

Tidal Energy Opportunities in the Bristol Channel and Severn Estuary

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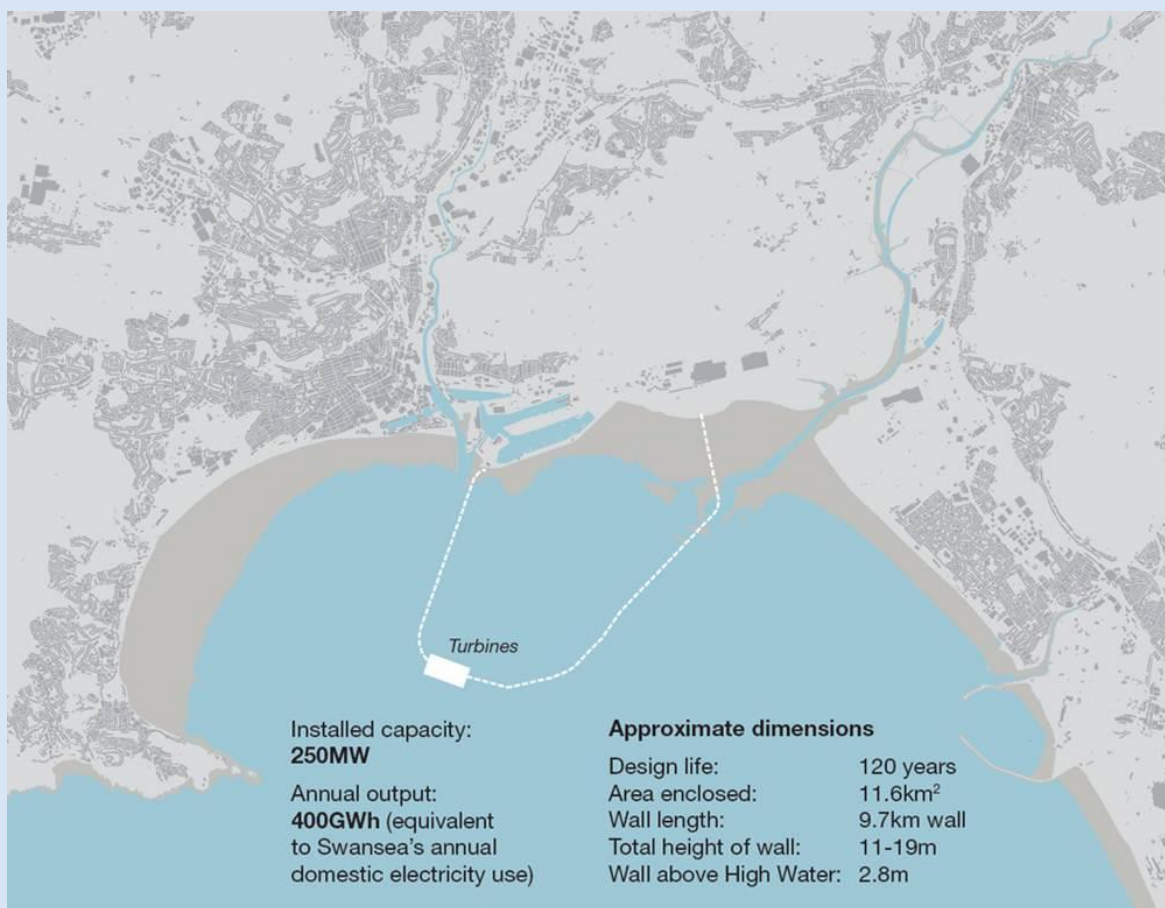
La Rance Tidal Barrage Scheme



Key details:

- Completed in 1966
- 24 x 5.5m dia. bulb turbines & 6 sluices
- Turbine trials \Rightarrow ebb-only (+ pumping)
- Generate 0.54TWh/y
- Energy cost €20/MWh \Rightarrow cheapest in EU
- No baseline studies prior to construction

