Severn Estuary Tidal Power
Feasibility Study

Not just a barrage!

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ICES – South Wales and South West
1 December 2008 – Aberdare Hall, Cardiff
Who am I?

• Currently on secondment from National Grid to DECC (formerly BERR formerly DTI)
  – Looking at Grid impacts of tidal generation in the Severn Estuary

• National Grid “born and bred”
  – Joined in 1990
  – Research and Development
  – System Operations
  – Commercial
    • Transmission charging
    • Charging methodologies
    • New Connections contracts
Severn Estuary Tidal Power Feasibility Study

Background
Sustainable Development Commission Report
“Tidal Power in the UK”
Background to the Severn Tidal Feasibility Study

- Sustainable Development Commission study of tidal power commissioned in Energy Review 2006
- ‘Tidal Power in the UK’ published Autumn 2007:
  - strong case for a sustainable Severn barrage; it must comply with environmental legislation
  - ‘environmental opportunity’ linking environmental compensation measures to climate adaptation
  - HMG should own and lead the project and
  - decision making should be open and transparent
Feasibility study overview

• September 2007 – Secretary of State commissioned 2 year BERR led feasibility study (now DECC)
• January 2008 – Terms of Reference for 2 year study published
• To answer question: could Government support a Severn Estuary tidal power scheme and if so on what terms?
• 2 year study to early 2010; 2 stage process with 2 public consultations
• External advice
• All tidal range schemes, not just barrages
• Set in wider context: renewable energy strategy, energy and climate change goals
Policy Context

Government Aims
To ensure the reliable and efficient use of clean, safe and affordable energy
- Lead the global effort to tackle climate change.
- UK energy mix should be diverse, more efficient use of energy and reduction in demand
- Obligation on UK to meet share of EU renewable target of 20% by 2020
Renewable Energy Strategy

- Consultation towards strategy next year and UK action plan 2010; heat and energy efficiency consultations to come
- 10-fold increase in renewable energy by 2020
- Split across electricity, heat and transport
- Proposed measures include:
  - extending and raising the level of the Renewables Obligation, new financial instrument for heat, more effective financial support for microgeneration, RTFO increase
  - addressing key barriers to delivery: planning system - deployment strategy at regional level; improving grid access; supply chain.
Feasibility study progress

• Long-list of 10 potential tidal power schemes
• Gathering and analysing evidence through:
  – Strategic Environmental Assessment (SEA) – PB consortium
  – PWC work on financing, ownership structures, and possible subsidy mechanisms
  – Regional economic impact study (DTZ)
  – Considering energy market impact, grid implications, and supply chain
• Peer review processes for external work include expert technical panel
• Comes together for review at the end of the year
Introduction to Tidal Generation (1/2)

- Tides caused by interaction of oceans with the moon and the sun
- Two high tides every 24 hours and 50 minutes
- Height of low and high tides changes
  - Spring tide gives biggest difference between high and low tide
  - Neap tide gives lowest range
- Ebb generation – generates as tide is going out
- Flood generation – generates as tide is coming in
Introduction to Tidal Generation (2/2)

- Tidal Range: Uses change in sea level to generate power
  - Severn Estuary has best tidal range resource in UK
  - 14 metre peak range
  - Highest range furthest upstream
  - Conventionally generates on ebb for 4-6 hours roughly twice a day
  - Additional output with additional pumping

- Tidal Stream: Uses velocity of water to generate power
  - Some potential in the Severn but not a prime site

- Wave Power: Uses wave action to generate power
Severn Estuary Tidal Power Feasibility Study

Initial Options
Severn Tidal Power Initial Options (1/3)

Minehead to Aberthaw alignment:

- Barrage
- Tidal Reef
- Tidal Fence
Initial Options – 20km Minehead to Aberthaw Alignment (1/2)

- Outer Barrage – 14.8GW 25TWh per year (conventional Barrage)
- Tidal Fence Proposal – 1.3GW 3.5TWh per year (an array of tidal stream turbines proposed by Pulse Tidal)
Initial Options – 20km Minehead to Aberthaw Alignment (2/2)

