Energias Marinhas Renovaveis e a Microgeracao de Energia em Rios

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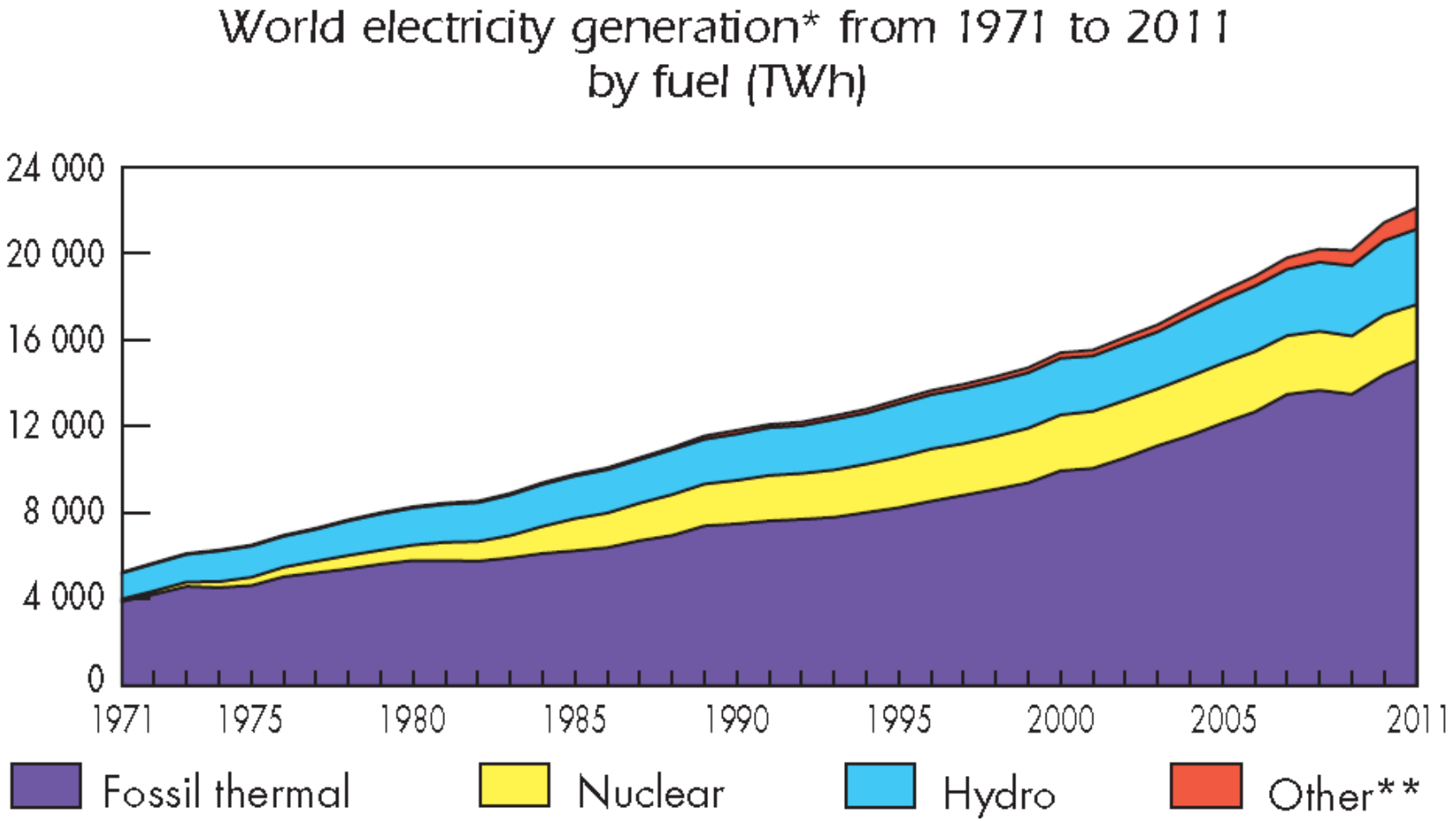
Produção de Energia Elétrica no mundo



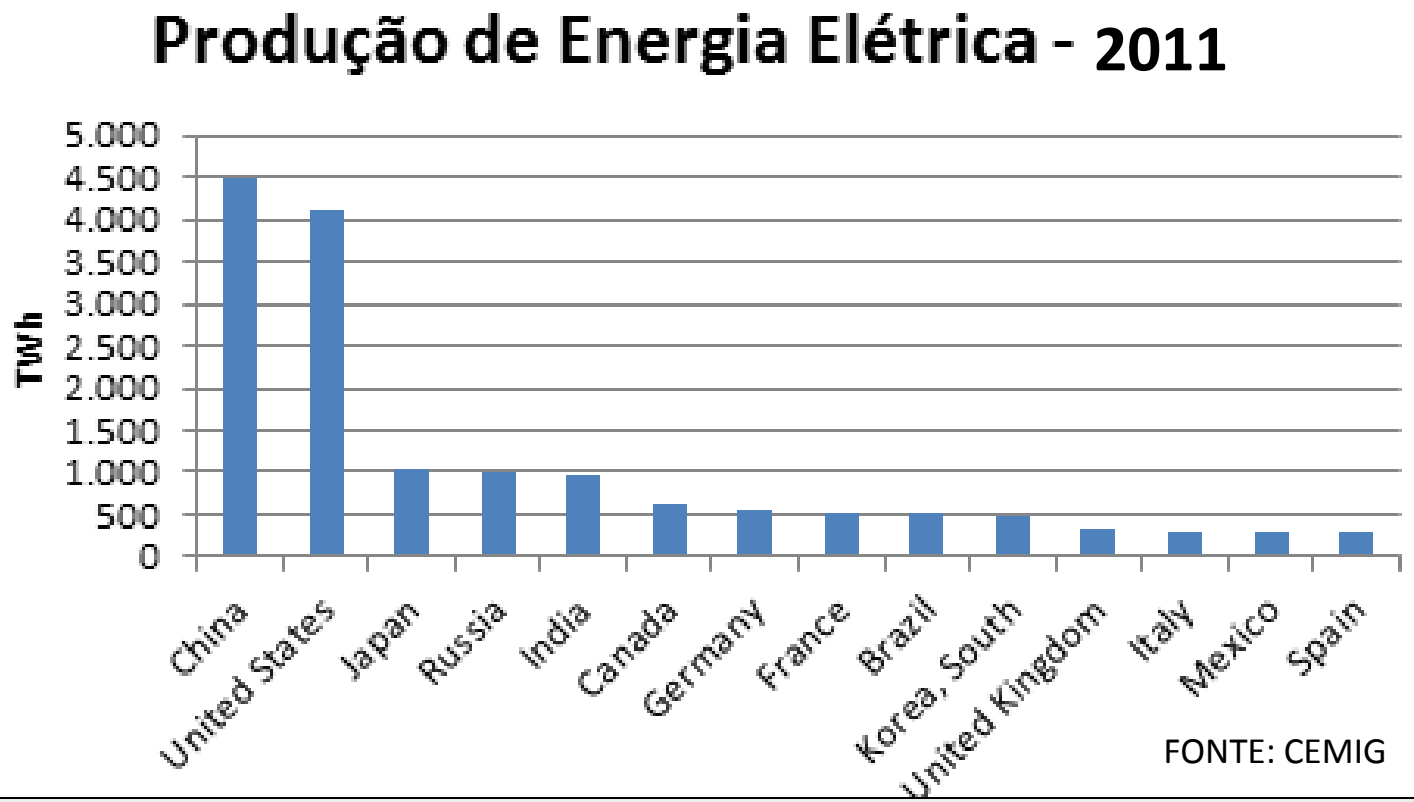
Fonte: IEA – International Energy Agency

Produção de Energia Elétrica no mundo (MW-med)

	Fóssil	Hidro	Nuclear	Eólica	Solar	Total	% Hidro	% Renov.
China	411.758	78.836	9.426	8.356	342	512.618	15%	18%
United States	318.364	36.456	90.206	13.719	208	468.053	8%	13%
Japan	86.750	9.402	17.829	496	434	117.720	8%	11%
Russia	76.285	18.743	18.495	0	0	113.792	16%	17%
India	89.677	14.767	3.305	2.968	114	111.287	13%	16%
Canada	15.560	42.458	10.082	2.247	49	71.117	60%	64%
Germany	38.856	1.951	11.679	5.308	2.169	64.763	3%	22%
France	5.097	5.065	48.346	1.397	230	60.796	8%	12%
Brazil	**6.455**	**48.408**	**1.689**	**342**	**0**	**60.547**	**80%**	**87%**
Korea, South	38.294	520	16.868	98	92	55.893	1%	2%
United Kingdom	27.911	643	7.153	1.772	30	39.096	2%	11%
Italy	23.025	5.179	0	1.158	1.225	32.688	16%	30%
Mexico	25.623	4.099	1.063	158	5	31.795	13%	16%
Spain	15.475	3.458	6.292	4.837	1.041	31.596	11%	31%
South Africa	26.141	232	1.477	4	2	27.783	1%	1%
Australia	24.364	1.894	0	667	93	27.416	7%	11%

FONTE: CEMIG

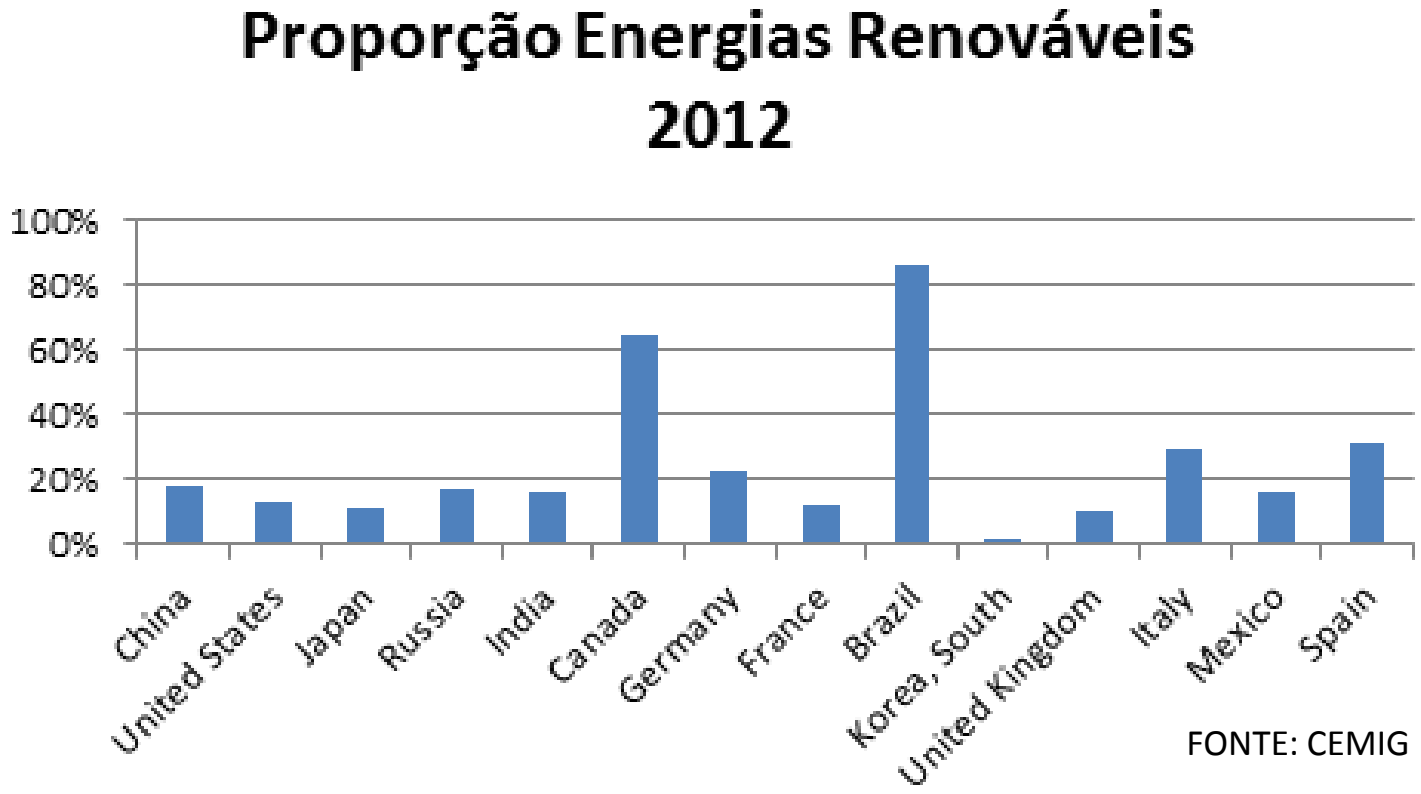
Ranking de Produção de Energia Elétrica



FONTE: CEMIG

O Brasil é o 9º maior produtor de energia elétrica do mundo...