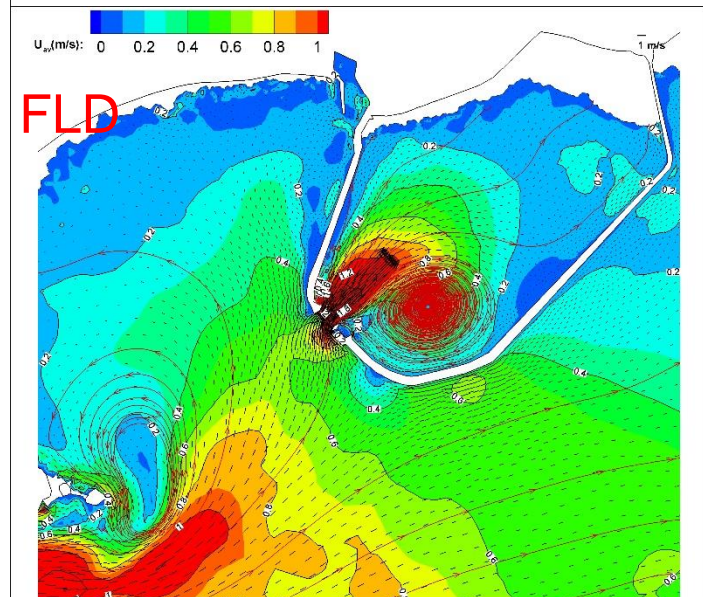
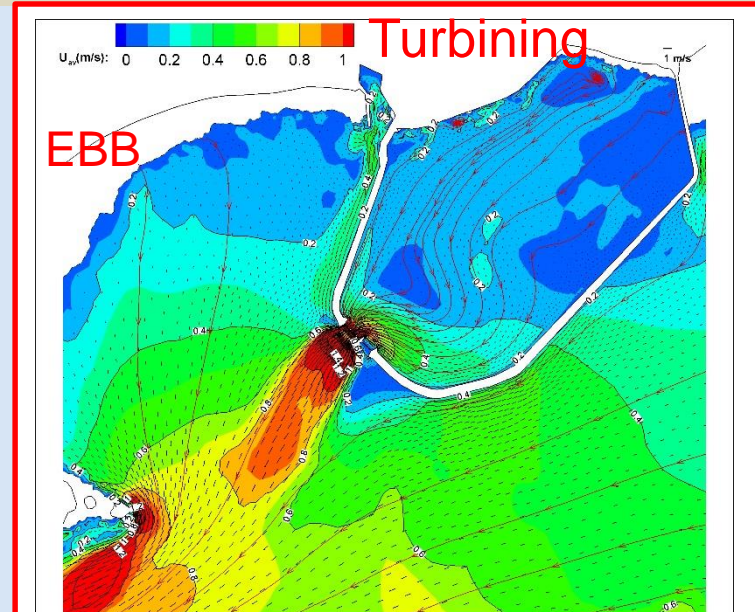
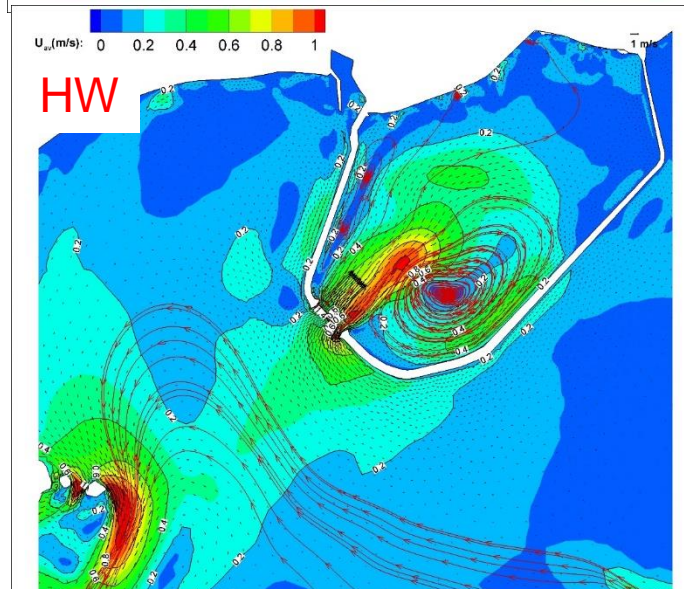
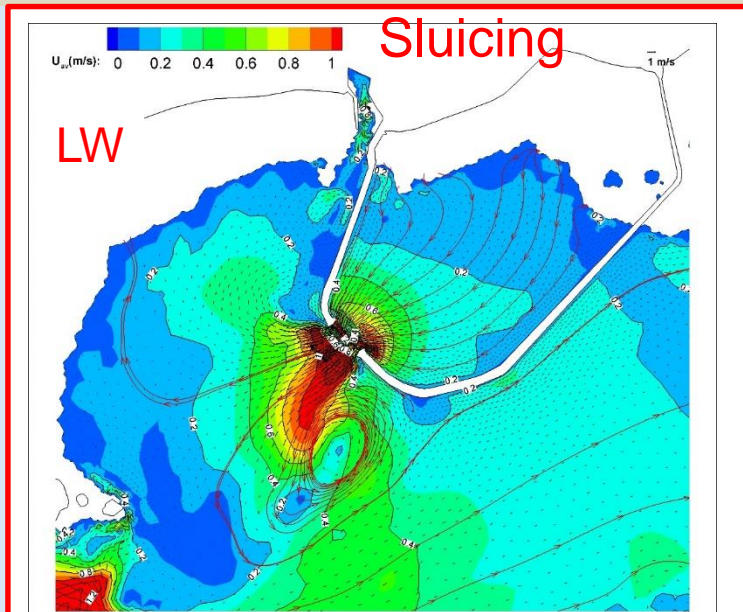
Swansea Bay Lagoon - Current Design



Key details:

- Wall $\approx 9.7\text{km}$ long
- Area $\approx 11.6\text{km}^2$
- 16 x 7.3m diam bulb turbines & 8 sluices
- Turbines: two-way + pumping $\approx \text{HW} \& \text{LW}$
- Generate 0.54TWh/y
- Potential for large wakes and eddies

