Tidal Power In the Irish Sea

joule CENTRE

Northwest REGIONAL DEVELOPMENT AGENCY

Joule Project JIRP106/03

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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)

UNIVERSITY OF LIVERPOOL

Proudman Oceanographic Laboratory
NATURAL ENVIRONMENT RESEARCH COUNCIL

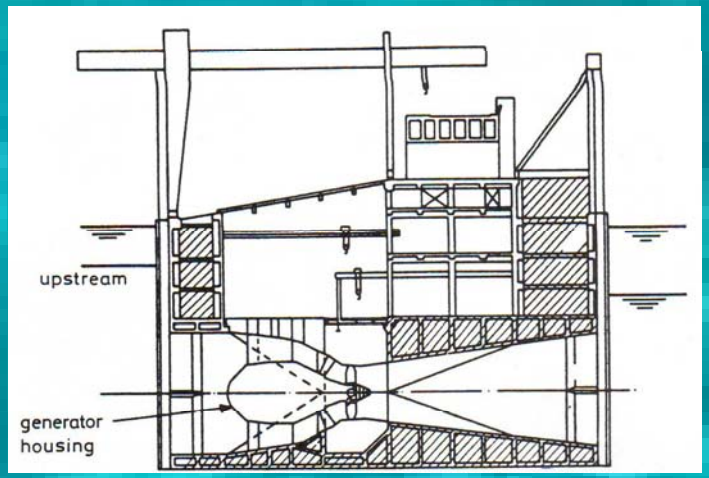
Renewable Future

UK Electricity Generation Energy Mix

2007		2020
5.5%	Renewable	30%
20.9 TWh		113.7 TWh
379 TWh	Total	379 TWh

Tidal Energy

Range (Barrage) (~50 TWh/y = 13%)



Stream (~20 TWh/y = 5%)

Operating Modes

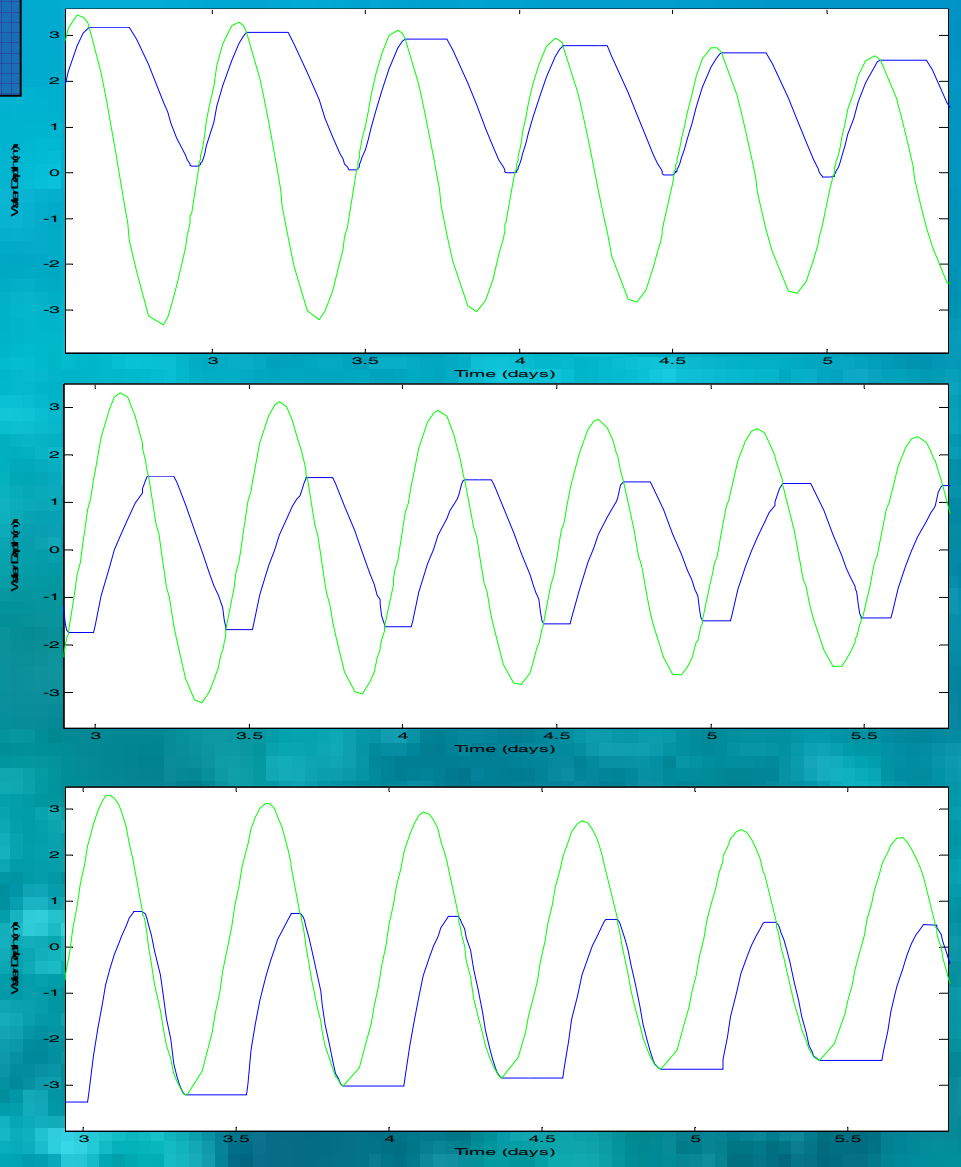
Ebb
1.35 TWh

Dual
1.30 TWh

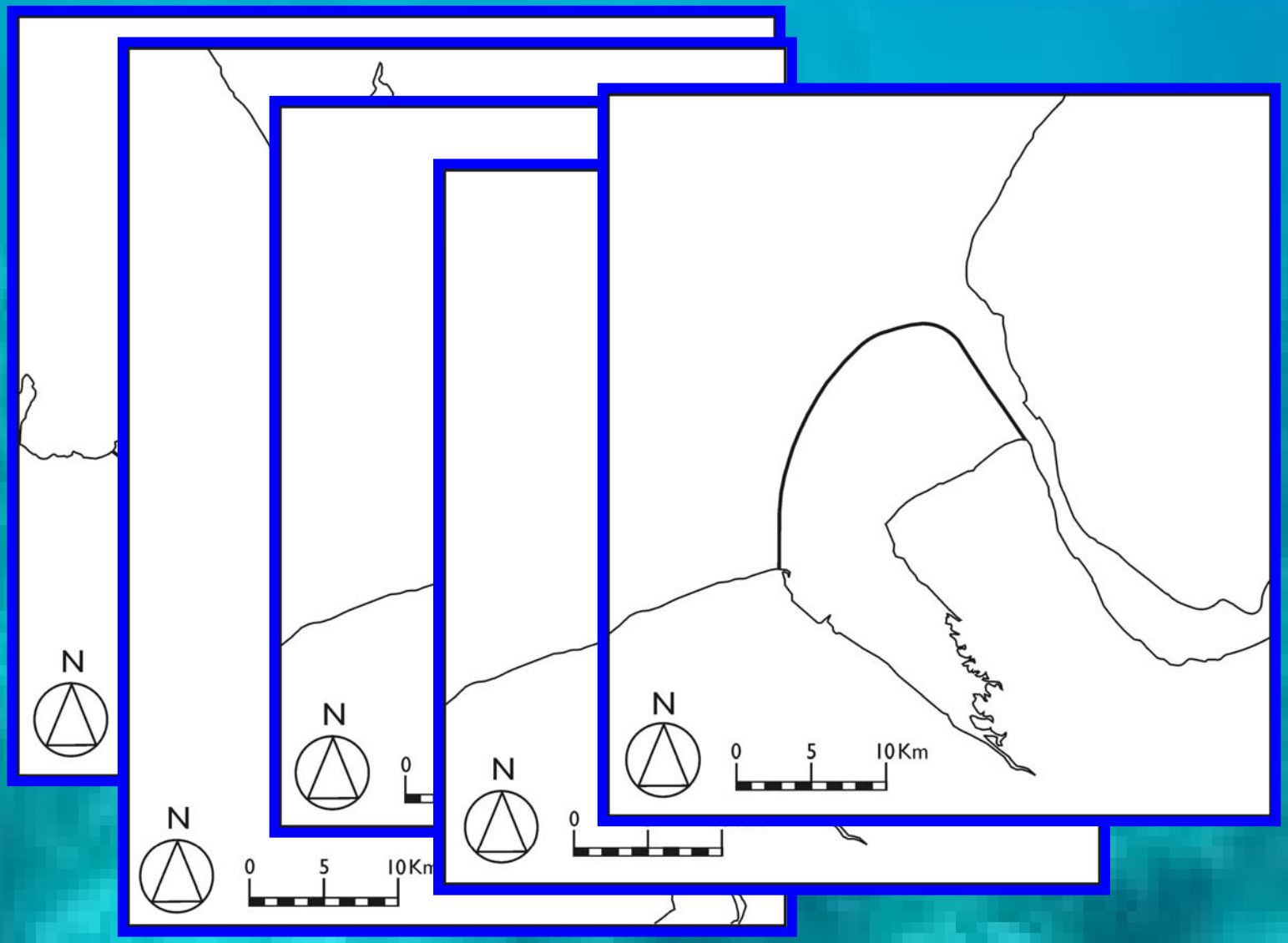
Flood
0.79TWh

Dee Estuary

(40x21MW 8m turbines, 40x8mx12m sluices)

