Agenzia nazionale per le nuove tecnologie, l'energia e lo sviluppo economico sostenibile

Project co-financed by the European Regional Development Fund

Promoting innovative networks and clusters for marine renewable energy synergies in Mediterranean coasts and islands

Naples 27 November 2017

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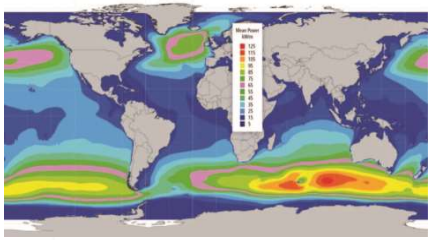
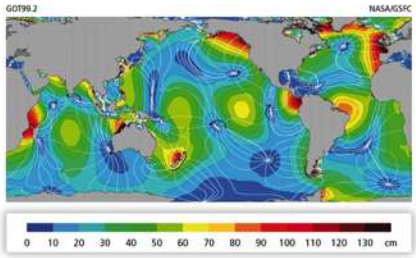
Global ocean energy

The RE resource in the ocean comes from six distinct sources, each with different origins and requiring different technologies for conversion



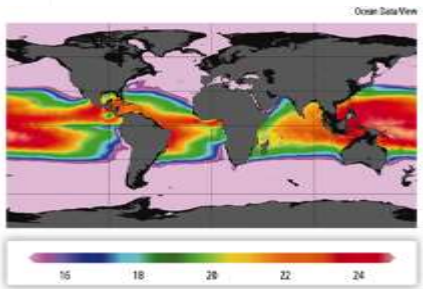
- **Waves**: derived from the transfer of the kinetic energy of the wind to the upper surface of the ocean.



- **Tidal Range (tidal rise and fall)**: derived from the gravitational forces of the Earth-Moon-Sun system.

- **Tidal currents**: water flow resulting from the filling and emptying of coastal regions as a result of the tidal rise and fall.

- **Ocean Currents**: derived from wind-driven and thermohaline ocean circulation.



- **Ocean Thermal Energy Conversion (OTEC)**:derived from temperature differences between solar energy stored as heat in upper ocean layers and colder seawater, generally below 1,000 m.

- **Salinity Gradients (osmotic power)**: derived from salinity differences between fresh and ocean water at river mouths.

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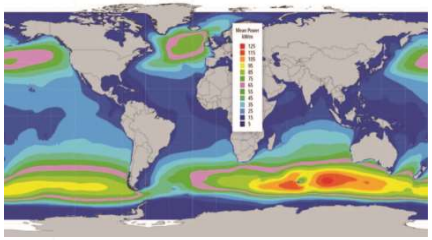

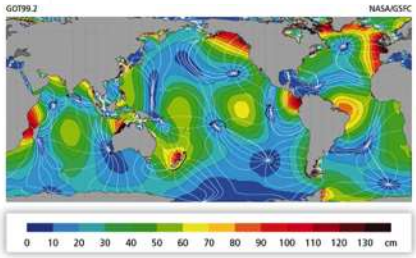

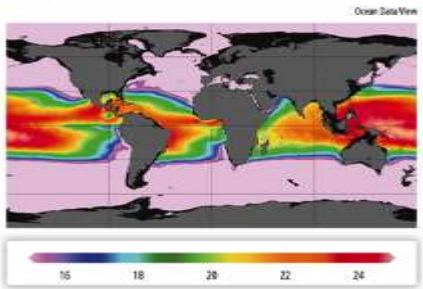

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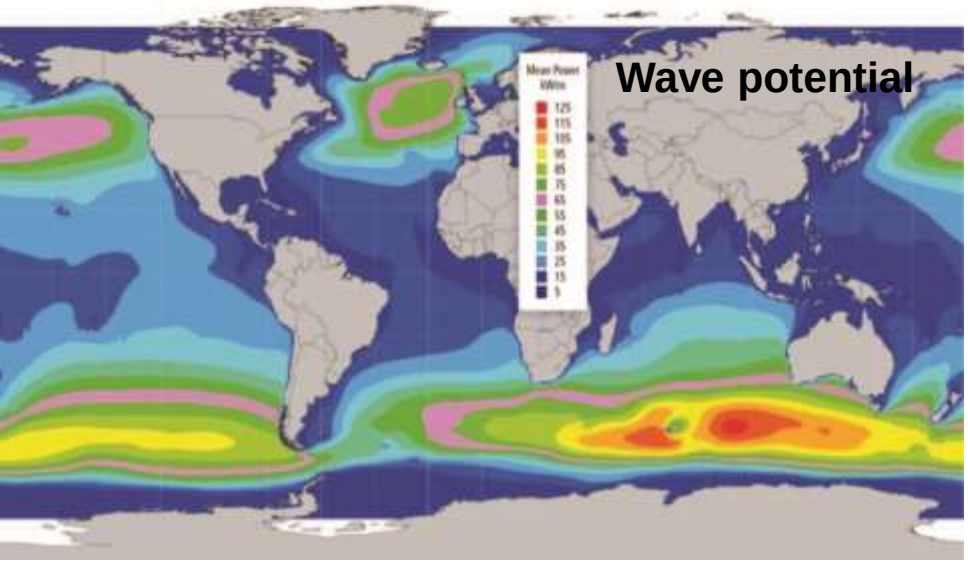
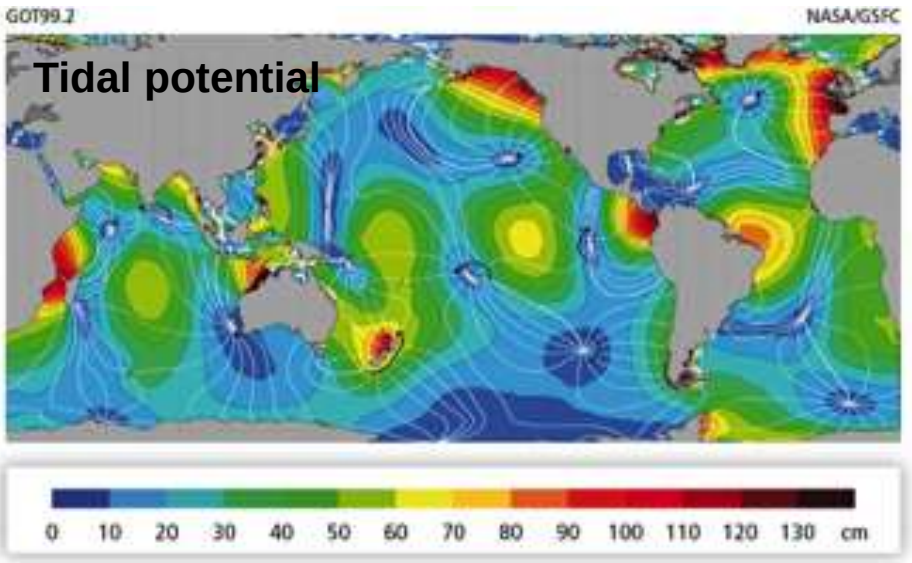
Global ocean energy potential