Swansea Lagoon - Current Predictions



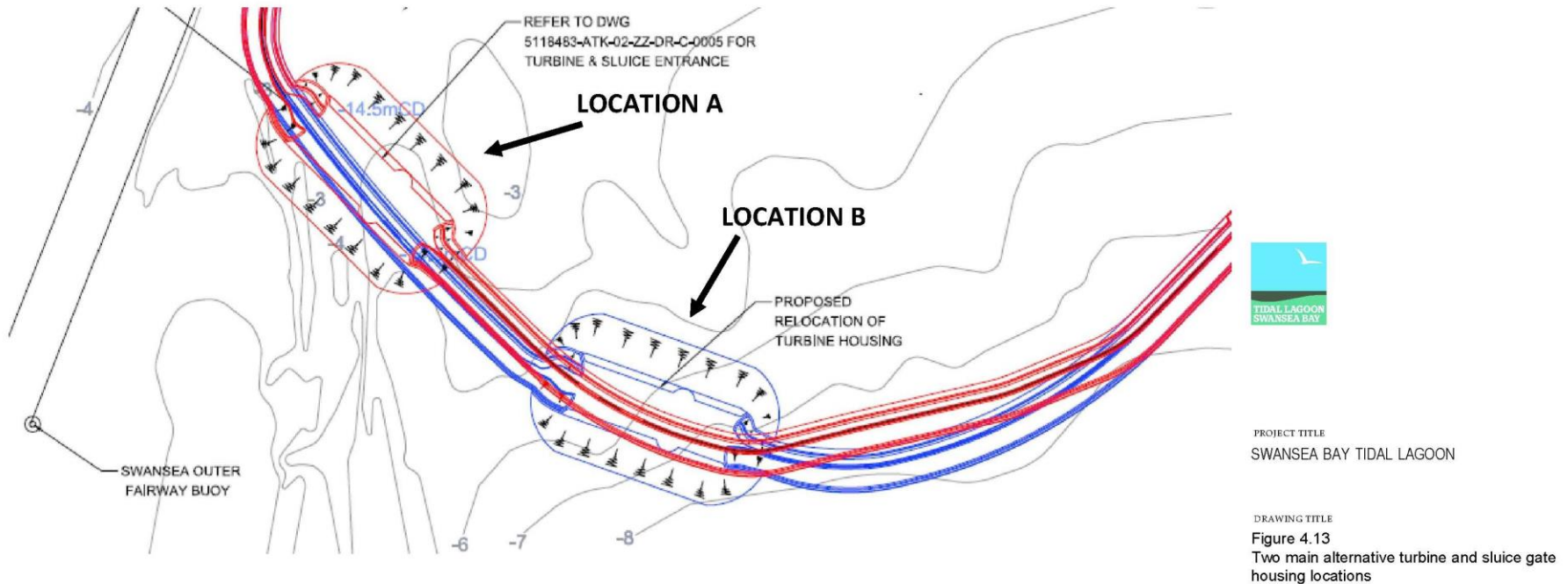
Annapolis Barrage - Sluice Gate Wake



Wake from 2 Sluices and 1 x 20 MW turbine



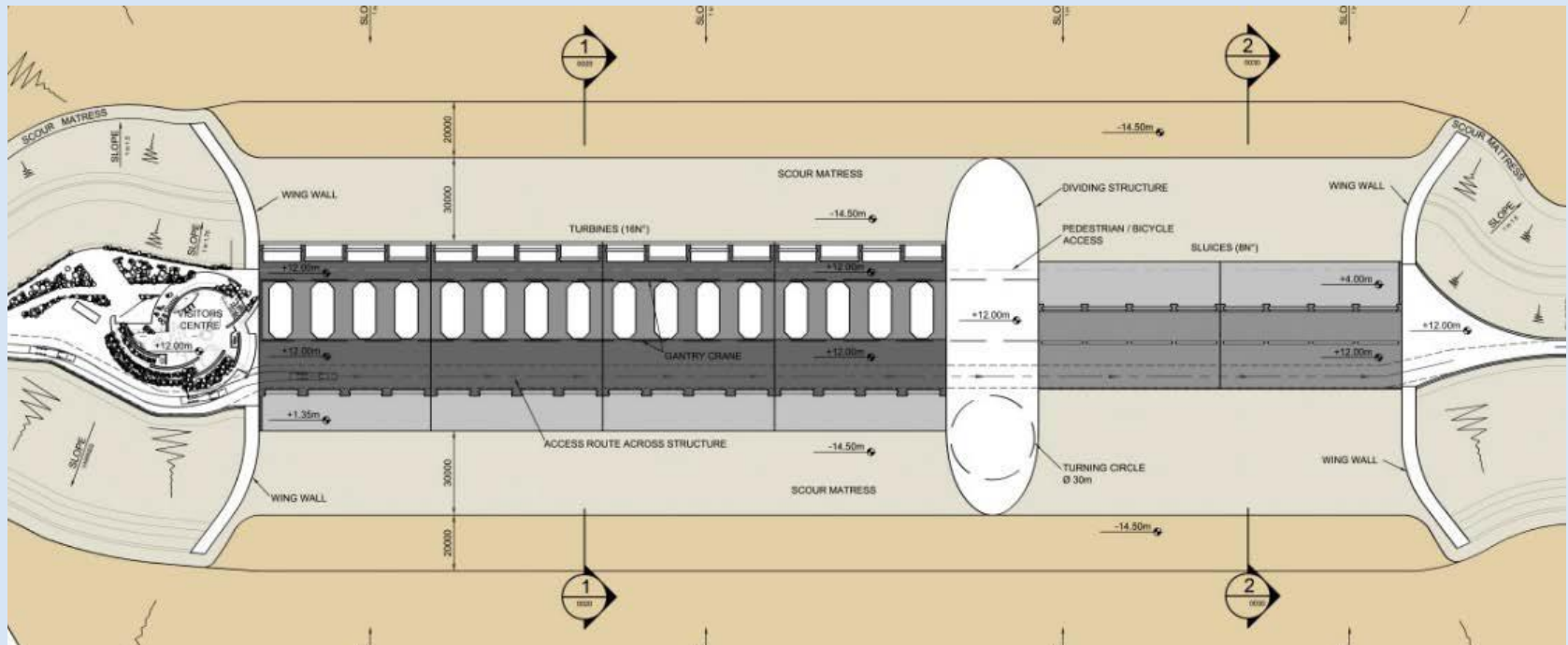
Swansea Bay - Design Modification 1



- Revert turbine/sluice location to Option B - submitted to DCO
- Wake would be parallel to, and away from, dredged channel