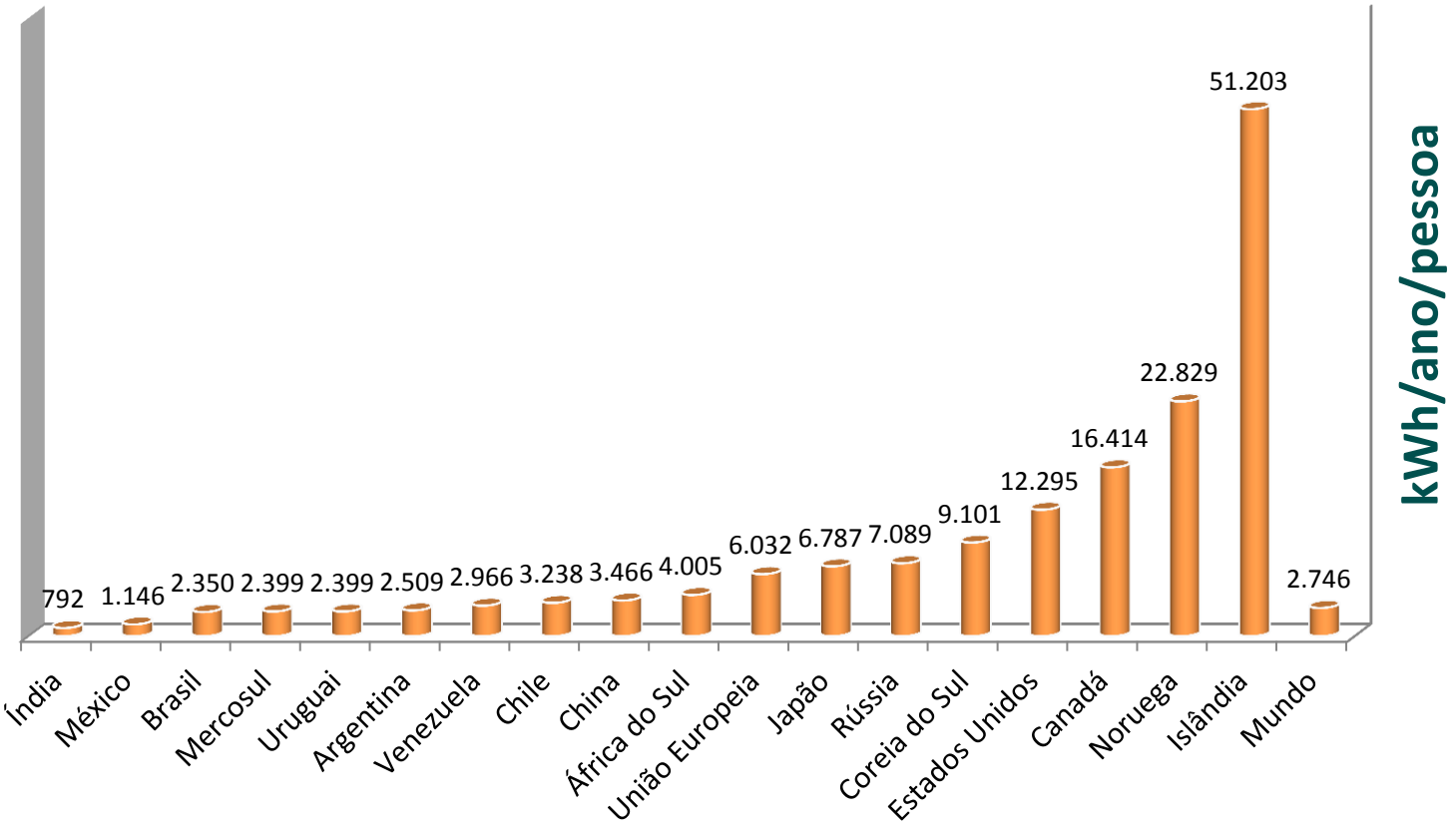
Matrizes renováveis



FONTE: CEMIG

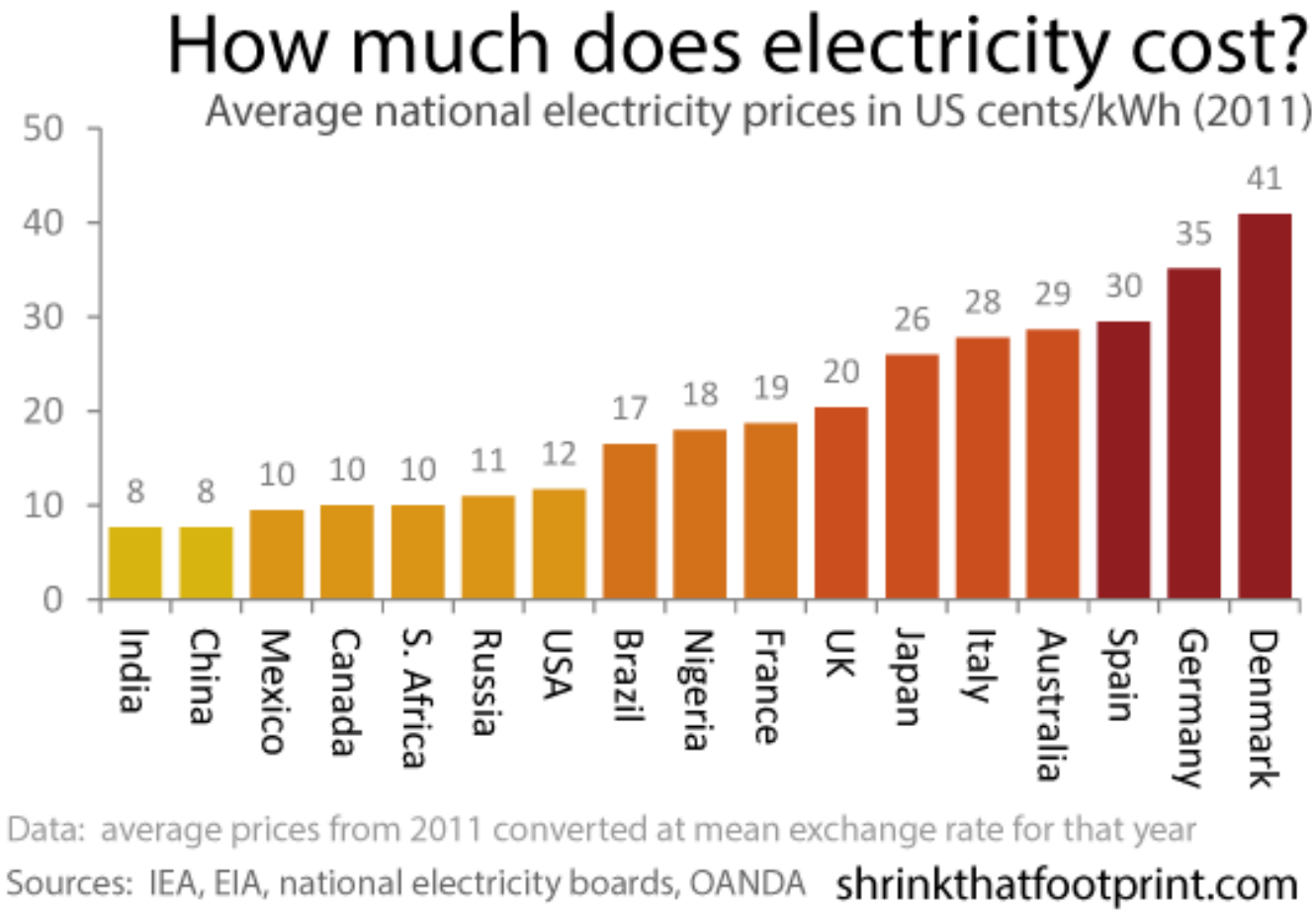
... e tem uma das maiores matrizes renováveis