Wave energy is the largest untapped form of renewable energy in the world. It is on track to produce 10% (**500 GW**)of the global energy demand in the upcoming decades. The global installed capacity of wind and solar power at the end of 2014 was 360 GW and 150 GW respectively.

The estimates of global potential of **tidal energy** generation vary, but it is widely agreed that tidal stream energy capacity could exceed **120 GW** globally.





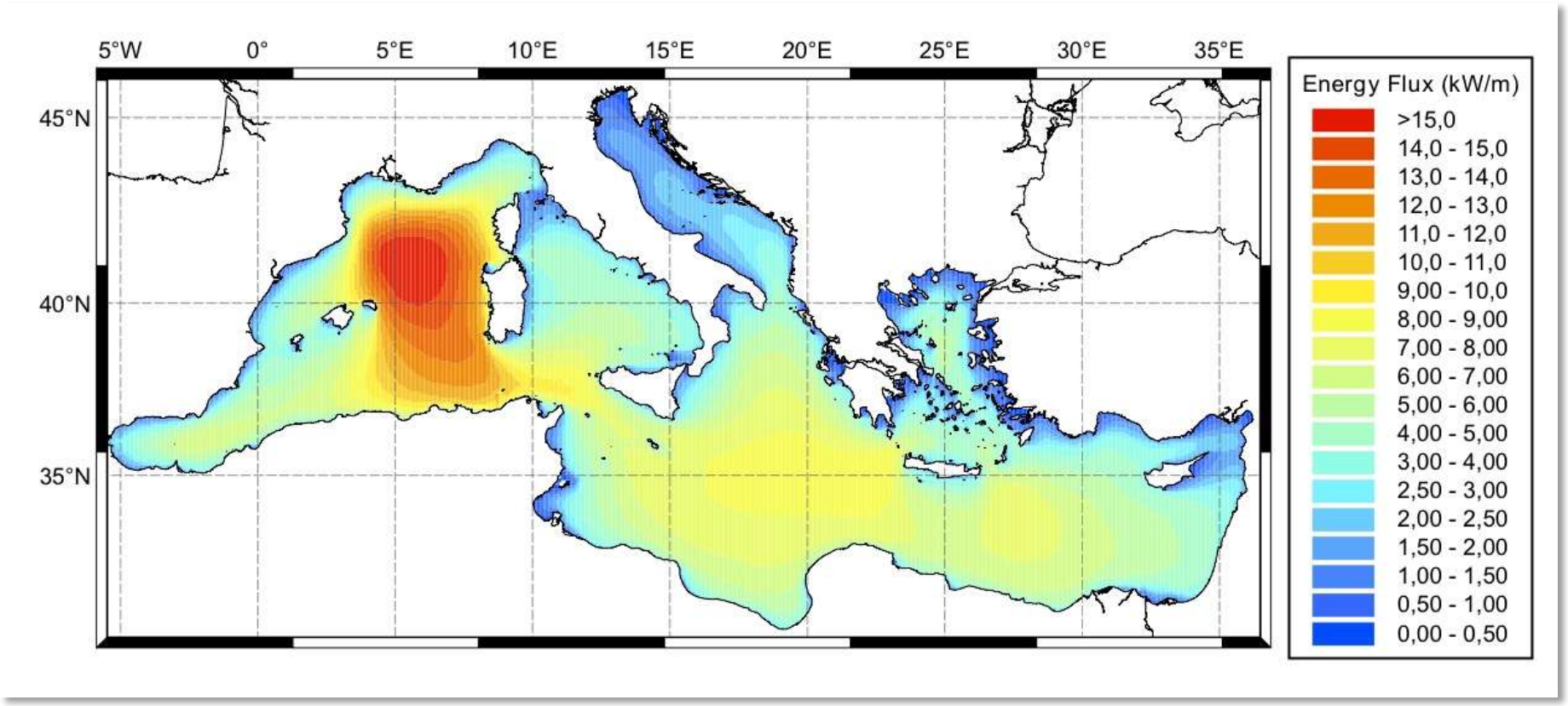
EU wave energy potential

TABLE 1: REGIONAL THEORETICAL POTENTIAL OF WAVE ENERGY

REGION	Wave Energy TWh/yr
Western and Northern Europe	2,800
Mediterranean Sea and Atlantic Archipelagos (Azores, Cape Verde, Canaries)	1,300
North America and Greenland	4,000
Central America	1,500
South America	4,600
Africa	3,500
Asia	6,200
Australia, New Zealand and Pacific Islands	5,600
TOTAL	**29,500**

Source: Mørk et al. (2010)