- Tidal Reef Proposal – 5000MW 20TWh per year (a new technology – Rotating turbine modules using 2 m head) – proposed by Evans Engineering
Severn Tidal Power Initial Options (2/3)
Cardiff to Weston-super-mare (Brean Down – Lavernock Point)
variants:
  • Cardiff – Weston barrage
  • Cardiff - Hinkley barrage
  • Severn Lakes
Initial Options – Cardiff to Weston (and variants)

- Lavernock Point to Brean Down – 16km 17TWh per year (conventional Barrage)

- Variant of B3 that runs to Hinkley Point rather than Brean Down (“improved flood defence and grid connections”) – proposed by Shawater

- Variant of B3 that employs a 1km wide causeway and adds land, leisure and wave energy developments – Severn Lakes proposal
Initial Options – Cardiff to Weston (and variants)
Severn Tidal Power Initial Options (3/3)

Upper Estuary Options:

- Beachley Barrage
- Shoots Barrage
- Welsh Grounds lagoon
- Generic lagoons
Initial Options – Upper Estuary Options (1/2)

• Shoots Barrage – 1.05GW 2.77TWh per year (conventional Barrage)

• Beachley Barrage – smaller than Shoots (0.6GW) but avoids blocking the Wye

• Welsh Grounds – 1.5GW 3TWh Tidal Impoundment proposed by Fleming Energy

• Tidal Lagoons – various onshore and offshore locations including options proposed by Tidal Electric extending throughout the estuary.
Initial Options – Upper Estuary Options (2/2)

- Shoots Barrage – 1.05GW 2.77TWh per year (conventional Barrage)
- Beachley Barrage – smaller than Shoots (0.6GW) but avoids blocking the Wye
Initial Options – Combinations and Modes of Operation

Potential Combinations

• Tidal Lagoons + Smaller Barrage
• Multiple Tidal Lagoons
• Tidal Fence + Smaller Barrage
• Others subject to further study

Modes of Operation

• Ebb only
• Ebb and Flood
• Pump Assisted
• Multiple Basins
Severn Tidal Power – Grid Issues

• Range of options being considered to harness the tidal resource in the Severn Estuary (200MW-12000MW).

• All transmission connected projects would require network reinforcements:
  – to connect the new generation to the existing transmission system;
  – to accommodate the changes in power flows.

• Smaller projects (< 2GW) should not cause any significant issues for National Grid.

• Larger projects such as the Cardiff-Weston barrage create a number of challenges.
Larger Tidal Projects

Grid Issues (1/2)

• Cardiff – Weston barrage has estimated output of 8.6GW.
• Over twice the size of largest existing power station.
• Would require significant transmission reinforcements including new substations and up-rated and additional transmission circuits.
  – Local and remote to the Severn Estuary.
• Scope of transmission works could be reduced if operation is coordinated with other generation in the vicinity.
• Peak capacity (MW) is the main driver of transmission reinforcements.
• Fault levels and system stability will also be an important consideration:
  – Cost benefit of direct current (DC) connection;
  – DC transmission.
Larger Tidal Projects
Grid Issues (2/2)

- Large barrage is expected to operate roughly twice a day.
- In order to manage system frequency, periods of “ramping” up and down will need to be carefully controlled.
- System Operator deals with 40-50MW/minutes ramp rates.
- Large barrage may be 100-200MW/minute:
  - May need new systems and processes;
  - Impact on system balancing costs.
- Intermittent generation with uncontrollable “fuel source”:
  - Impact on other generation.
- Although intermittent, output is highly predictable:
  - May be potential of linking to demand management scheme.
Severn Estuary Tidal Power Feasibility Study

Short-listing and Consultations
Assessment Framework for Initial Options

Initial Screen
- Technology and/or Financing Risks

Quantitative
- Energy Outputs and CO₂ savings
- Levelised Costs

Qualitative
- Environmental Effects
- Social / Regional and Economic Effects

Sensitivity Testing

Iterative Approach
- Review and Updating of Options during assessment
Strategic Considerations

- **Energy markets impact** e.g. fit with Renewable Energy Strategy displaced generation, impact on consumers

- **Affordability, deliverability and value for money** including the cost of the proposal relative to other options under RES, feasibility of financing the proposal, the cost and nature of the support package and how it would be funded; implications for the Government’s balance sheet

- A high level view of the scale of **environmental damage** and associated cost implications and ability to comply with EU environmental protection legislation including compensatory habitats

