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Tapping the Tidal Power Potential of the Eastern Irish Sea

Joule Project JIRP106/03

Investigator Team:

Oct 2006 – Sept 2008

UoL - Department of Engineering:

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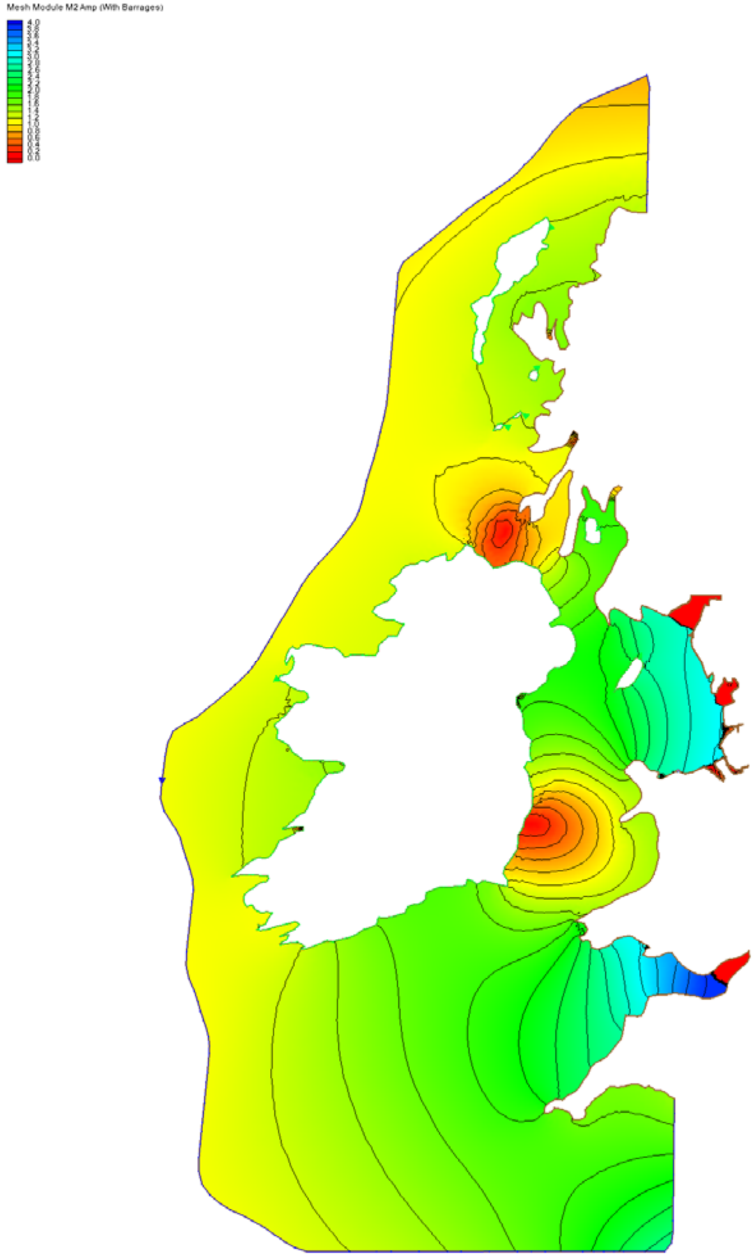
Principal study objectives:

- **To evaluate the tidal energy potential of the coasts of the North West of England**
  – by the installation of estuary barrages, tidal fence structures or tidal stream rotor arrays.
- **To establish the potential daily generation window from optimal conjunctive operation taking account of the different possible modes of operation.**
  – ebb, flood or two-way [*dual mode*] generation in the case of barrages.
- **To evaluate any impact of this energy extraction on the overall tidal dynamics of the Irish Sea.**
- **To assess any implications to biophysical coupling in the external marine ecosystem**
  – manifesting water quality or ecological consequences.
- **To ascertain the flood protection benefit from proactive operation of barrages.**
  – fully accounting for the worsening effects of sea level rise (SLR) and climate change.



Synthesising an Axial flow Bulb Turbine operation

– the 'Hill-Chart'

