch, Tidal Power in the UK contract 3 - [Review of the Severn Barrage proposals](#), Report for the Sustainable Development Commission, July 2007 [Accessed on 26 March 2010]

³⁹ Department of Energy and Climate Change, [Analysis of options for tidal power development in the Severn Estuary - Interim Option Analysis Report Vol. 1](#), December 2008 [Accessed on 26 March 2010]

6.2. Middle barrage (Hinkley to Lavernock Point) (B2)

The middle barrage was estimated to cost between £23.5-£26.9bn and with the potential to supply approximately 5.5 per cent of UK electricity demand.

Table 3: Middle barrage (Hinkley – Lavernock Point)⁴¹

Option	Pros	Cons
2. Middle barrage (B2) (Hinkley to Lavernock Point)	<p>Could provide a second 'basin' which could reduce intermittency</p> <p>Major contribution to carbon dioxide savings and security of supply</p> <p>May protect low lying areas of Somerset from tidal flooding</p> <p>Proven technology</p>	<p>Loss of 26,000 hectares of intertidal habitat</p> <p>Impact on migratory fish</p> <p>Additional £4.3bn capital cost compared to Cardiff-Weston resulting in a higher unit cost</p>

Option 2 was not recommended for short listing as it was deemed to have the same problems applying to the Cardiff-Weston barrage on a larger scale. It would have an increased cost, both financially and environmentally, compared to a relatively small gain in electricity generation.⁴²

⁴⁰ Department of Energy and Climate Change, [Analysis of options for tidal power development in the Severn Estuary – Interim Option Analysis Report Vol. 1](#), December 2008 [Accessed on 26 March 2010]

⁴¹ *ibid*

⁴² *ibid*

6.3. Middle barrage (Cardiff-Weston) (B3)

The Cardiff to Weston barrage is now commonly known as ‘The Severn Barrage’ and is estimated to generation 4.8 per cent of the UK electricity demand at a cost of between £19.6-£22.2bn.

Table 4: Middle barrage (Cardiff-Weston)⁴³

Option	Pros	Cons
3. Middle barrage (B3) (Cardiff-Weston) (Specifically Brean Down to Lavernock point)	<p data-bbox="695 573 1015 685">Major contribution to carbon dioxide savings and security of supply</p> <p data-bbox="695 725 954 763">Proven technology</p> <p data-bbox="695 804 1031 842">Low unit costs of energy</p> <p data-bbox="695 882 1054 994">May offer tidal flood protection to Gwent levels and Avonmouth</p> <p data-bbox="695 1034 1018 1137">Significant employment opportunities during construction</p>	<p data-bbox="1099 573 1473 645">Loss of 20,000 hectares of intertidal habitat</p> <p data-bbox="1099 685 1437 723">Impact on migratory fish</p> <p data-bbox="1099 763 1449 913">Would potentially require over £20bn to be raised either publically or privately</p> <p data-bbox="1099 954 1461 1066">Creates a physical barrier to four main ports in the Severn estuary</p>

Option 3 was recommended for short listing due to the high level of renewable electricity potential which could have a role in meeting the UK Government’s long term carbon reduction targets.⁴⁴

⁴³ Department of Energy and Climate Change, [Analysis of options for tidal power development in the Severn Estuary - Interim Option Analysis Report Vol. 1](#), December 2008 [Accessed on 26 March 2010]

⁴⁴ *ibid*

6.4. Inner barrage (Shoots barrage) (B4)

Located near the Severn road crossings the Shoots barrage is estimated to generate just under 0.8 per cent of the UK electricity demand and is estimated to cost £2.9-£3.5bn

Table 5: Inner barrage (Shoots barrage)⁴⁵

Option	Pros	Cons
4. Inner barrage (B4) (Shoots barrage)	<p>Largest barrage that could be taken forward with limited Government funding</p> <p>Unit costs of energy are the cheapest for all Severn options</p> <p>Does not directly impede the major Estuary ports</p> <p>Lower impact on intertidal habitat loss</p>	<p>Impact on migratory fish</p> <p>Loss of 5,000ha of intertidal habitat loss</p> <p>Does not make full use of Severn Estuary electricity potential</p> <p>Potential build up of sediment behind barrage - needs further investigation in Phase 2.</p>

Option 4 was recommended for short listing due to the low unit costs of energy (relatively large amount of energy for the estimated cost). The project was still considered significant enough in scale to contribute to renewable energy goals.⁴⁶

⁴⁵ Department of Energy and Climate Change, [Analysis of options for tidal power development in the Severn Estuary - Interim Option Analysis Report Vol. 1](#), December 2008 [Accessed on 26 March 2010]

⁴⁶ *ibid*

6.5. Beachley barrage (B5)

Located upstream of the Shoots barrage and upstream of the River Wye, the Beachley barrage is the smallest barrage to be considered with an estimated generation capacity of 0.4 per cent of UK electricity demand. Construction costs were estimated at between £2.1-£2.5bn.