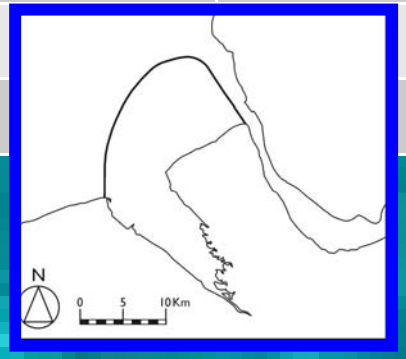


Barrage Locations

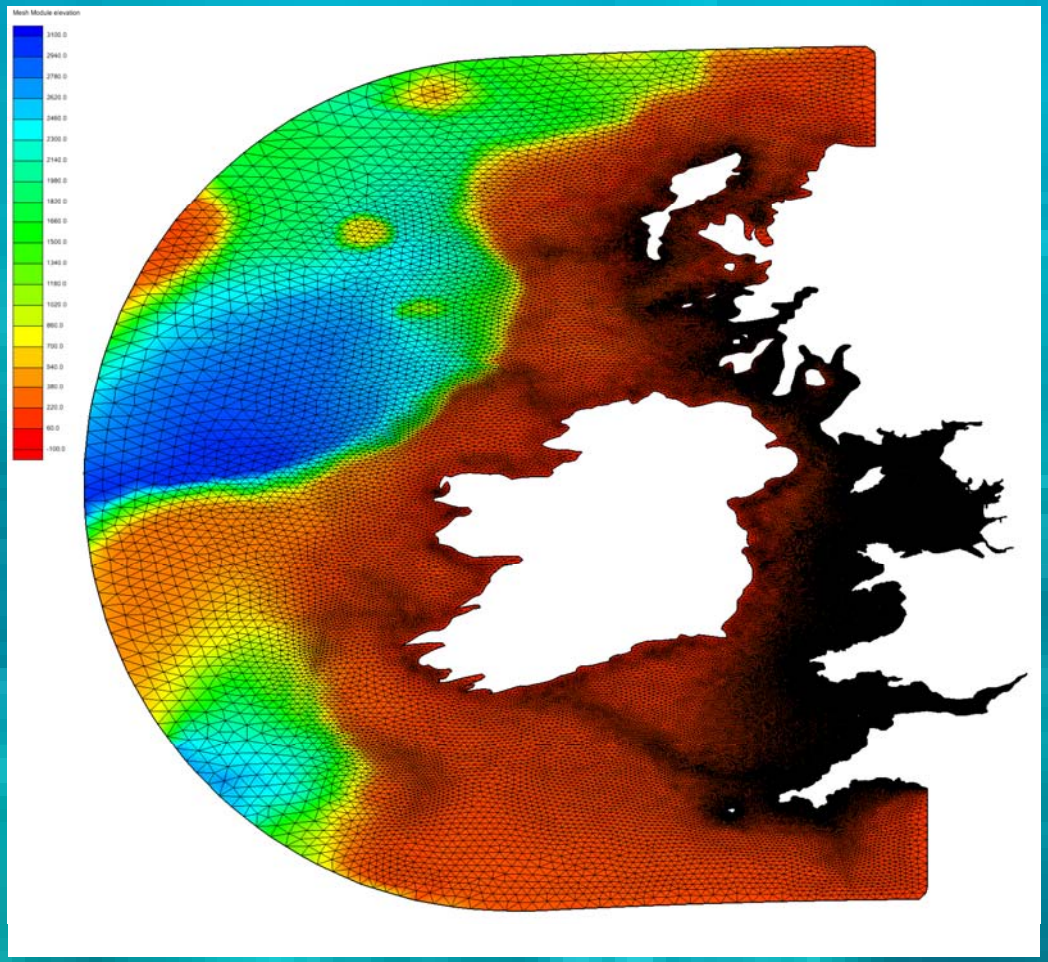


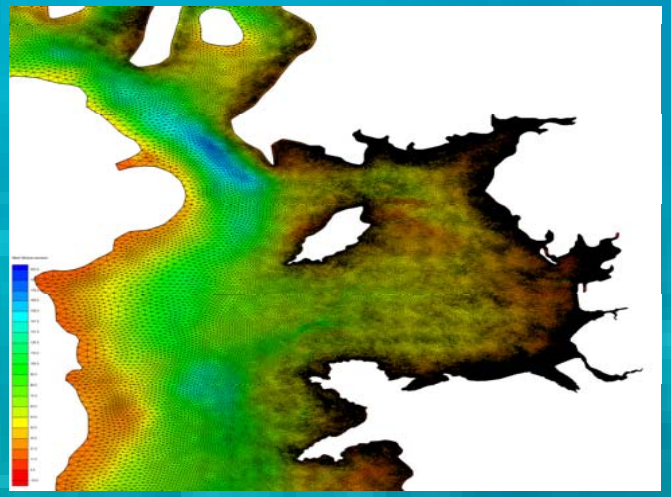
O-D Modelling Summary

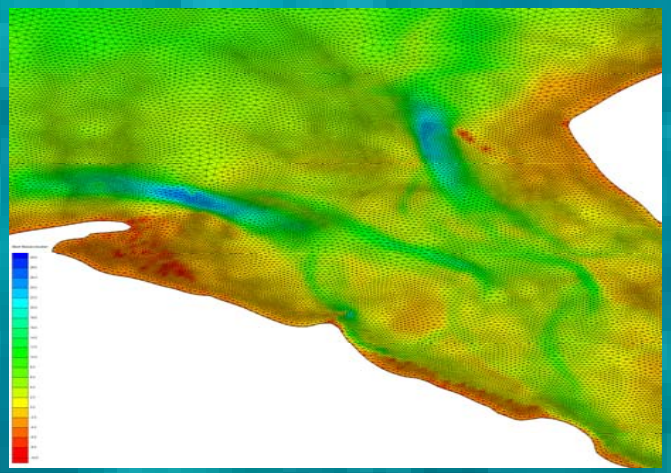
Ebb / Dual mode based on DoEn installation	1xDoEn Ebb Mode Energy TWh (Cost p/KWh)		1xDoEn Dual Mode Energy TWh (Cost p/KWh)		3xDoEn Dual Scheme Energy TWh (Cost p/KWh)	
Solway Firth	8.44 (5.83)		7.78 (6.71)		17.84 (5.86)	
Morecambe Bay	5.83 (6.04)		5.75 (6.46)		11.45 (7.39)	
Ribble	0.08 (7.75)		0.06 (11.03)			
Mersey	1.07 (4.28)		0.98 (5.12)		1.72 (6.16)	
Dee	1.35 (6.81)		1.30 (8.15)		2.21 (10.20)	
Dee Outer / Lagoon	4.60 (8.15 / 11.32)					
	Energy TWh	% of UK Electricity	Energy TWh	% of UK Electricity	Energy TWh	% of UK Electricity
NW Total (Dee/Outer)	16.76 / 20.01	**4.3 / 5.2**	15.87 / 19.17	4.1 / 5.0	33.30 / 35.69	**8.6 / 9.2**
Severn (SDC 2007)	17.00	**4.4**				
UK Total (Dee/Outer)	33.76 / 37.01	**8.7/ 9.6**				



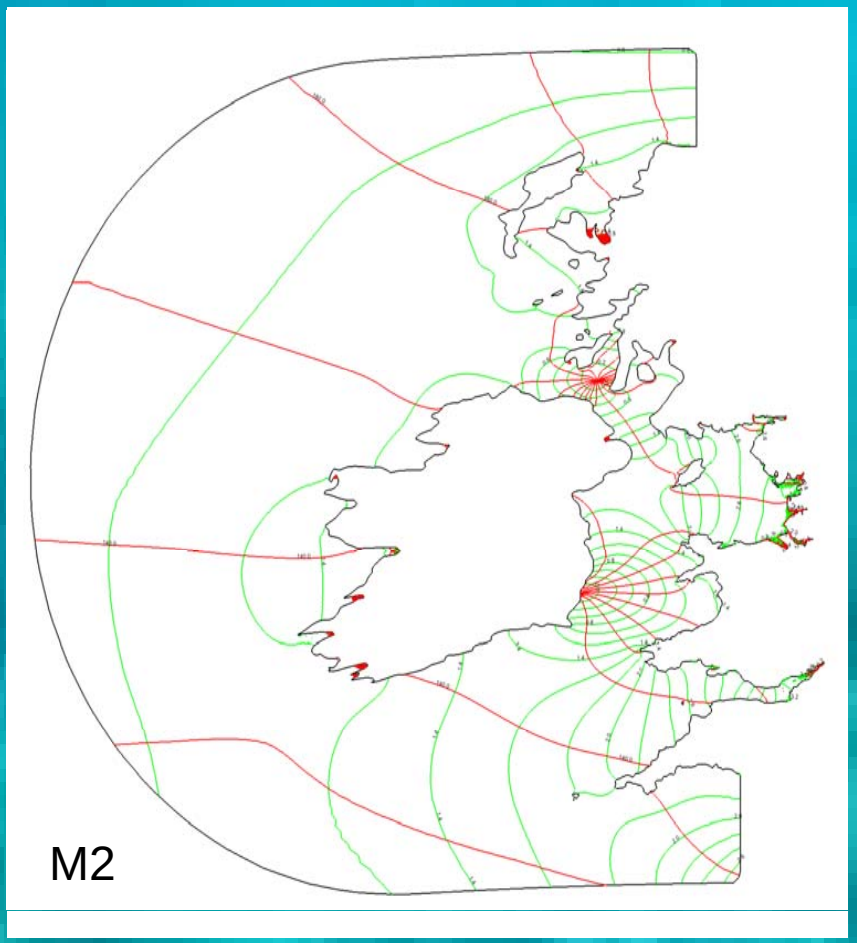
2-D Modelling using ADCIRC and Unstructured Grid Generation