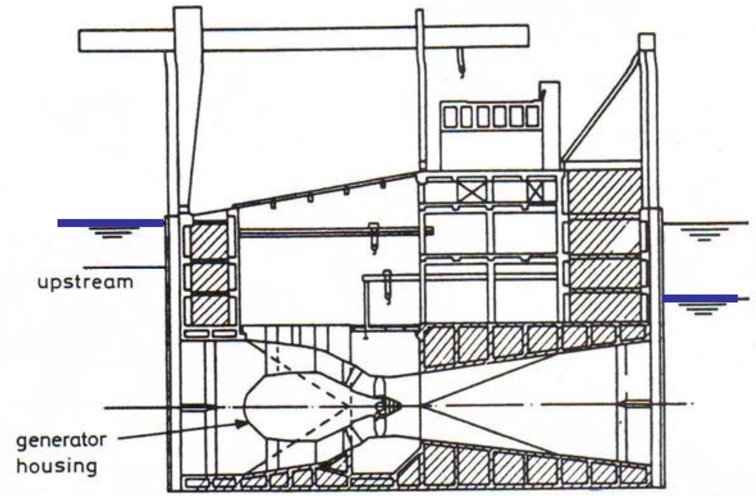
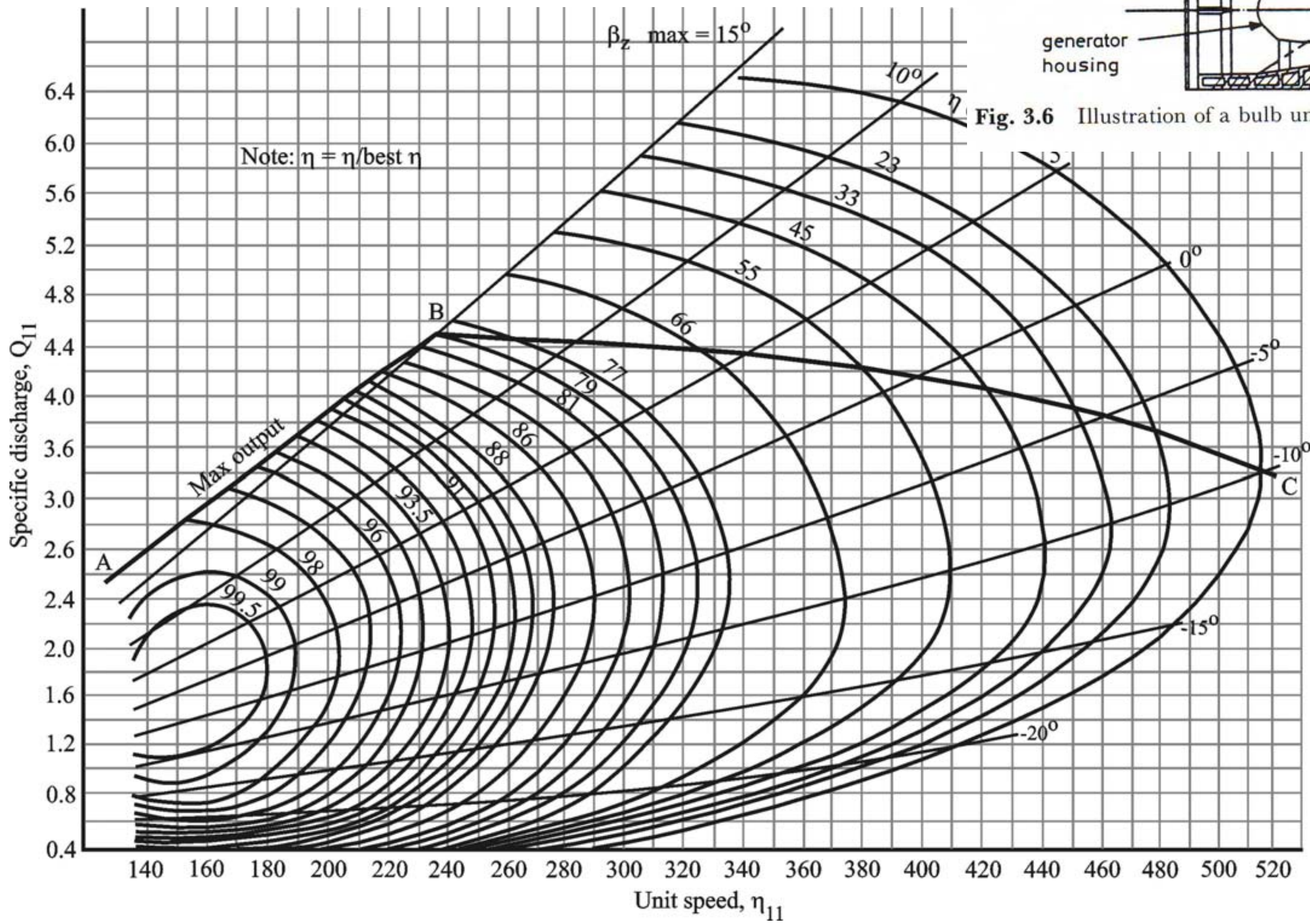