Table 6: Beachley barrage⁴⁷

Option	Pros	Cons
5. Beachley barrage (B5)	<p>Does not impact on the major ports</p> <p>Causes the least intertidal habitat loss</p> <p>Least impact on fish</p> <p>Cheapest in terms of capital cost</p> <p>Low unit cost of energy</p>	<p>Smaller energy output than the majority of other schemes</p> <p>Loss of 3,500ha of intertidal habitat loss</p> <p>Potential build up of sediment behind the barrage - needs further investigation in phase 2.</p>

Option 5 was recommended for short listing due to low unit costs of energy and low capital costs. Furthermore, although it has the potential of providing a relatively small energy output the Beachley barrage has smaller environmental and port impacts than the larger barrage options.⁴⁸

⁴⁷ Department of Energy and Climate Change, [Analysis of options for tidal power development in the Severn Estuary - Interim Option Analysis Report Vol. 1](#), December 2008 [Accessed on 26 March 2010]

⁴⁸ *ibid*

6.6. Lagoon enclosure on the Welsh grounds (Fleming lagoon) (L2)

An impoundment lagoon located on the Welsh shore of the estuary between Newport and the Severn road crossings. The Fleming lagoon has an estimated energy generation of 0.65 per cent of UK electricity demand with an estimated construction cost of between £4.1-£4.9bn.

Table 7: Fleming lagoon⁴⁹

Option	Pros	Cons
6. Fleming lagoon (L2) (Between Newport and Severn road crossings)	<p>Proven technology, less technical risk than embryonic technology.</p> <p>Potential to have less detrimental effect on local ports and fisheries.</p> <p>Lower impact on intertidal habitat than large barrage schemes.</p>	<p>Loss of 6,500ha of intertidal habitat loss</p> <p>Potential build up of sediment within the impounded area - needs further investigation in phase 2.</p>

Option 6 was recommended for short listing due to its predicted potential for a reduced negative environmental impact compared to the large barrage schemes.⁵⁰

⁴⁹ Department of Energy and Climate Change, [Analysis of options for tidal power development in the Severn Estuary - Interim Option Analysis Report Vol. 1](#), December 2008 [Accessed on 26 March 2010]

⁵⁰ *ibid*

6.7. Onshore and offshore tidal lagoon (Bridgewater Bay) (L3d and L3e)

Bridgewater Bay onshore tidal lagoon would be located on the English shore of the estuary between Hinkley Point and Weston Super Mare. The project is estimated to generate 0.6 per cent of UK demand with a construction cost of between £3.4-£4.1bn.

Table 8a: Bridgewater Bay lagoon (Onshore)⁵¹

Option	Pros	Cons
7a. Onshore tidal lagoon (L3d) (Bridgewater Bay)	<p>Proven technology.</p> <p>Lowest unit cost of energy for lagoon options (although not cheapest over all Severn options).</p> <p>Negative impacts on ports and fisheries are potentially less than for the barrage proposals.</p>	<p>Loss of 5,500ha of intertidal habitat loss.</p> <p>Possibility of sediment build up within the impounded area - needs further investigation in Phase 2.</p>

Option 7a was recommended for short listing because it was deemed the best performing lagoon on cost of energy.⁵²

Option 7b was a series of lagoons located completely offshore generating an estimated 0.7 per cent of UK electricity demand at an estimated construction cost of between £3.5-£5.8bn

Table 8b: Bridgewater Bay lagoon (Offshore)⁵³

Option	Pros	Cons
7b. Offshore tidal lagoon (L3e(i,ii))	<p>Small loss of intertidal habitat.</p>	<p>Very high cost of energy (nearly twice that of Bridgewater Bay land-connected lagoon).</p> <p>Difficult to predict impact on the structure of the Estuary and its wildlife.</p>

Option 7b was not recommended for short listing due to the high cost of energy.⁵⁴

⁵¹ Department of Energy and Climate Change, [Analysis of options for tidal power development in the Severn Estuary - Interim Option Analysis Report Vol. 1](#), December 2008 [Accessed on 26 March 2010]

⁵² *ibid*

⁵³ *ibid*

⁵⁴ *ibid*

6.8. Tidal fence (F1b)

Located between Minehead and Aberthaw (site of the outer barrage) the tidal fence scheme was estimated to generate 0.9 per cent of UK electricity demand at an estimated construction cost of between £6.5-£6.9bn.