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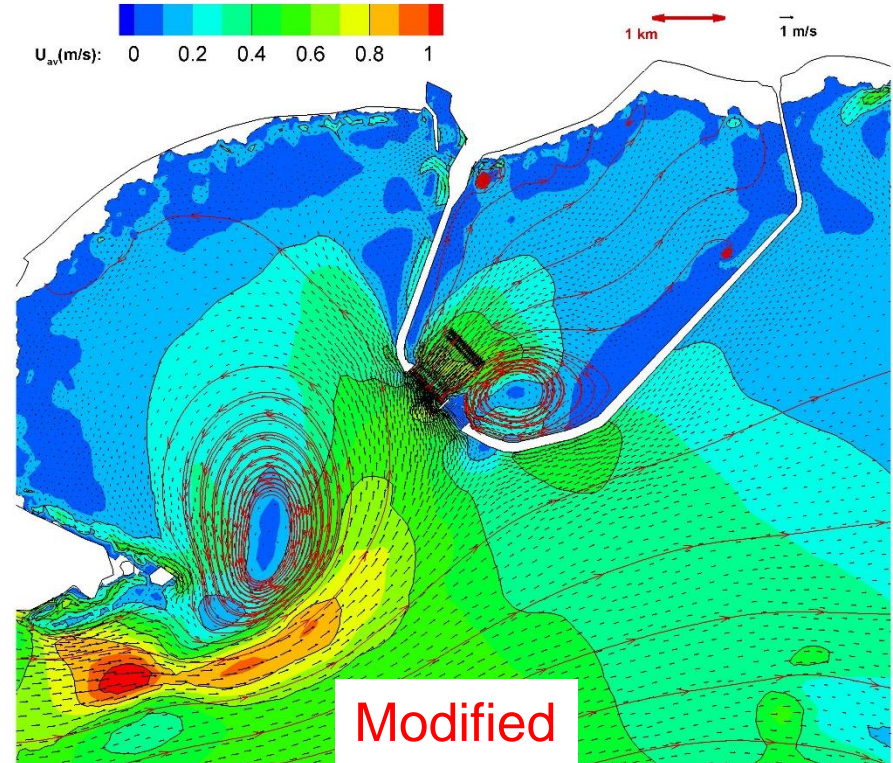
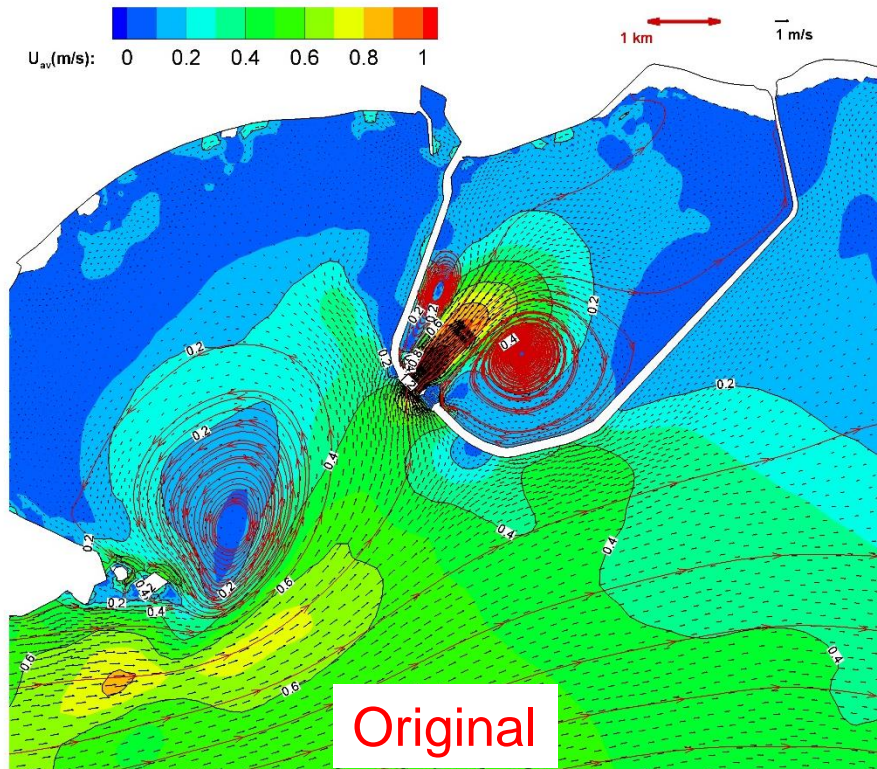
Swansea Bay - Design Modification 2