Fig. 3.6 Illustration of a bulb unit



Specific Discharge

$Q_{11} = Q/(D^2 H^{0.5})$

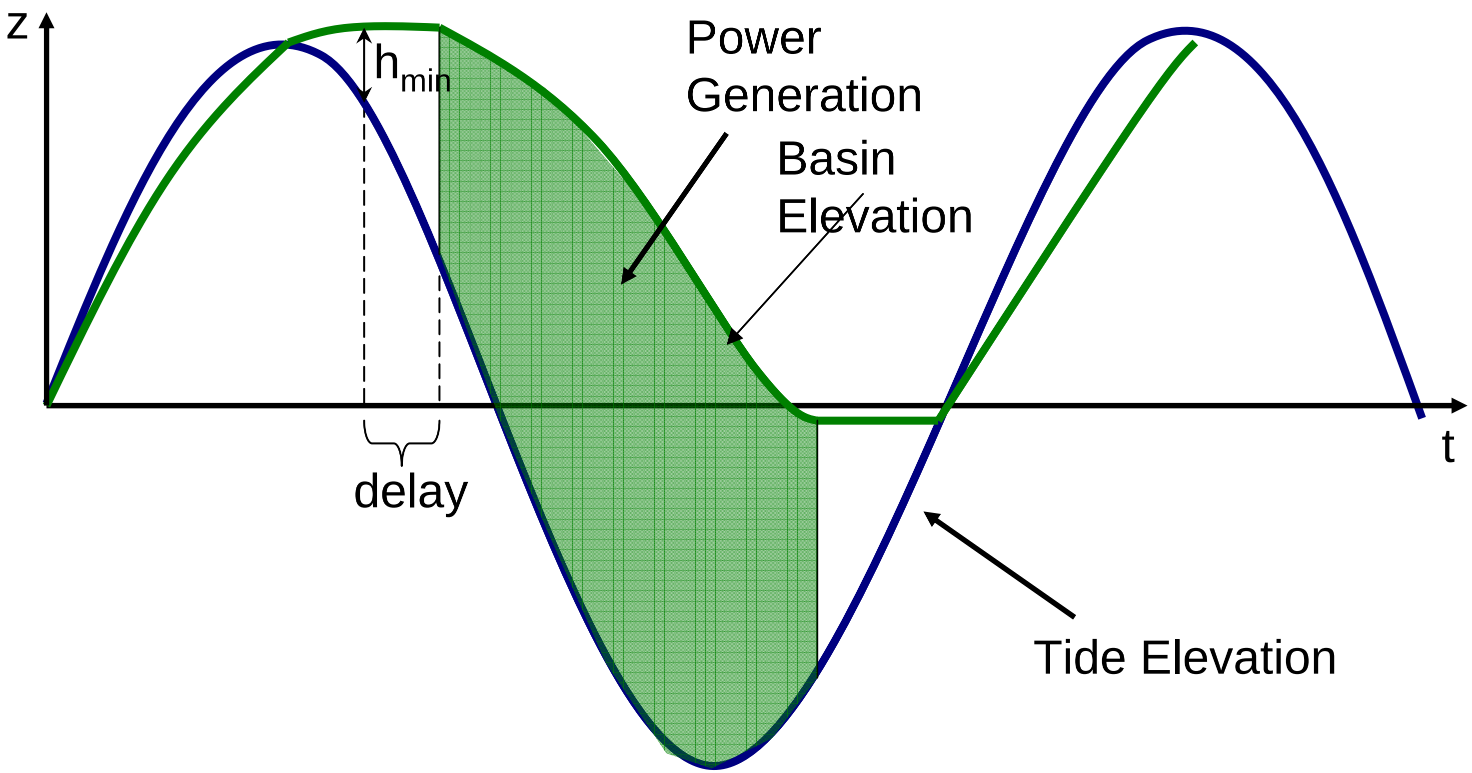
Unit Speed

$n_{11} = n D/(H^{0.5})$

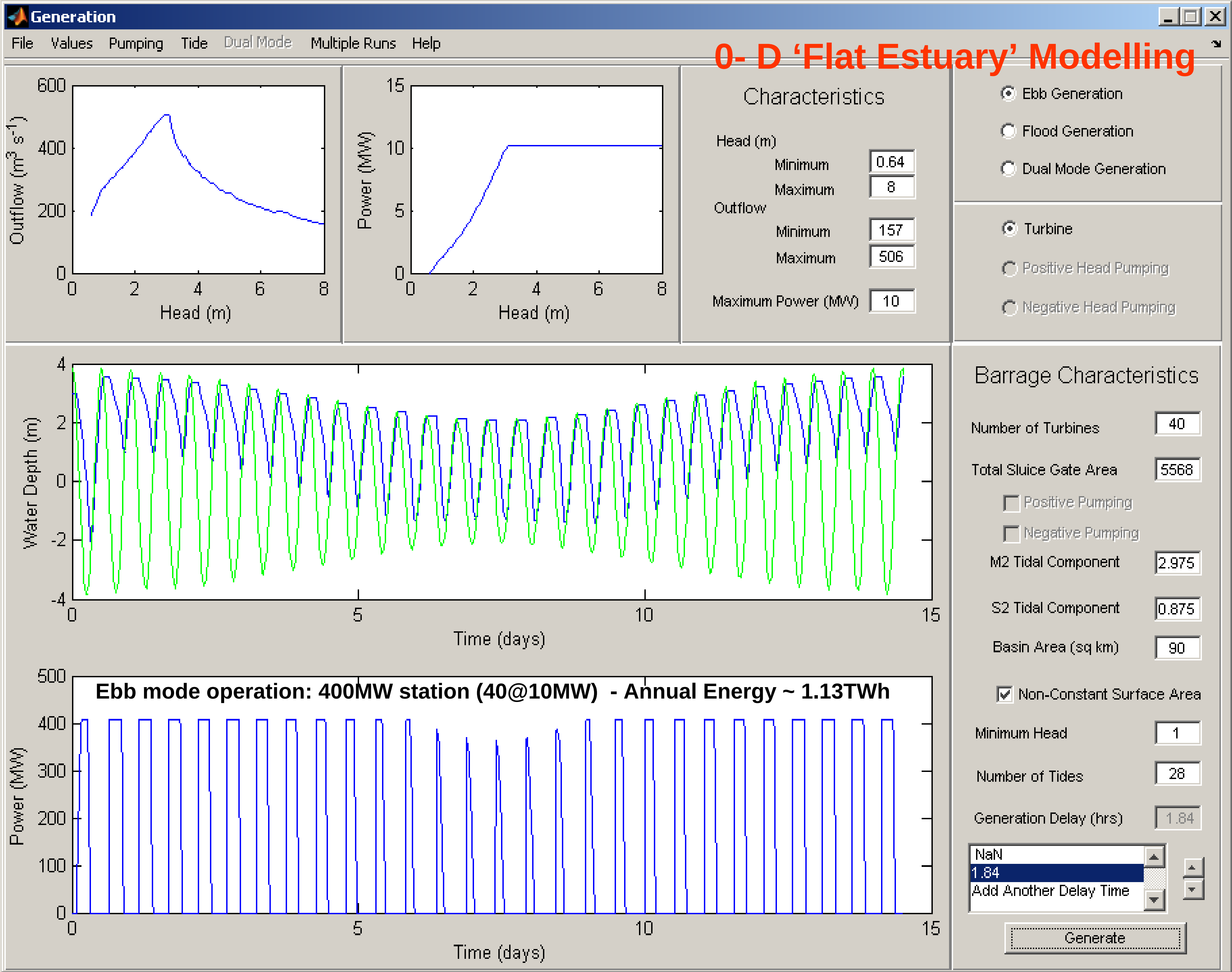