Mediterranean Wave energy potential

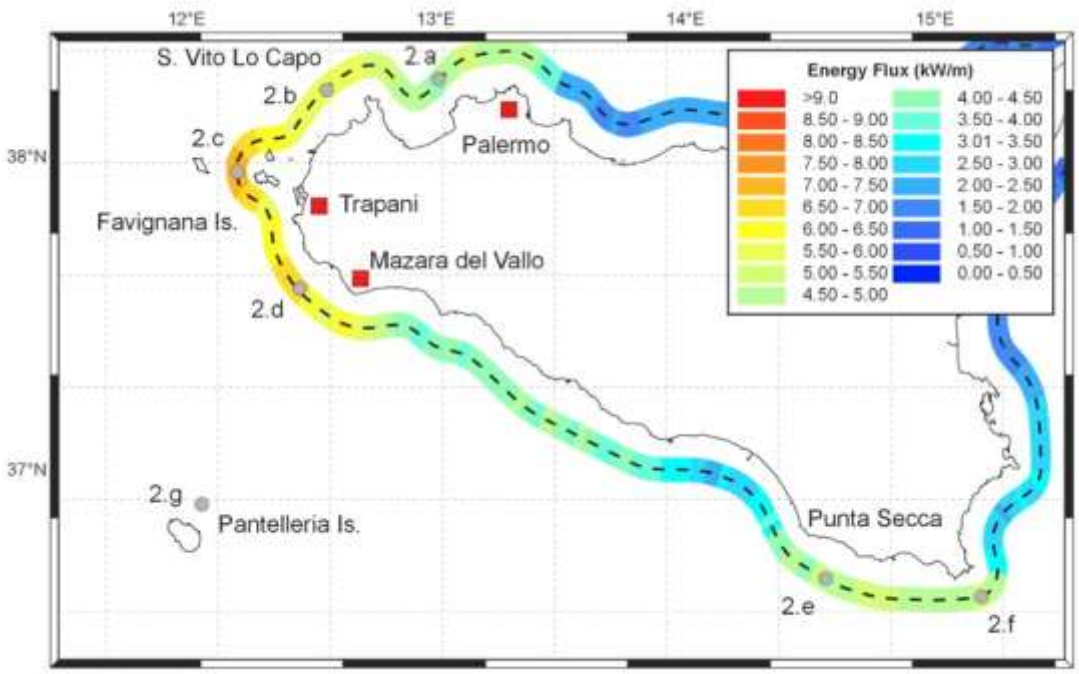


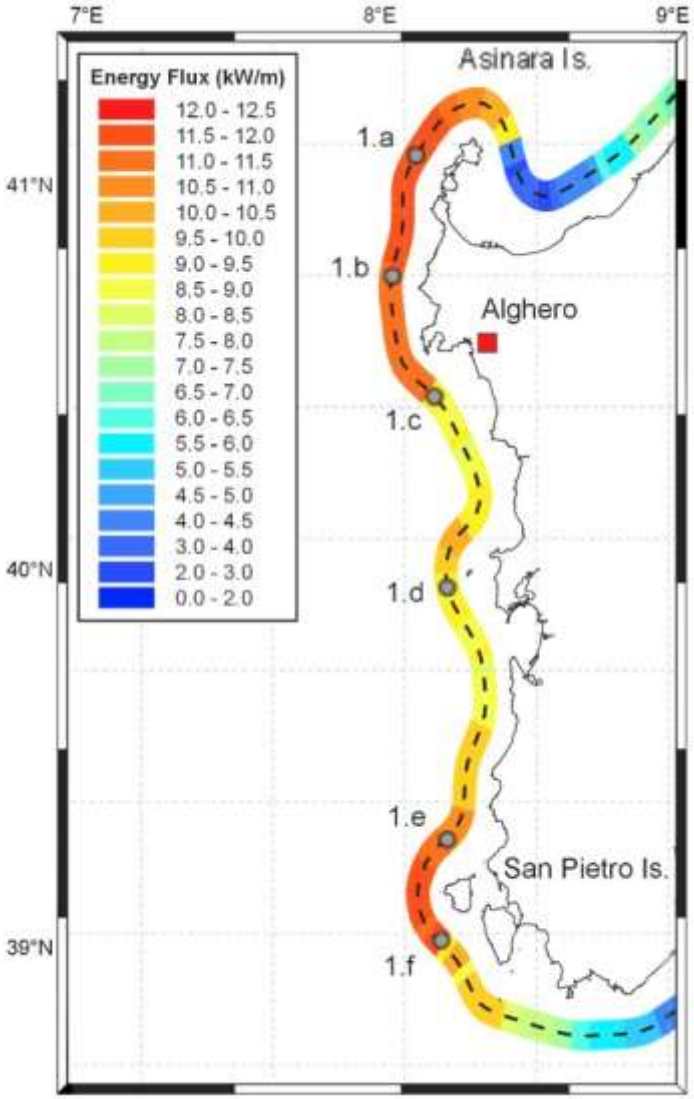
Distribution of average power per unit crest in the Mediterranean between 2001 and 2010.