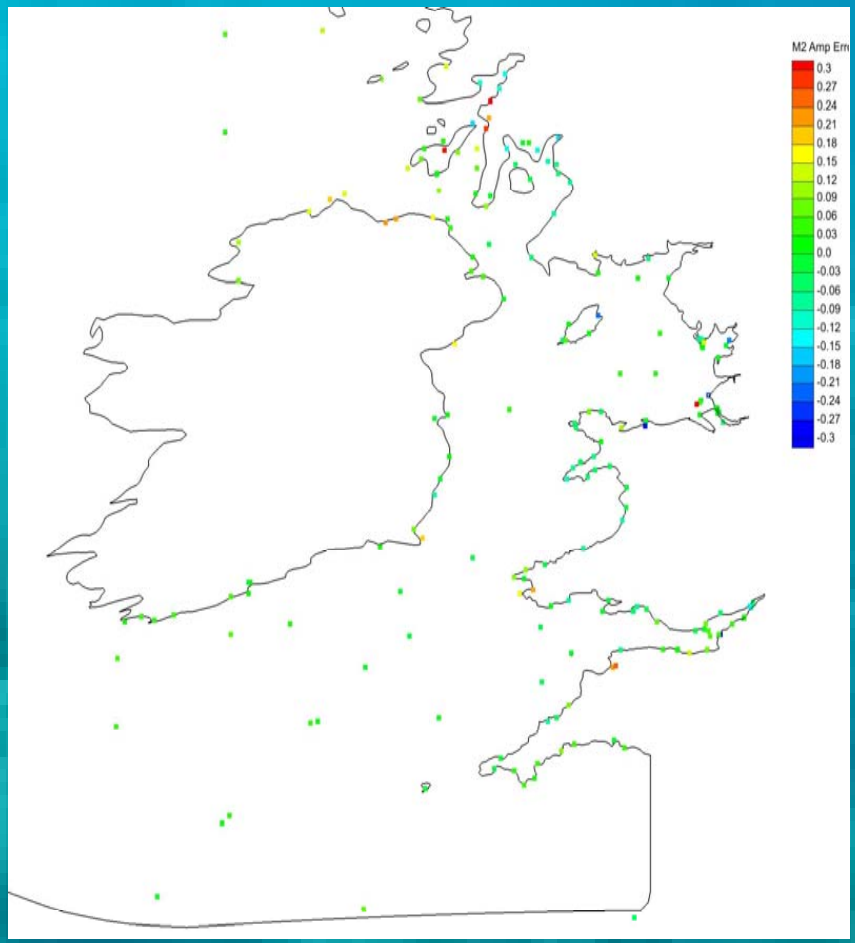






Validation


M2

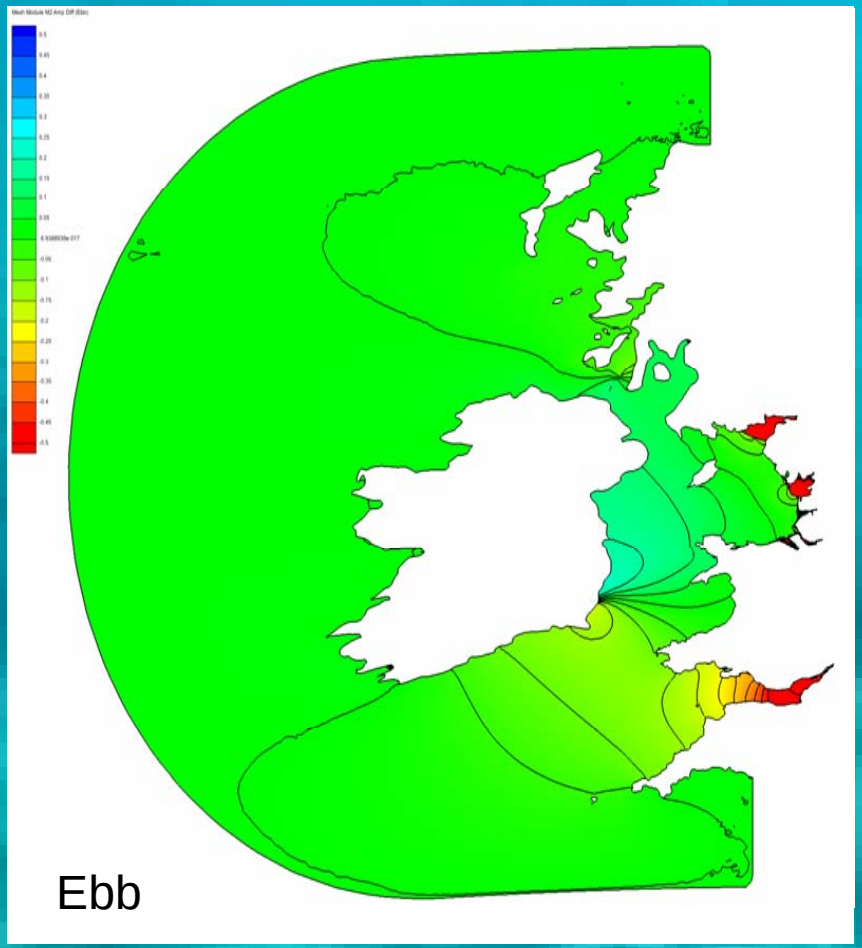

M2 Amp Err
0.3
0.27
0.24
0.21
0.18
0.15
0.12
0.09
0.06
0.03
0.0
-0.03
-0.06
-0.09
-0.12
-0.15
-0.18
-0.21
-0.24
-0.27
-0.3

Intercomparison

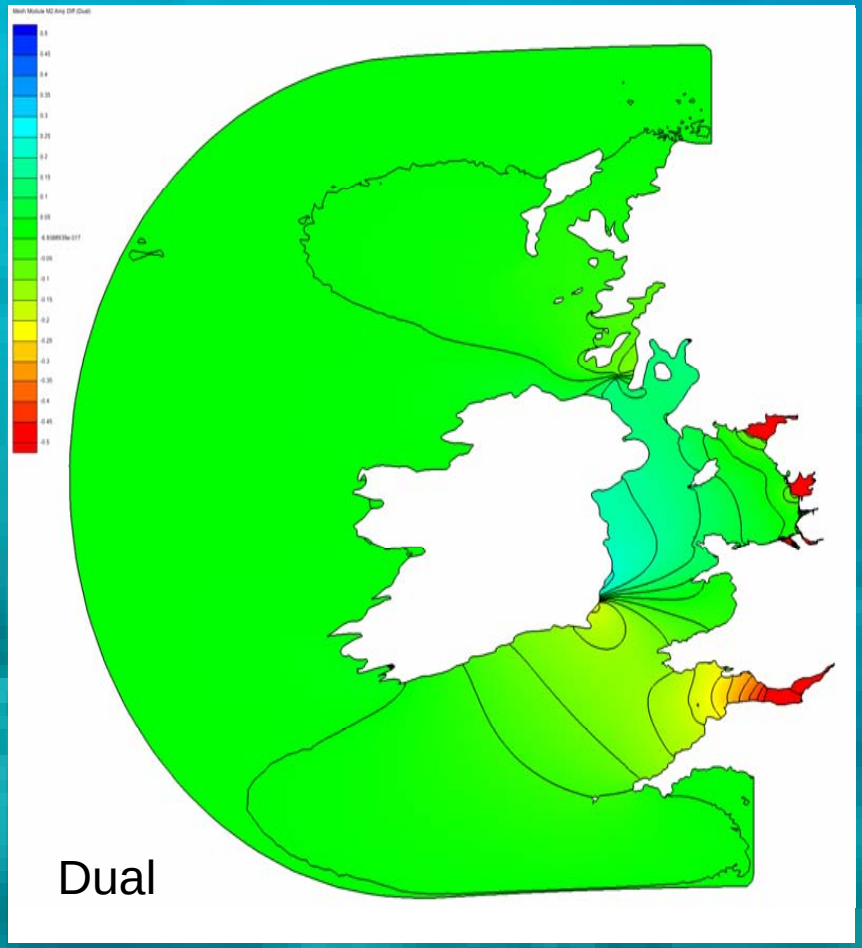
	Dataset 1 (59)	Dataset 2 (198)	Jones ADCIRC (198)	Jones Telemac (198)	POLCOMs (257)
Amp Mean (cm)	1.04	0.41	6.41	3.85	-4.99
Amp RMS (cm)	9.89	10.15	17.14	23.97	14.90
Phase Mean	0.30	0.29	-1.07	0.28	-1.00
Phase RMS	9.59	11.53	17.62	41.08	14.76
H_s (cm)	11.09	14.42	31.50	36.05	21.61