Power

$P = \rho.g.Q.H.\eta$

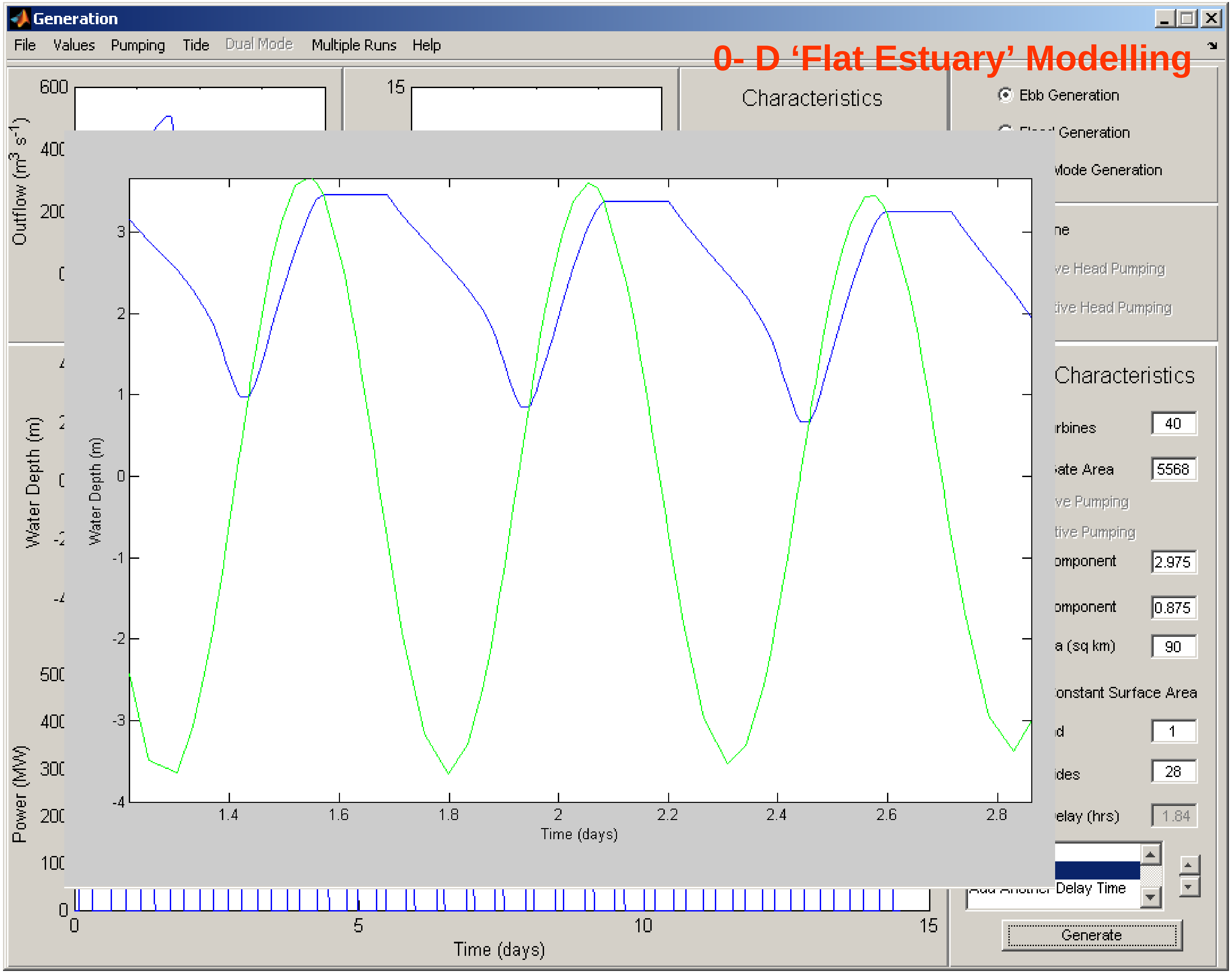
Tidal Power Generation Cycle

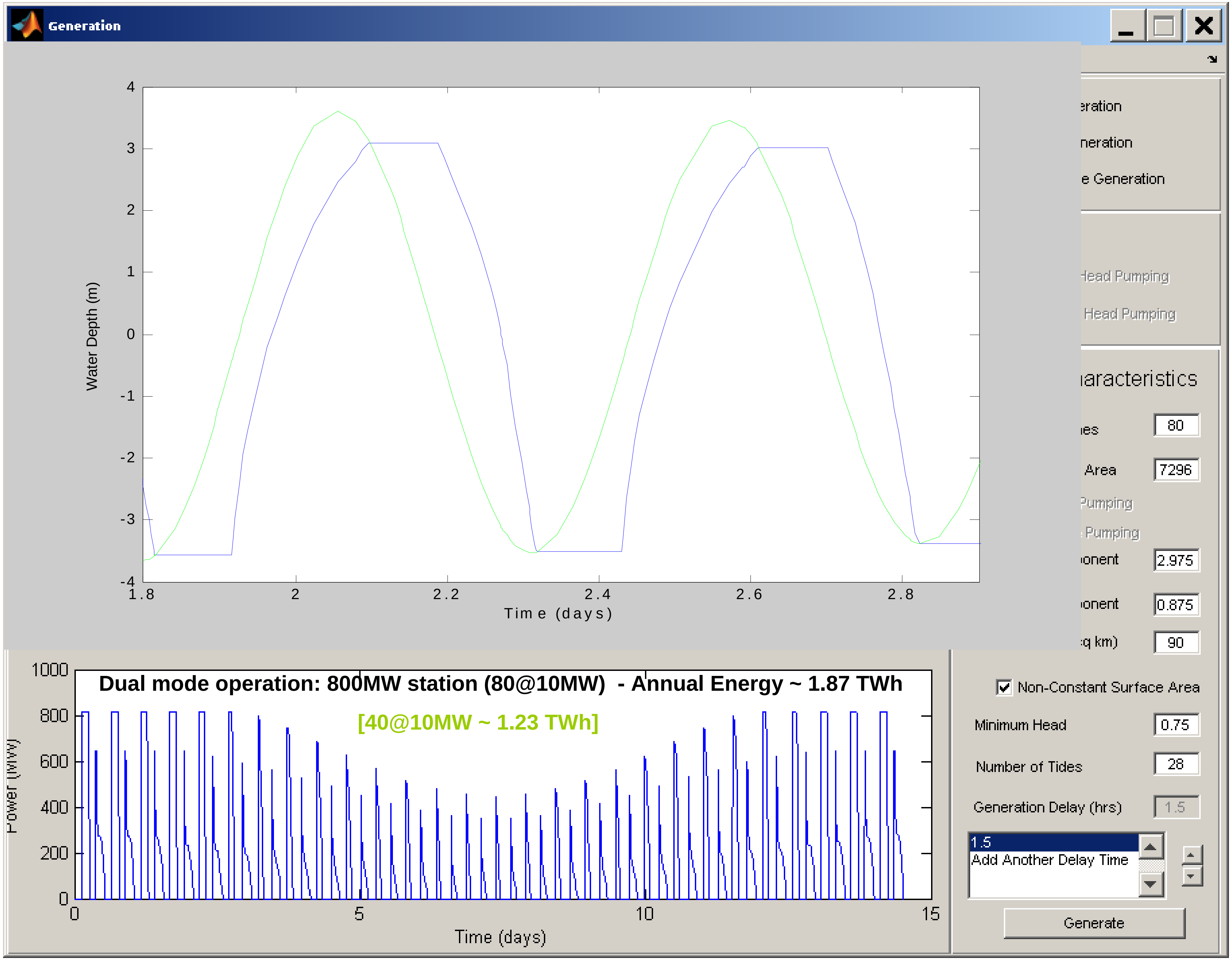


0- D 'Flat Estuary' Modelling