<https://www.ice.org.uk/ICEDevelopmentWebPortal/media/.../6-loan-Jenkins.pdf>

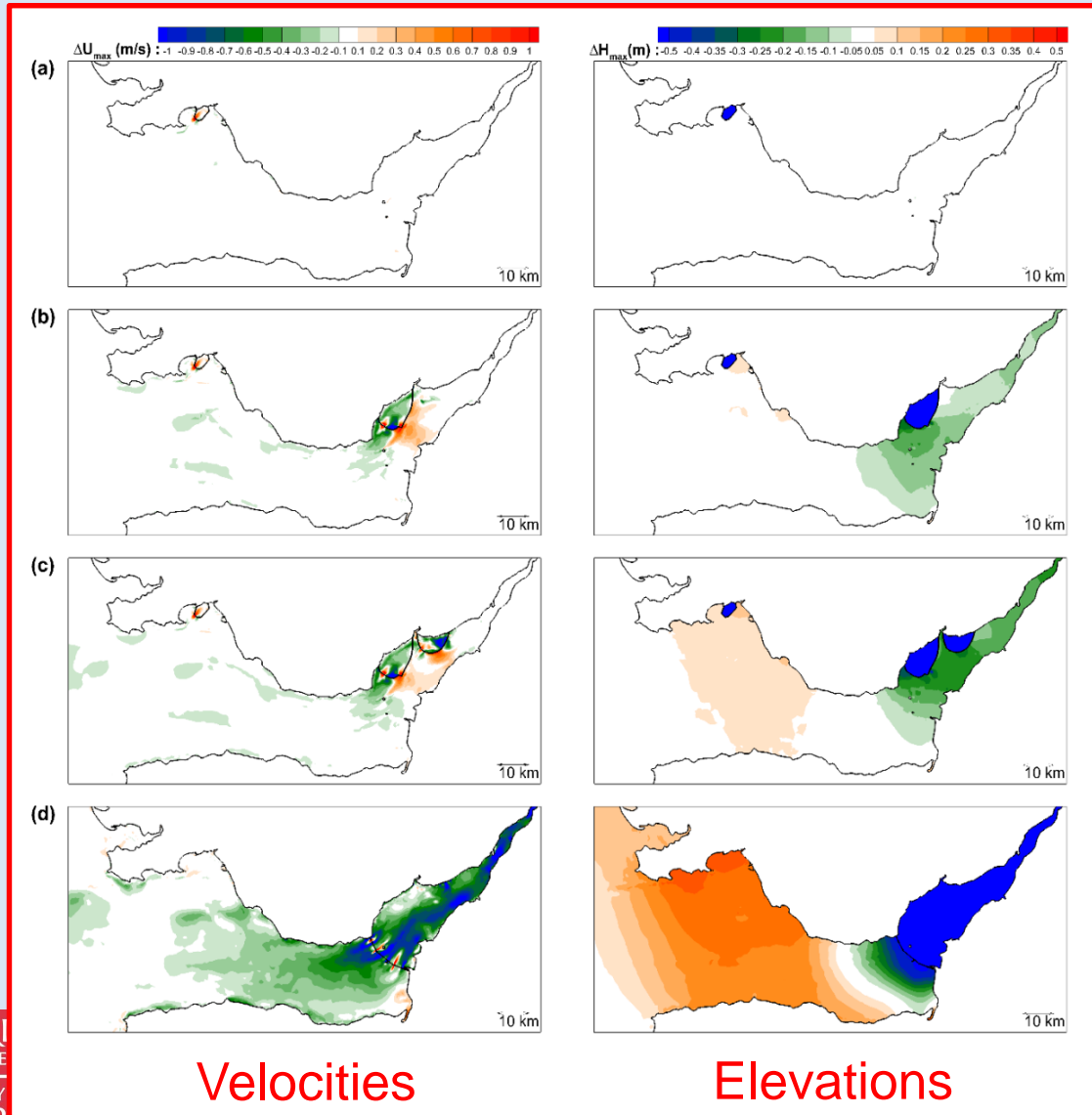
- Focusing turbines and sluice gates leads to high wake/jet effects
- Flow through turbines \approx emptying 2 Olympic swimming pools/sec

Swansea Bay - Design Modification 2



- Wider distribution of turbines & sluices leads to weaker eddies

Cumulative Impacts Studied



General Findings:

- Larger impoundment size \Rightarrow greater impact
- Multiple schemes in close proximity have cumulative impacts
- Impacts reduced by refined turbine/slucice design

Tidal Lagoon - Barrage Interactions

- Various Barrage lines (STPG & Atkins) and Lagoons (Cardiff & Swansea) considered, with interactions studied:

Run	Barrage/Lagoon	Annual Energy* Alone (TWh/yr)	Annual Energy* Combined
1	Severn (HRC)	19.82	17.184
2	Severn (Atkins)	19.77	17.141 (est)
3	Cardiff Lagoon	4.680	1.783
4	Swansea Lagoon	0.586	0.531

Note: Figures do not include effects of pumping

- Results show Barrage would reduce Cardiff output $\approx 60\%$ and Cardiff would reduce Barrage output $\approx 13\%$