(1xDoEn) ebb / dual

Change to M_2 Tidal Component

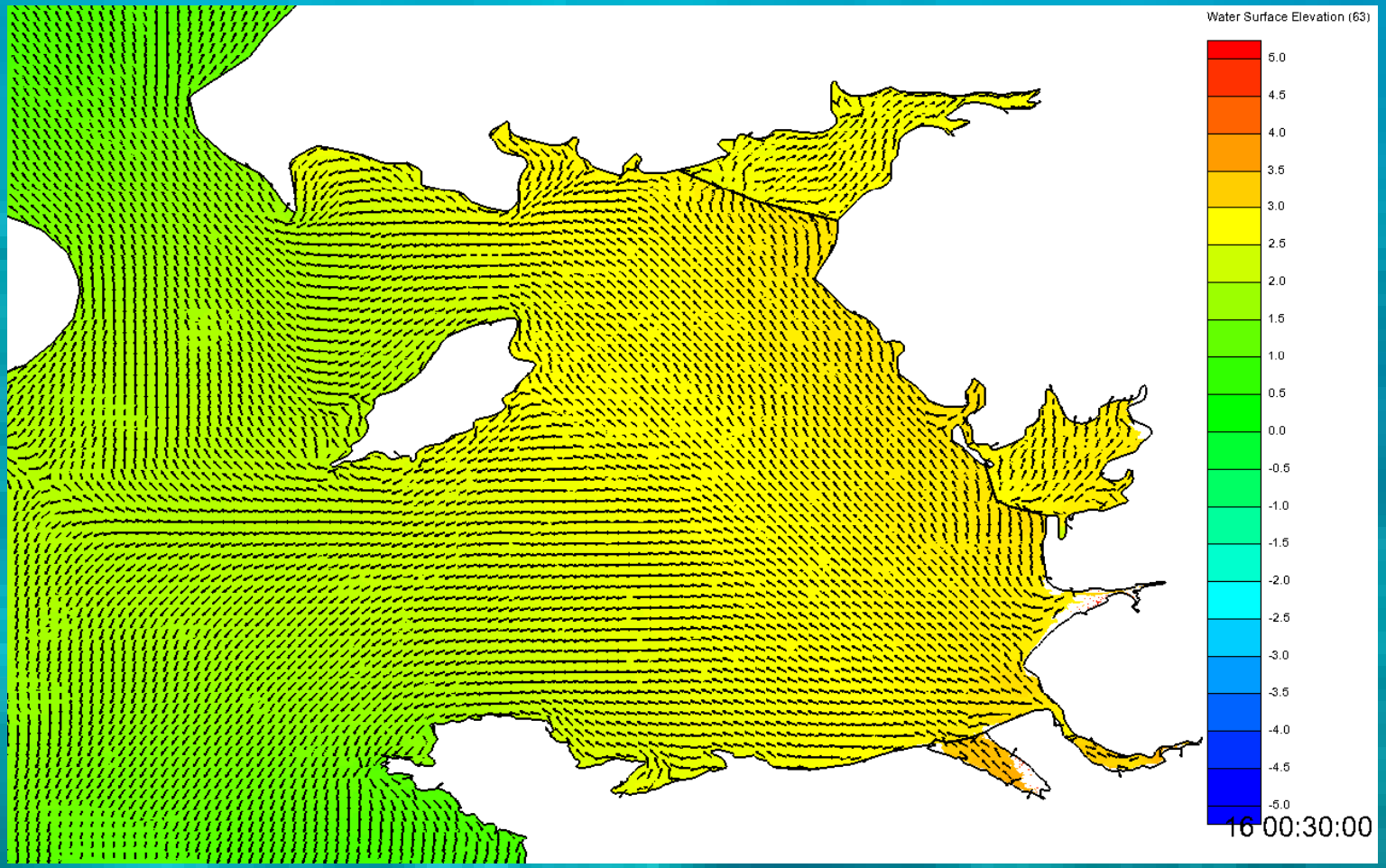


Ebb

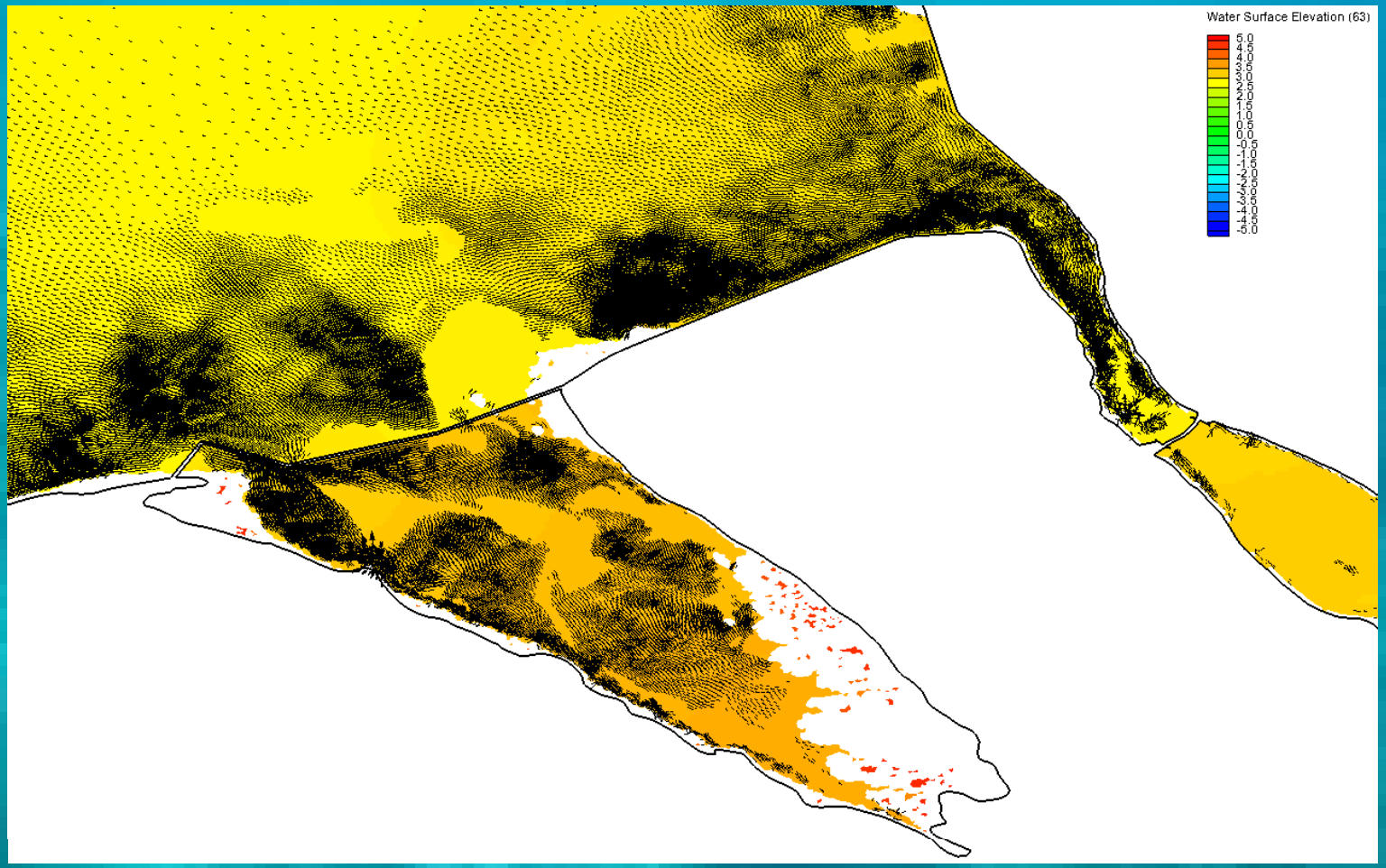


Dual

Flow Simulations Irish Sea

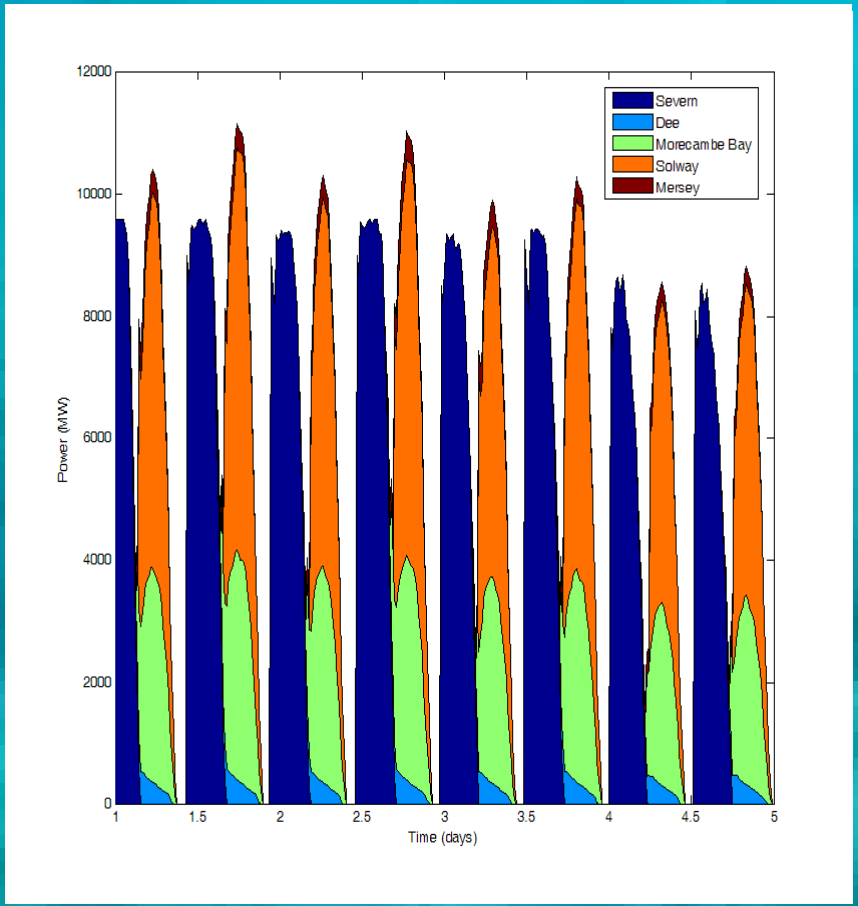