Table 9: Tidal fence (Minehead to Aberthaw)⁵⁵

Option	Pros	Cons
8. Tidal fence (F1b) (Minehead to Aberthaw)	May be less environmentally damaging as it causes less intertidal loss than schemes producing a similar energy output.	<p>Unprecedented deployment of embryonic tidal stream technology.</p> <p>Great number of uncertainties including time needed to build reliable devices of the proposed size.</p> <p>Negative impacts on all ports within the Severn estuary and Bristol Channel.</p> <p>High unit energy cost.</p>

Option 8 was not recommended for short listing as it was considered to have too many unknowns in relation to the technology and impact on local environment. A tidal fence project is being developed as part of the SETS program.⁵⁶

⁵⁵ Department of Energy and Climate Change, [Analysis of options for tidal power development in the Severn Estuary - Interim Option Analysis Report Vol. 1](#), December 2008 [Accessed on 26 March 2010]

⁵⁶ *ibid*

6.9. Tidal reef (R1)

The tidal reef option, located between Minehead and Aberthaw, was estimated to generate 3.7 per cent of UK electricity demand at an estimated construction cost of £18.7-£19.8bn.

Table 10: Tidal Reef (Minehead to Aberthaw)⁵⁷

Option	Pros	Cons
9. Tidal reef (R1)	<p>May be less environmentally damaging than barrage options.</p> <p>May offer some flood protection.</p>	<p>Unproven application of technology - likely to need over a decade to reach commercial deployment.</p> <p>Estimated costs unknown.</p>

Option 9 was not recommended for short listing as it was considered to contain too many uncertainties regarding the technology development and environmental impacts.⁵⁸ A tidal reef project is being considered as part of the SETS program.

6.10. Severn lake scheme

Option 10, the Severn lake scheme (U1), was a 1km wide causeway as an addition to the Cardiff-Weston barrage designed to allow the construction of a number of additional features, including a wave farm on the seaward side and four marinas.⁵⁹ The scheme was not considered feasible solely as an energy project, relying on non-energy income to justify the cost and as such was not recommended for short listing.⁶⁰

⁵⁷ Department of Energy and Climate Change, [Analysis of options for tidal power development in the Severn Estuary - Interim Option Analysis Report Vol. 1](#), December 2008 [Accessed on 26 March 2010]

⁵⁸ *ibid*

⁵⁹ *ibid*

⁶⁰ *ibid*

Table 11: Short listed STP proposals⁶¹

Tidal Power Option	Generating Capacity	Annual Output	Contribution to UK electricity supply
	<i>GW</i>	<i>TWh/year</i>	<i>Per cent</i>
Cardiff - Weston Barrage	8.6	16.8	4.4
Shoots Barrage	1.1	2.77	0.7
Beachley Barrage	0.6	1.67	0.4
Fleming Lagoon	1.4	2.31	0.6
Bridgewater Bay	1.4	2.64	0.7

Table 12: Levelised Energy Costs⁶²

Tidal Power Option	Levelised Energy Costs*	Construction Cost**
	<i>£/MWh</i>	<i>£bn</i>
Cardiff - Weston Barrage	127	19.6 - 22.2
Shoots Barrage	104	2.9 - 3.5
Beachley Barrage	137	2.1 - 2.5
Fleming Lagoon	183	4.1 - 4.9
Bridgewater Bay	142	3.4 - 4.1

* Levelised energy costs use the estimated construction costs and the predicted energy generation potentials to calculate a unit cost of energy.