Sustainable Severn Forum

27th April 2017

Energy opportunity for the estuary

Updating the Severn barrage

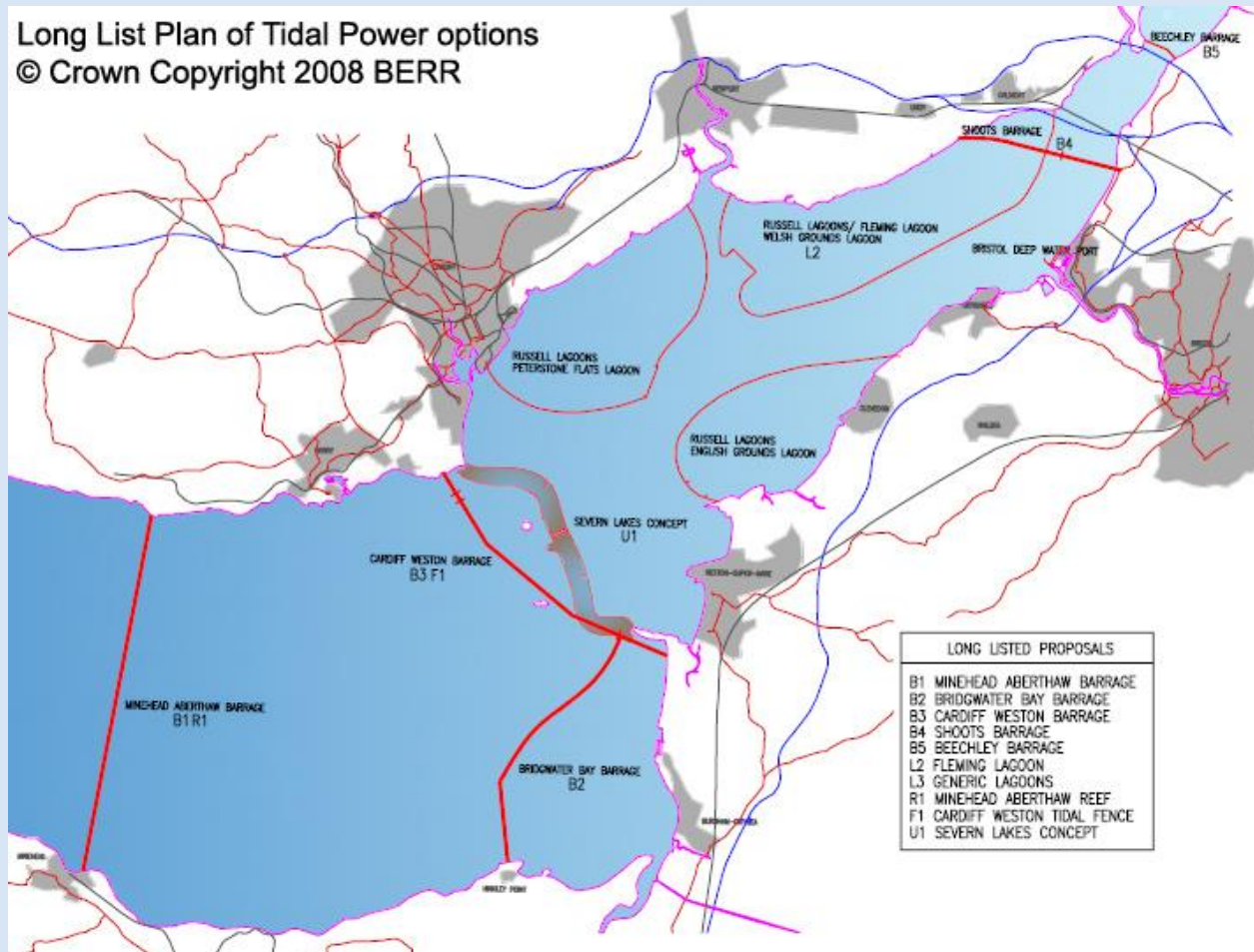
By

Prof Chris Binnie

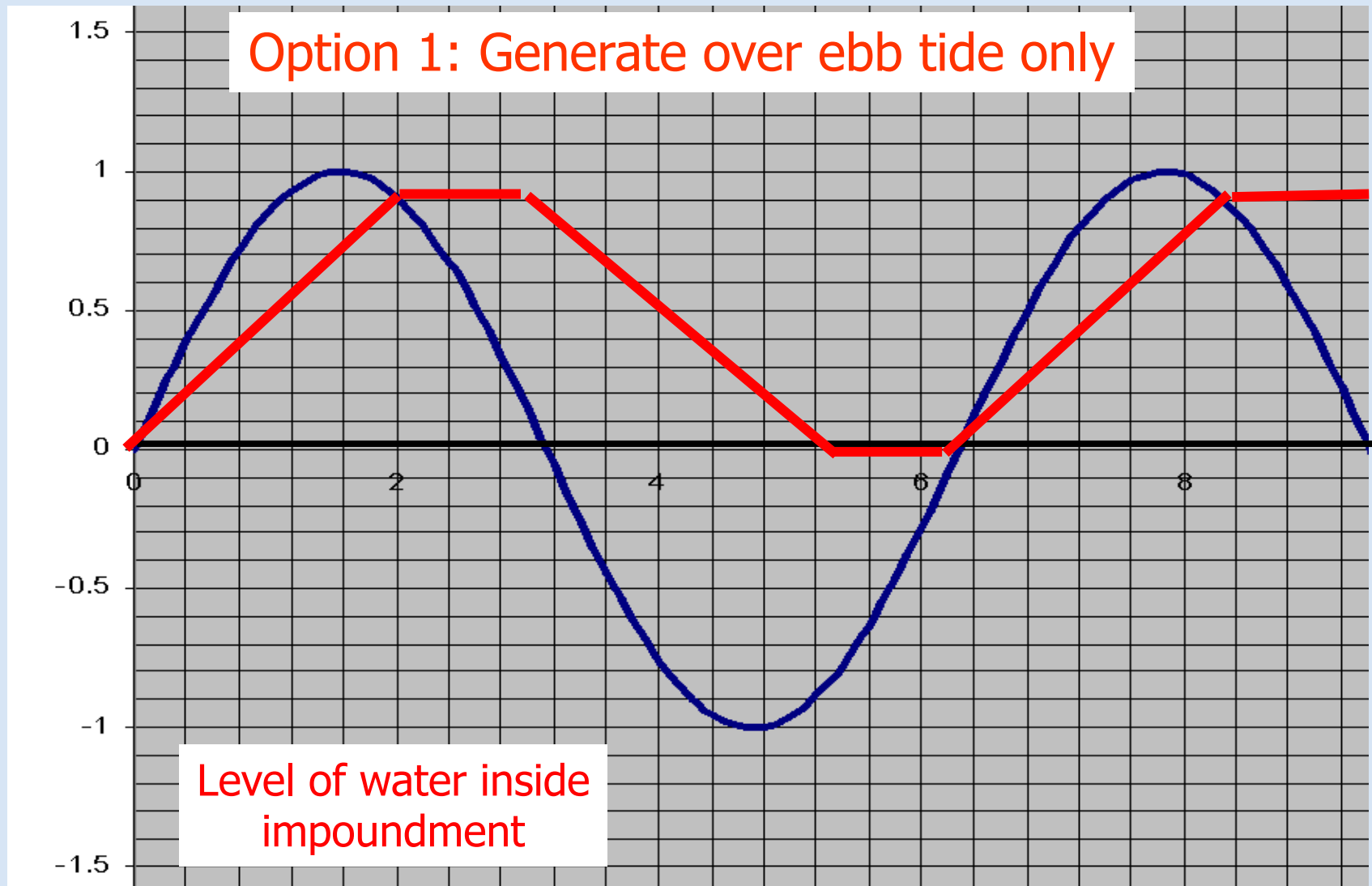
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DECC Severn tidal schemes



DECC ebb only generation.