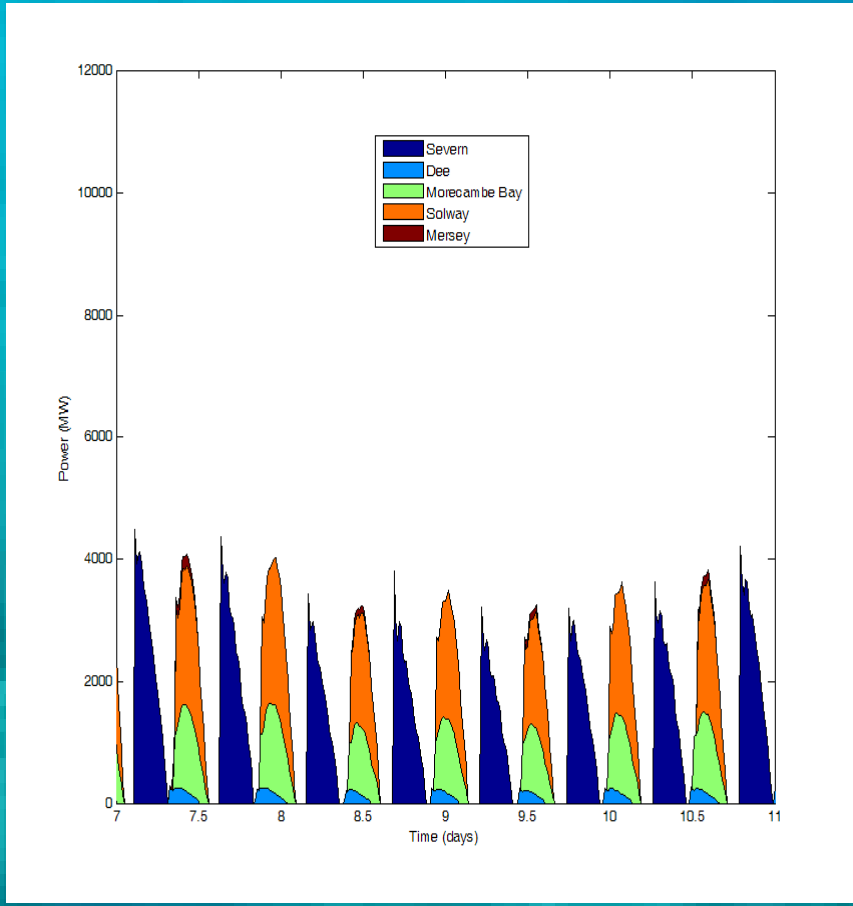
Flow Simulations Liverpool Bay



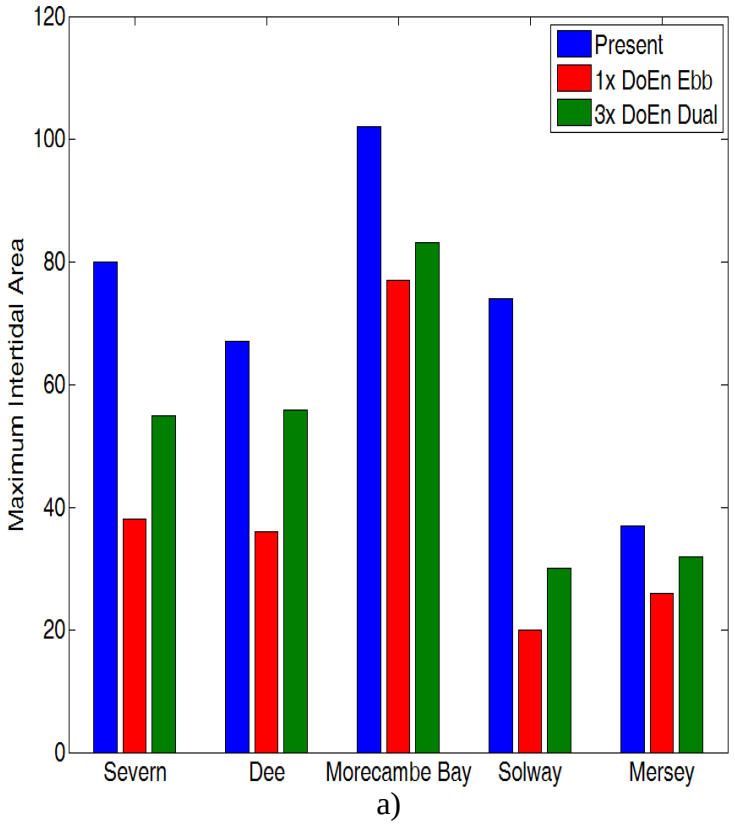
(1xDoEn) ebb

Spring / Neap Power





Intertidal Area



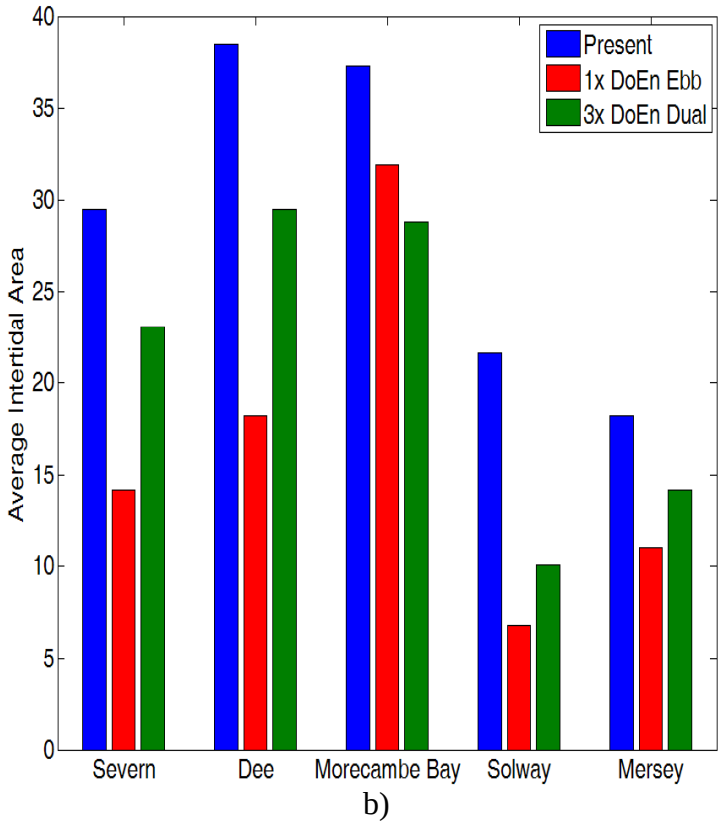