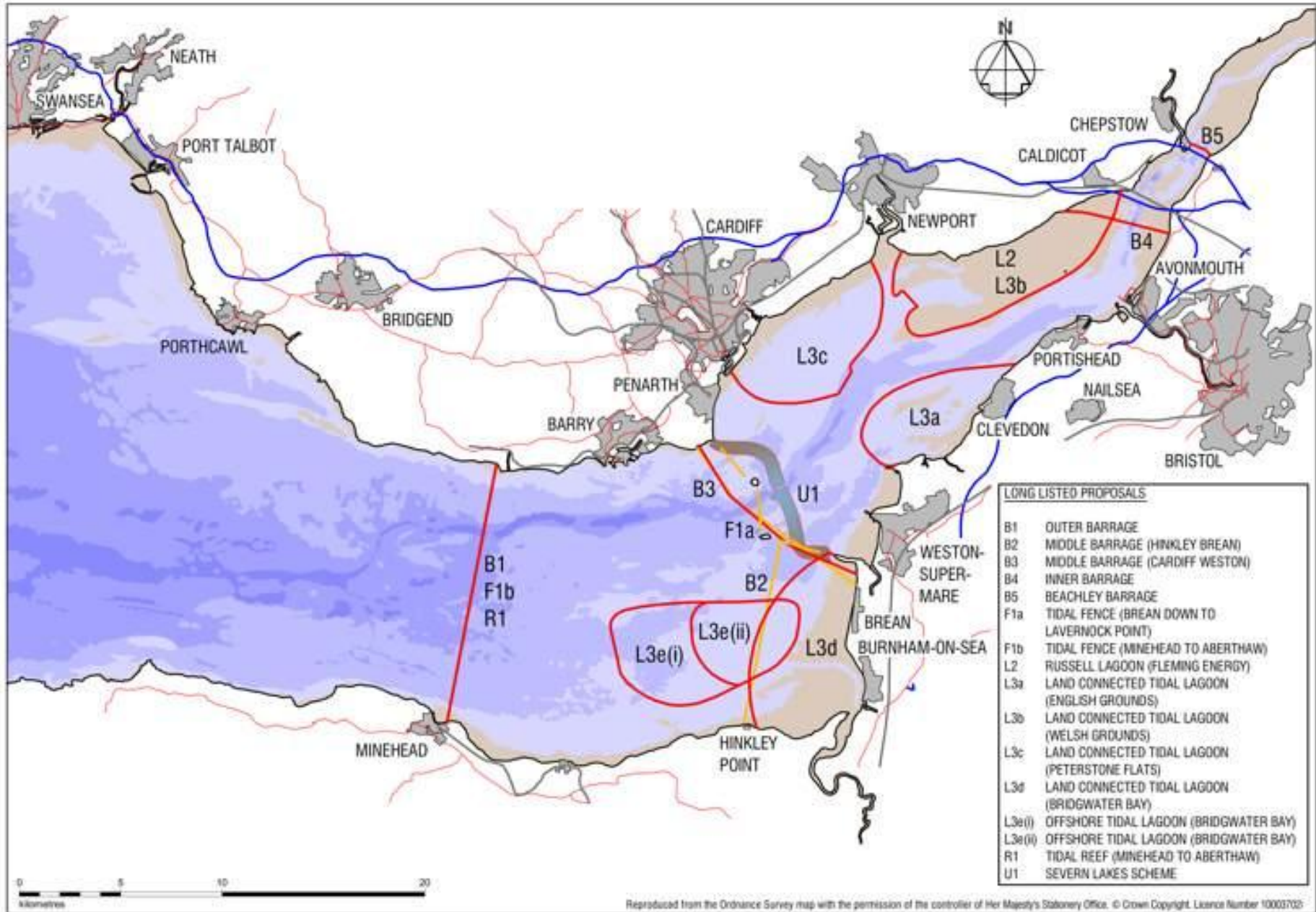
** Estimated construction costs have included predicted compensatory habitat costs and a 15 per cent contingency fund.

More detailed information regarding the short listed schemes, as well as comparisons with existing tidal power projects can be found in the Severn Estuary Tidal Power: Supplementary Information research paper.

⁶¹ Department of Energy and Climate Change, [Severn Tidal Power Phase one consultation](#), p28-29, January 2009 [Accessed on 10 March 2010]

⁶² Department of Energy and Climate Change, [Severn Tidal Power Phase one consultation](#), p28-31, January 2009 [Accessed on 10 March 2010]

Figure 3: Long listed STP proposal map



7. Future plans

The first public consultation period of the feasibility study closed at the end of April 2009.⁶³ As a result of the responses received the DECC is at present completing a formal Strategic Environmental Assessment (SEA) for the three barrages and two lagoons short listed which is covering the environmental, social and regional impacts of each of the schemes. Other proposals will be added to the scope of the assessment if they can demonstrate the potential for economic and technical feasibility.⁶⁴

The STP SEA is due to end in 2010 and will be followed by a second public consultation phase, probably opening in the second half of 2010 after the UK general election.

Decisions to be taken as a result of public evidence received will include:⁶⁵

- Is there a strategic case for a Severn tidal power scheme given the assessment of costs, benefits, risks and impacts compared to other technologies that are needed to meet renewable targets for 2020 or 2050?
- If the impacts, costs and risks of a proposal are acceptable, which scheme or schemes should the UK Government look to build, on what terms and in what timescale?

⁶³ Department of Energy and Climate Change, [Phase one consultation, Government response](#), July 2009 [Accessed on 26 March 2010]

⁶⁴ Department of Energy and Climate Change, [Severn Tidal Power, Strategic Environmental Scoping Report](#), January 2009 [Accessed on 26 March 2010]

⁶⁵ Department of Energy and Climate Change, UK energy supply, [Severn Tidal Power Feasibility Study](#), website [Accessed on 26 March 2010]

