Stepping Stones
Tidal Lagoon

An outline proposal for a new tidal range project in the Severn Estuary

by

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in association with Black & Veatch

Peter Kydd - August 2012

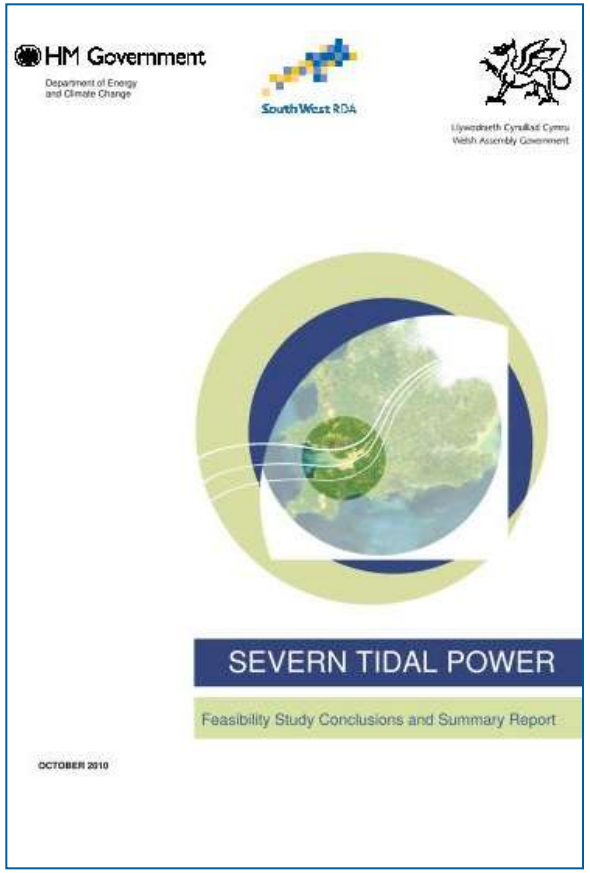
Realising the knowledge from the STPFS

A new proposal for tidal power from the Severn Estuary

The Severn Tidal Power Feasibility Study highlighted many issues and uncertainties.

This new proposal has been developed and informed by the STPFS outputs

It has been developed by Parsons Brinckerhoff in association with Black & Veatch



The STPFS and other studies highlighted key issues

Issues

- Tidal range projects studied recently have some common conclusions:
  - Mitigation or compensation of environmental impacts have increased energy costs
  - Uncertainties in extent of environmental and regional impacts
  - Longer term benefits from the initial investment are largely ignored

Opportunity

- Potential tidal power resource in UK is significant (>15GW), located close to demand and predictable – additional system costs are therefore lower than offshore wind

But

- Uncertainties, high cost commitment and scale are not attractive to investors or policy makers

What is the next logical step?

Stepping Stone Concept

Could an interim smaller option for the Severn be developed in the private sector to improve confidence without compromising the business case for a subsequent larger option?

How can the longer term benefits of such an option be realised in today's economic climate?

A stepping stone to future development of tidal power?

An incremental approach

A new proposal, smaller in size than the Severn options, to assess tidal power in action.

Objectives

- To demonstrate that tidal power can be generated from the Severn Estuary with acceptable cost, environmental and social impacts and build UK confidence in ocean energy
- To be informed by the Severn Tidal Power Feasibility Study research and add to that research base through full scale demonstration
- To be financeable in the private sector but developed in partnership with the public sector

Constraints

- Should not compromise future development of the short listed options in the Severn Tidal Power Feasibility Study
- Should not impact Severnside Ports
- Should not involve significant habitat and ecological loss
- Should be competitive with offshore wind in the long term