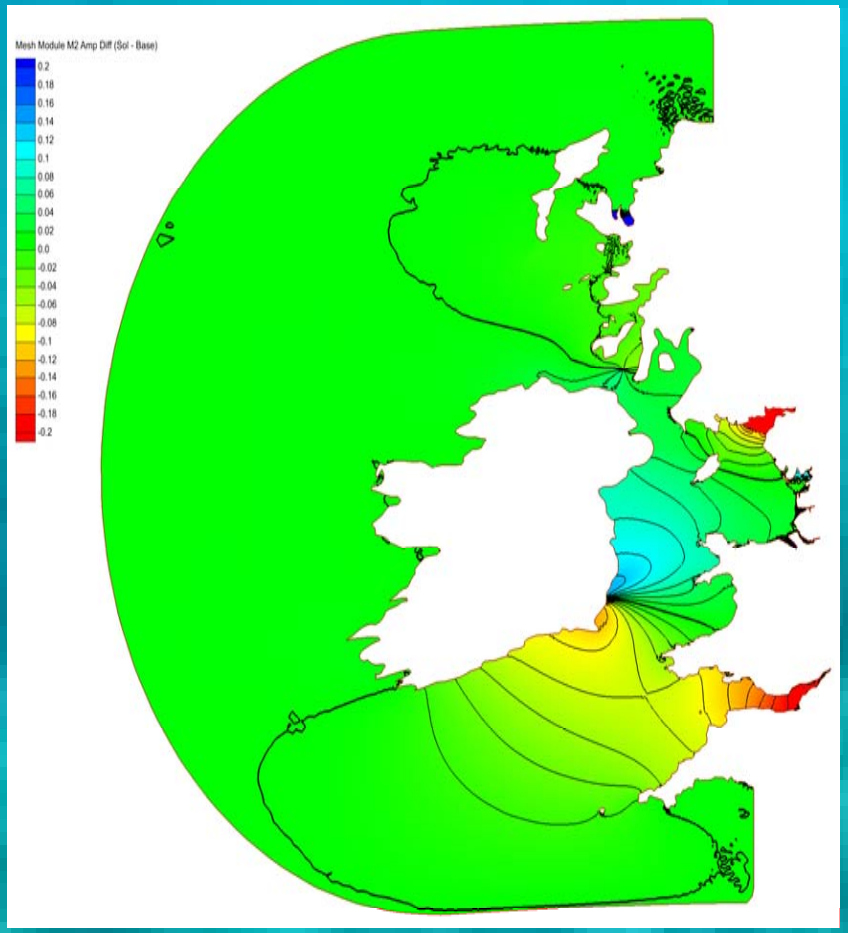
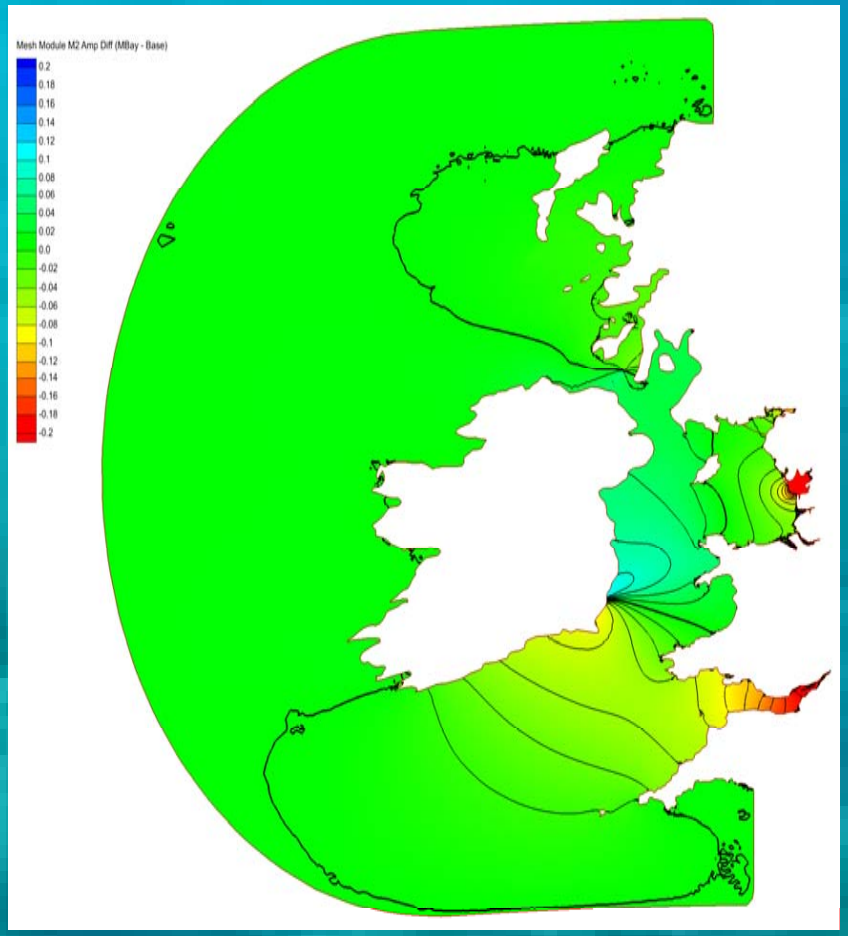


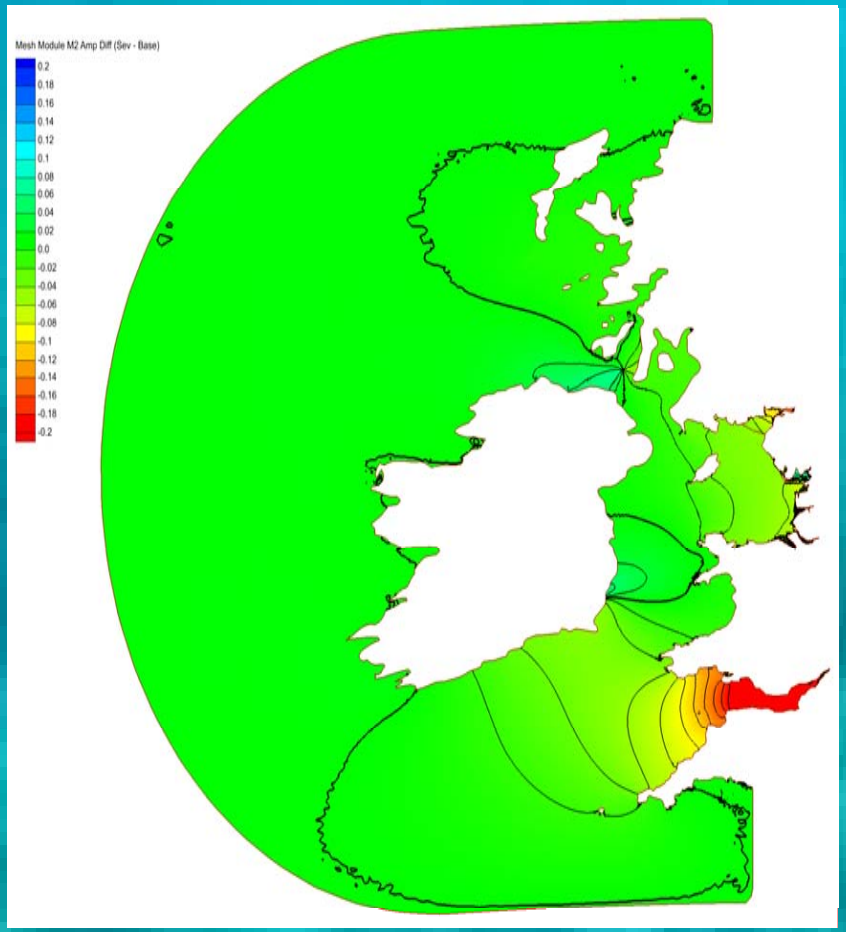
Figure Intertidal area for each basin as: a) maximum extent; b) average available.