Table 13: Timeline of Severn Tidal Power Feasibility Study⁶⁶

Date	Milestone	Comment	
2008	Proposals & shortlisting	Call for Severn Tidal Power proposals and subsequent shortlisting procedure based on feasibility and cost	
2009	1st Public Consultation	Public consultation in 2009 on shortlisting procedure and short listed proposals	
2010	2nd Public Consultation	Public consultation probably in 2010 on whether Government should support a Severn scheme in principle. If a preferred option is identified following review of responses to consultation	If conclusion of study is not to support
2011-15	Scheme Development	Includes detailed engineering desings, financing arrangements, Environmental Impact Assessment and other preparation and impact assessment.	Regular reviews of progress towards energy goals will be held.
2014-16	Planning Permission	Planning and consenting process for both power scheme and measures to compensate for impact on environmentally-designated habitat. Opportunity for public comment. If approved: next stages are as follows	Need for Severn energy could be reconsidered in the light of these.
2015-20/22	Construction	Compensatory habitat and other compensatory measures, and power scheme. 5 years construction period is assumed for most scheme options, 7 years for a larger scheme.	
2018/23	Operation commences		

7.1. Severn Embryonic Technologies Scheme (SETS)

The latest update on the SETS progress indicated that the work-programme had concluded on 29 January 2010 and that all proposed schemes had submitted a final report, along with a development route-map. The three SETS proposals made formal presentations to the scheme’s programme board on 8 February 2010 and are now being reviewed. Recommendations are due to be published alongside the second STP feasibility study consultation later this year.⁶⁷

⁶⁶ Department of Energy and Climate Change, UK energy supply, [Severn Tidal Power Feasibility Study](#), website [Accessed on 26 March 2010]

⁶⁷ Department of Energy and Climate Change, UK energy supply, [Severn Embryonic Technologies Scheme](#), website [Accessed on 10 March 2010]

8. Stakeholder views

The DECC received a total of 734 formal written responses to the first public consultation held between January and April 2009. All of the responses can be viewed at the DECC website.⁶⁸ The following paragraphs detail the opinions of some of the main stakeholders and interested organisations.

Bristol Port Company:⁶⁹

...our comments should be read in the context of the Bristol Port Company's overarching concerns as a statutory undertaker which operates one of the UK's major deepwater ports. These concerns are directed, therefore, at any of the STP proposals, which are likely to prejudice the environment within our area of jurisdiction and its approaches and the safe, efficient (and cost-effective) conduct of navigation of ships which wish to use Bristol Port to the extent that the viability of this piece of national transport infrastructure will be placed in jeopardy. Also at stake here are the livelihoods of the seven and a half thousand people who depend on the Port.

British Wind Energy Association (BWEA):⁷⁰

BWEA are encouraged by the Severn Tidal Power – Embryonic Technologies Scheme and greet this as a positive opportunity for the tidal energy industry. However there is concern that there has not been sufficient time for interested parties to formulate comprehensive responses to the call for expressions of interest. It is also thought that £500,000 of funding and the limited duration of phase 2 are not sufficient to develop emerging technology projects to a comparative level of technical understanding to conventional barrage technologies.

Cardiff County Council:⁷¹

The Council recognises the extensive work undertaken to date and is satisfied that the short listing process, scope of the Strategic Environmental Assessment and issues covered by the feasibility study represents a sound bases on which to further examine options. However, it is recommended that further dialogue with the Council and other bodies continues as the on-going studies provide further information. Such dialogue will help inform the Council of the merits or otherwise of options being considered.

Countryside Council for Wales (CCW):⁷²

All short-listed options will result in changes to the natural environment of the Severn Estuary and surrounding area to some extent. While acknowledging the need to uphold existing legal frameworks to safeguard protected species and designated areas, CCW recognises that we need to accept small-scale, local environmental impacts from renewable energy developments to secure global, long-term environmental benefits. This is set out in our *Energy & Natural Heritage* position statement. However, the scale of environmental impacts which would result from the Cardiff-

⁶⁸ Department of Energy and Climate Change, [Consultations: Full responses to the Severn Tidal Power – phase one](#), website [Accessed on 26 March 2010]

⁶⁹ The Bristol Port Company, [response to UK Government STP phase one consultation](#), April 2009 [Accessed on 26 March 2010]

⁷⁰ British Wind Energy Association, [response to the UK Government STP phase one consultation](#), April 2009 [Accessed on 26 March 2010]

⁷¹ Cardiff County Council, [response to the UK Government STP phase one consultation](#), April 2009 [Accessed on 29 March 2010]

⁷² Countryside Council for Wales, [response to the UK Government STP phase one consultation](#), April 2009 [Accessed on 26 March 2010]

Weston barrage, and compensation required, means that we question its inclusion in the short-list. The next phase of the feasibility study will need to take a robust look at the environmental risks and whether it is realistic and affordable to provide compensatory habitats at this scale and whether the impacts on migratory fish can be resolved.

Environment Agency (EA):⁷³

We support the development of appropriate energy schemes in the Severn Estuary and elsewhere to secure the reduction in green house gas emissions required by 2050; the particular tidal movements of the Severn have a clear potential for the development of renewable energy.