$$J = \frac{\rho g^2}{64\pi} T_e H_s^2$$

Liberti, Carillo and Sanino, RE 2009

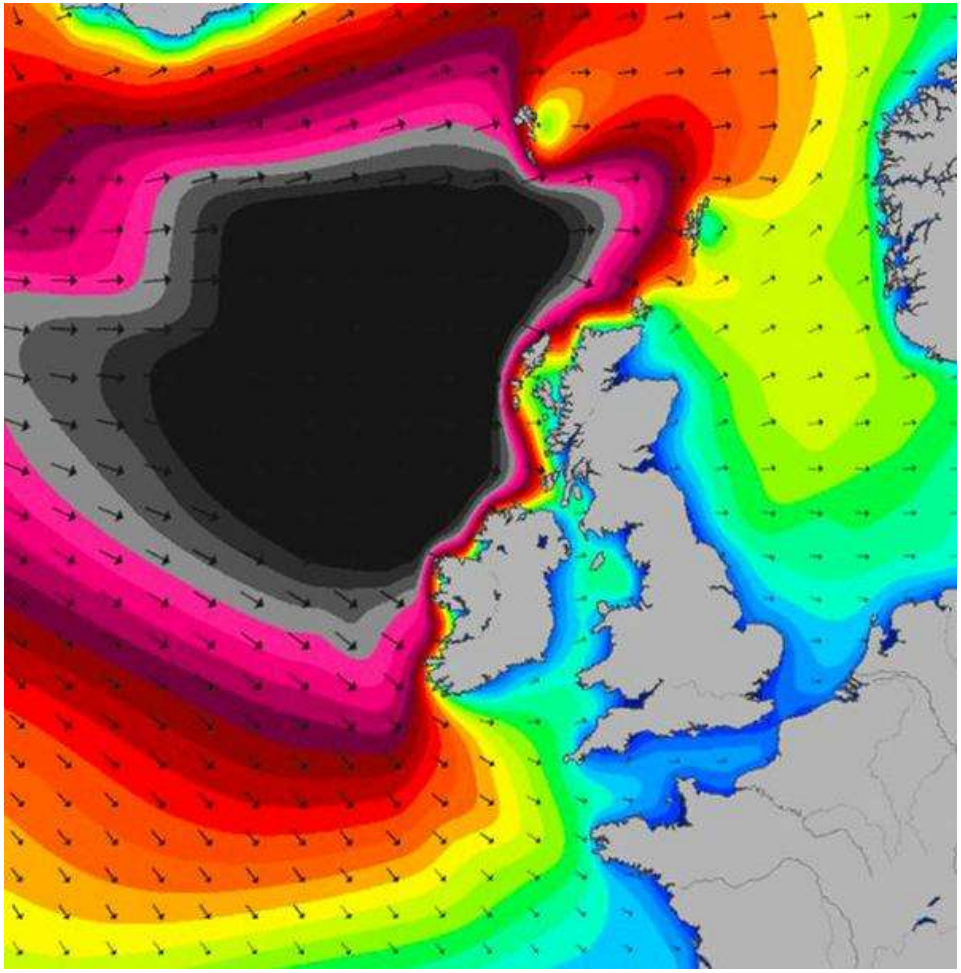
Mediterranean Wave energy potential





Distribution of average wave power flux per unit crest on western Sardinia and Sicilian coastline. Values are calculated on a line located 12 km off the coast.