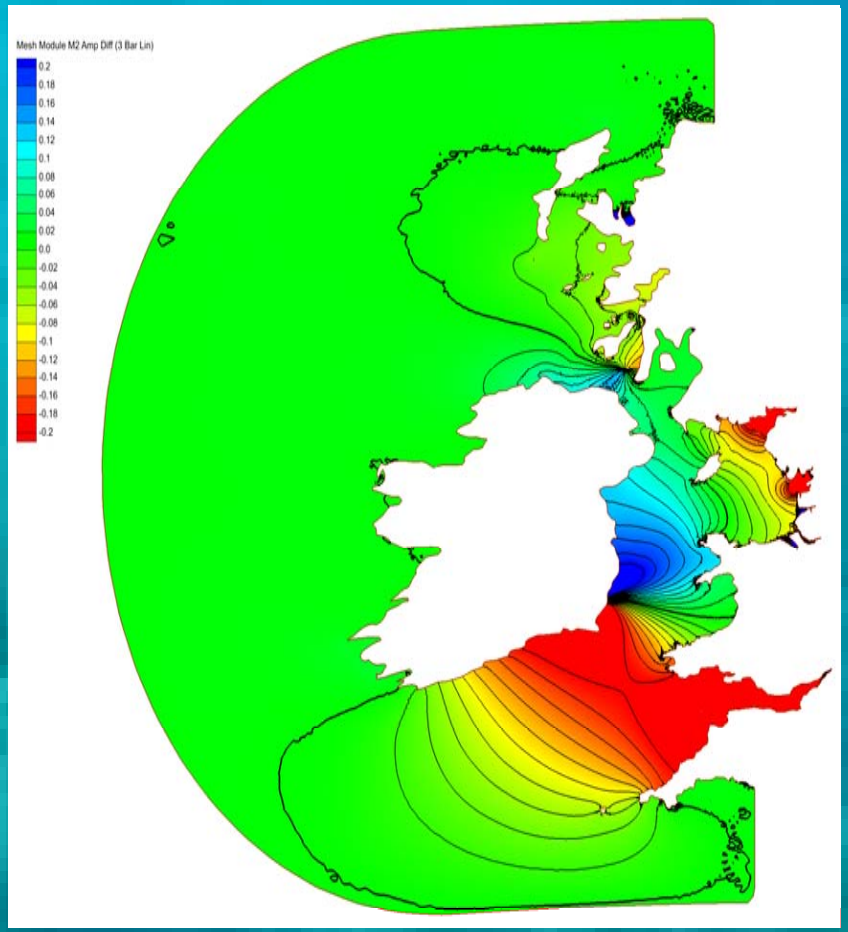
Solway and Morecambe Bay



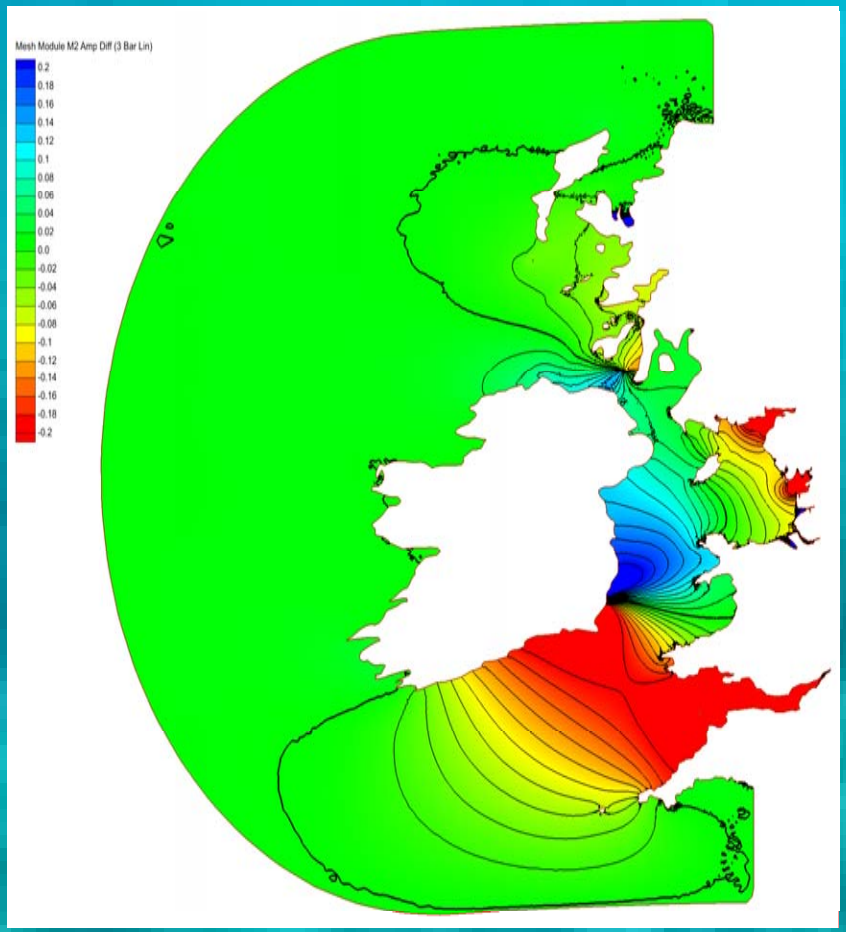


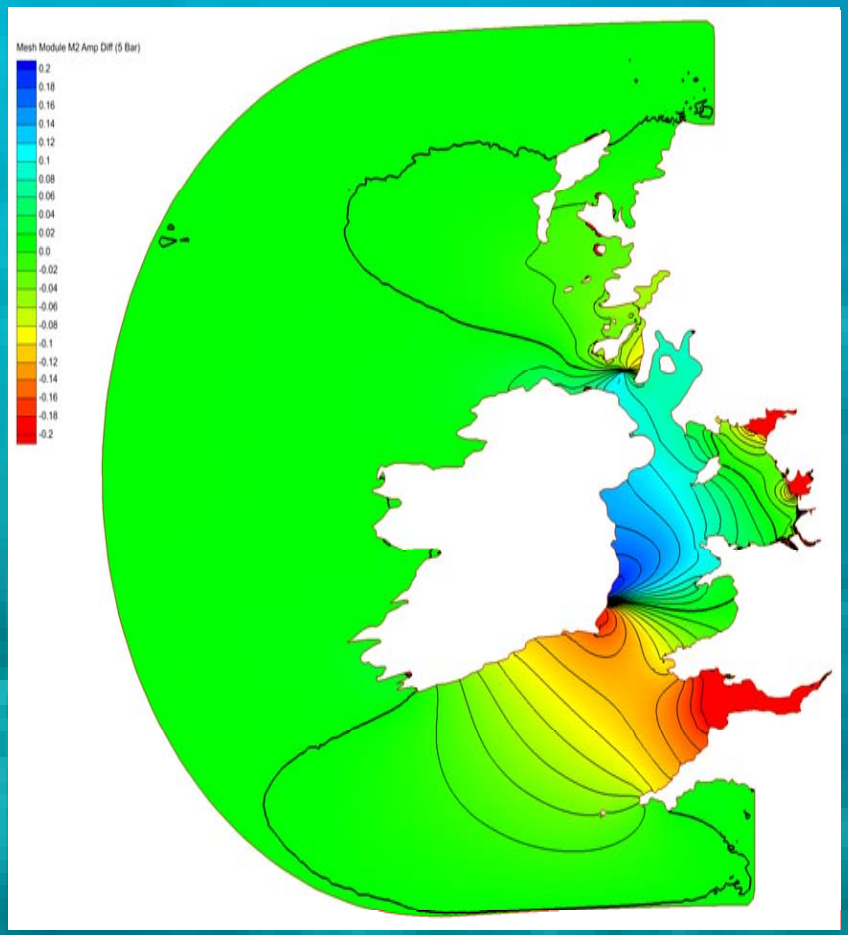
Severn and Total





Linear or Non-Linear?