- Associated **Risks** – legal, commercial, technical, scientific and public/private exposure to these

- **Economic, social, regional impacts** e.g. the effects on local business and residents, on UK ports capacity, transport implications (from PB and Regional Economic study)
Strategic Environmental Assessment Scoping

• SEA forms part of option comparison process

• Scoping of issues to be covered in SEA, and research to address them, is currently underway and includes:
  – Literature and data review
  – Technical consultations
  – Stakeholder consultation
  – Preparation of 16 topic papers detailing issues and studies required

• Scoping Report will be published as part of public consultation in early 2009.
16 Topic Papers

- Carbon footprint
- Fish and fisheries
- Flood risk & land drainage
- Groundwater, freshwater & soils
- Historic environment
- Hydraulics & Geomorphology
- Landscape and seascape
- Marine ecology

- Marine water quality
- Navigation
- Noise and vibration
- Ornithology
- Other sea-bed uses
- Socio economics & community
- Terrestrial ecology
- Waste and resources
Short-List of Potential Options

SDC Report

Call for Proposals

Strategic Locations

Long-List of Potential Options

SEA Reasonable Alternatives

Assessment Framework

SEA Scoping & Early Research

Public Consultation

Fair Basis Estimation of Costs, Programme and Energy Yield

SEA Scoping Report

Optimised Designs, Detailed Assessment of Costs, Programme and Energy Yield

SEA Research, Consultation and Assessment

Preferred Option

Environmental Report and Appropriate Assessment
### Stakeholder Engagement

#### Internal stop/continue review points

<table>
<thead>
<tr>
<th>2008</th>
<th>2009</th>
<th>2010</th>
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<tbody>
<tr>
<td><strong>Policy analysis - Stage 1</strong></td>
<td><strong>Public Consultation</strong></td>
<td><strong>Policy analysis – Stage 2</strong></td>
</tr>
<tr>
<td>Focus on high level issues and short-listing of tidal power options.</td>
<td>Scope of SEA</td>
<td>Consideration of costs, impacts and benefits of short-listed options in more detail.</td>
</tr>
<tr>
<td>Reach a first view on whether there are any fundamental issues that mean the Government is not interested in promoting a Severn scheme.</td>
<td>Short-listing of options for detailed assessment</td>
<td>Full cost-benefit analysis.</td>
</tr>
<tr>
<td><strong>Strategic Environment Assessment – Scoping Stage Activities</strong></td>
<td><strong>SEA – Data Gathering and Analysis Activities</strong></td>
<td><strong>Public Consultation</strong></td>
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<tr>
<td>High level assessment of options. Collect information for environmental baseline and decide on approach to be used for data gathering and analysis etc.</td>
<td>Survey, consultation and assessment processes</td>
<td>High level evidence analysis and Government recommendations</td>
</tr>
<tr>
<td>How the feasibility study is being conducted, the issues it is considering and how these are being approached</td>
<td>Commission additional related studies as needed</td>
<td>Question: should Government support a Severn Tidal Power project and if so on what terms?</td>
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**Policy analysis - Stage 2**
- Consideration of costs, impacts and benefits of short-listed options in more detail.
- Full cost-benefit analysis.

**Public Consultation**
- Scope of SEA
- Short-listing of options for detailed assessment
- Survey, consultation and assessment processes
- Commission additional related studies as needed

**Public Consultation**
- High level evidence analysis and Government recommendations
- Question: should Government support a Severn Tidal Power project and if so on what terms?

**Consideration of responses and Government Decision**
How to get involved

• 2 public consultations:
  – Early 2009
    • scope of the SEA
    • which of the 10 possible Severn tidal power schemes under consideration will be short-listed for detailed impact assessment during 2009
    • how the feasibility study is being conducted, the issues it is considering and how these are being approached
  – 2010
    • Evidence gathered and analysis done, in order to inform the decision on whether to proceed, the terms of proceeding and a single preferred option

• Quarterly stakeholder events
• Contact the team at: severntidalpowerunit@decc.gsi.gov.uk
Further Information

www.berr.gov.uk/energy/severntidalpower

www.wales.gov.uk/severntidal

www.decc.gov.uk
Questions?
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Stuart Easterbrook
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ICE West Midlands
19 November 2008 - Austin Court, Birmingham