Conclusions of the DECC study

from the Executive Summary

- *Half of the schemes, including the Cardiff lagoon, were judged to be unviable and were not included in the more detailed consideration.*
- *The Welsh Grounds lagoon, (Newport lagoon), is no longer considered feasible.*
- *The Cardiff-Weston, Severn, barrage, 15.6 TWh/y, offers the best value for money.*
- *Combinations of smaller schemes do not offer cost or energy yield advantages over a single larger scheme between Cardiff and Weston.*

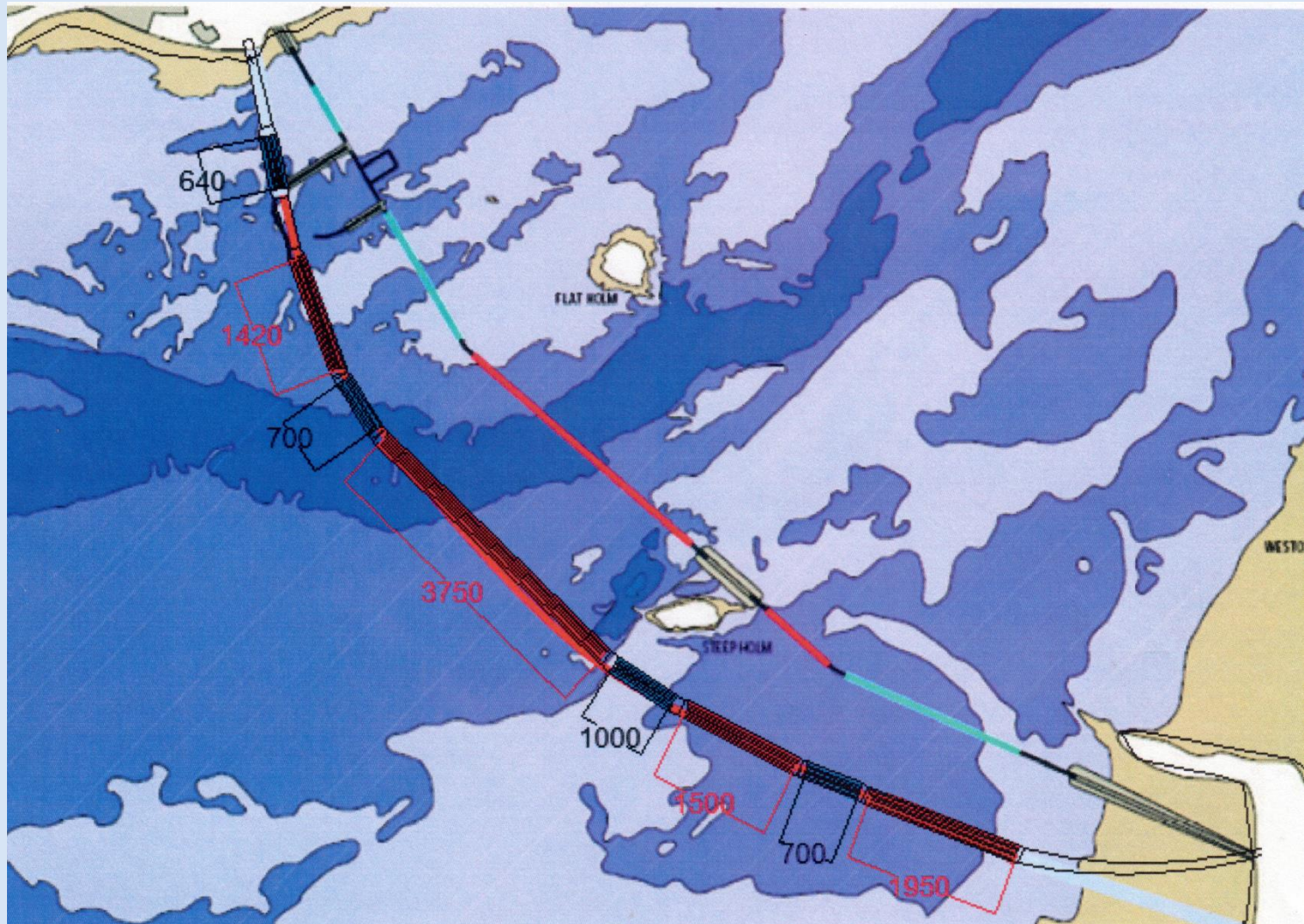
Reasons the Severn barrage was not supported.

- Enormous loss of inter-tidal habitat, *118-163 km²*
- Birds. *Reduction in SPA feeding ground, significant negative effect on 30 species*
- Land Drainage. *area affected 372km²*
- Fish mortality, *SAC, possible local extinction of shad and salmon.*
- Navigation,
 - *delays to ships transiting the barrage*
 - *BPC planned Deep Sea Container Terminal*

Improvements to turbines and operation achieved by TLP, Andritz and GE.