The Severn Estuary is however a unique natural environment. The bird and fish habitats in the estuary and its tributaries are among the most important in Europe. We believe that compliance with the Habitats Directive, particularly with respect to migratory fish, is the most difficult challenge for any potential project in the Severn Estuary. All of the options included in the short list will result in changes – some irreversible – to designated habitats and species.

Given the potential impacts on the environment, Governments must make sure that any energy development in the Severn Estuary is justified both by its contribution to greenhouse gas reduction and energy security, and by how it keeps habitat impacts to a minimum.

E.ON UK:⁷⁴

Generally we believe that the feasibility study has taken the correct factors in to account. However, we do have some comments with regard to the relevant weighting given to each of the factors.

Paragraph 163 splits five of the criteria into Group 1 (technical risk, cost of energy, affordability) to determine whether a project could be built and Group 2 (environmental impact, regional and social factors) to *“identify whether there are reasons why a scheme that is less favourable on economic and technical grounds should be given further consideration”*. It is not clear why environmental impact is only a consideration for a scheme that is less economically or technically favourable.

Given the rigorous nature of the Habitats Directive (and to a lesser degree other environmental legislation such as the Water Framework Directive and Eel Passage Regulations) the most economically and technically favourable scheme may not necessarily be able to be built within the requirements of environmental legislation. Conversely the most environmentally favourable scheme may be more technically challenging. Consequently there is a need to take a holistic approach and address both environmental and commercial risks in coming to the conclusion of the best option to follow.

Friends of the Earth Cymru:⁷⁵

...Friends of the Earth Cymru recommend that the draft Phase 2 short list should be revised to include tidal reefs and offshore lagoons. Furthermore, we note a failure in the study methodology and structure which needs addressing if the Government’s remit, if not EU law, is to be best served. Reasonably sufficient optimisation of reef and offshore lagoon schemes in Phase 1 may well have led to their inclusion on the draft short list for Phase 2 studies. Yet optimisation is only planned in the Phase 2 studies. Optimum combinations of schemes, addressing non-economic as well as economic issues, may include technologies or schemes which have been recommended for exclusion in the Phase 1 studies. So we believe that the study should be re-structured to be fair and

⁷³ Environment Agency, [response to the UK Government STP phase one consultation](#), April 2009 [Accessed on 26 March 2010]

⁷⁴ E.ON UK, [response to the UK Government STP phase one consultation](#), April 2009 [Accessed on 26 March 2010]

⁷⁵ Friends of the Earth Cymru, [response to the UK Government STP phase one consultation](#), April 2009 [Accessed on 26 March 2010]

sufficiently flexible to include a variety of possible project proposals including combinations of schemes and new innovations.

Institution of Civil Engineers (ICE):⁷⁶

The development period [for new tidal technologies] before they could be implemented on the very large scale needed in the Severn is likely to be 10 to 20 years or more. On the Severn we therefore believe it is better to move ahead quickly with proven technology or technologies where only minor modifications are required for operation in the Severn Estuary. However, as Government is faced with pressing obligation for both reducing CO₂ emissions and increasing renewable energy generation we strongly support the Government's proposed fund for development of the tidal fence and reef proposals on the ground that feasibility and cost need to be determined for the longer term development of tidal energy in the UK. Given the size of the energy generation challenge facing the UK, we require the rapid introduction of demonstrator projects connected to the grid and monitored effectively.

We believe that a number of the environmental issues have been considered on a precautionary basis, identifying the worse case impact. We believe that more detailed and site specific studies will show some of these impacts to be overstated. As an example, many of the changes resulting from the power scheme on the Rance Estuary in France have been shown to be beneficial, and the impact of the Rance barrage turbines on fish has been found to be minimal.⁷⁷

National Grid:⁷⁸

Of all the intermittent forms of generation, tidal power is predictable, which should present a number of opportunities so seek longer term 'demand' solutions, where demand could follow generation by design. This could be by one or a combination of managing demand by direct system operator action, (e.g. pumped storage) by new 'wholesale' electricity demand (e.g. available in the Balancing Mechanism) or market price sensitive demand (e.g. Smart technology). This new 'wholesale' electricity demand could be aimed at meeting the overall transport, heat and electricity environmental goals.

National Trust:⁷⁹

The Severn Tidal Power Feasibility Study should seek to identify a project which maximises the generation of renewable energy, while minimising damage to the Severn Estuary's internationally important wildlife, and natural and historic environment. Any solution should also be consistent with the tests which the Sustainable Development Commission posed in its review of tidal power, 'Turning the Tide: Tidal Power in the UK'. The first is compliance with EU law, e.g. the Habitats and Birds Directives. Secondly, the solution should form a significant part of a radical plan to tackle climate change, including reduction in energy demand, rapid deployment of sustainable, low impact renewables and development of a more decentralised energy system.

