



POL Seminar
The Climate System and our Oceans
17th March 2010

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**Releasing the tidal power
potential of UK coastal waters**

Joule Project JIRP106/03

Oct 2006 – Dec 2008

Tapping the Tidal Power Potential of the Eastern Irish Sea

Investigator Team:

UoL - Department of Engineering:

Richard Burrows,
Nick Yates, TS Hedges, DY Chen, Ming Li, JG Zhou

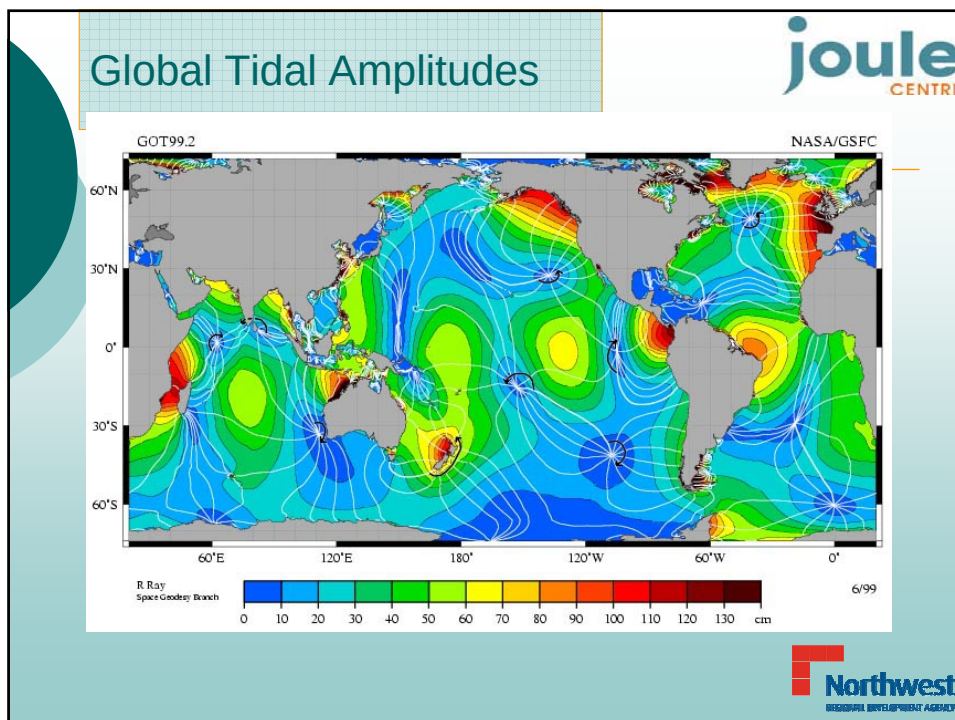
POL: *Ian Walkington, Judith Wolf,*
J Holt, R Proctor, (D Prandle)





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Extracting Energy from the Tides

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Tidal barrages



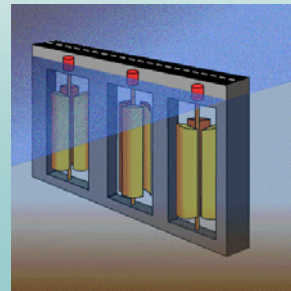
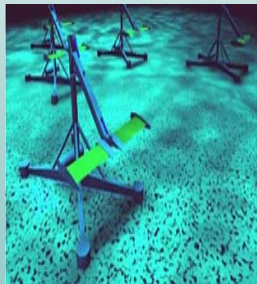
Max (Potential) Energy available per tidal cycle

$\sim \rho g \cdot \text{basin area} \cdot (\text{tidal range})^2$
- max practical extraction (ebb-only) $\sim 25\%$

Power density in tidal stream

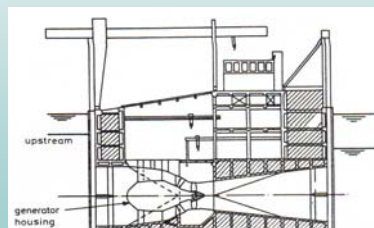
$\sim \rho \cdot (\text{current speed})^3 / 2$ per m^2
- max practical extraction $\sim 40\%$