The New Proposal

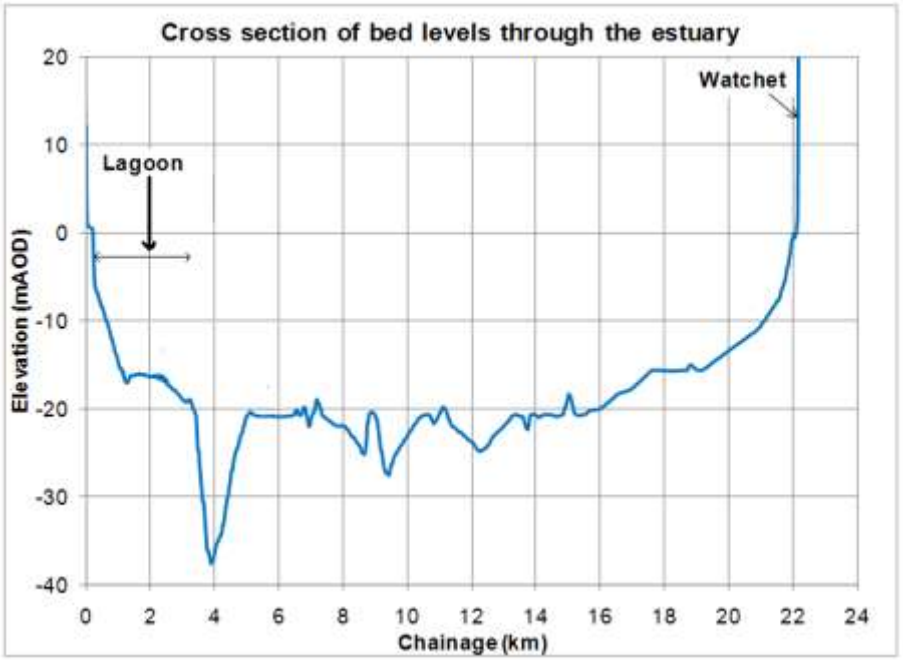
A Tidal Lagoon

- Why?
  - Because of the performance of the Bridgwater Bay lagoon in the STPFS
  - a lagoon does not inhibit access to commercial ports in the Severn
  - Noted that Bridgwater Bay location has poor ground conditions and was significantly larger reflected in the overall capital cost
  - Also noted that the locations of all STPFS short-listed options resulted in impacts on protected environmental areas
- **The new proposal** is located:
  - on a rock formation
  - in a less protected environmental area (but still impacts on the East Aberthaw SSSI)
  - is significantly reduced in scale (600MW) but would still be the largest tidal power plant in the world
  - and close to grid connection (at Aberthaw PS)
- It uses an optimised form of lagoon wall construction based on reinforced concrete units capable of over-topping but otherwise is based on STPFS assumptions