⁷⁶ Institution of Civil Engineers, [response to the UK Government STP phase one consultation](#), April 2009 [Accessed on 29 March 2010]

⁷⁷ Kirby R & Retiere C, (2009) Comparing environmental effects of Rance and Severn barrages, *Maritime Engineering* 162 p11-26

⁷⁸ National Grid, [response to the UK Government STP phase one consultation](#), April 2009 [Accessed on 26 March 2010]

⁷⁹ National Trust, [response to UK Government STP phase one consultation](#), April 2009 [Accessed on 26 March 2010]

Royal Society for the Protection of Birds (RSPB):⁸⁰

The right way forward must be to actively pursue wave and tidal power solutions that deliver maximum energy at minimal environmental cost. In this context and timeframe, and given the huge long-term potential of wave and tidal energy, our focus should be on getting the right solutions in place to provide a significant percentage of our energy needs in the period 2020-2050, at an appropriate economic and environmental cost. The RSPB believes that this can be achieved by taking a strategic approach to investing in, designing and pilot testing wave and tidal energy projects that incorporate environmental concerns from the outset.

Severn Rivers Trust:⁸¹

From the outset, we have argued that the feasibility study should have looked at how to give environmental constraints equal consideration alongside economic factors, energy generation potential and technological advancement in the design of any solution to harness the power of the estuary. Having rejected this approach in favour of tendering for proposals, we believe that the Government has adopted an assessment framework to appraise options that is seriously flawed. Application of the current assessment framework means that only schemes which meet specified economic and technical criteria have been short-listed, irrespective of their socio-environmental impacts. In contrast, those projects that take socio-environmental considerations into account in innovative designs appear to have been rejected on cost grounds. In our view, this approach is irrational and contrary to public interest in that it could lead to the rejection of a practicable alternative on cost grounds alone.

Severn Tidal Power Group (STPG):⁸²

In general all the issues have been taken into consideration. However, although referred to, insufficient emphasis has been placed on the positive aspects and benefits of the schemes. Most importantly the key flood protection, security of supply and potential transport, inward investment and thus job creation benefits are glossed over, and their value has not been estimated.

Intermittency during the tidal cycle is not a serious technical problem because the grid already copes with similar changes in demand occurring at similar rates. [...] To balance the intermittency, more work must be done to evaluate the costs and benefits of storage mechanisms. These may include multiple basins and pumped storage whether on mountain tops or in underground caverns.

World Wildlife Fund (WWF):⁸³

WWF believes that a revolution in our energy systems is vital if we are to meet the challenges of climate change and energy security. Our absolute priorities must be a strong drive for energy efficiency and sustainable, low-impact renewable energy technologies.

We strongly support the Government's commitment to deliver the UK's fair share of the EU renewable energy target for 2020, but believe that in doing so it must respect wider concerns over environmental sustainability.

⁸⁰ Royal Society for the Protection of Birds, [response to the UK Government STP phase one consultation](#), April 2009 [Accessed on 26 March 2010]

⁸¹ Severn Rivers Trust, [response to the UK Government STP phase one consultation](#), April 2009 [Accessed on 26 March 2010]

⁸² The Severn Tidal Power Group, [response to the UK Government STP phase one consultation](#), April 2009 [Accessed on 26 March 2010]

WWF is concerned that a Severn Barrage may impose unacceptable environmental impacts on the Severn Estuary and entail a serious breach of the Habitats Directive. We therefore call on the Government to ensure that alternative, lower impact options to exploit the Severn's tidal energy are not prematurely excluded from the ongoing feasibility study, and to ensure that its overall energy policy is designed to deliver rapid uptake of lower-impact technologies both in the Severn and across the UK.

⁸³ World Wildlife Fund, [The Severn barrage debate: Summary of WWF's position](#), April 2009 [Accessed on 26 March 2010]

9. Compensatory habitats

As part of phase one of the STP feasibility study, a preliminary screen report on compensatory habitat and mitigation measured investigated what the requirements would be to comply with EU legislation. The STP SEA in phase two will further investigate the costs and proposal specific requirements.⁸⁴ For any STP proposal to proceed, it would be a legal requirement to establish compliance with certain aspects of the *Habitats Directive*⁸⁵ and *Birds Directive*⁸⁶ and to maintain the overall coherence of the Natura 2000⁸⁷ network.⁸⁸ The SDC paper on tidal power in the UK came to the following conclusions regarding the European conservation legislation relating to the Severn Estuary:⁸⁹

The Directives [*Habitats Directive* and *Birds Directive*] provide clear and robust legal framework for achieving sustainable development and therefore compliance with the Directives is a central condition for a sustainable Severn barrage. The SDC would be firmly against moves to reform or derogate from the Directives, as this would send a dangerous signal to other European Member States that could end up harming compliance with the Directives, and the biodiversity objectives that they uphold. This means that proponents of a Severn barrage must be prepared to fully comply with the process laid out by the EU Directives, including the requirement for a full compensatory habitats package to be in place before a barrage is built. Providing compensatory habitat on this scale would be a very significant undertaking matched by an equally high cost, but it needs to be seen as a central part of any proposal which may eventually dictate whether or not it can proceed.