North Sea wave energy potential



Large storm
December 2013 – Jannuary2014

North Sea wave energy potential

North Sea wave energy potential

North Sea wave energy potential

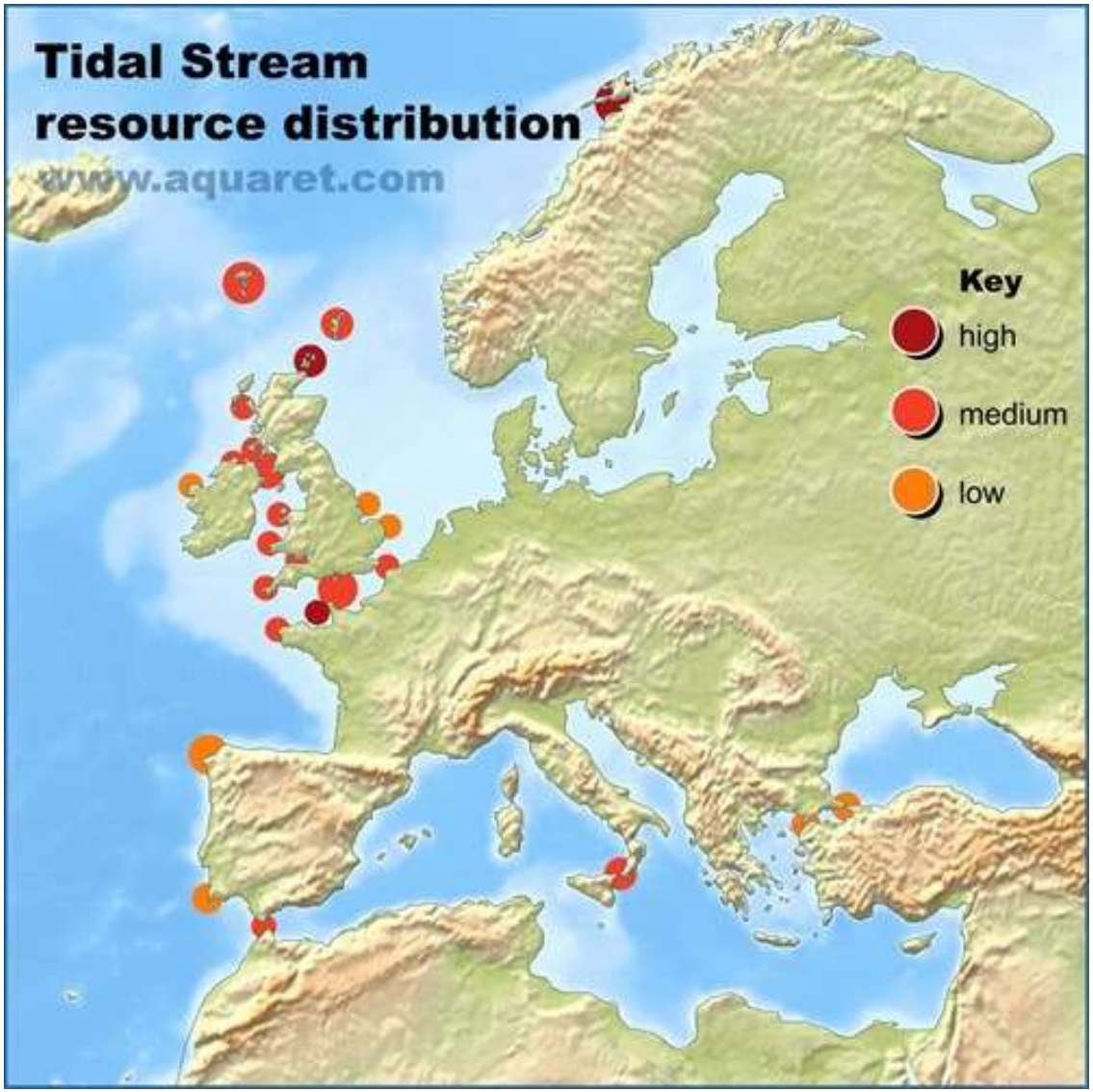

Porthcothan Bay: Before