Is relatively small in the context of the estuary

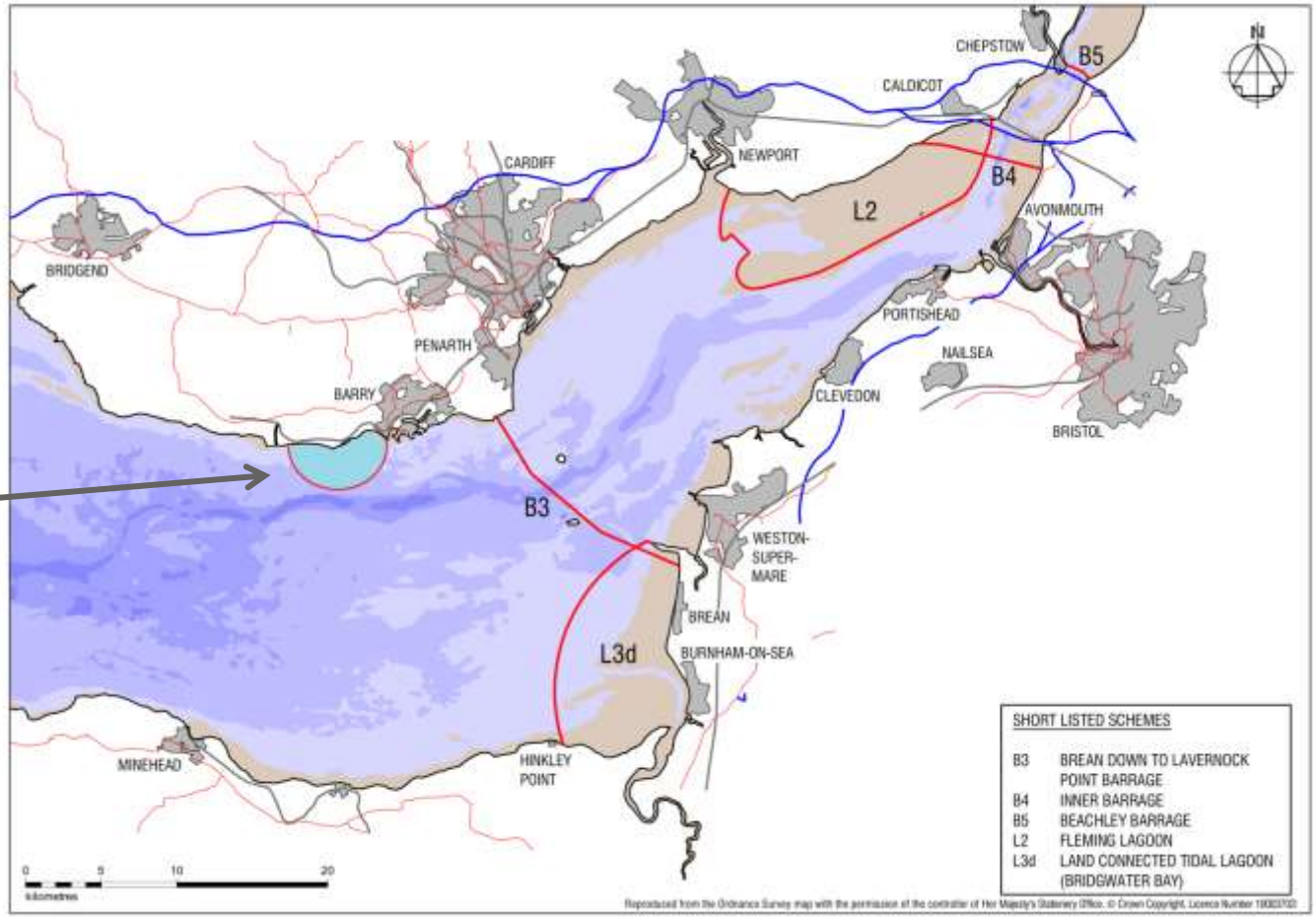
Key Location Characteristics

- On the rock formation between Aberthaw and Barry in South Wales – the lagoon's power station would be located close to Aberthaw Power Station
- Foundation depth varies but is typically -18m OD, requiring caissons of up to 25m in height for the main lagoon wall
- Avoids the main shipping channels and the most sensitive (and protected) areas of the Severn