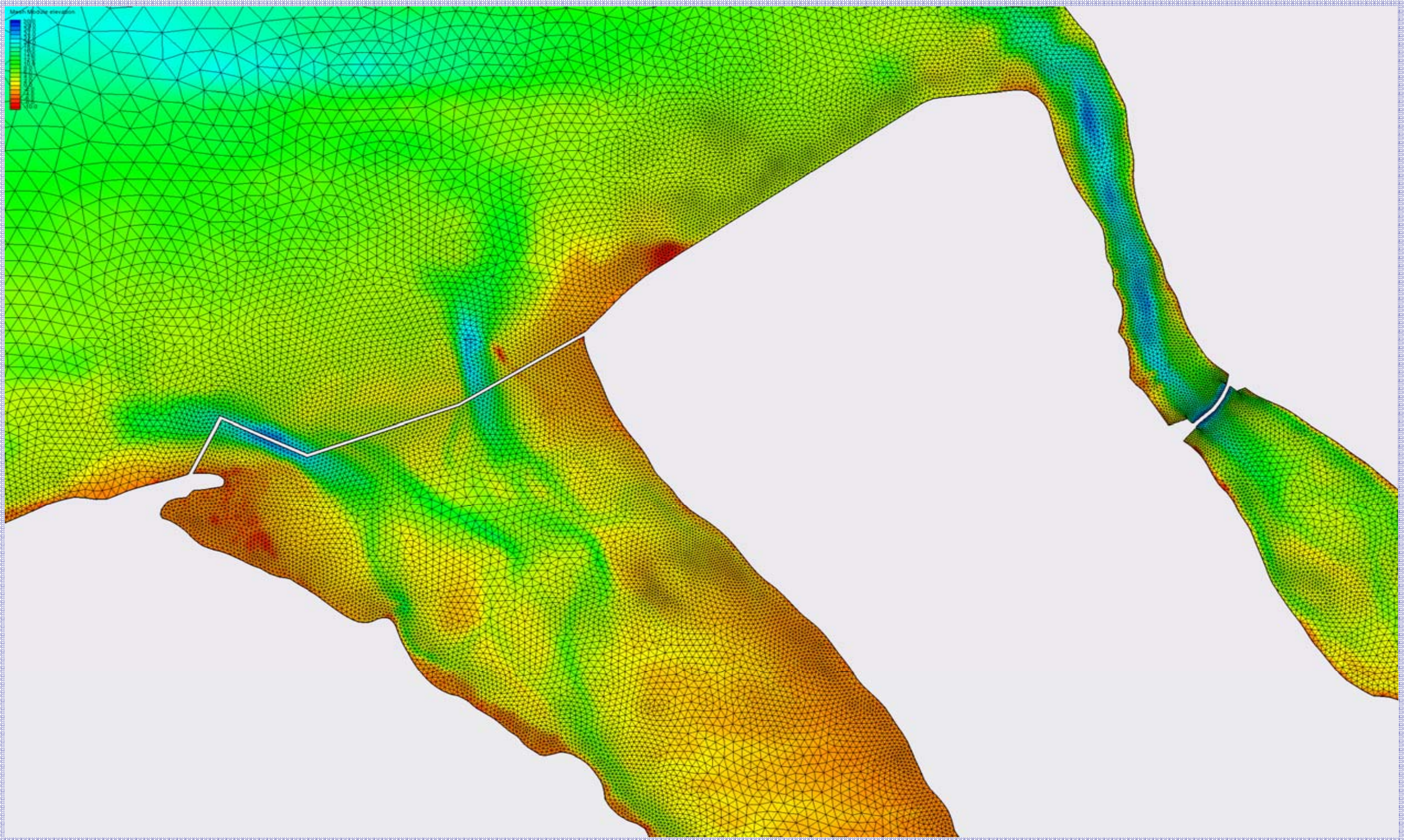


0- D 'Flat Estuary' Modelling

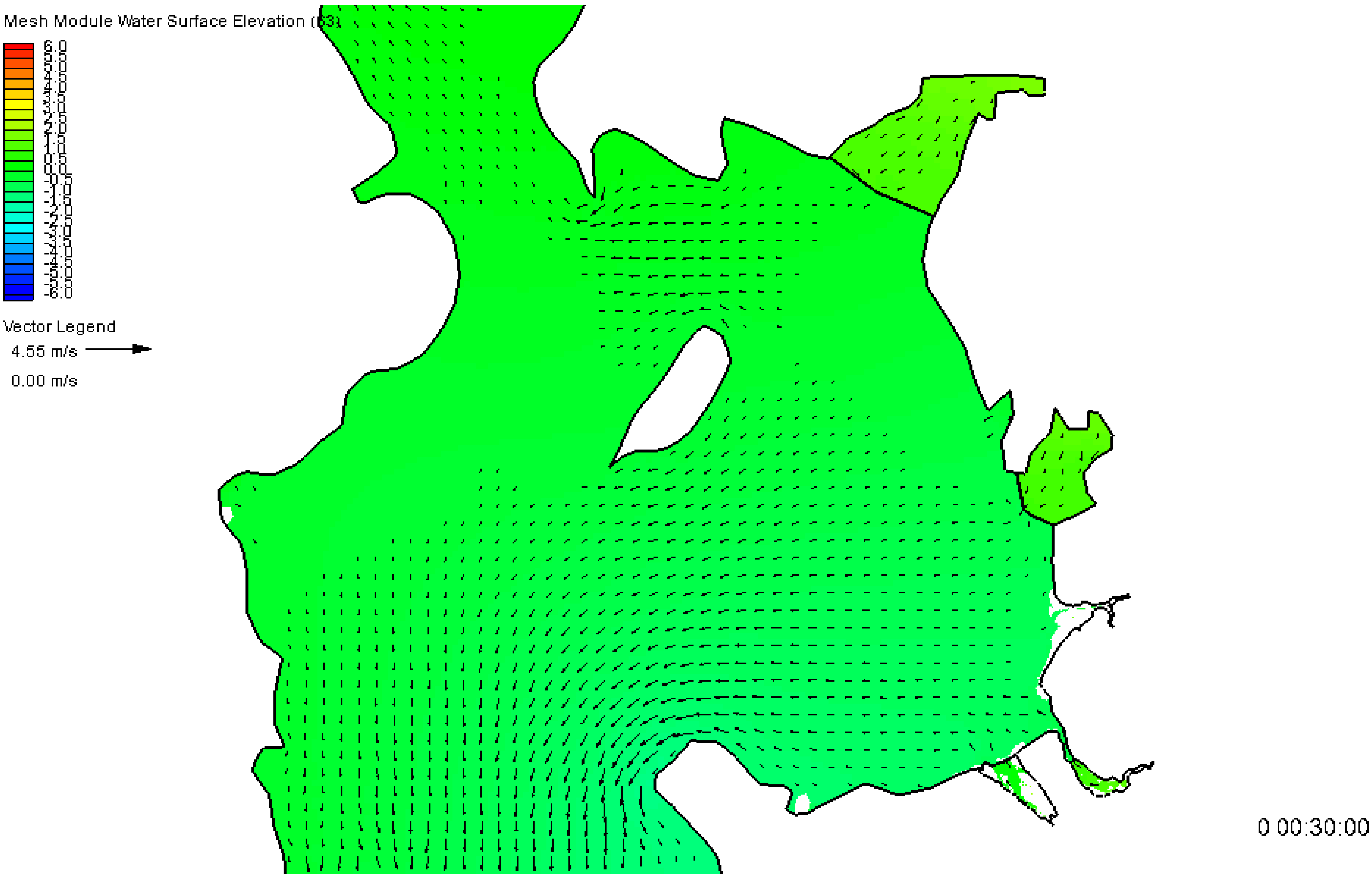



Generation
Water Depth (m)
Time (days)
Dual mode operation: 800MW station (80@10MW) - Annual Energy ~ 1.87 TWh
[40@10MW ~ 1.23 TWh]
Power (MW)
Time (days)
Non-Constant Surface Area
Minimum Head
0.75
Number of Tides
28
Generation Delay (hrs)
1.5
Add Another Delay Time
Generate