Consumo de energia por habitante

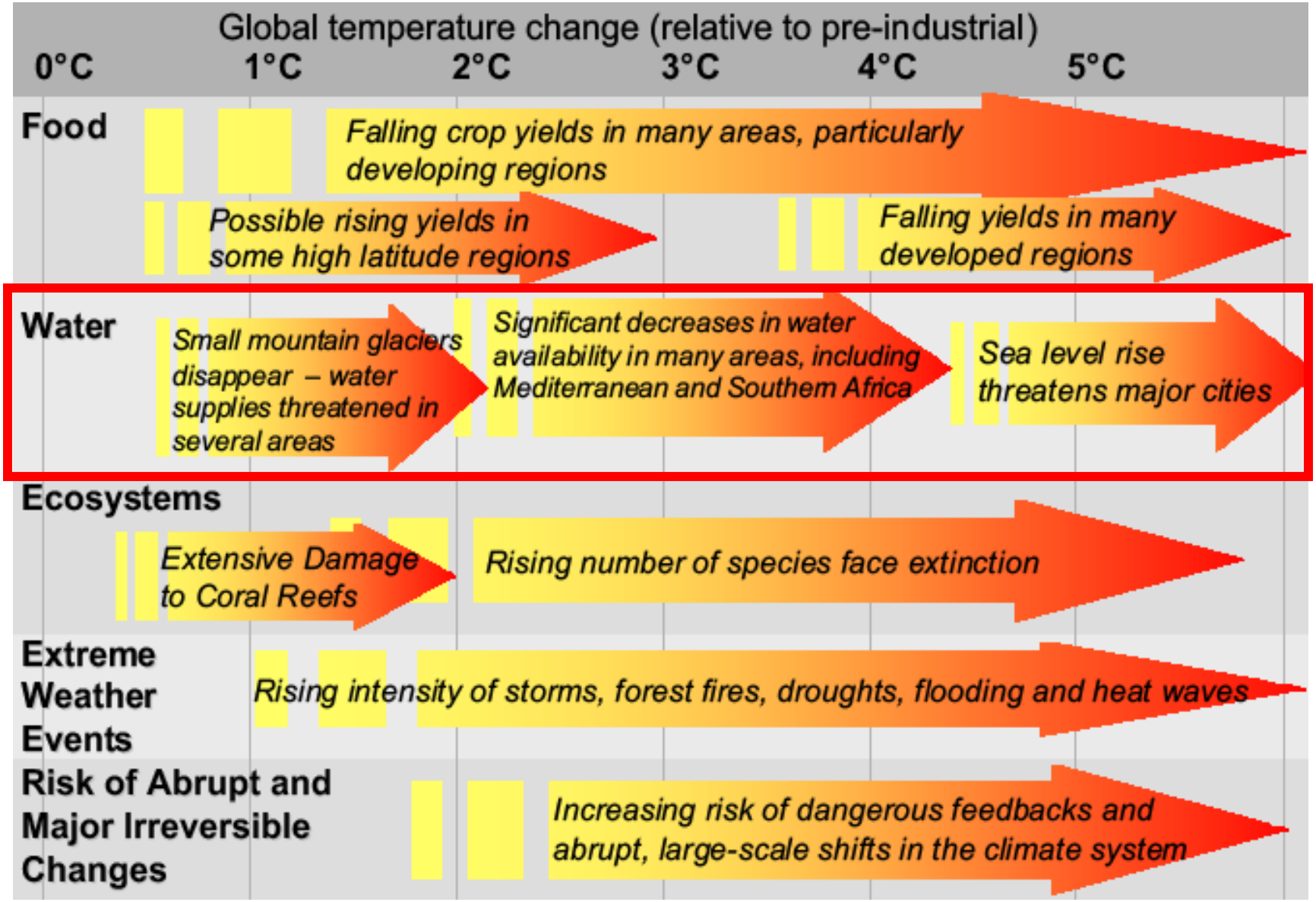


FONTE: CEMIG

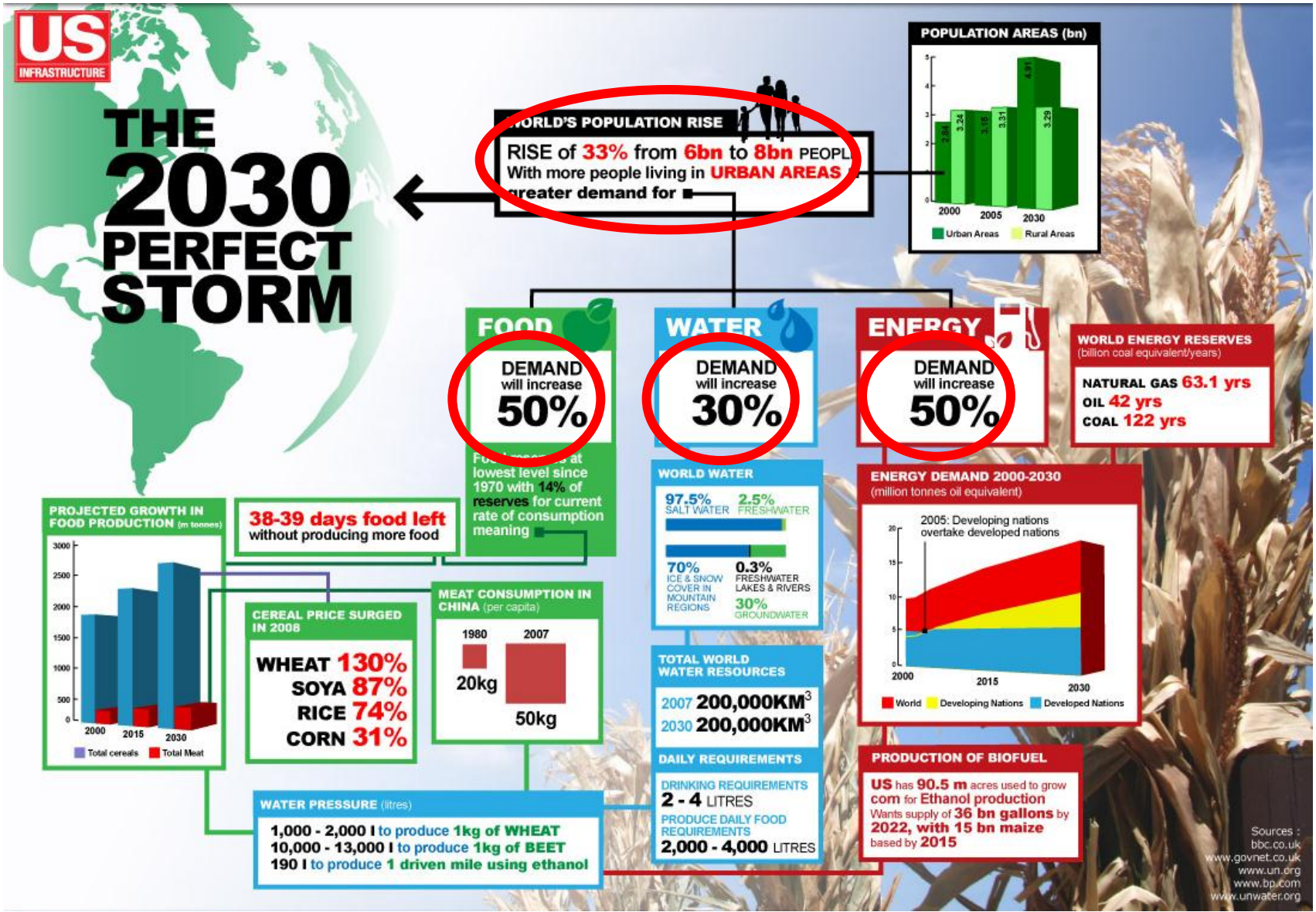
- **Custo da eletricidade**



Stern 2006: Impactos Causados pelas Mudancas Climatica

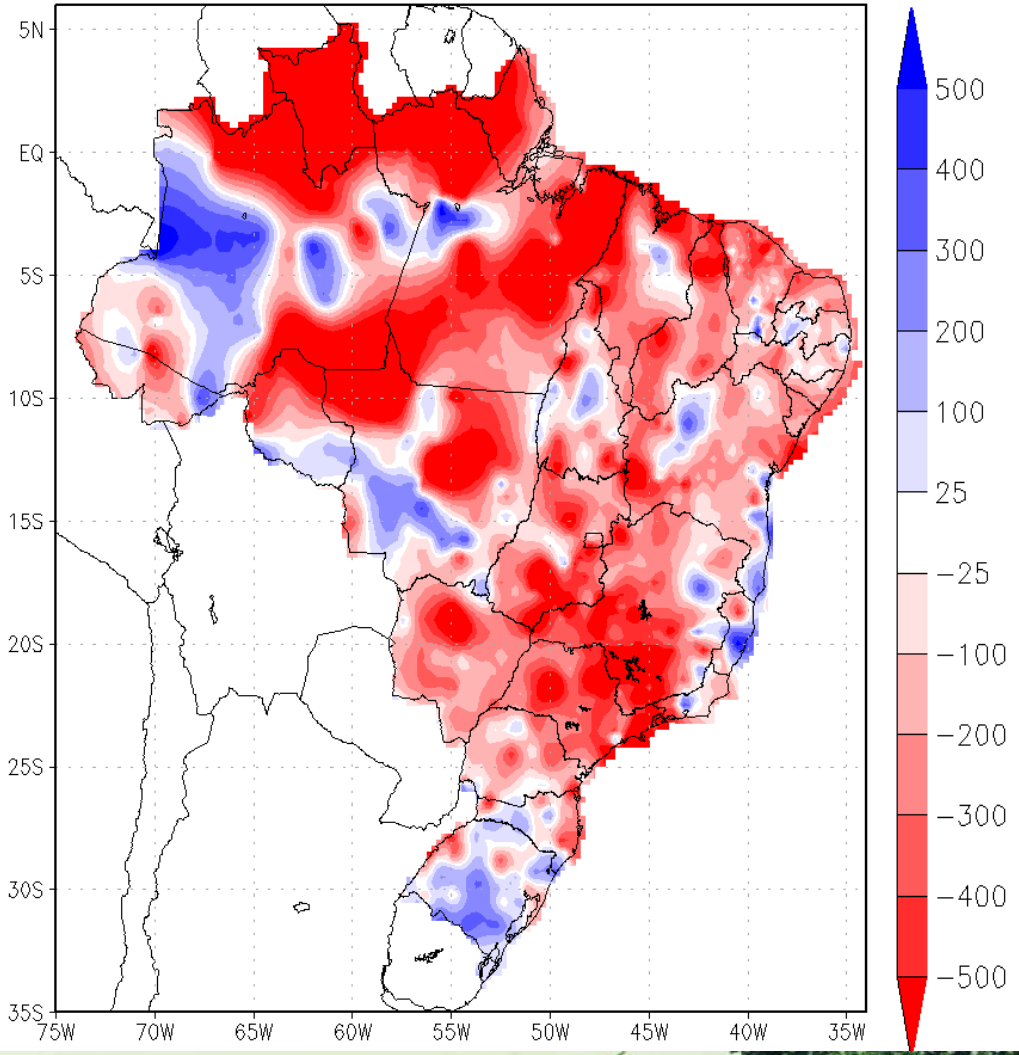


A Tempestade Perfeita ➔ 2030



Análise da estação chuvosa – Atual conjuntura

Importantes bacias hidrográficas receberam chuvas muito abaixo da média entre novembro de 2013 e abril de 2014

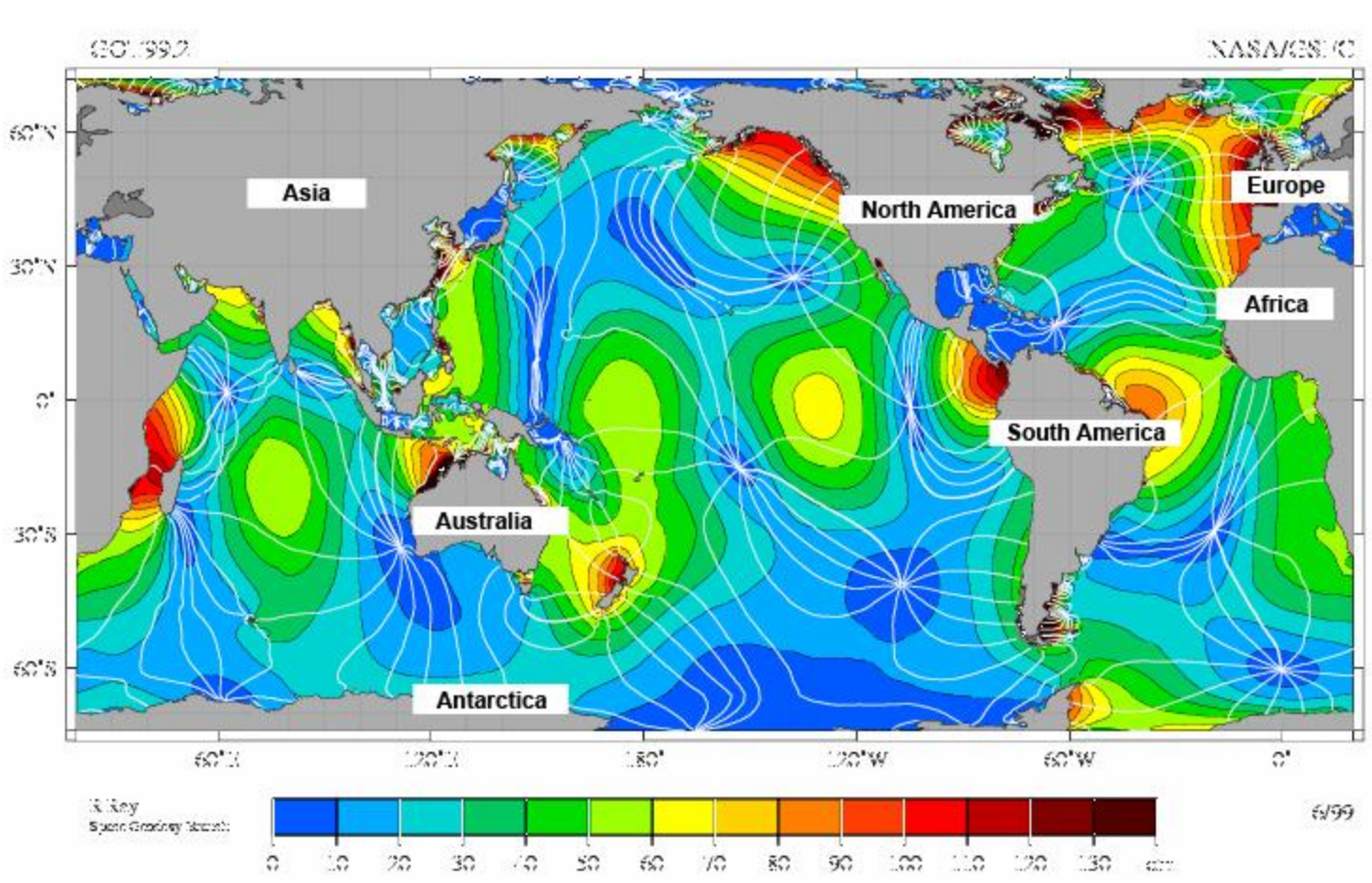


Por que nao aproveitar a energia do oceano?

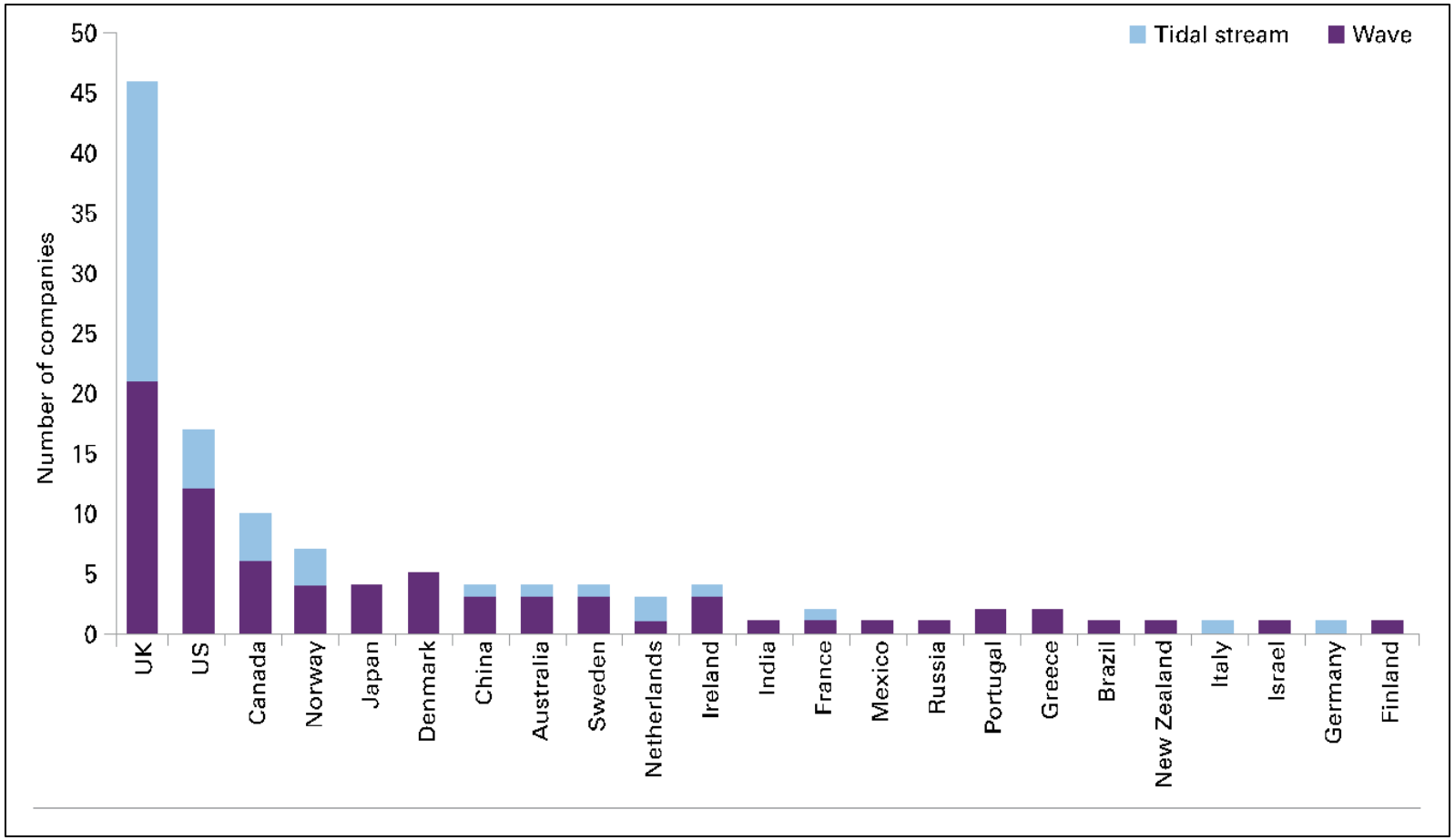
Consideracoes Importantes

- crescimento mundial aumenta a demanda de energia, em particular, nas economias dinâmicas, por exemplo, China
- As mudanças climáticas e o crescimento da população estao levando a um aumento na demanda de energia
- A descarbonização da energia – causa aumento na demanda de energia elétrica
- A energia das marés tem a vantagem de ser:
  - **Limpa, renovavel, carbono free**
  - **100% previsível**
  - **Fonte inesgotavel de energia**
  - **Alta densidade de potencia**