Tidal stream/fence



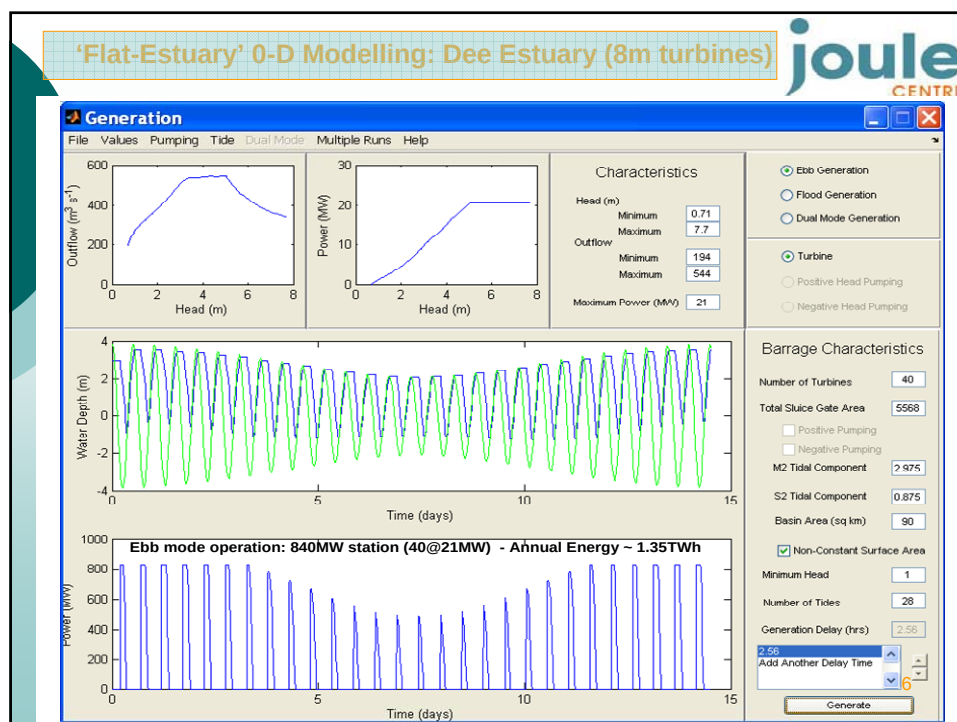
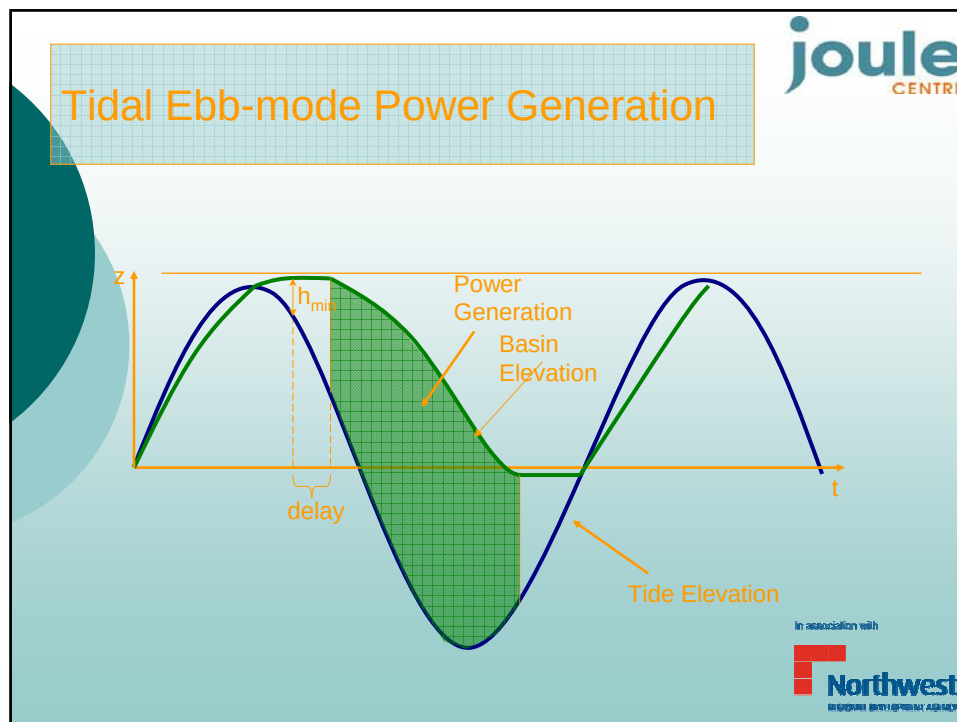
Tidal Barrage Power Generation