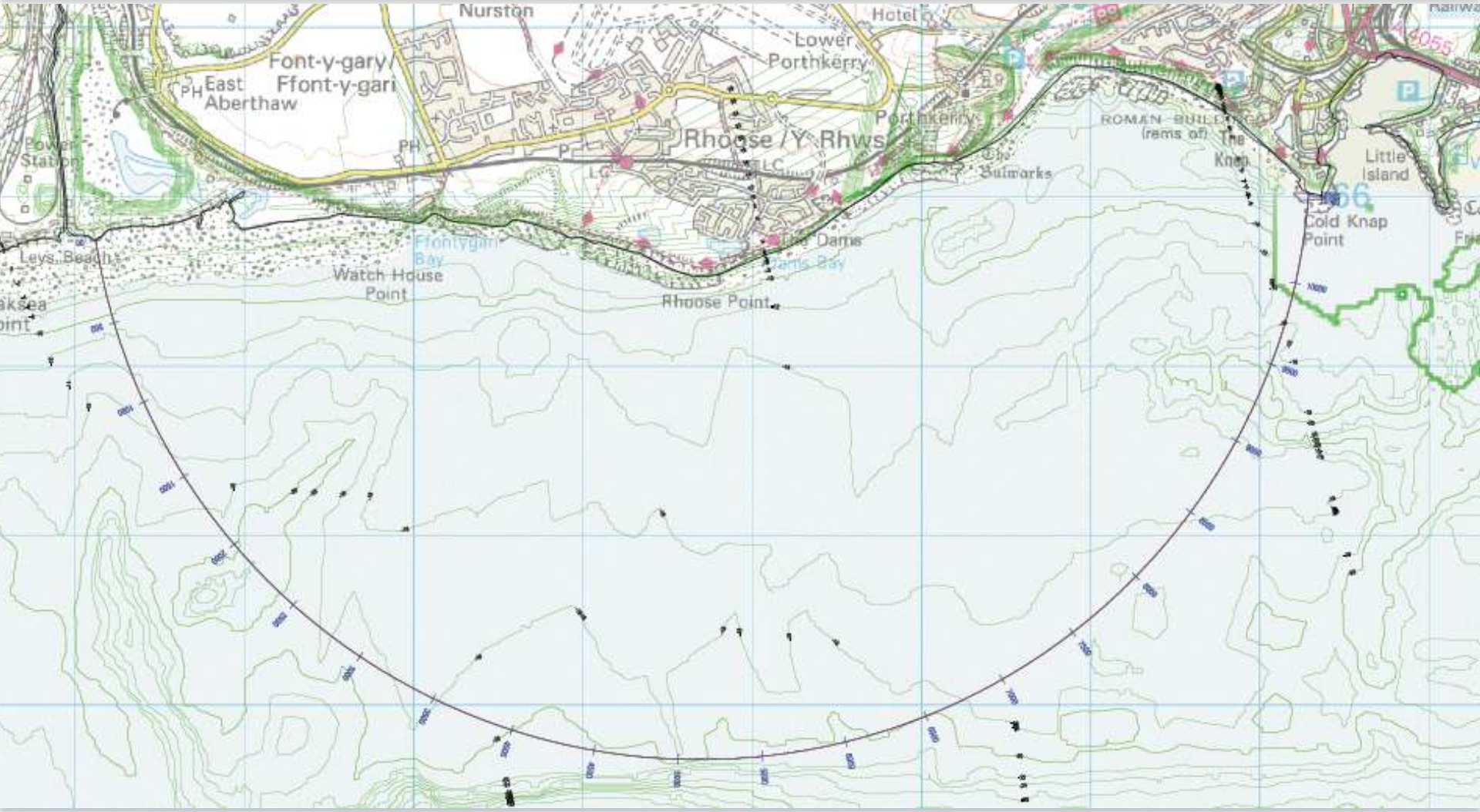


Downstream of STPFS projects

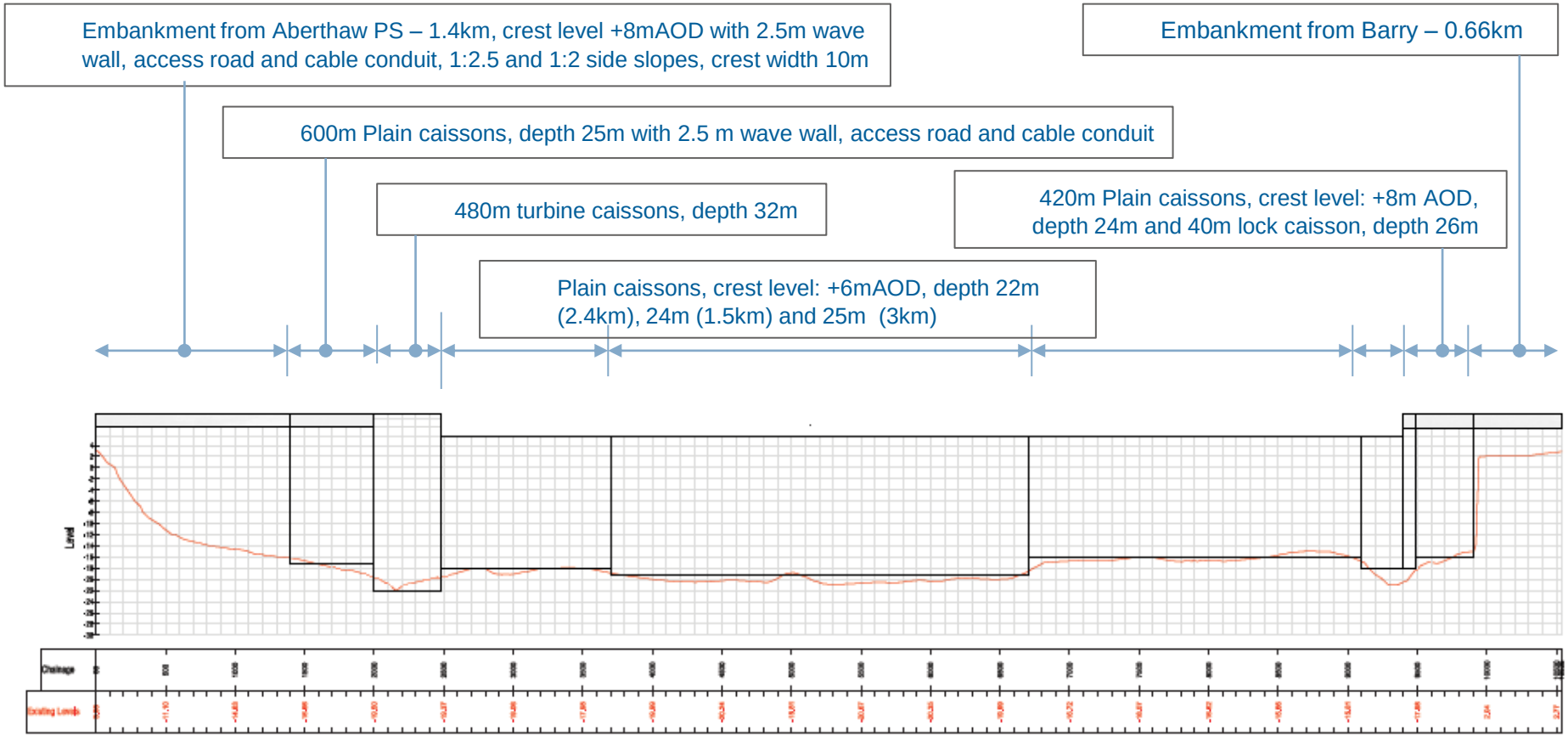
Stepping Stones Tidal Lagoon



A stepping stone to tidal power development



Uses conventional construction and technology elements



Lagoon Long Section

Stepping Stones Tidal Lagoon

Looking West to Aberthaw Power Station

Looking South – proposed lagoon basin

Looking South – from the cliff top