Fontes de energia marinha no mundo



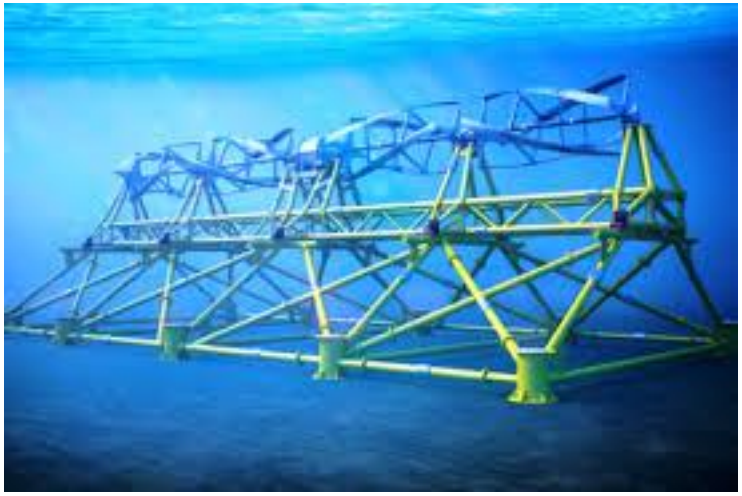
Indicativo global da atividade de energia das mares e das ondas

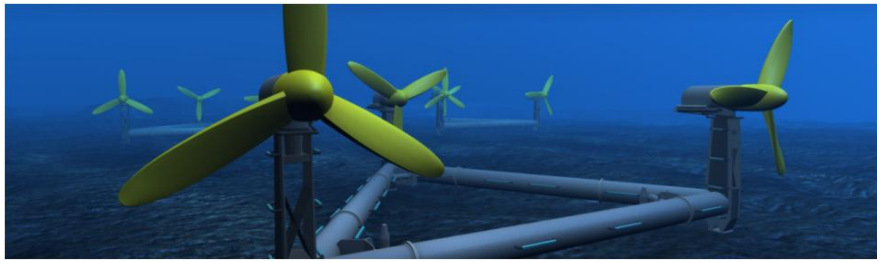


Tecnologias usadas para a obtencao de energia maritima

Energia das ondas

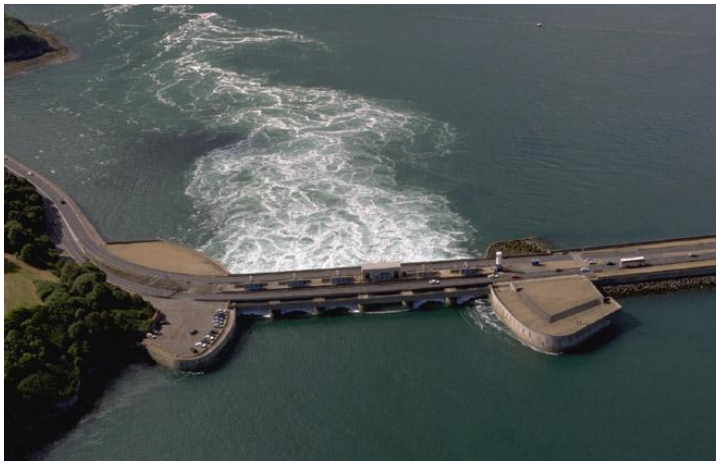
Correntes de Mares



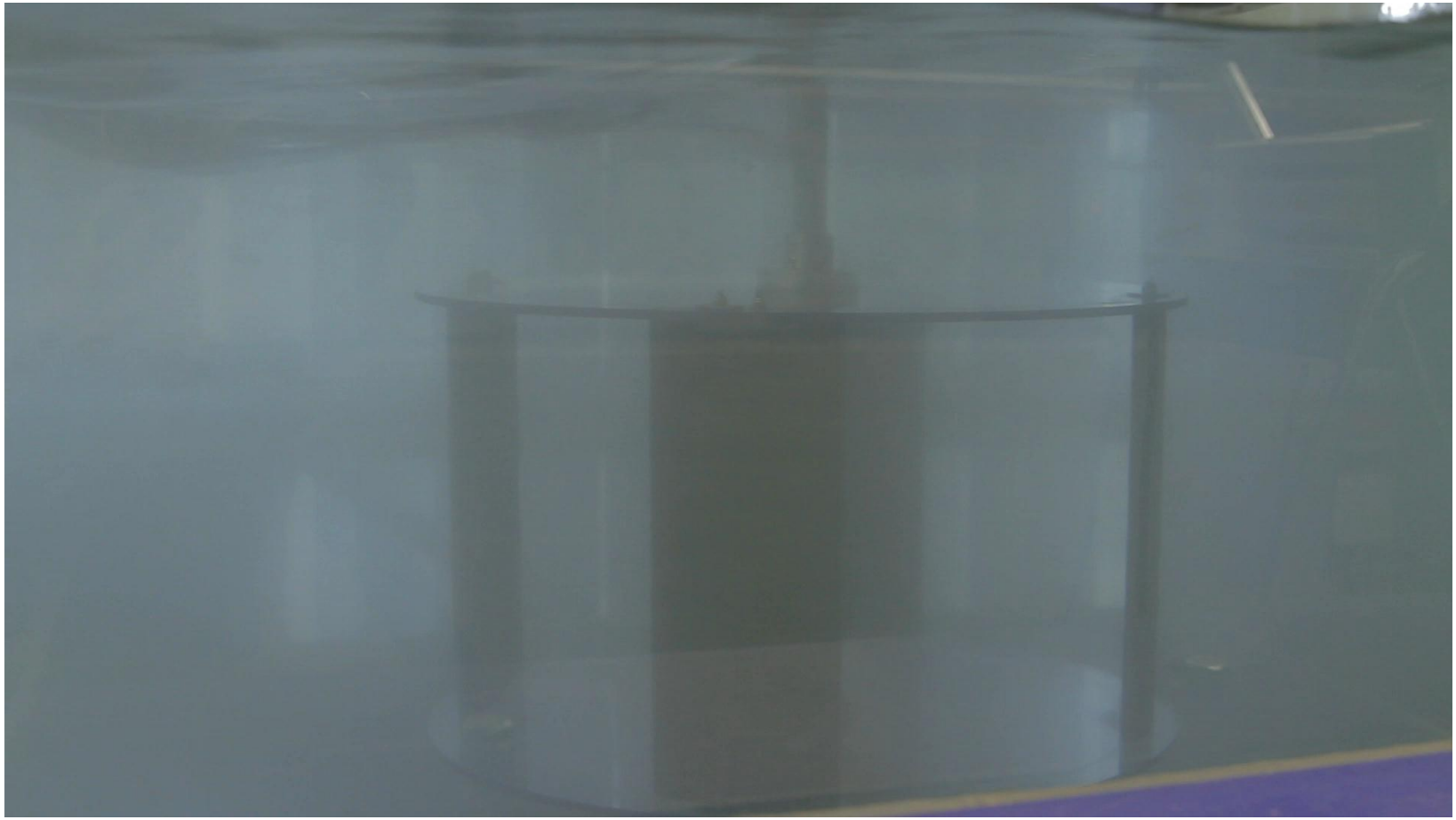


Lagoas de mares

Barragens de mares

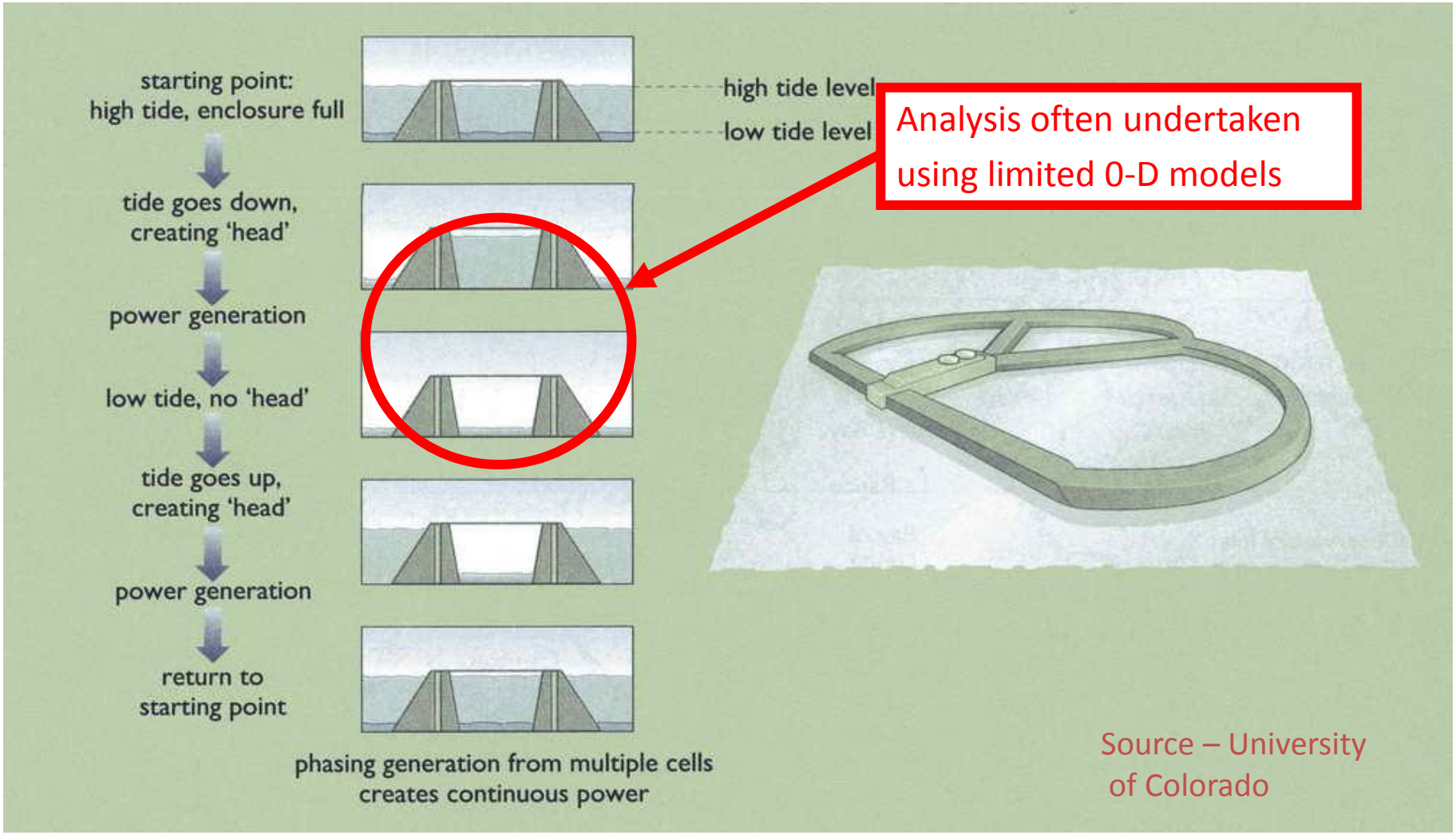


CarBine (Vertical Axis Turbine)



Designed by Prof Thorsten Stoesser - Cardiff University

Conceito das lagoas de mares



Energia maritima no mundo

Primeira e maior barragem, a de La Rance, na França, que gera até 240 MW e opera somente durante maré vazante.