After: 6 January 2014


Pom Pom rock: 29 December 2013

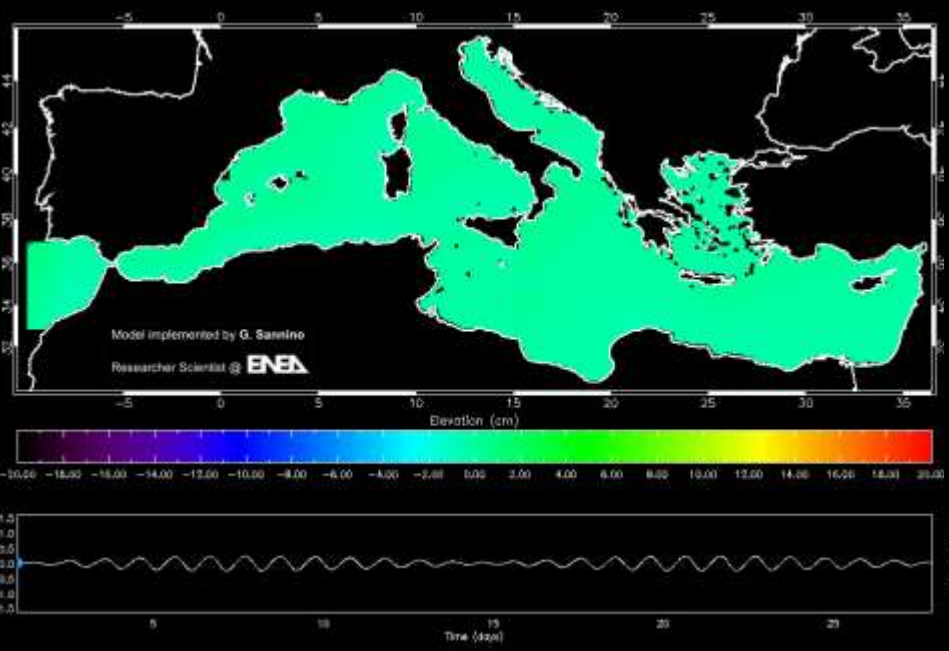

After: 6 January 2014

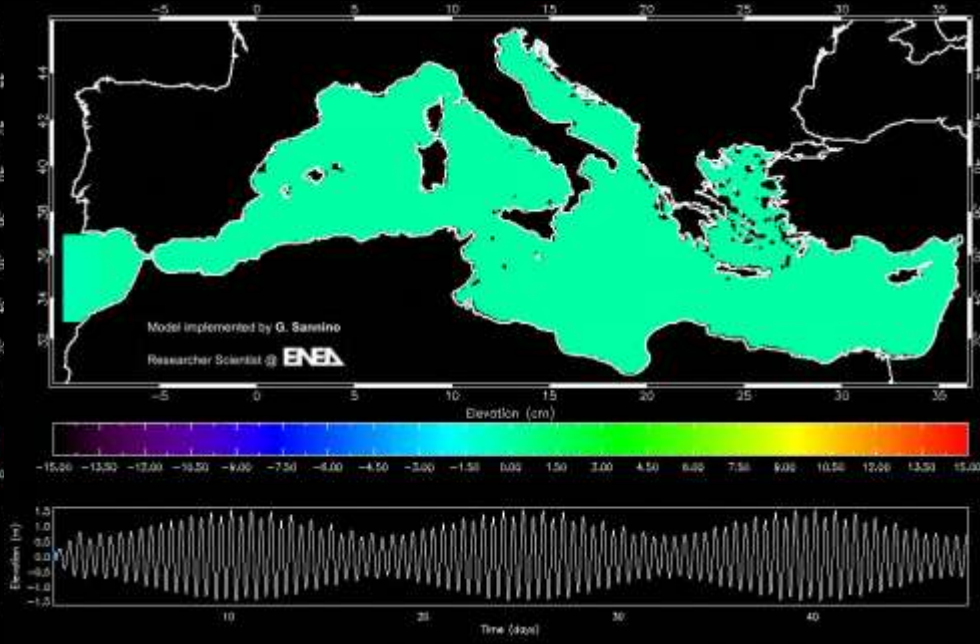
EU tidal energy potential



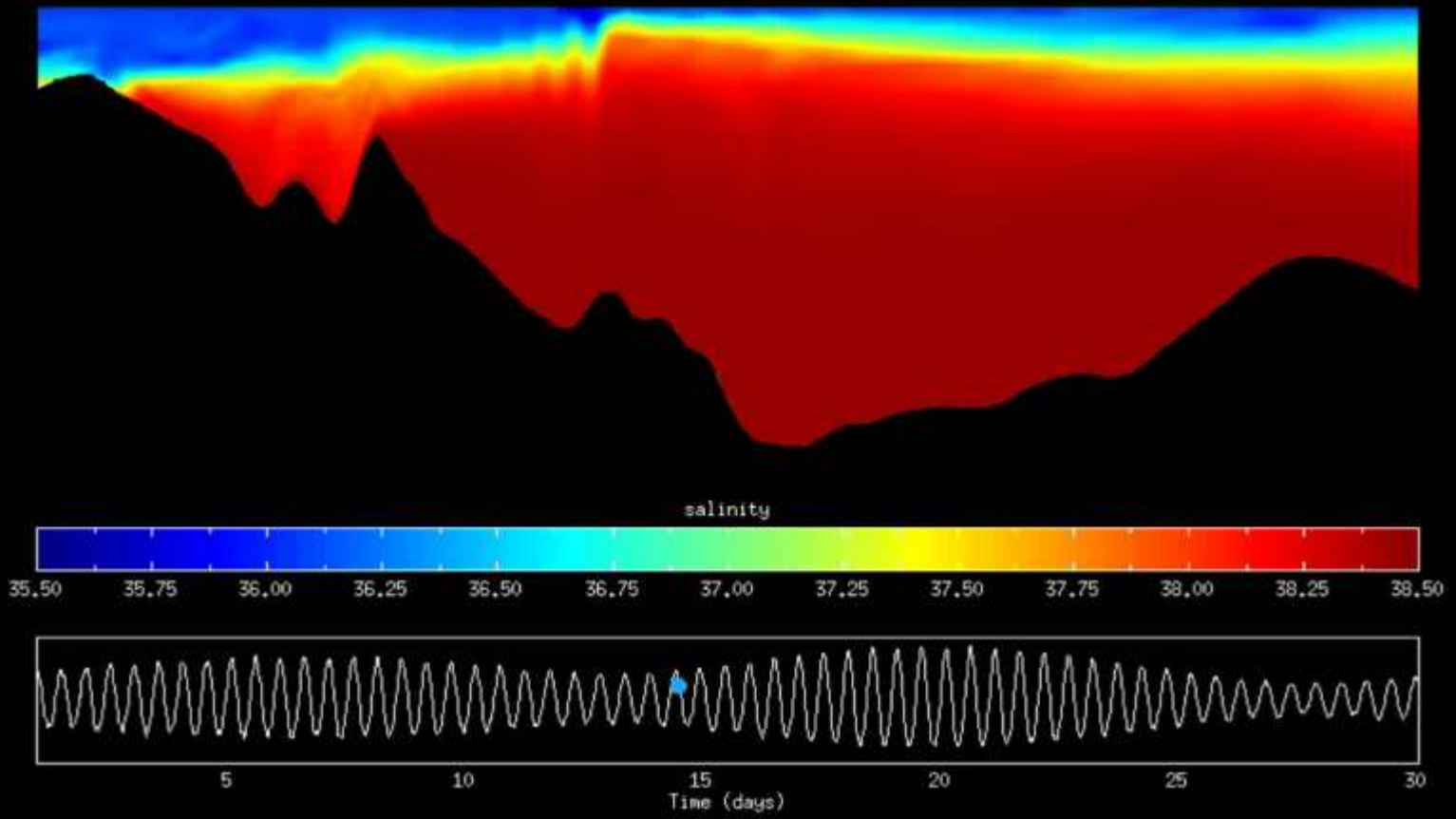
Source: Aqua-RET (2012)