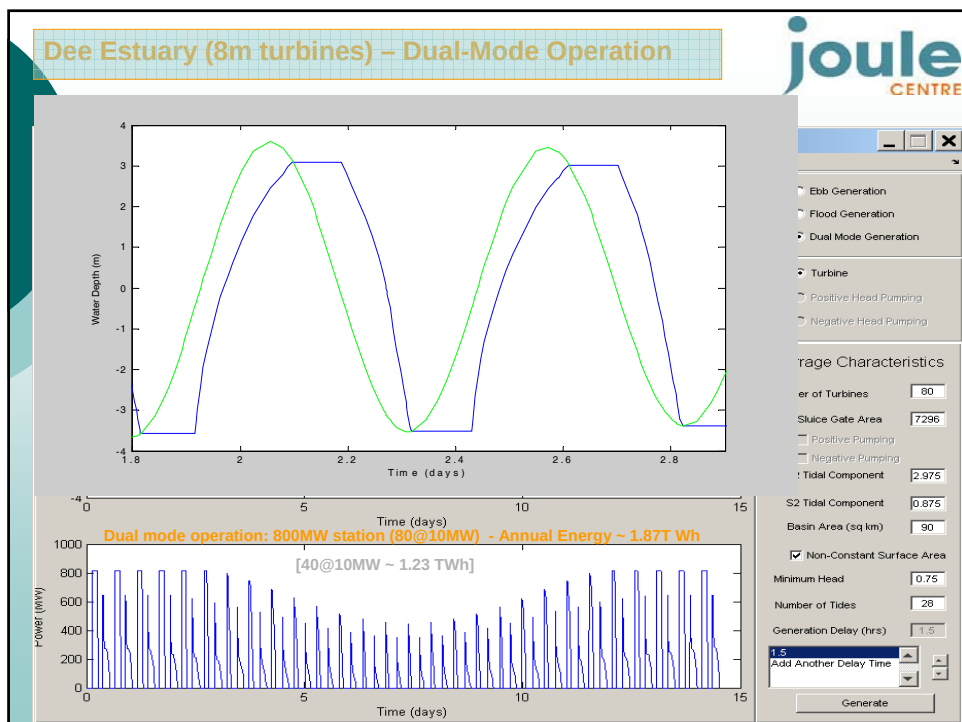
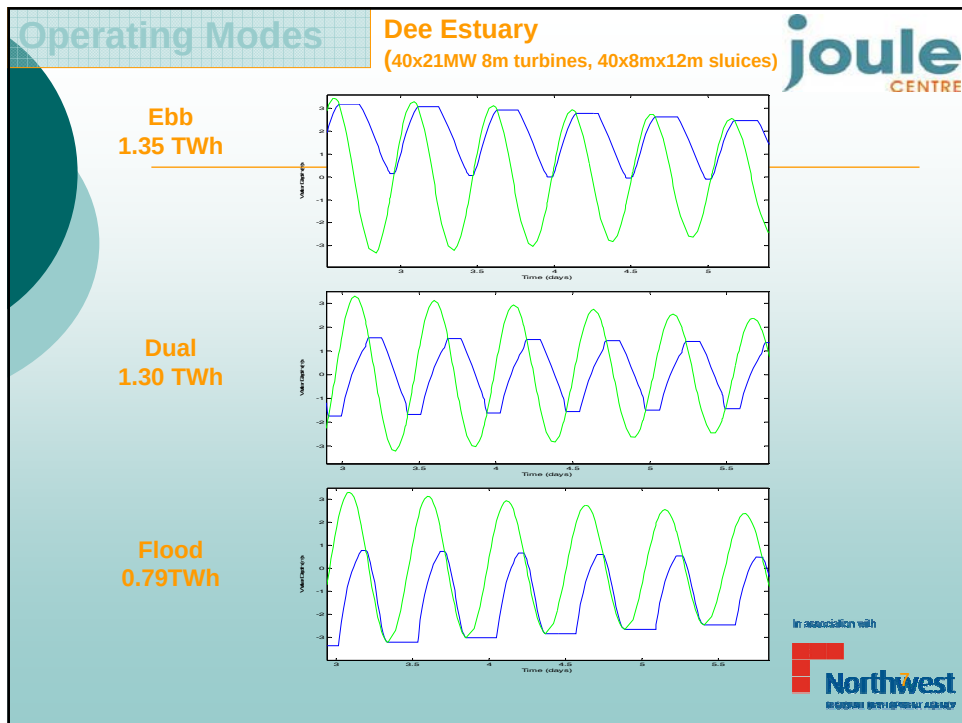
- Lasting source of clean energy
- Large capacity and secure
- Time of production predictable
- Tried and tested
- La Rance operating > 40 yrs
- Flood protection
- Transport link
- Tourism
- **Disadvantage** - some environmental modification but not necessarily degradation!!



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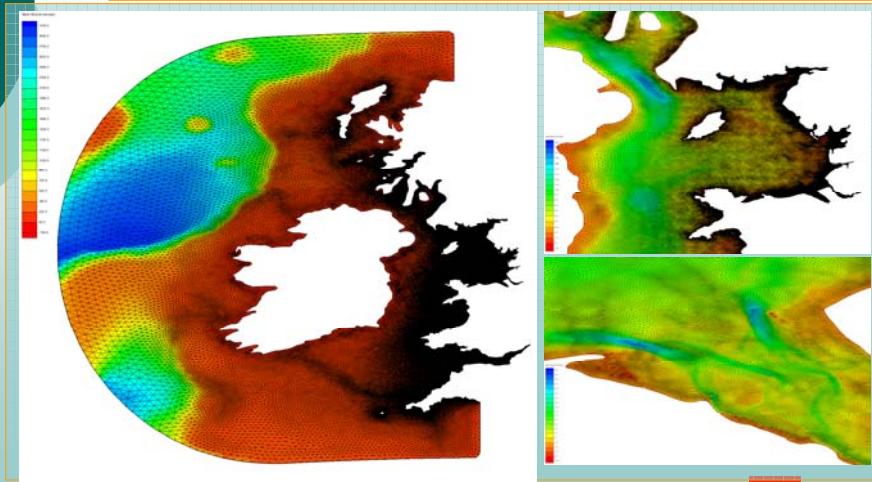
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2-D Modelling using ADCIRC and Unstructured Grid Generation