Stepping Stones Tidal Lagoon

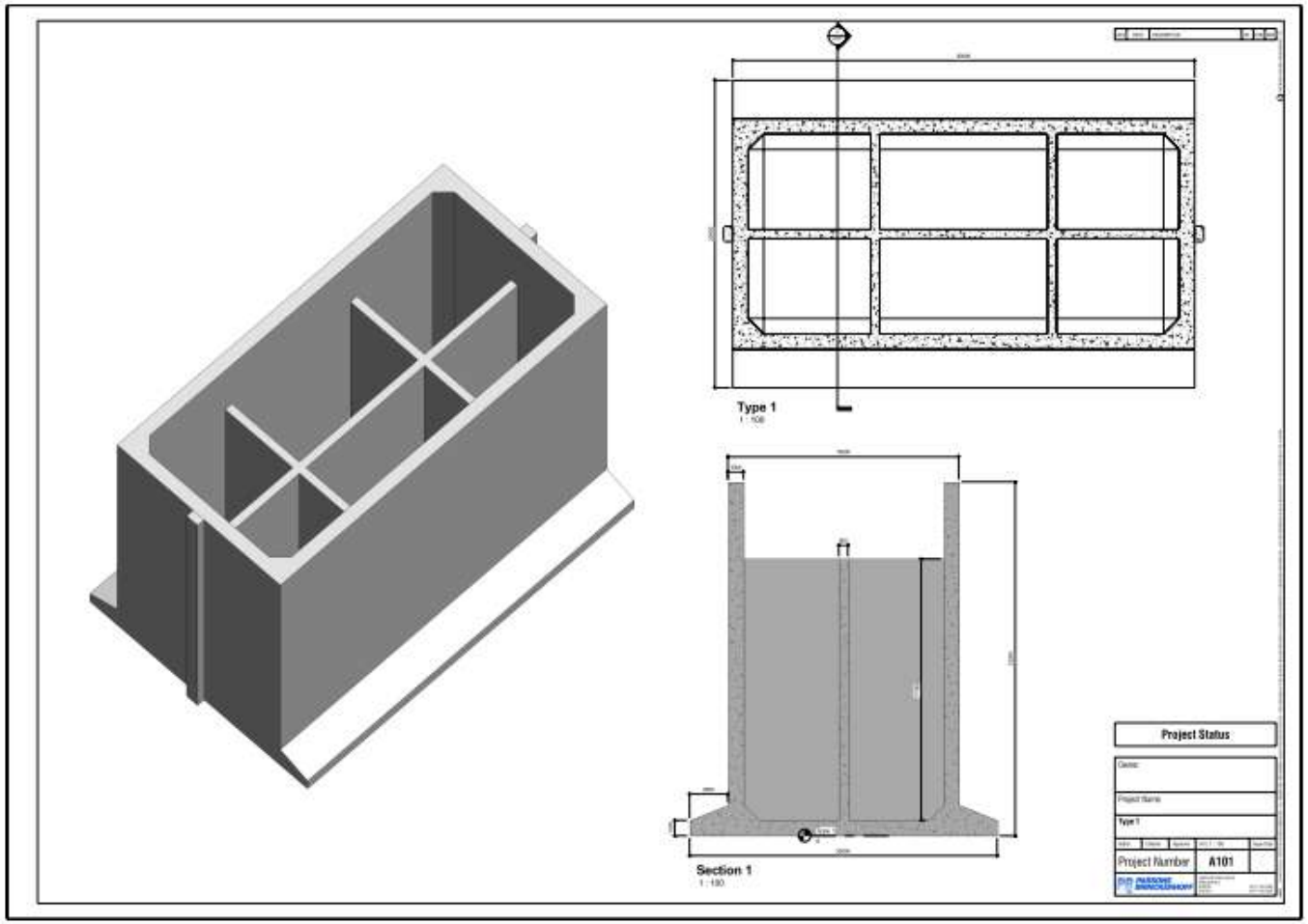
Looking East - on the cliff top

Key Details

Technical Data

- 600MW of installed capacity (bulb turbines operating on ebb and flood tides but could also house prototypes as well)
- 1.2TWh per year of energy production
- £1.7bn construction cost (built up using same principles as STP)
- Lagoon surface area: 18sq km
- Length of lagoon impoundment: 10.6km
- Construction Period: 4 years (preceded by 4 years in planning/consents)
- Largest tidal power plant in the world
- Cost of Energy @ 10% (including construction + decommissioning costs)
  - Financing period (30 years): £194/MWh or £160/MWh @ 2% inflation (based on ratio of cost to energy over the period)
  - Residual operating life (90 years): £30/MWh, (or less in real terms as ratio of cost to energy will reduce with inflation)