A maior estação de energia das marés do mundo será construída na Escócia entre duas ilhas, a ilha de Jura e a ilha de Islay. O projeto terá 10 turbinas de maré

O maior projeto de Energias Renovaveis Marinhas da Europe

BARRAGEM SEVERN

Hydro-environmental Research Centre
School of Engineering, Cardiff University

Fundos de Pesquisa

LCRI LOW CARBON RESEARCH INSTITUTE

MAREN marine renewable energies

ERDF

Llywodraeth Cymru
Welsh Government

Ewrop & Chymru: Buddsoddi yn eich dyfodol
Cronfa Datblygu Rhanbarthol Ewrop

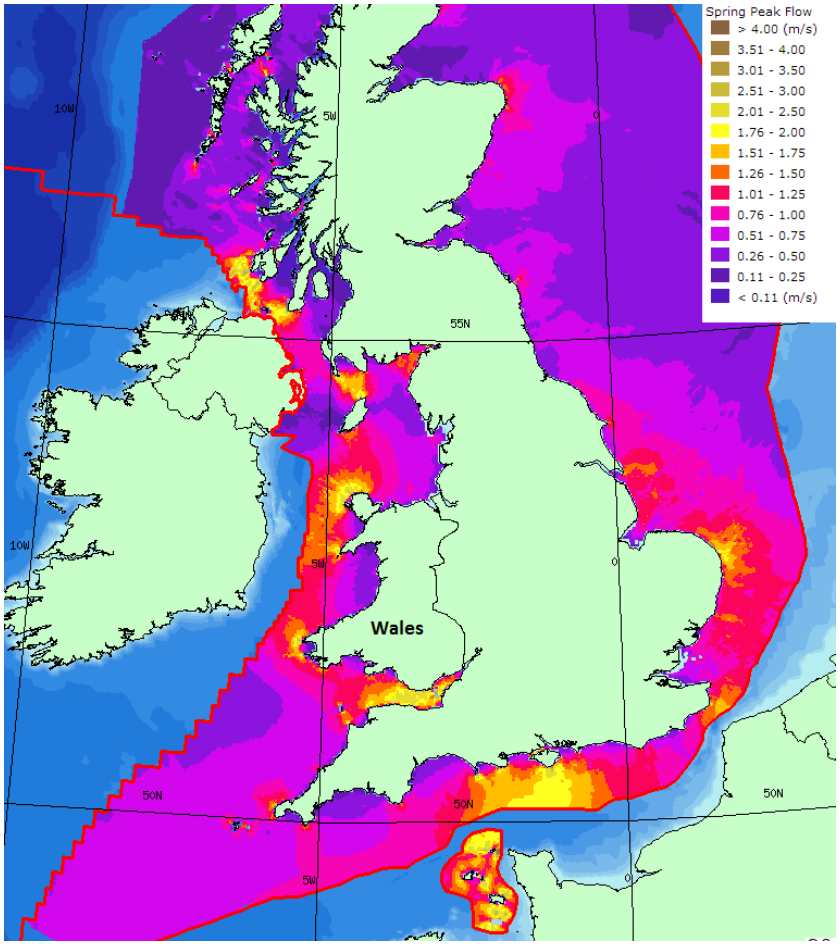
Europe & Wales: Investing in your future
European Regional Development Fund

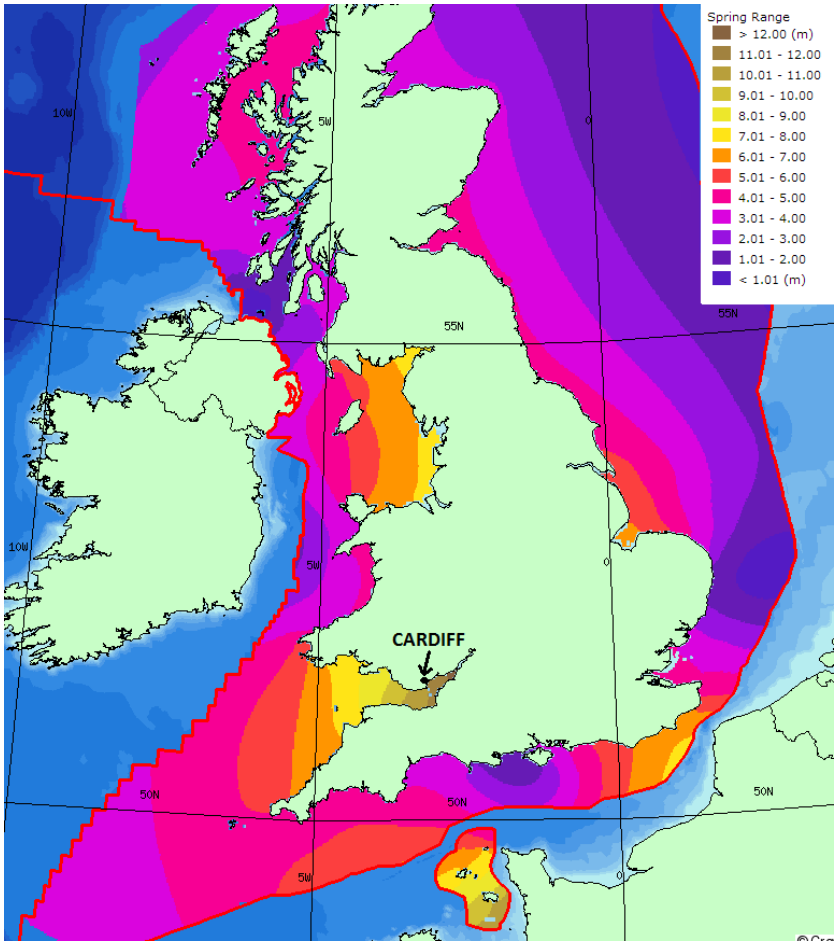
ATLANTIC AREA
Transnational Programme

MARINE ENVIRONMENT & RENEWABLE ENERGIES

INVESTING IN OUR COMMON FUTURE

Fontes de energia marinha em UK



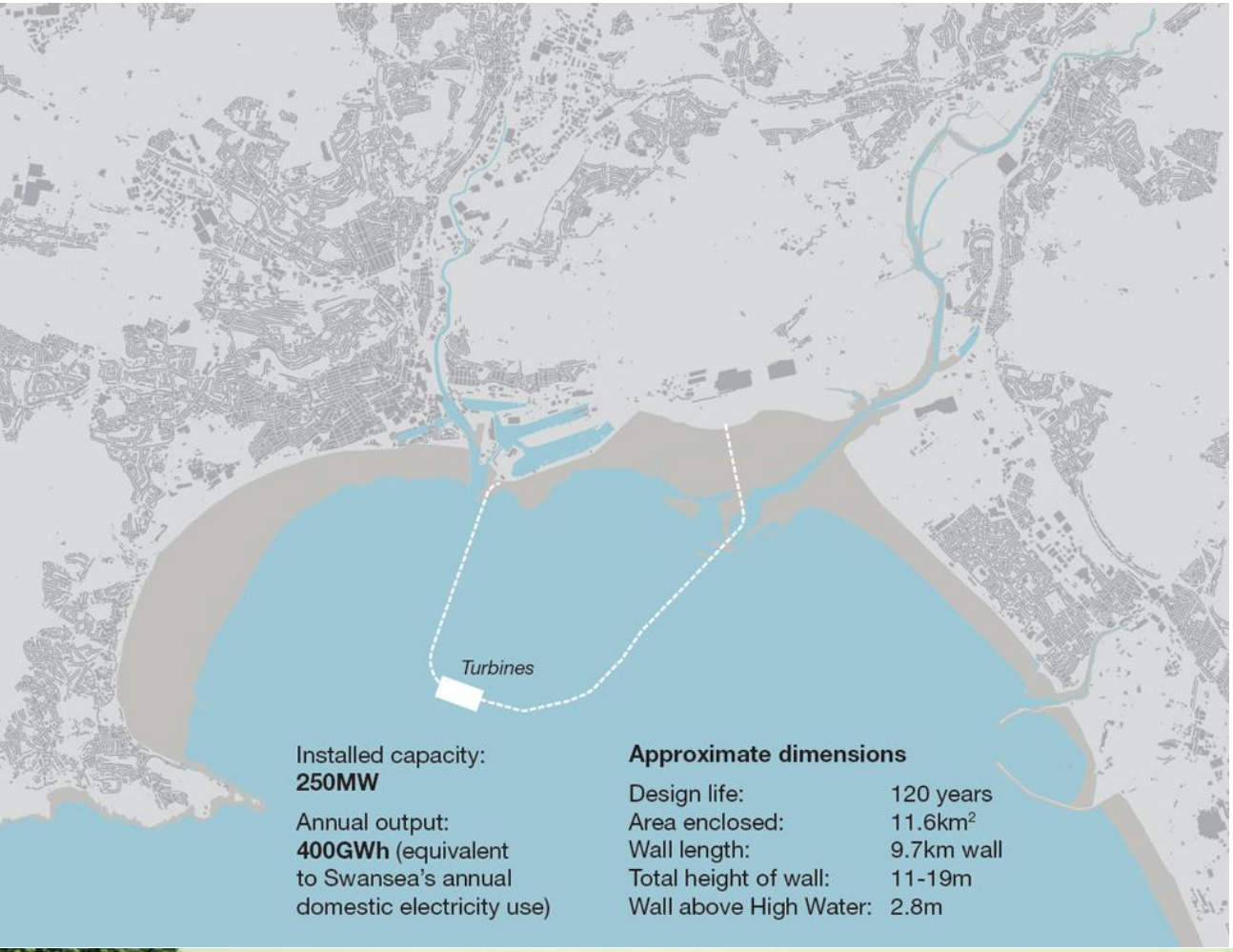


Pais de Gales

Estuario Severn

Inglaterra

Lagoa – Baia de Swansea



Detalhes:

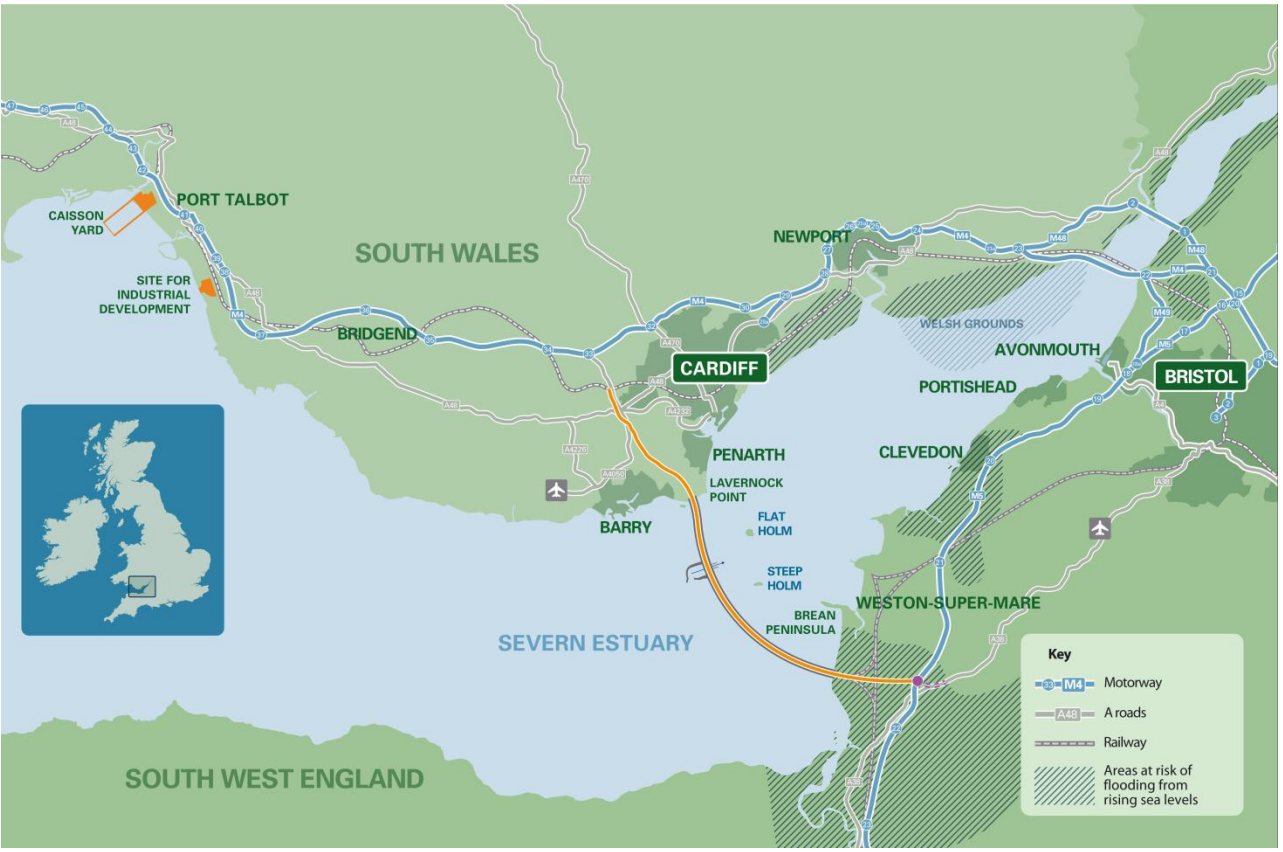
- Muro ≈ 9.7km de comprimento
- Area ≈11.6km^2 = 1624 campos de football
- Producao de energia de 0.4 TWh/ano
- Barragem Severn > 42 lagoas
- Potencia de 5%/42 de uso em UK ≈ 75k pop

Represamentos – Costa Norte do Pais de Gales

Potencial de producao de energia de 26TWh/ano

4h fora de fase com a Barragem Severn

Esquema de Barragem de Hafren Power (HP) Severn



Fatos importantes:

- 1026 turbinas VLH – cada 6.3 MW ≈ 16.4TWh/ano
- Nao ha comportas
- Comprimento cerca de 18km
- Custo total ≈ £25 bilhoes
- Passagem para navios
- Economia > 7.2 milhoes de toneladas de carbono por ano
- Rodoviario, ferroviario, peixes?