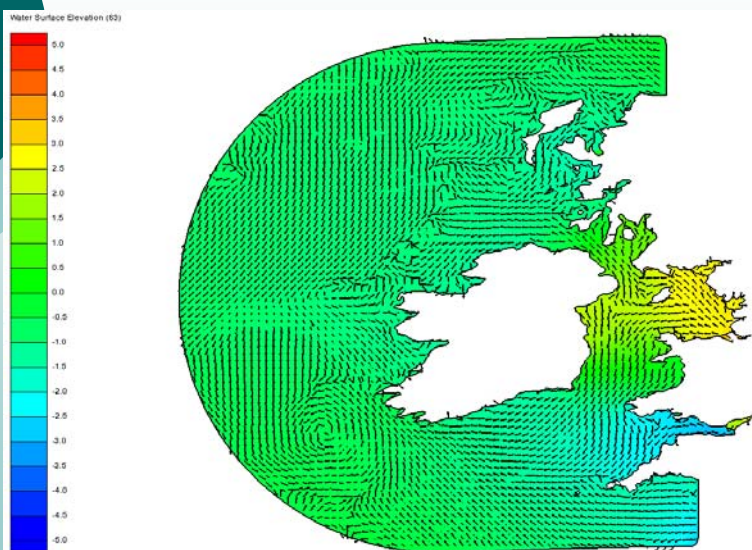
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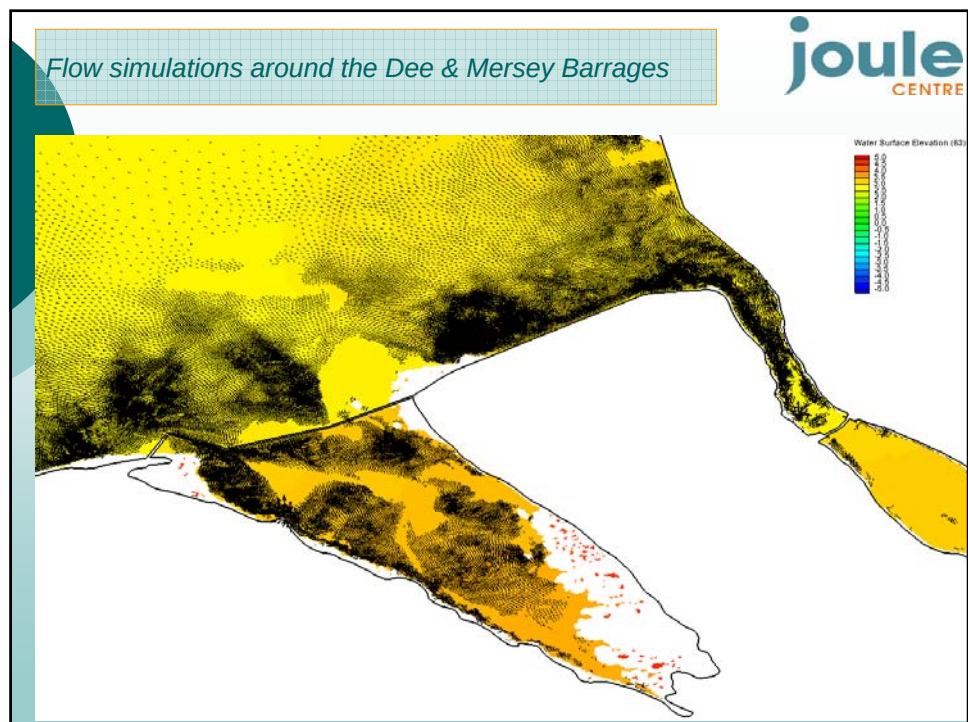
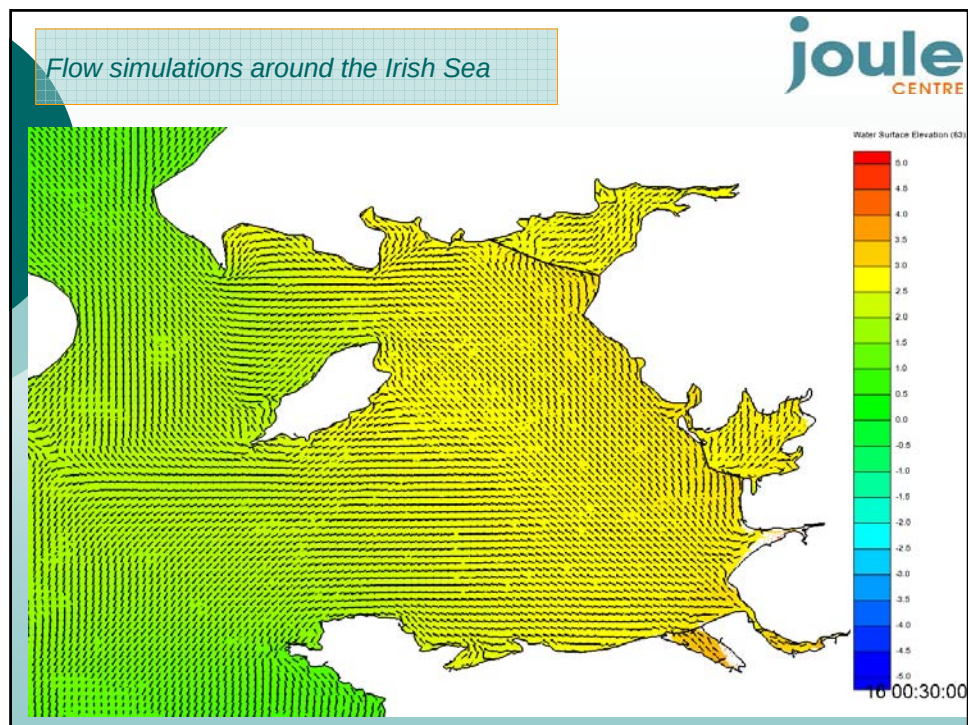
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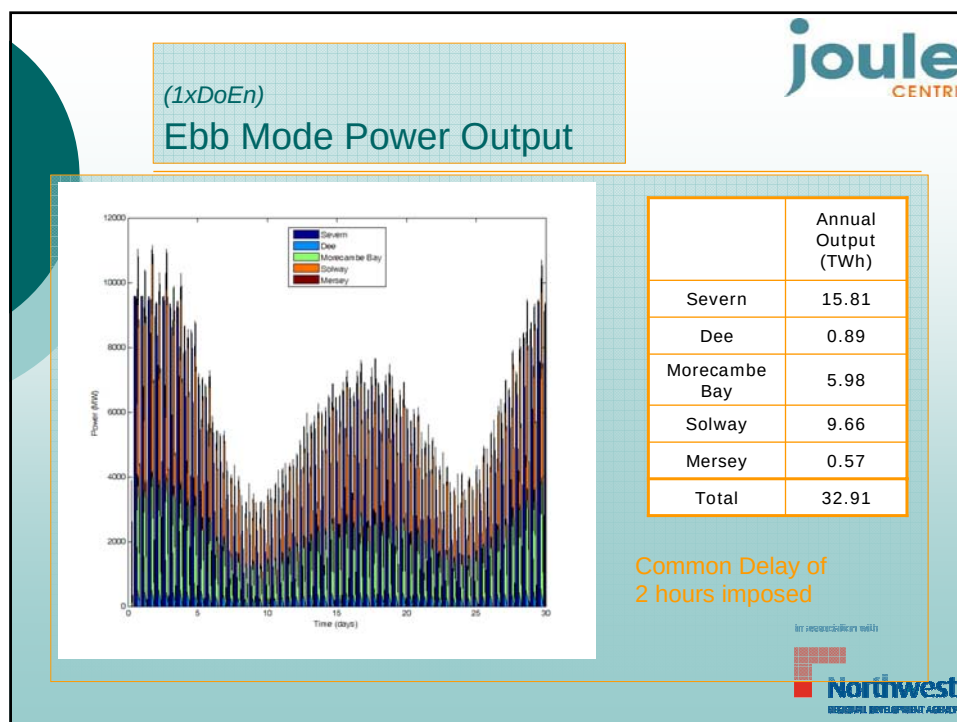
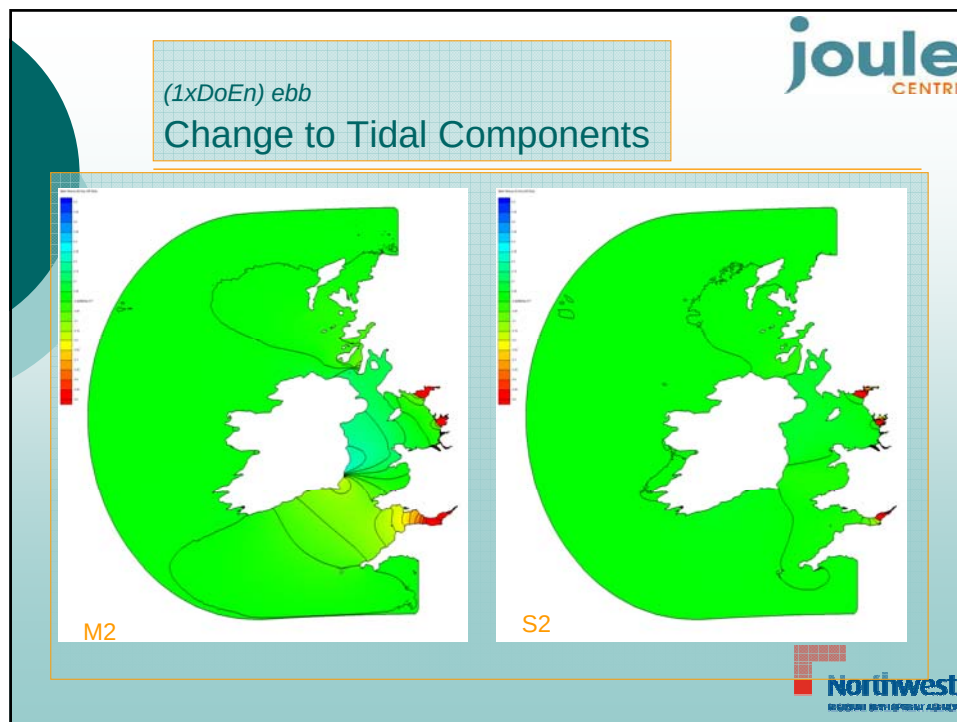
Flow simulations around the whole grid