- Ebb/flood generation
- Improved basin water levels and generation output
- Pumping
- Basin water levels become near normal
- Triple Regulation
- Improvement in energy generation
- Non-synchronous generators
- Reduced fish mortality
- Smoother passageway
- Reduced shear so greatly improved shad mortality

Severn Barrage on the Atkins line



Tidal curve with ebb/flood generation with pumping.

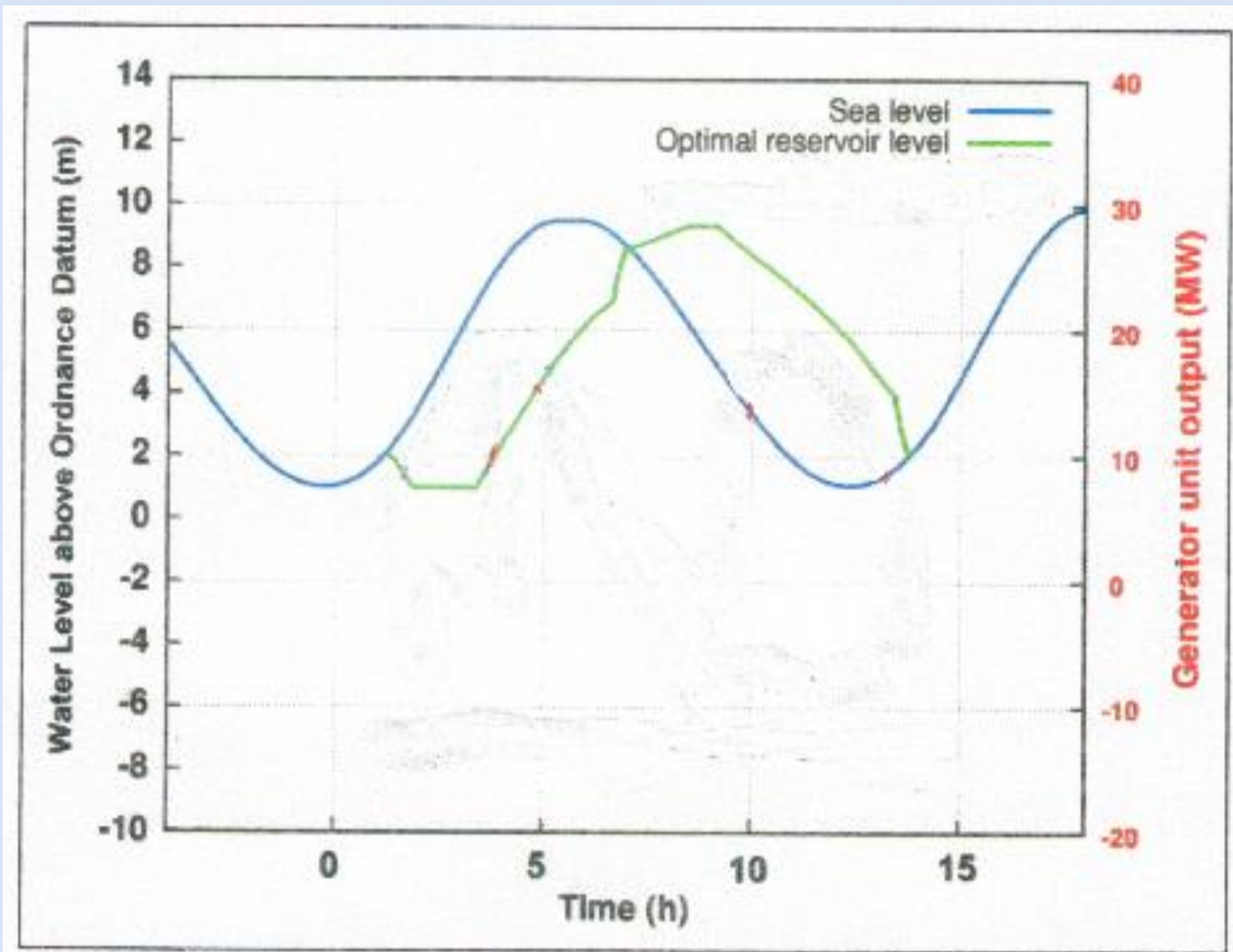


Figure 4.4: Spring tide generation cycle for the Wyre Barrage (Source: Andritz Hydro)

Statistics of the revised barrage

- Energy increased from 15.6 TWh/y to 20.5 TWh/y
- Low water at the barrage increased from 0.34m CD to 0.39m CD, an increase of 0.05m.
- High water at the barrage reduced from 13.84m CD to 13.40m CD, a reduction of 0.44m.
- Mean water level marginally reduced.

Revised impact

- Loss of SAC inter-tidal habitat considerably reduced.
- Loss of bird feeding ground considerably reduced.
- Drainage issue eliminated.
- Fish impact considerably reduced.
- Navigation. Two new container terminals at Liverpool and London Gateway. BPC DSCT postponed.

Comparison of Cardiff and Updated Severn barrage

- Cardiff and Newport lagoons about 8 TWh/y
- Severn barrage about 20 TWh/y.
- Loss of national energy source of about 10 TWh/y
- Severn barrage impact much reduced but still more navigation and fish impact than lagoons.
- Before proceeding, independently update the comparison?

Concluding Remarks

- Welcome Hendry Review and support for Swansea Bay Lagoon as “Pathfinder Project”.
- Swansea Lagoon needs to be successful and would suggest further consideration of two design aspects.
- DECC 2010 Severn Barrage had high impact.
- Tidal energy parameters now much improved.
- Lagoon and barrage impact much reduced.
- Need for independent updated comparison?