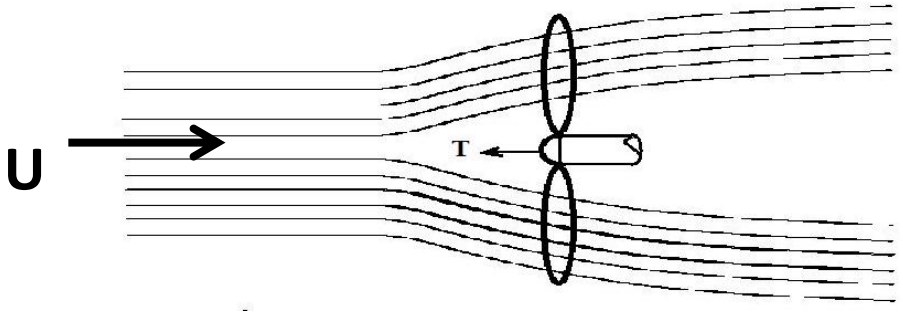
Barragem Severn - 1849

Primeiro proposto por Thomas Fulljames - 1849

Por que nao usar os rios para a micro-geracao de energia?

Conceito

→ Utilize a free stream of water to turn blades around an axis



$$P = \tfrac{1}{2}\,\rho\, c_p\, A_S\, U^3$$

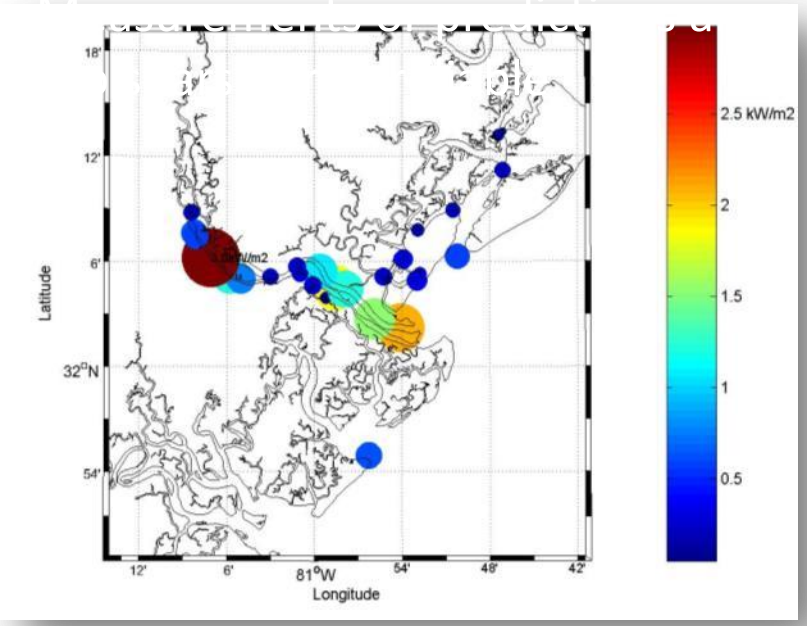
Extracted Power = Fluid density x Power coefficient x Swept Area x Cubed Velocity

→ Similar technology to wind turbines, Betz limit applies i.e. $C_p < 59\%$

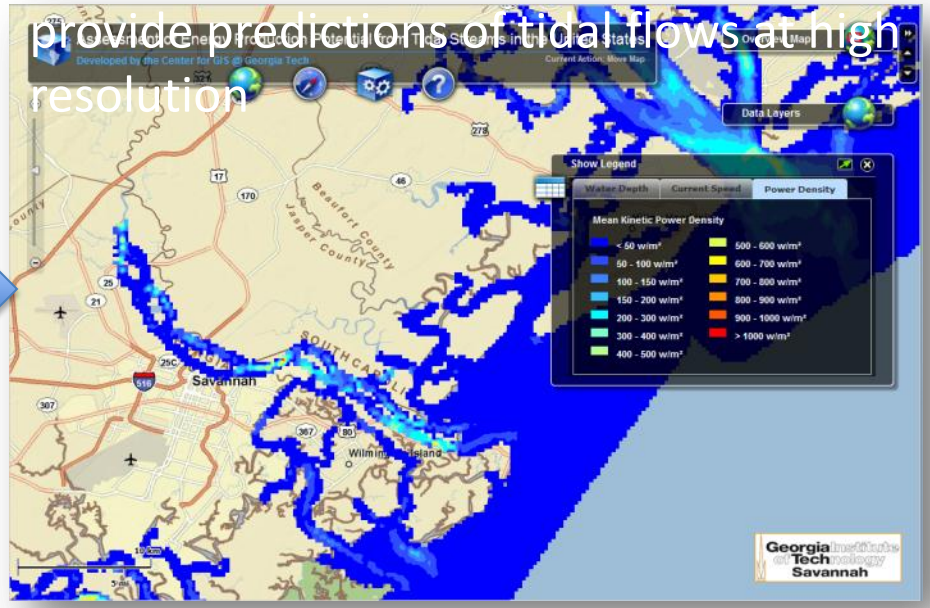
→ Tidal turbines $11\% < C_p < 40\%$

→ Doesn't have to be in a tidal stream, any free-stream will do

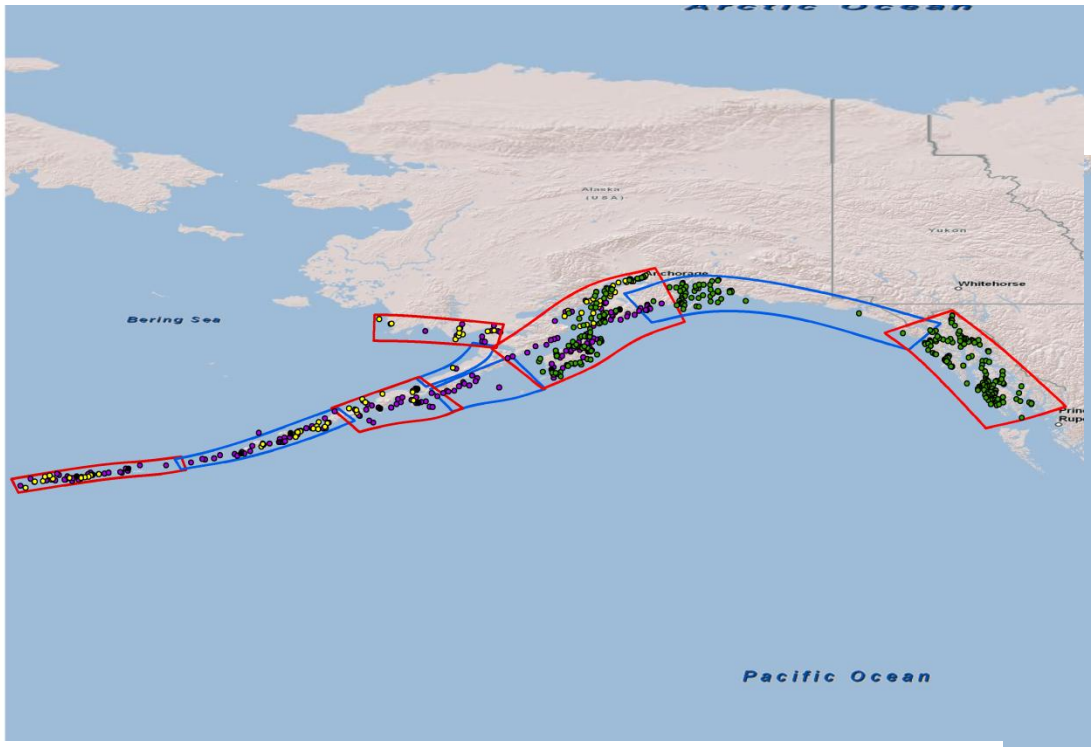
Computing the US National Theoretical Tidal Resource