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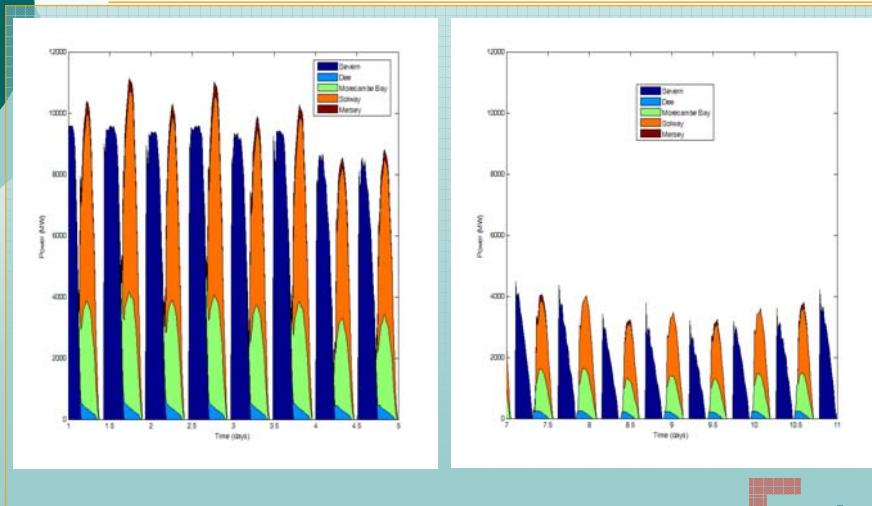


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(1xDoEn) ebb
Spring / Neap Power