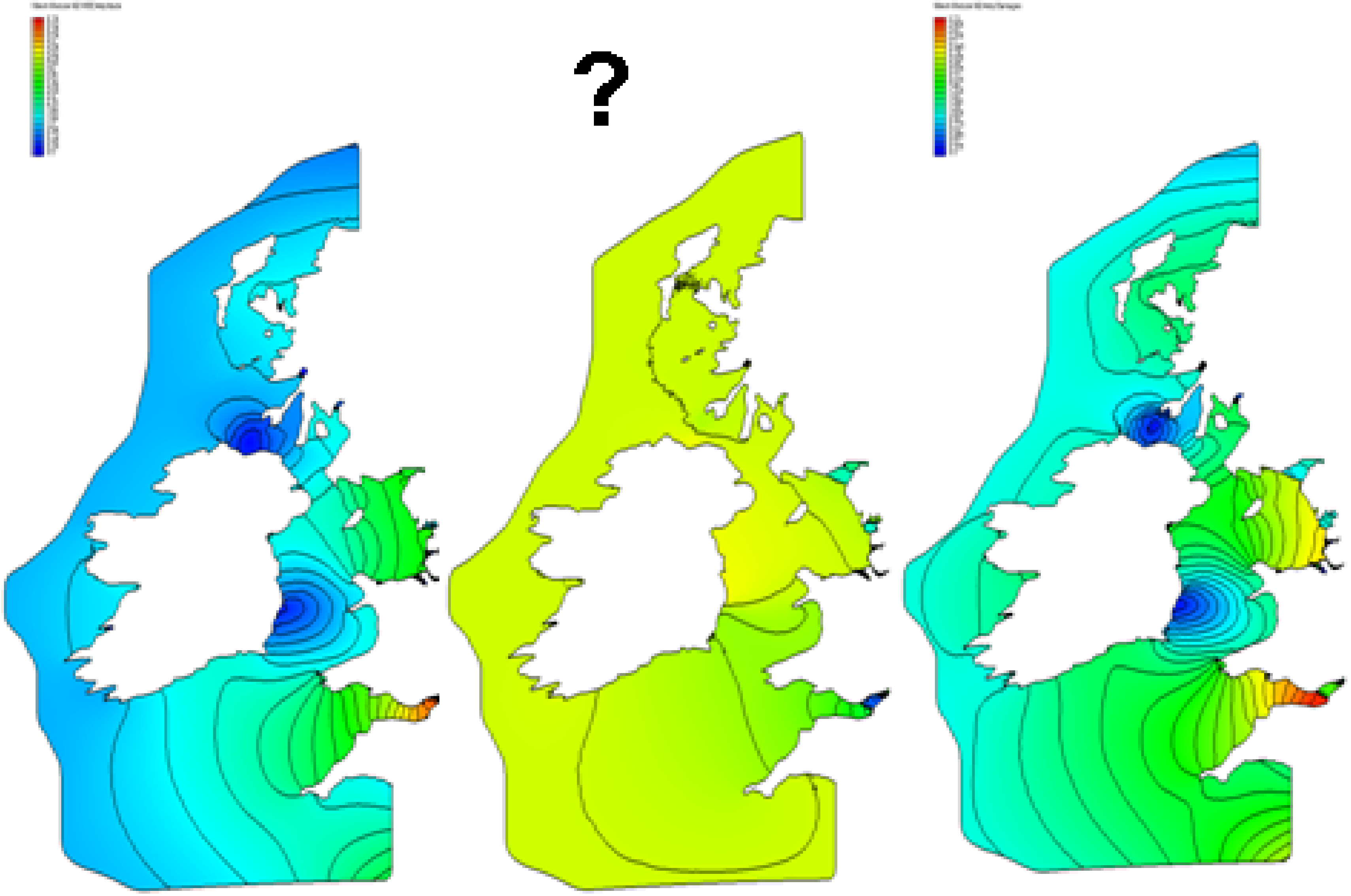
ADCIRC Grid



Irish Sea Circulation with Barrages

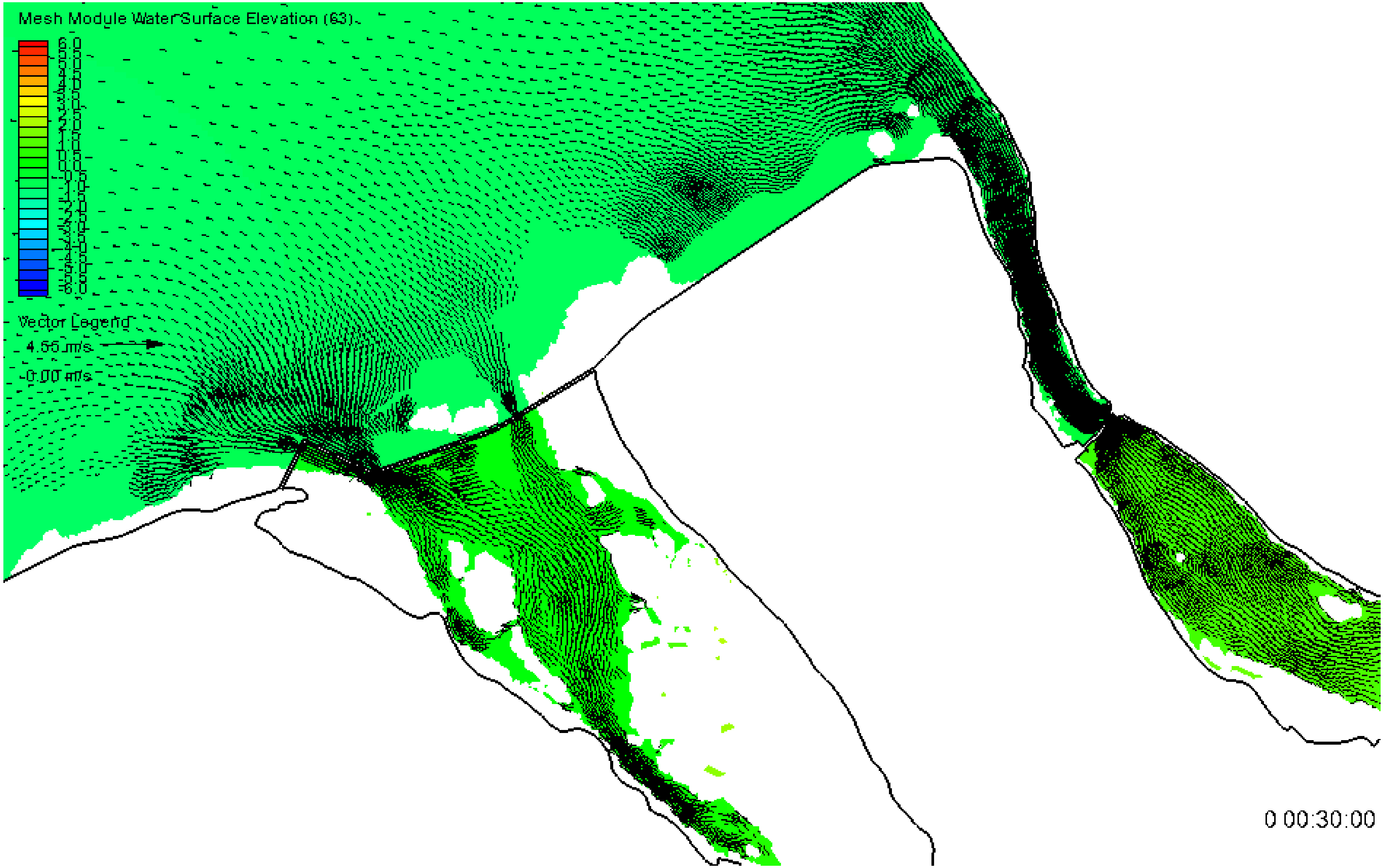

Mesh Module Water Surface Elevation (63)
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
-1.5
-2.0
-2.5
-3.0
-3.5
-4.0
-4.5
-5.0
-5.5
-6.0
Vector Legend
4.55 m/s
0.00 m/s
0 00:30:00