Tides in the Mediterranean Sea



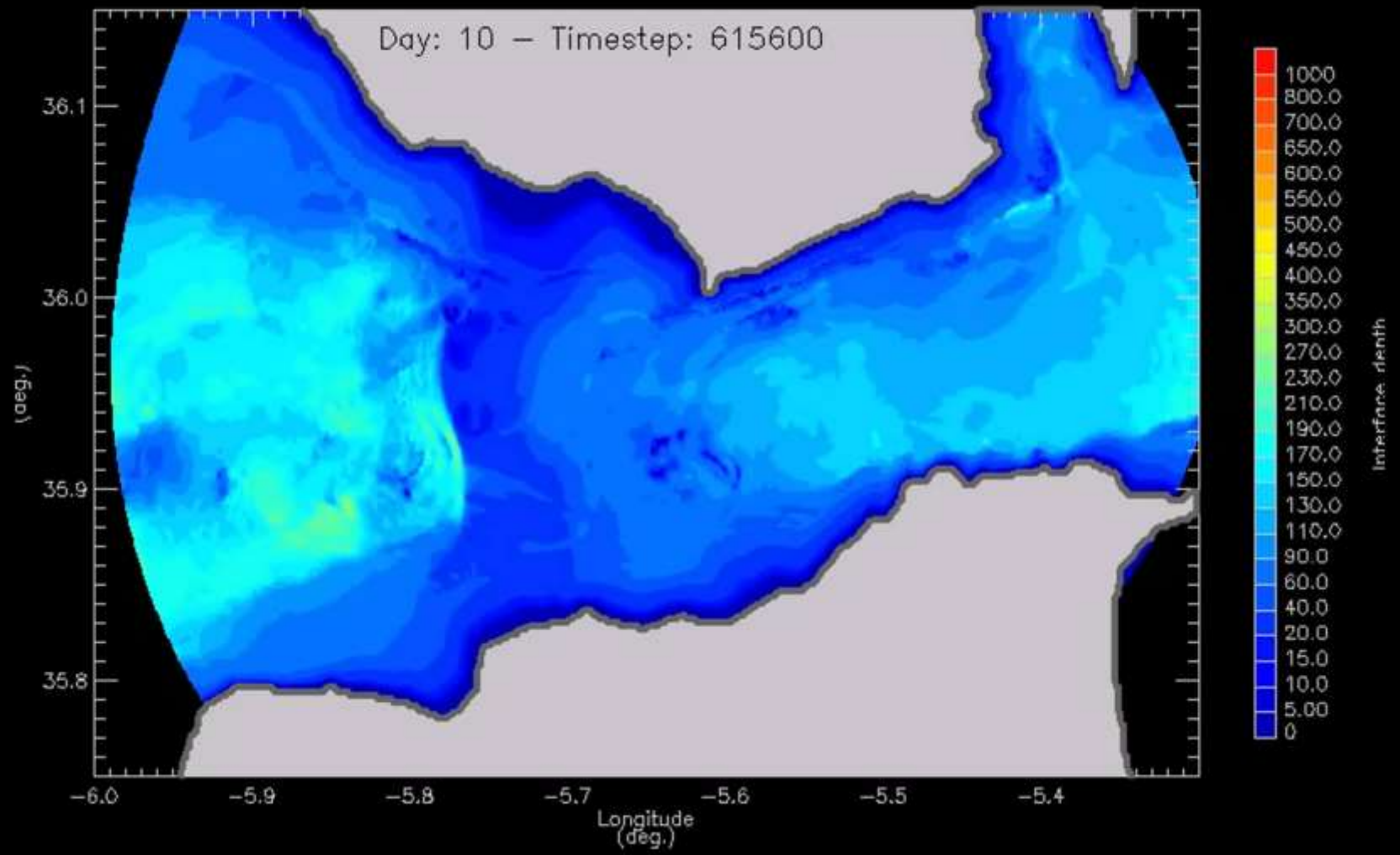


Tides in the Strait of Gibraltar



salinity along-strait section

Tides in the Strait of Gibraltar

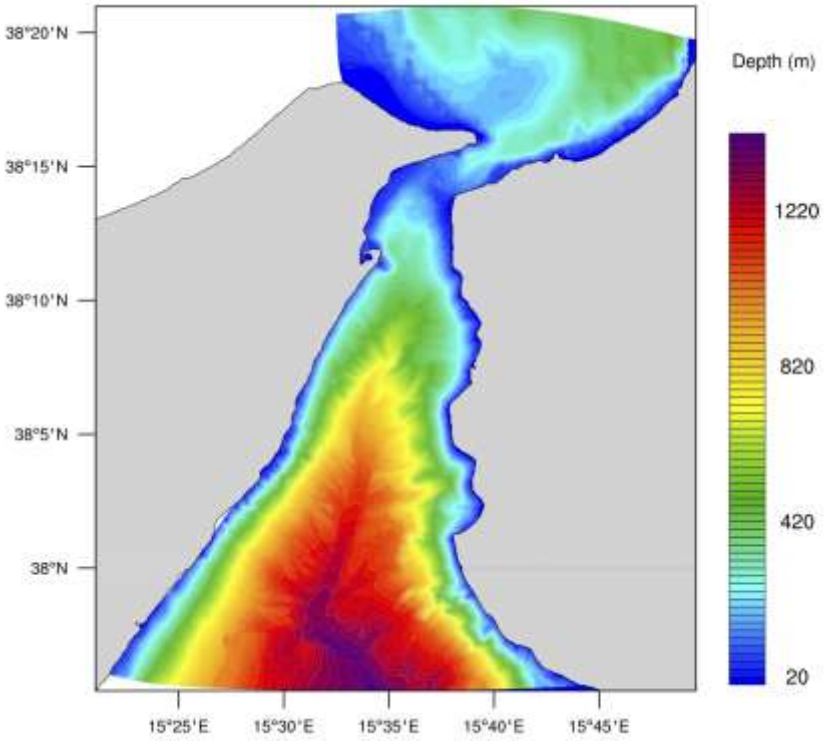


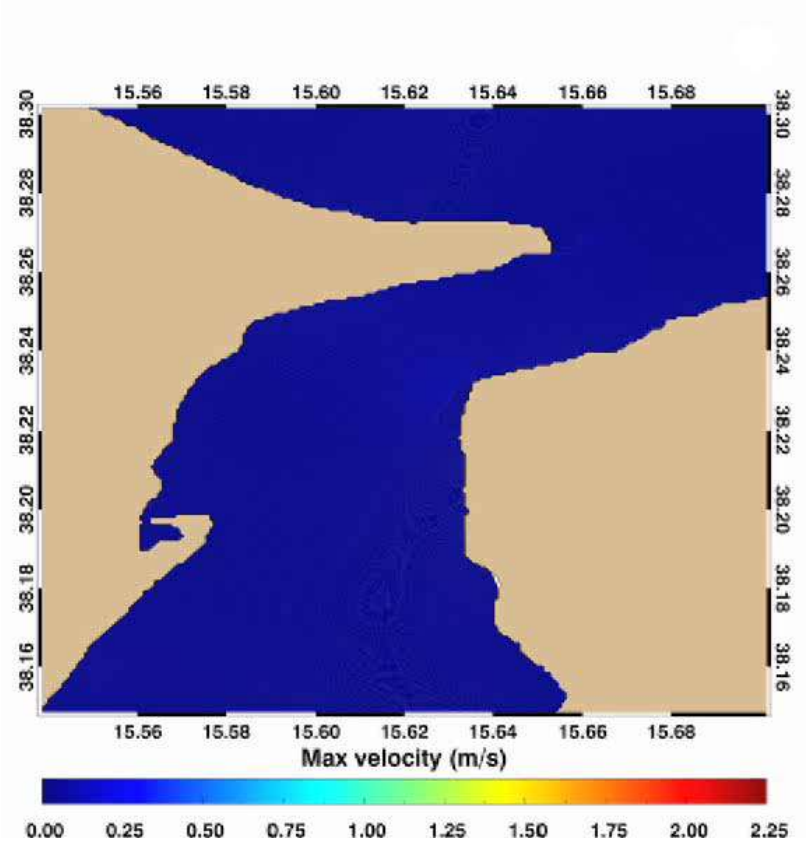
Sannino et AGU-BOOK 2014
Lafuente et al. JMS 2013
Garrido et al. JGR 2011