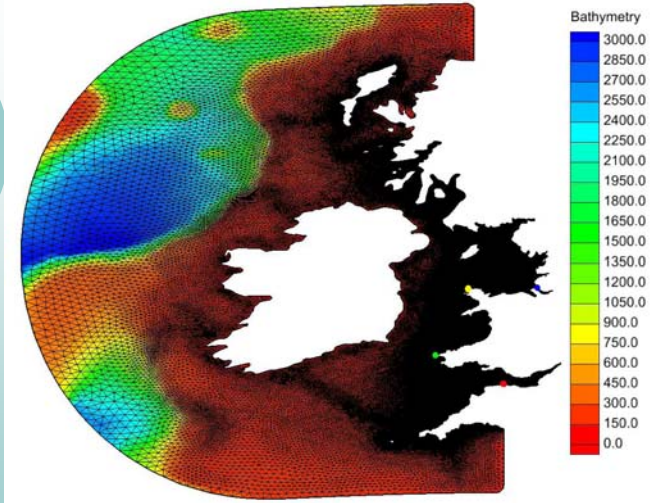


Energy Outputs from 2-D Modelling
- provisional figures not fully validated

	1xDoEn Ebb-Mode Energy (TWh)		1xDoEn Dual-Mode Energy (TWh)		3xDoEn Dual-Mode Energy (TWh)	
Solway	9.66		6.82		10.80	
Morecambe Bay	5.98		3.99		7.13	
Mersey	0.57		0.74		0.97	
Dee	0.89		0.80		1.35	
	Total Energy (TWh)	UK (%)	Total Energy (TWh)	UK (%)	Total Energy (TWh)	UK (%)
North West	17.10	4.5	12.34	3.2	20.24	5.3
Severn	15.81	4.2	14.01	3.7	20.01	5.3
Total	32.91	8.7	26.35	6.9	40.25	10.6

Modelling tidal stream power potential

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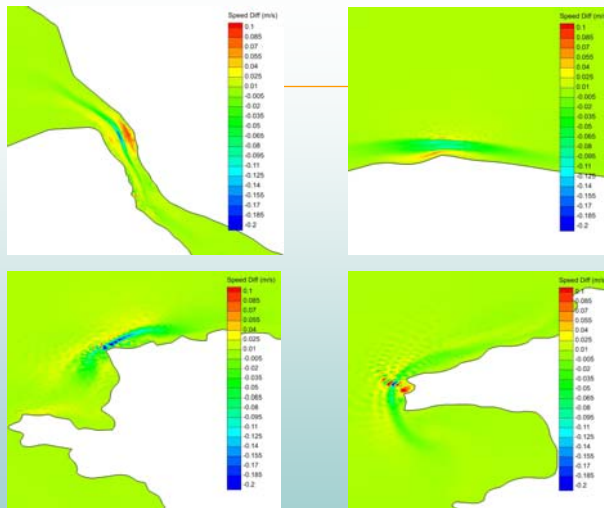
Grid of the west coast model showing the locations of the four simulated tidal stream farms:
Mersey (blue); Skerries (yellow); West Wales (green);
Lynmouth (red).

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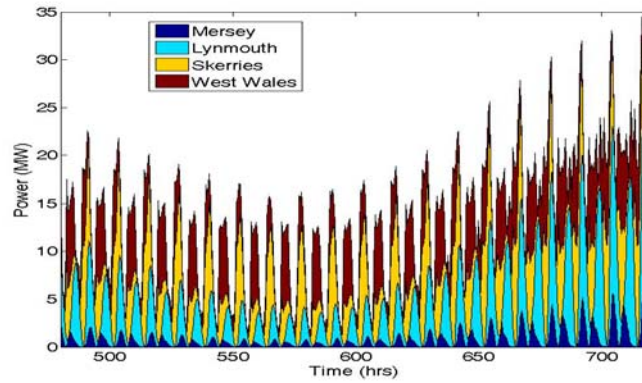
Change in current speed at the tidal stream farms:-
Mersey Lynmouth
Skerries West Wales

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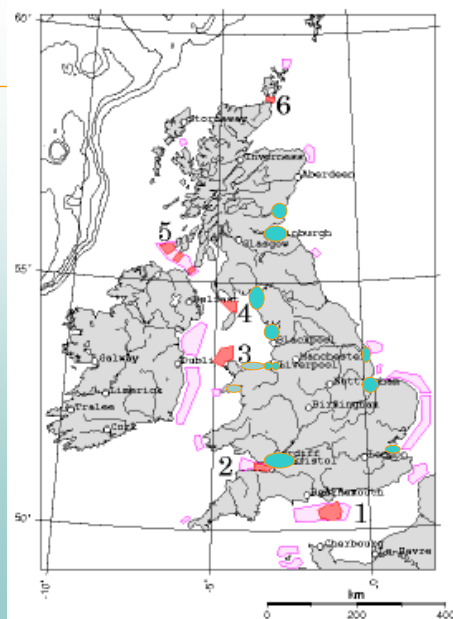
	Rated Capacity (MW)	Rated Speed (m/s)
Mersey	20	2.4
Lynmouth	30	2.0
Skerries	10.5	2.4
West Wales	8	2.0

	Annual Output (GWh/y)	Utilisation (%)
Mersey	7.8	5
Lynmouth	40.9	16
Skerries	40.0	44
West Wales	37.9	55

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From MacKay (2009)

'Sustainable Energy-
without the hot air'

Red/pink - Regions with
peak currents exceeding
1m/s

Blue circle - Estuary barrage

Yellow circle - Coastal lagoon

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CONCLUDING COMMENT

The UK possesses natural resources in tidal energy capable of making a significant impact on its CO₂ emissions.