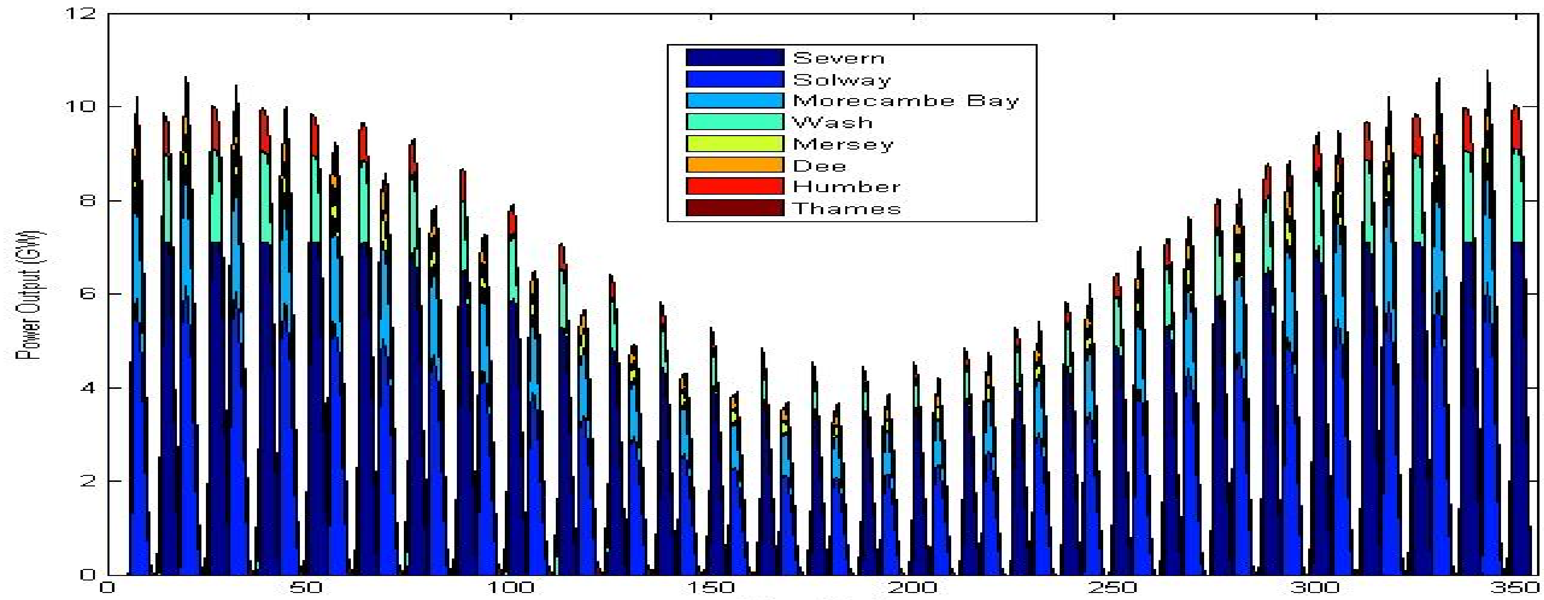
M2 Tidal Elevations



Existing Change with Barrages

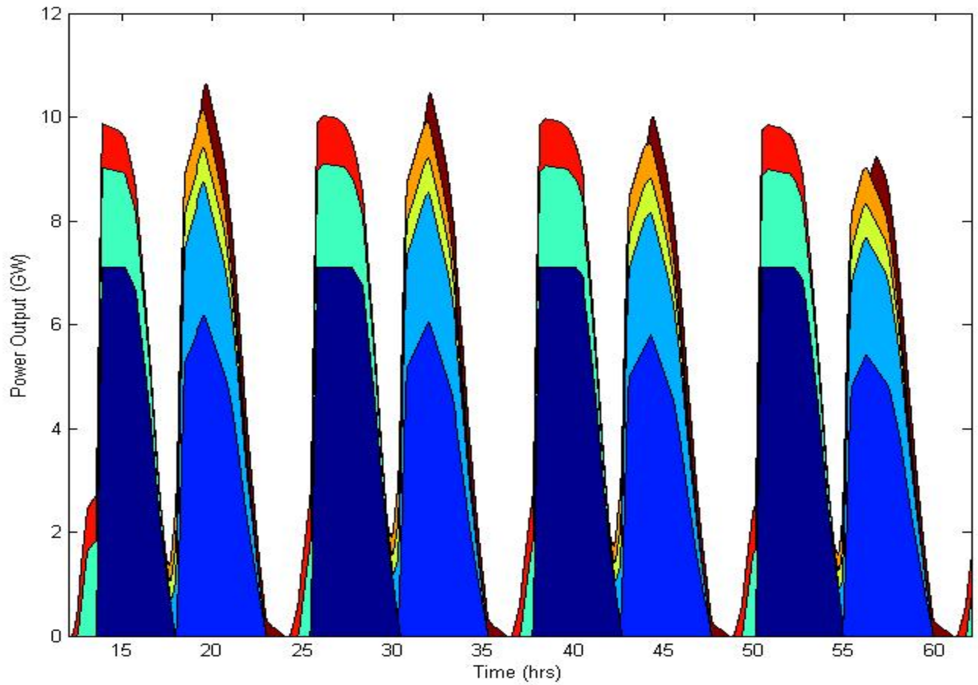
Barrage Circulation





Potential UK Resource

Some Preliminary 0-D model Outputs

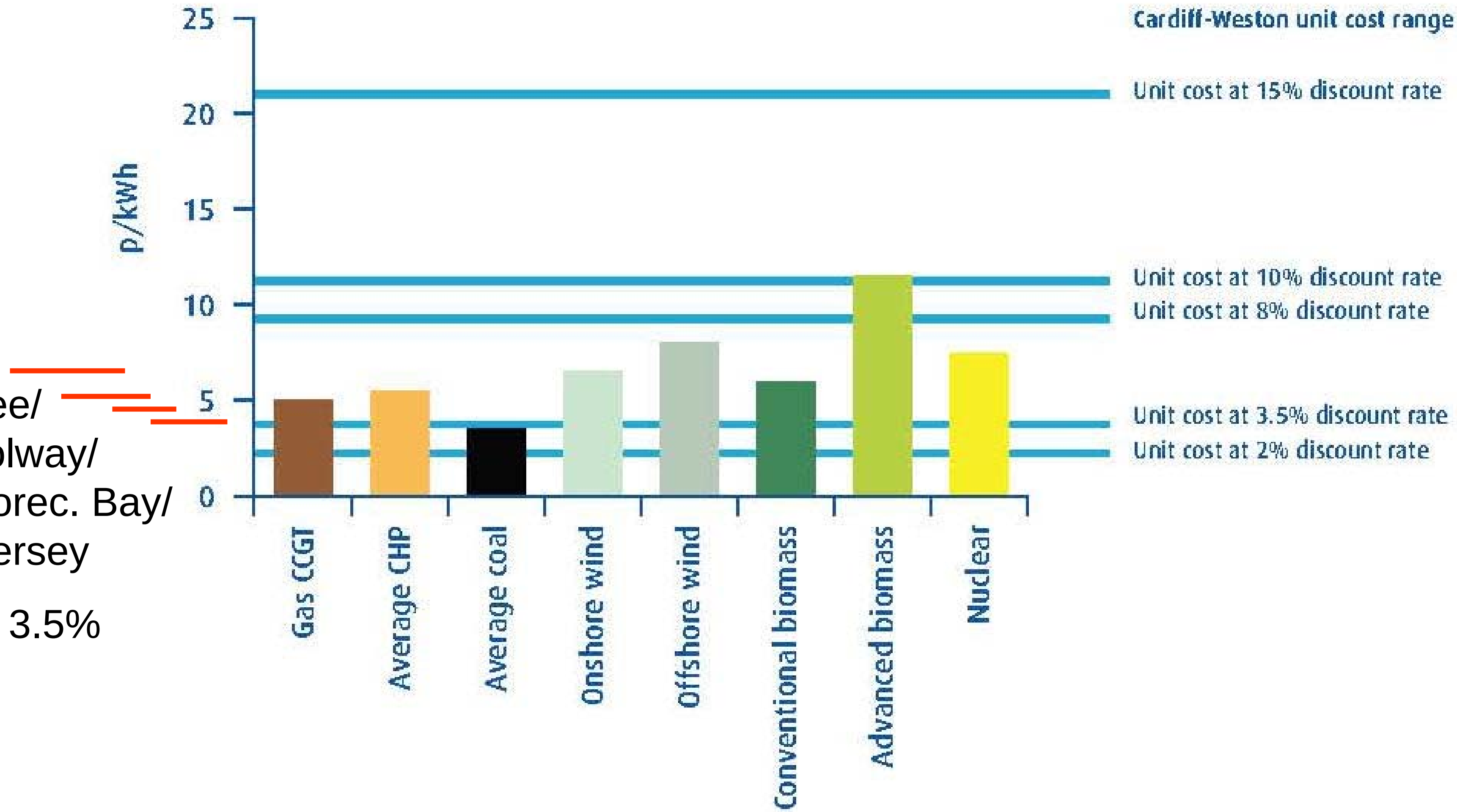


Annual output from maximum energy generation using best delays

= 36.1 TWh

SDC report 2007

Figure 33 Comparing the cost of a tidal barrage against other technologies



Dee/
Solway/
Morec. Bay/
Mersey

@ 3.5%

In CONCLUSION:

The UK possesses natural resources in wind, tide and wave energy capable of making a significant impact on its CO_2 emissions.

- It owes a duty to the international community to exploit these resources in the global battle against climate change and towards sustainability.

- Tidal barrages in the estuaries of the Northwest would be capable of meeting about half the region's electricity need.

Any Questions?

Prof Richard Burrows

Richard Burrows is Professor of Environmental Hydraulics in the Department of Engineering at the University of Liverpool. With over 30 years of research experience, he holds a portfolio spanning activities across the fields of water resources and coastal/offshore engineering. He is a Chartered Engineer and Fellow of the Institution of Civil Engineers and holds memberships of the Chartered Institution of Water and Environmental Management and the International Water Association.