There is a strong presumption in guidance under the *EU Habitats Directive* that developments will seek to minimise their impacts on designated sites before recourse to compensatory measures.⁹⁰ Although it is clear that there are likely to be very significant impacts on internationally designated sites as a result of a STP build, a major problem lies in the uncertainty surrounding the potential magnitude of many of the suggested impacts, especially over the long term.⁹¹

The main areas of uncertainty surrounding impact predictions include:⁹²

- The potential impacts on the estuary hydrodynamics, particularly its tidal prism, which is fundamental in informing an evaluation of changes in the extent of intertidal habitat.
- Limited understanding of the impacts of tidal power development on long-term geomorphology, which is likely to strongly influence the distribution, quality and functional

⁸⁴ Department of Energy and Climate Change, STP – [Habitats Regulations Assessment: Preliminary Screening Report](#), December 2008 [Accessed on 29 March 2010]

⁸⁵ Council Directive 92/43/ECC 21 May 1992 [Conservation of natural habitats and of wild fauna and flora](#). [Accessed on 26 March 2010]

⁸⁶ Council Directive 79/409/EEC [on the conservation of wild birds](#). [Accessed on 29 March 2010]

⁸⁷ Natura 2000 network was established as a combination of the Special Areas of Conservation (SACs) and Special Protection Areas (SPAs) created by the two European directives on birds and habitats. All EU Member States contribute to the network of sites in a Europe-wide partnership.

⁸⁸ [The Conservation \(Natural Habitats, &c.\) Regulations 1994](#). SI 1994/2716 [Accessed on 26 March 2010]

⁸⁹ Sustainable Development Commission, [Turning the Tide, Tidal Power in the UK](#), October 2007 [Accessed on 29 March 2010]

⁹⁰ Council Directive 92/43/ECC 21 May 1992 [Conservation of natural habitats and of wild fauna and flora](#). [Accessed on 26 March 2010]

⁹¹ Department of Energy and Climate Change, [Severn Tidal Power – Preliminary review of possible mitigation and compensation requirements under the Habitats Directive](#), October 2008 [Accessed on 26 March 2010]

⁹² *ibid*

aspects of ecological features as well as impacting on the effectiveness of potential mitigation measures.

- Aspects of the use of the Severn Estuary by some migratory fish species (e.g. shad, lamprey) and thus the potential risk posed by tidal power developments in specific locations.

The consideration of compensation measures has focused on three main options:⁹³

- Creation of new estuarine habitats through managed realignment or other techniques such as Regulated Tidal Exchange at locations within and beyond the Severn Estuary. Such habitats could provide compensation for potential impacts to waterbirds.
- Opportunities for ecological enhancement measures within existing designated sites where such measures are not already required to support achievement of conservation objectives. Such measures might include habitat improvements and also in the case of migratory fish, stock enhancement measures.

The following table compares the cost estimates, provided in the DECC preliminary review of compensation requirements, (excluding optimism bias)⁹⁴ for appropriate compensatory habitats for each of the short listed STP proposals.

Table 14: Cost comparison of compensatory habitats for the short listed STP proposals.⁹⁵

Tidal Power Option	Compensatory habitat cost	Construction cost
	<i>£bn</i>	<i>£bn</i>
Cardiff - Weston Barrage	2.6	19.6 - 22.2
Shoots Barrage	0.6	2.9 - 3.5
Beachley Barrage	0.5	2.1 - 2.5
Fleming Lagoon	0.8	4.1 - 4.9
Bridgewater Bay	0.7	3.4 - 4.1

⁹³ Department of Energy and Climate Change, [Severn Tidal Power – Preliminary review of possible mitigation and compensation requirements under the Habitats Directive](#), October 2008 [Accessed on 26 March 2010]

⁹⁴ Optimism bias is the inclusion within a cost estimate of a contingency to account for the susceptibility of systematic tendencies towards over-estimating the likelihood of positive events and under-estimating the likelihood of negative events.

⁹⁵ Department of Energy and Climate Change, [Partial Impact Assessment for the Phase One consultation on the Severn Tidal Power Feasibility Study](#), November 2008 (amended February 2009) [Accessed on 26 March 2010]