- Tidal barrages in the estuaries of the Northwest would be capable of meeting about half the region's electricity need
- UK tidal resource ~ 15 % barrage/lagoon + ~ 5 % 'stream'

- ISSUES outstanding:-

tidal regime change & biodiversity implications;
sediments – morphological changes;
tidal stream resource and array performance evaluation;
optimal operational scheduling - grid balancing;
hydro-mechanical plant performance;
economics - holistic cost-benefit analysis

- Further information:

www.liv.ac.uk/engdept/tidalpower

- Any questions?

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Forth Estuary

0-D Analysis

Barrage

4.7TWh/yr (2.7GW)

Lagoon1

0.4TWh/yr (240MW)

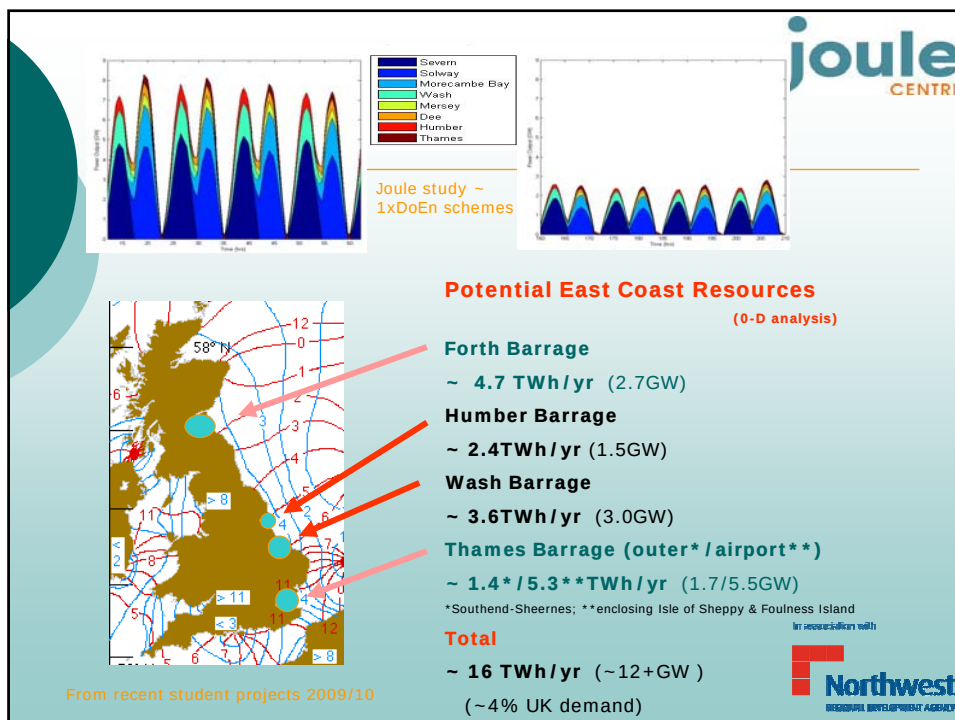
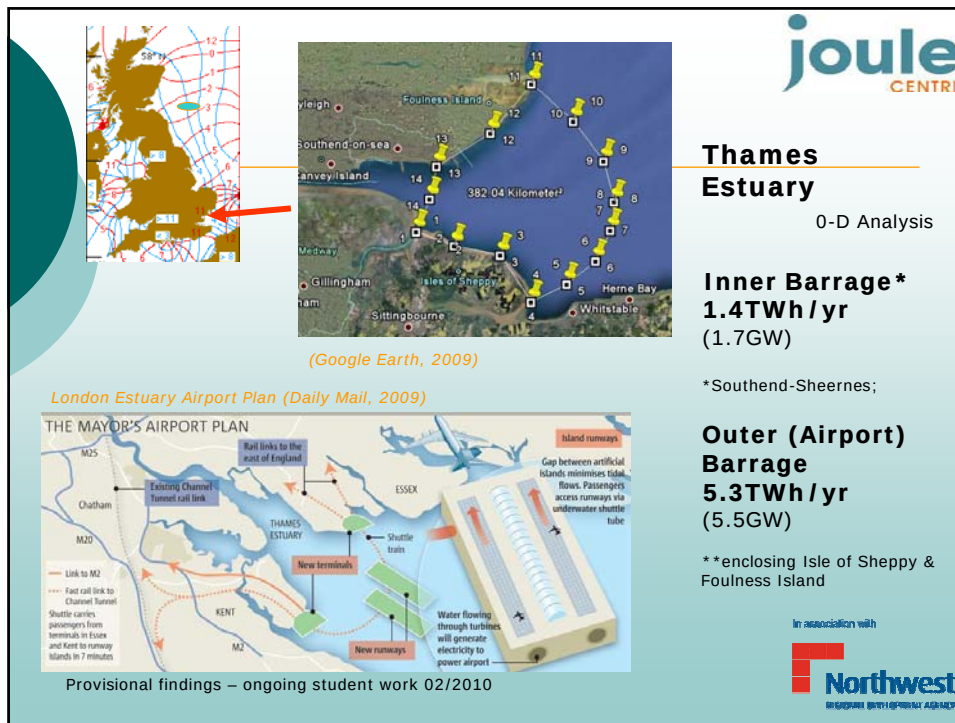
Lagoon 2

0.25TWh/yr (140MW)