New Plain Caisson design to form main lagoon wall

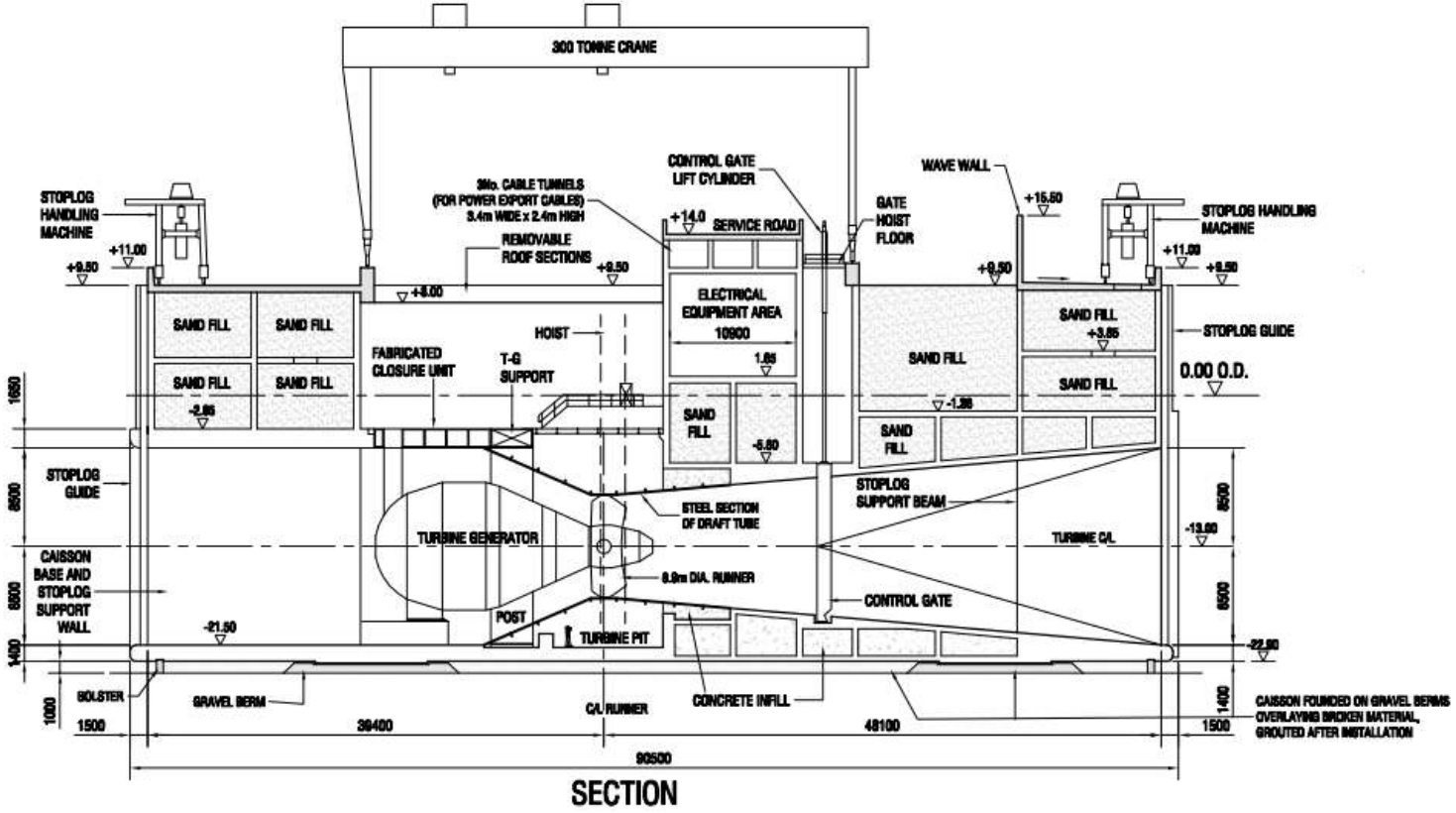


Plain caissons are designed to overtop

The majority of the lagoon impoundment does not require access

- As a consequence, plain caisson heights have been reduced so that they have a crest level of +6mOD, slightly higher than MHWS;
- They are designed to enable safe over-topping by waves
- Where access on the lagoon wall is required, the crest level is raised to +8mOD and a 2.5m wave wall provided giving protection from waves for these sections (from Aberthaw to the turbine caissons and from Barry to the navigation lock).
- Caissons would be ballasted with locally won material with rock armour protection on the crest.
- Significant cost reductions over previous caisson designs

Turbine Caissons as per STPFS ebb/flood designs



Lagoons have long asset lives and value

Recognising Long Term Value

- Levelised cost analysis favours short term net benefits, particularly when higher discount rates are used – as they tend to be in the power sector
- The longer term benefits arising from assets such as lagoons or barrages whose operating lives extend beyond the financing period consequently attract little value in financial business cases.
- However, if the long term benefits are evaluated more pragmatically, for example by employing an initial DBFO contact for the first 30 years and then re-cycle the residual asset value the cost of energy is significantly reduced for the remaining life (£30/MWh for 90 years)
- This is one of the few forms of power generation that can exert a future downward trend on future electricity costs.
- Potentially reproducable – both in other parts of the Severn and on the western UK seaboard.

Next Steps

- Policy Feedback
- Stakeholder Perspectives
- Market Testing

1	Explore with policy makers at DECC and Welsh Government the context of this proposal within future Energy Policy	▪ *To confirm policy support for tidal range projects in principle and the Stepping Stones proposal* ▪ *To understand Government ability to mitigate initial risks such as planning through policy statements*
2	Assess the relative merits of this proposal in terms of economic and financial benefits in delivering growth and long term worth	▪ *To highlight job creation benefits, longer term value and research potential –catapult, universities, BIS ..* ▪ *To understand what, if any, support mechanisms would be available in current fiscal conditions*
3	Undertake a programme of preliminary stakeholder consultation to understand issues and concerns,	▪ *To brief stakeholders such as statutory planning agencies, local authorities and interested NGO's on the proposals and understand key issues from their perspective with a view to refining the proposal*
4	Review feedback from Government and Stakeholders and update proposal accordingly)	▪ *A proposal that includes outcomes from discussions with Government and Stakeholders and with clear research and societal benefits will be critical to implementation of the concept*
5	Assess market appetite for investment and delivery	▪ *Confirmation of buildability , timeframes and costs from the construction supply chain* ▪ *Appetite for investment from developers, investors*