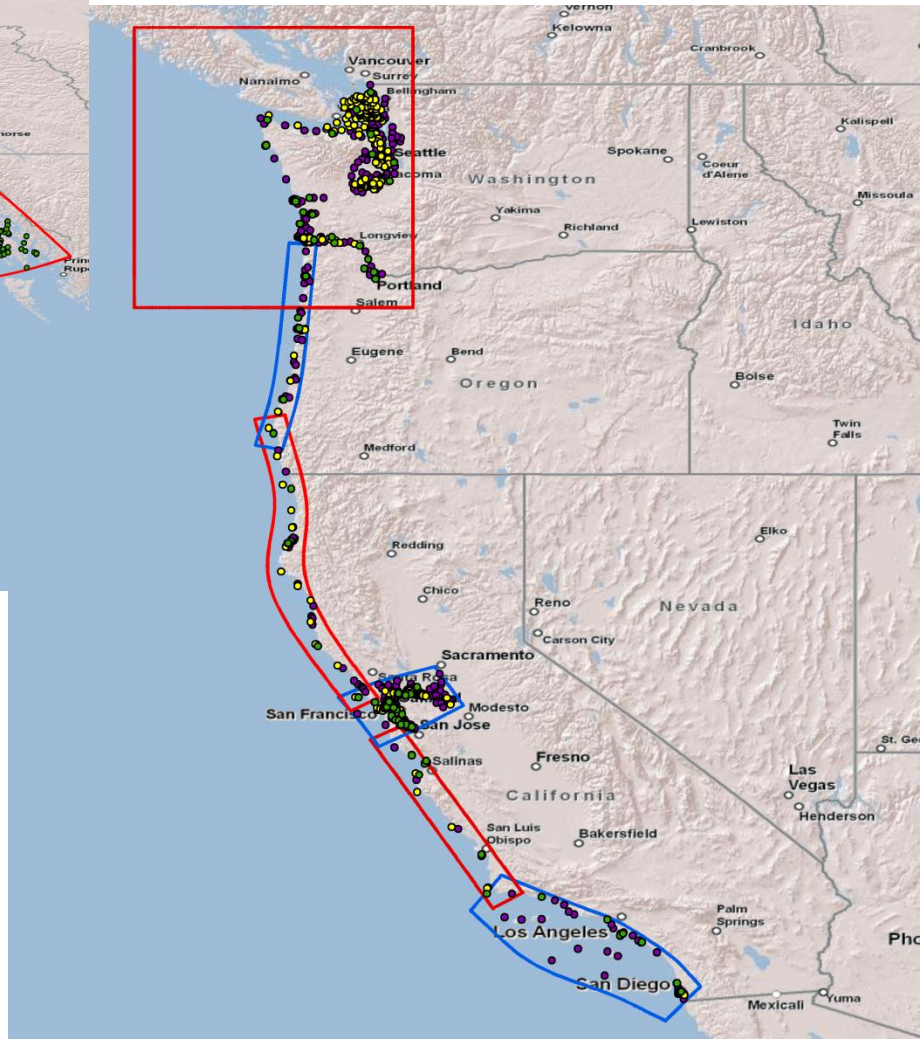


provide predictions of tidal flows at high resolution



Numerical Model - ROMS Regional Ocean Model System





Breakdown of the theoretical total available power

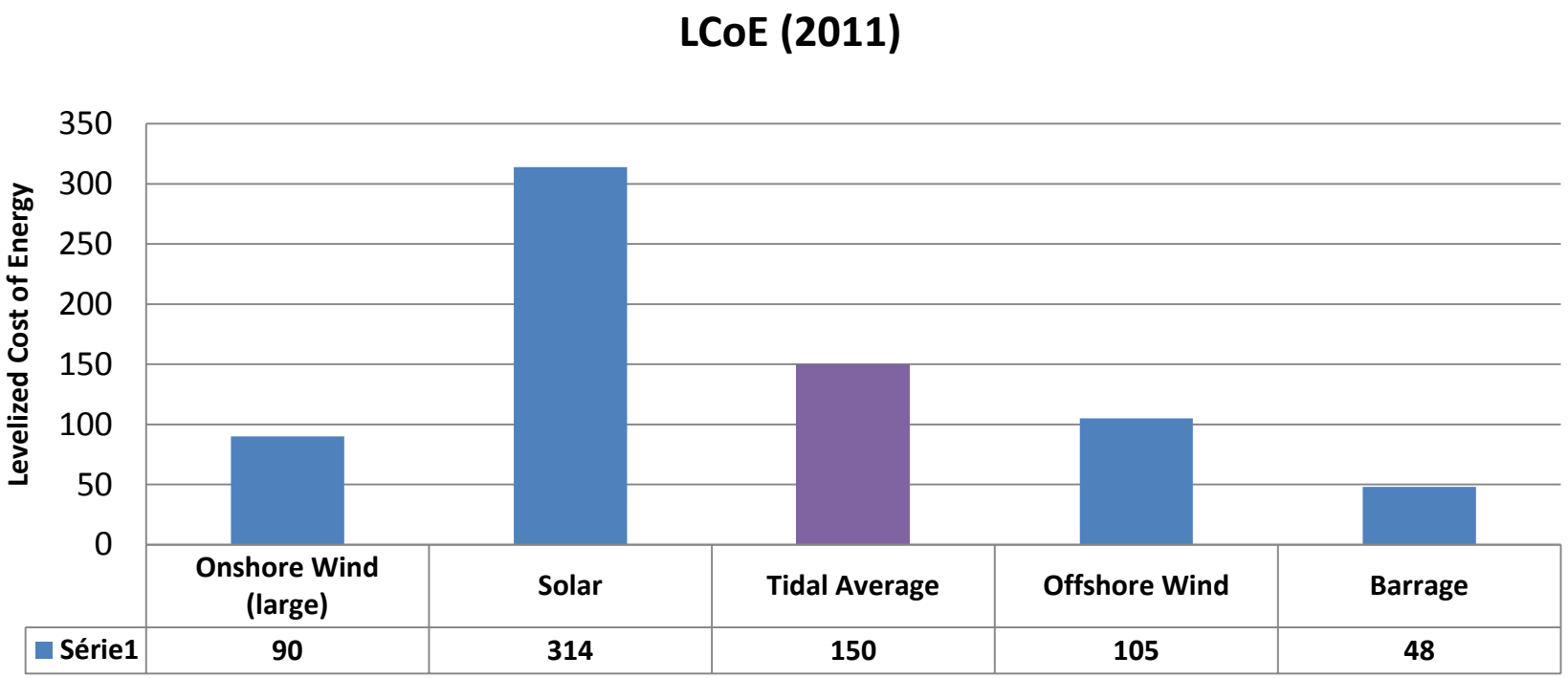
State	Maximum Power (MW)
ME	675
NH	21
MA	45
RI	16
NY	280
NJ	191.5
DE	165.5
MD	35
VA	133
NC	61
SC	388

State	Maximum Power (MW)
GA	219
FL	166
AL	7
LA	2
TX	6
CA	204
OR	118
WA	613
AK	47437
USA	**50783**

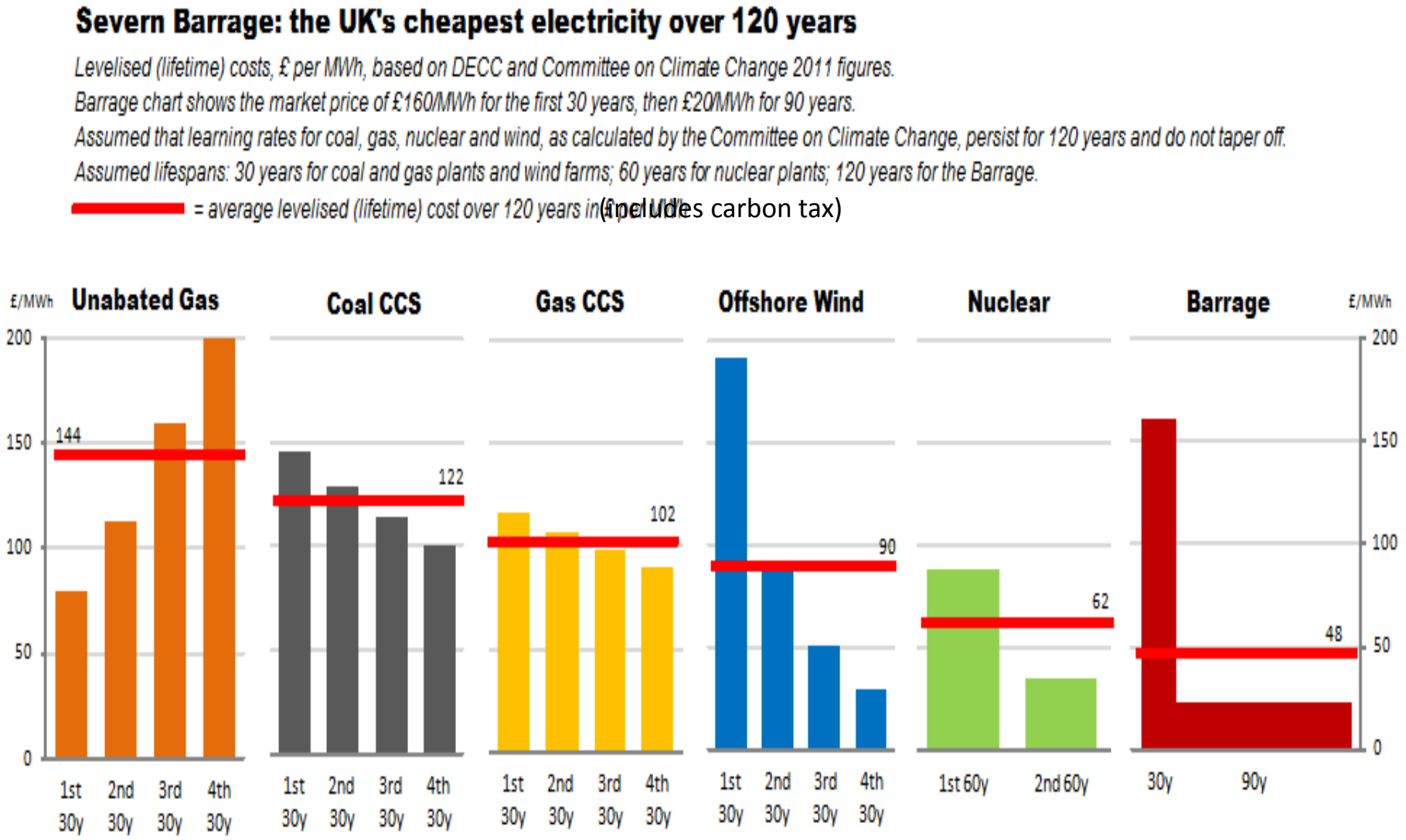
Site Tidal Resource Assessment

- Proposed site of Girl Scout “Eco-Village,” powered by renewable resources
- Project was to assess available hydrokinetic energy
- Consisted of boat based tidal measurements of currents, water levels, and bathymetry
- Numerical model, validated by measurements, utilized to predict available power

E quanto ao custo?



Comparacao de Custos



E quanto ao meio-ambiente?

Danos devido à lâmina em peixes, botos e mamíferos

Ruído operacional e deslocamento de peixes etc

Perturbação de campo eletromagnético

Habitat alteração dos pássaros e as comunidades bentónicas

CONCLUINDO

Energia hidrocinética Mares / Marinha é uma fonte 100% previsível de energia renovável

No entanto:

Jovem indústria (25 anos mais nova que a industria eolica) enfrenta enormes desafios,

- **ambiente de operação especialmente hostil**

- **Futuro da energia hidrocinética Marinha:**

Parece brilhante!!!

As melhorias são necessárias e estao em andamento …

Agradecimentos

FEAM

Dr. Marcelo de Deus - CEMIG

Professor Roger A. Falconer- Cardiff University

Professor Thorsten Stoesser – Cardiff University

Dr. Kevin Haas – Georgia Tech

Patrick Lewis – Repetitive Energy - UK

OBRIGADA!

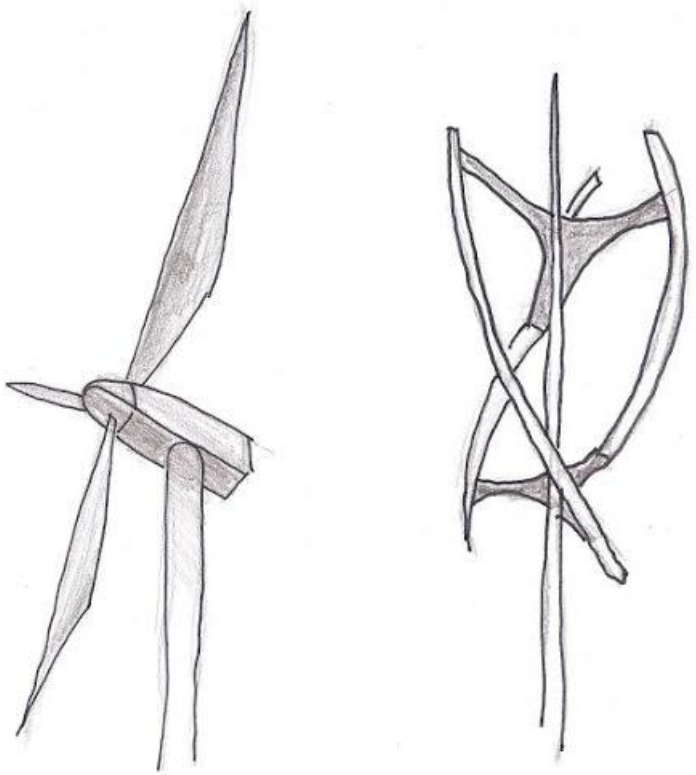
CURIOSIDADES

Technologies

Three types of turbine technologies:

1) Horizontal axis turbines

2) Vertical axis turbines



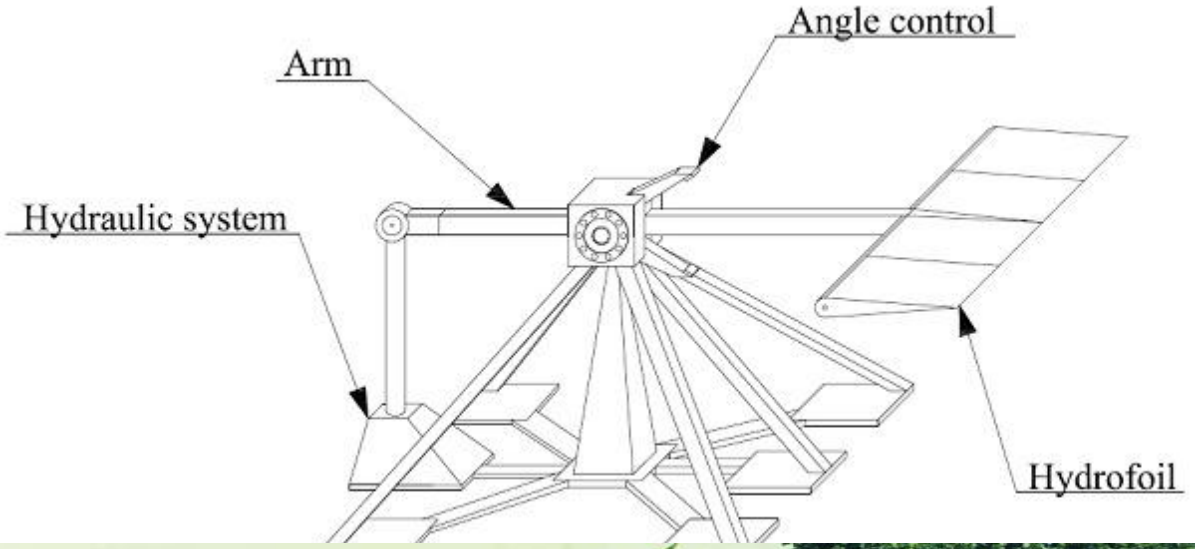
Technologies

Three types of turbine technologies:

1) Horizontal axis turbines

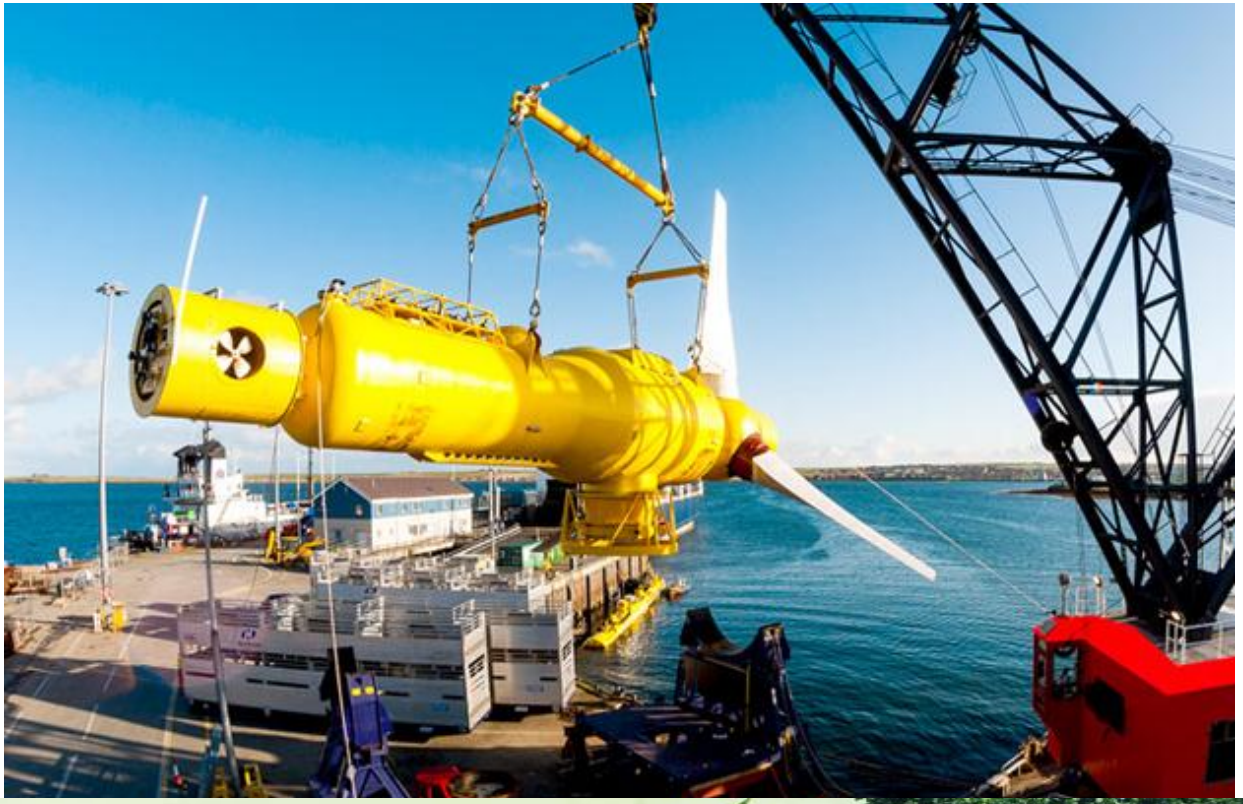
2) Vertical axis turbines

3) Oscillating lift devices



Horizontal Axis Turbines - Alstom

Diameter: 18m
Rated Velocity: 2.7m/s
Rated Power: 1MW
Power Coefficient: 40%



Horizontal Axis Turbines – Verdant

Diameter: 10m
Rated Velocity: 3.3m/s
Rated Power: 500kW
Power Coefficient: 36%

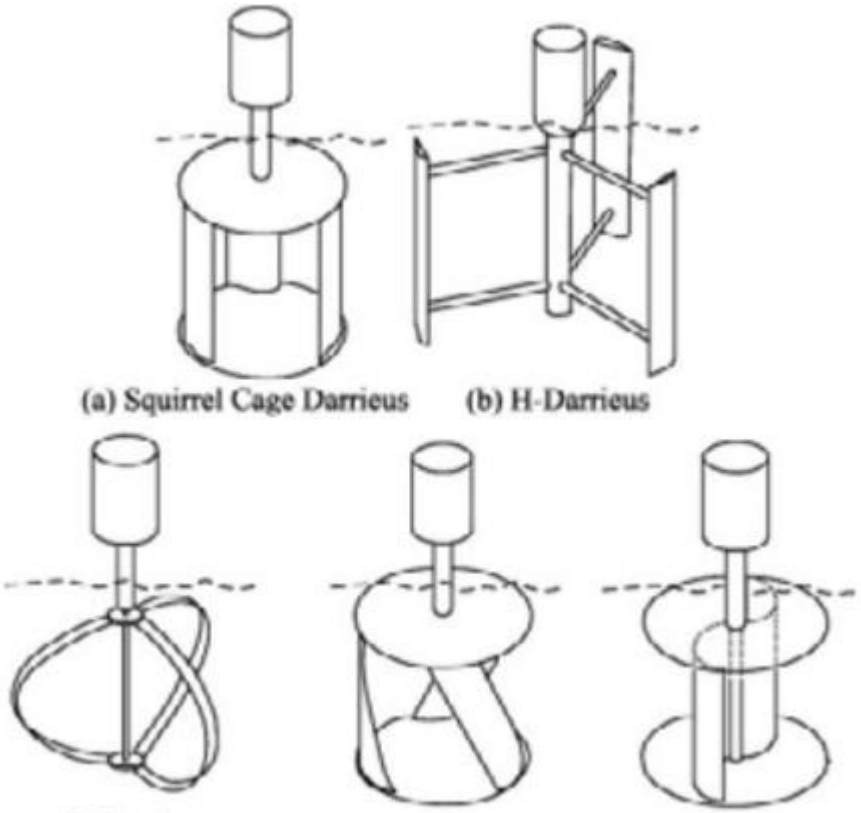
Horizontal Axis Turbines – MCT

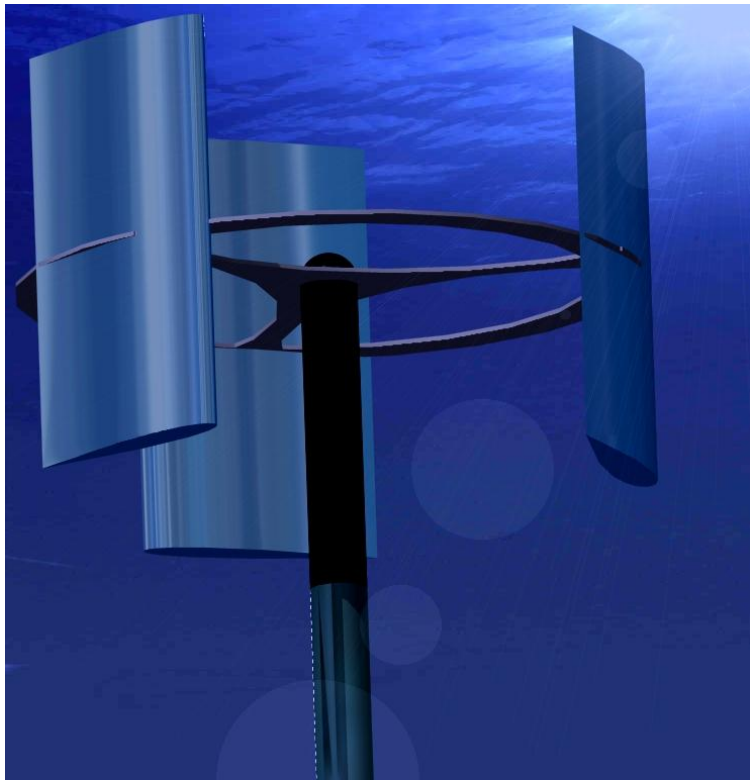
Diameter: 2 x 16m
Rated Velocity: ?
Rated Power: 1.2MW
Power Coefficient: ?

Horizontal Axis Turbines – Open Hydro

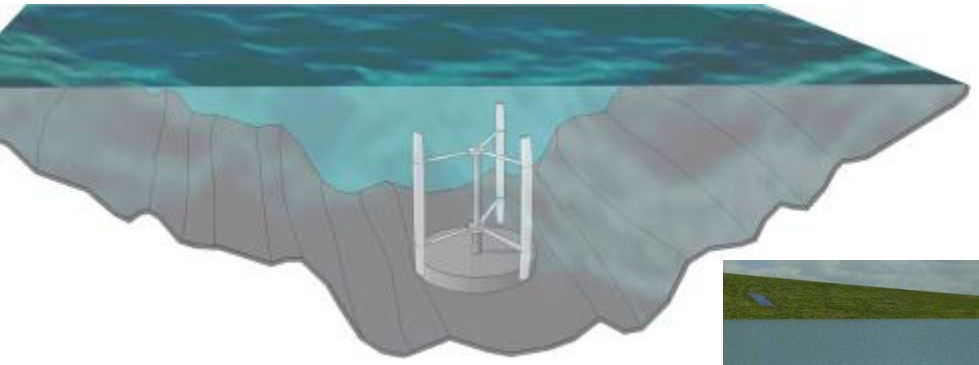
Diameter: 6m
Rated Velocity: ?
Rated Power: 300kW
Power Coefficient: ?

Vertical Axis Turbines I



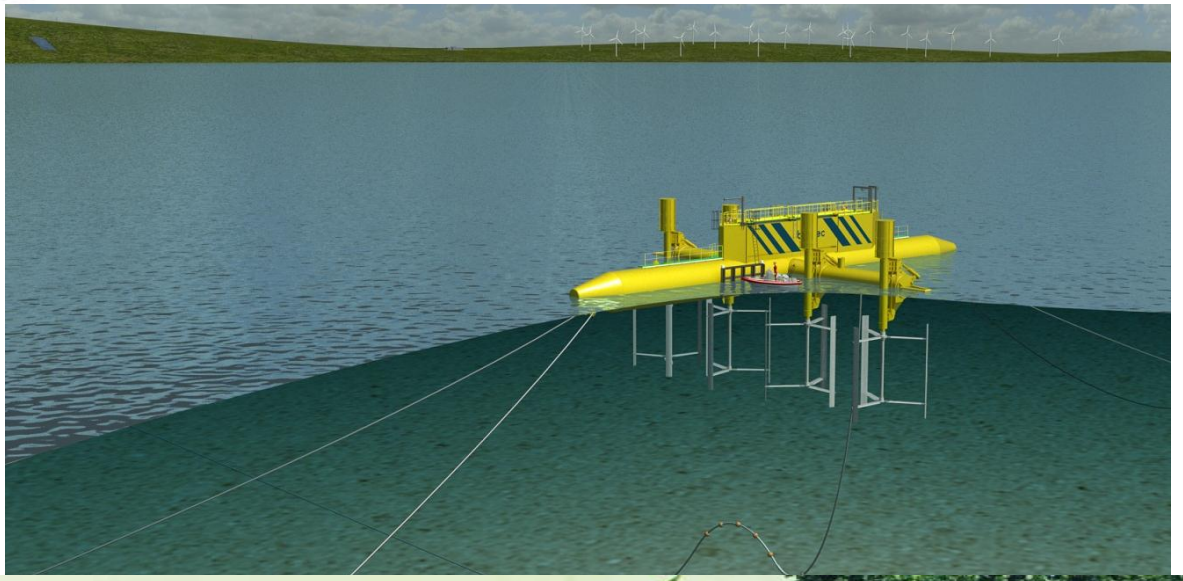


Vertical Axis Turbines II



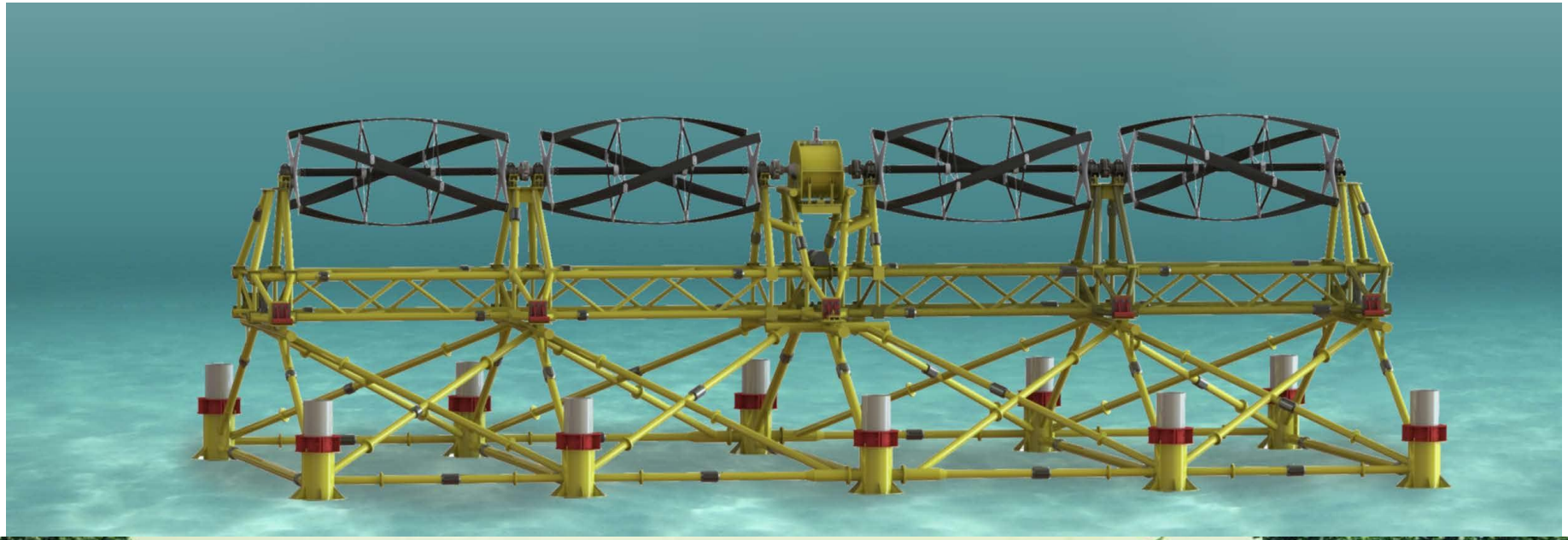
www.el.angstrom.uu.se

www.bluewater.com



Vertical Axis Turbines III

Ocean Renewable Power Company's TidGen Turbine – D = 2.5m, Rated Power = 240kW



Other Concepts – e.g. Oscillating hydrofoil