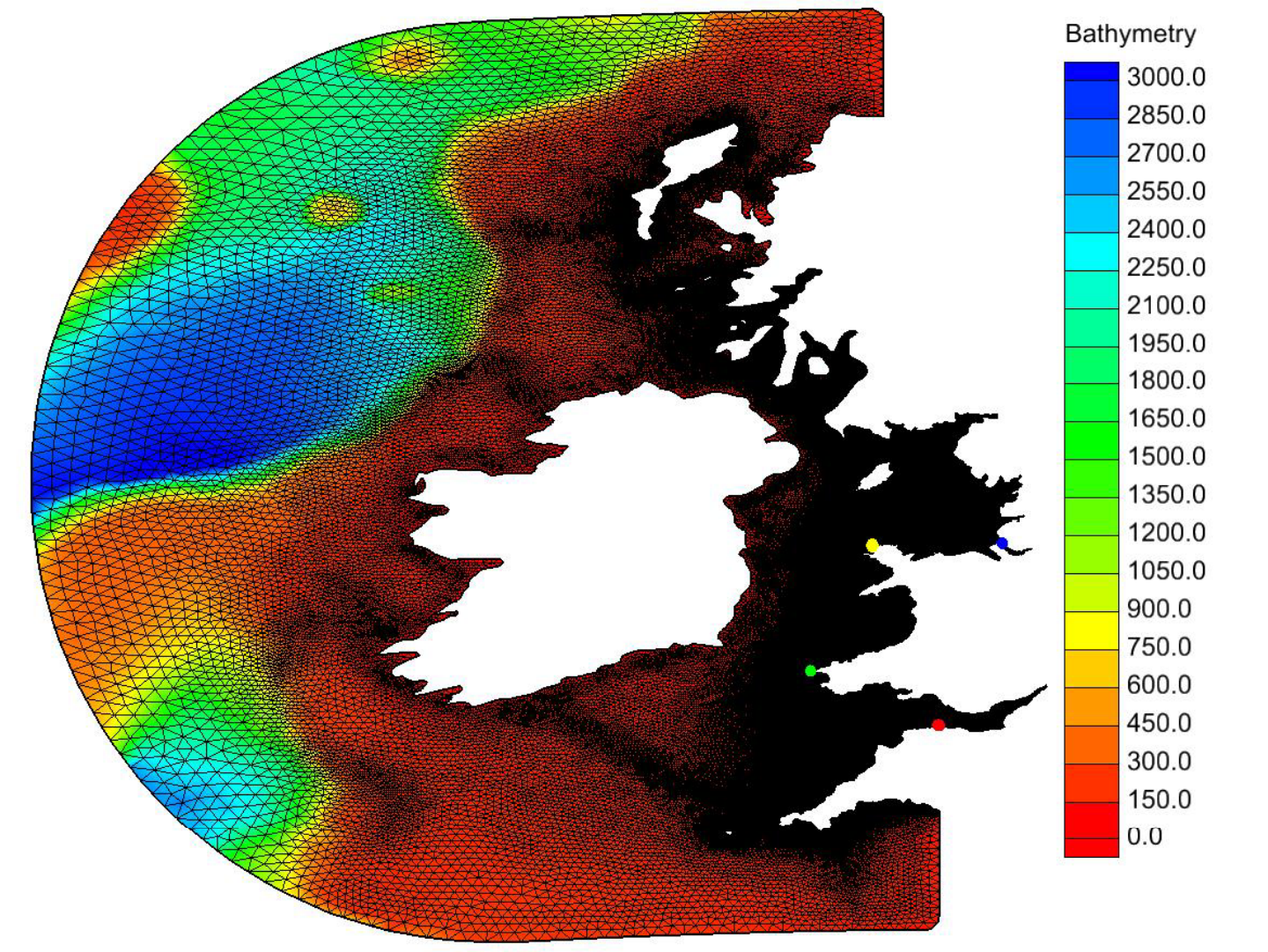




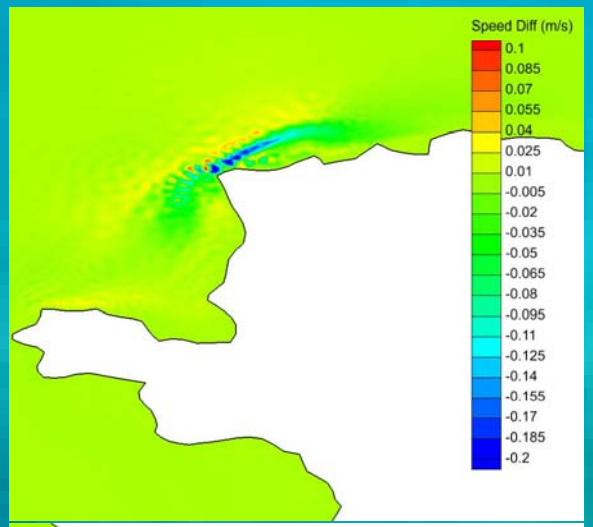
Energy Outputs from 2-D Modelling
- provisional figures not fully validated

	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

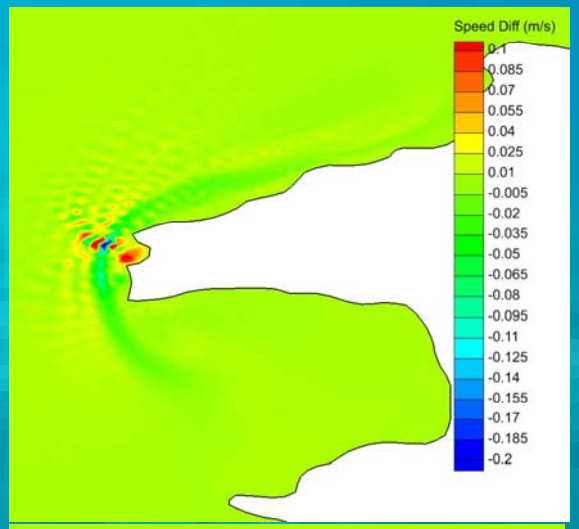
Tidal Stream Locations



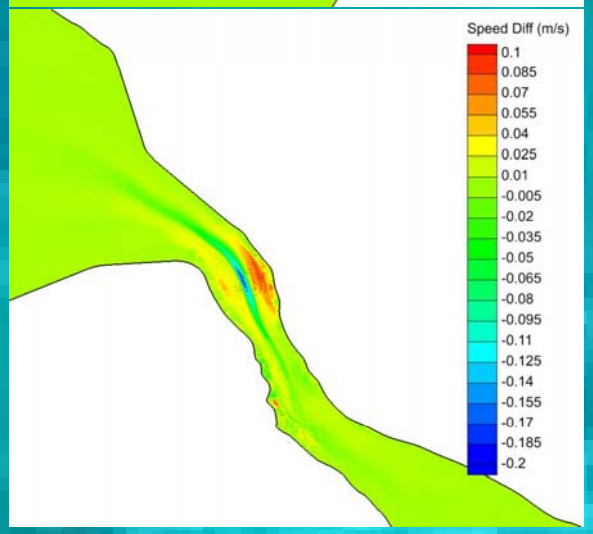
Change in Velocity



Skerries

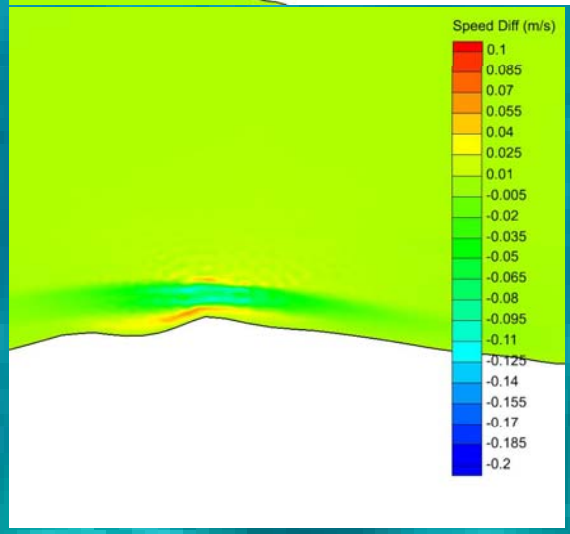


West Wales

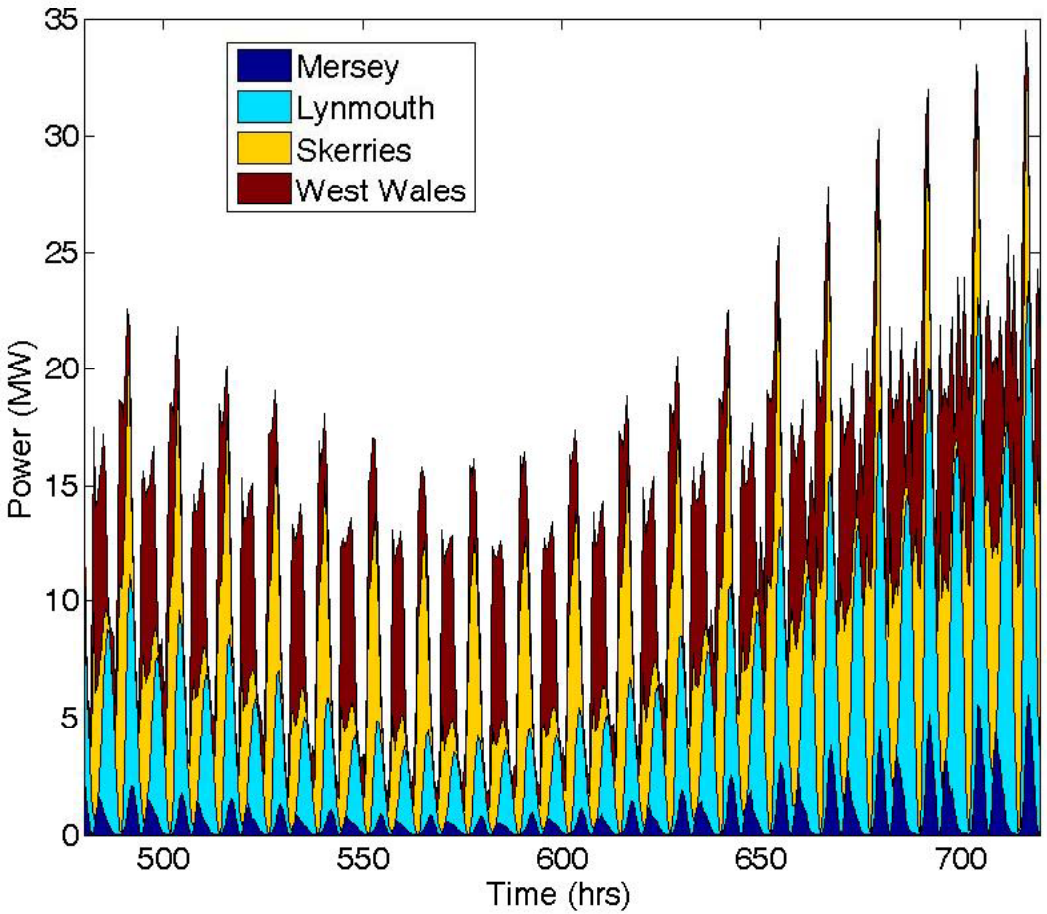


Mersey

Lynmouth



Power Output



	Installed Power (MW)	Annual Output (GWh)
Lynmouth	30	51.07
Mersey	20	18.18
Skerries	10.5	45.45
West Wales	8	42.58
Total	68.5	157.28