Provisional findings – ongoing student work 02/2010

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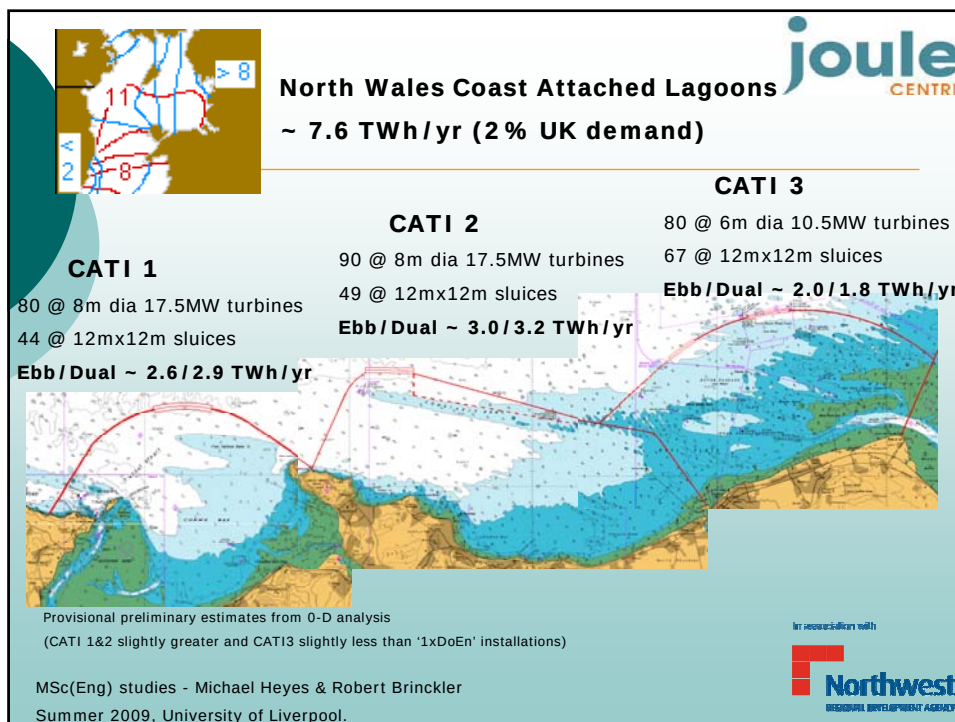
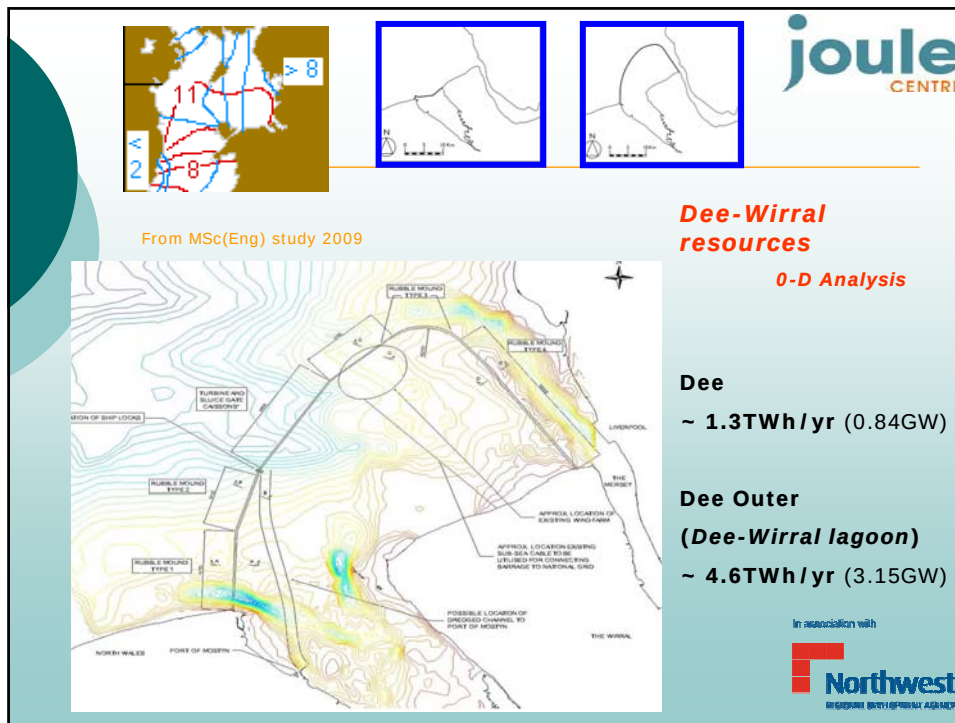
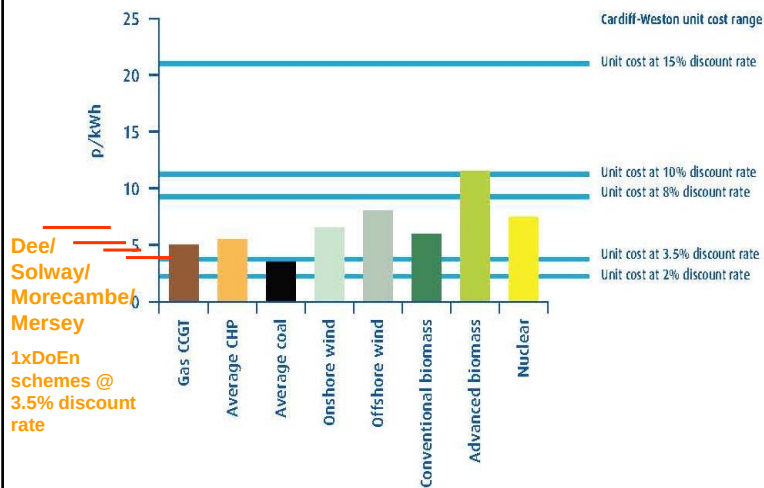


Figure 33 Comparing the cost of a tidal barrage against other technologies



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