Interface depth evolution

Tides in the Strait of Messina

Mediterranean and strait models

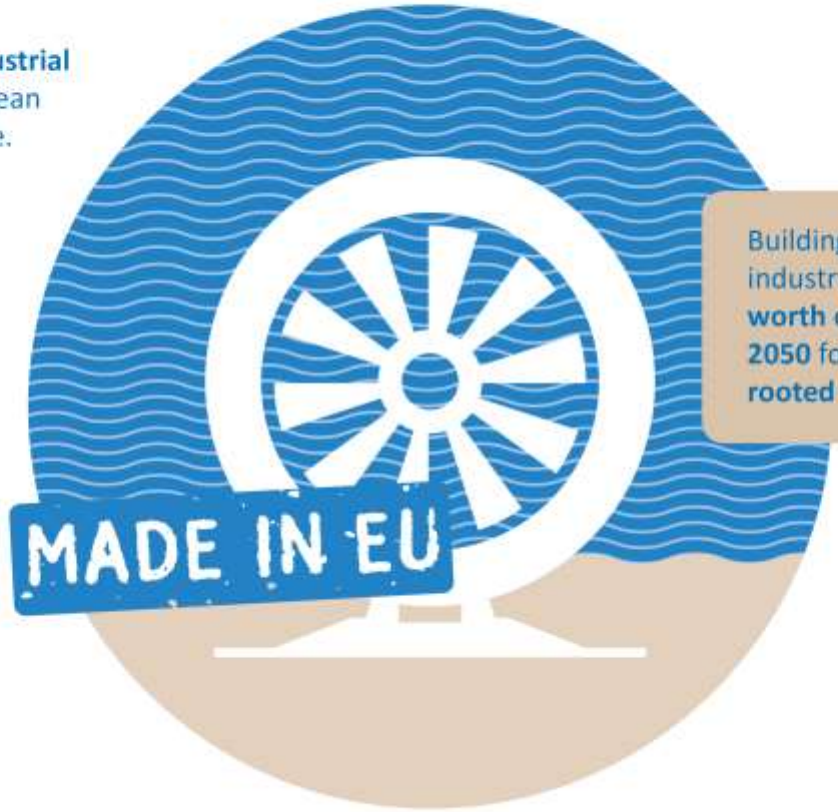




Some Reasons why we need ocean energy: #1

Ocean Energy
brings a new industrial sector to Europe

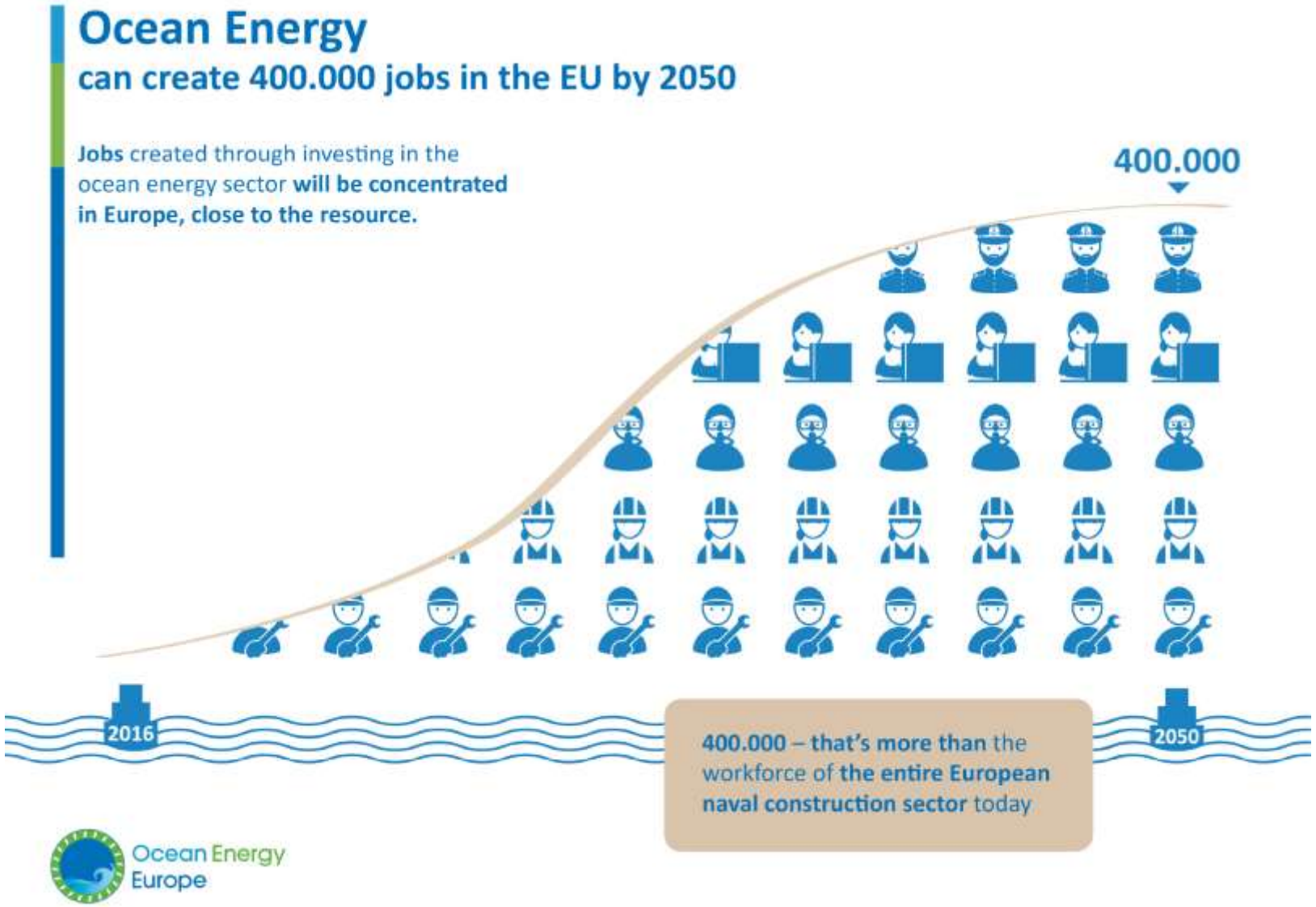
Europe needs new **industrial success stories**, and ocean energy can be a big one.



Building an ocean energy industry means creating **100GW worth of economic activity by 2050** for a **supply chain firmly rooted in Europe**

Ocean Energy Europe

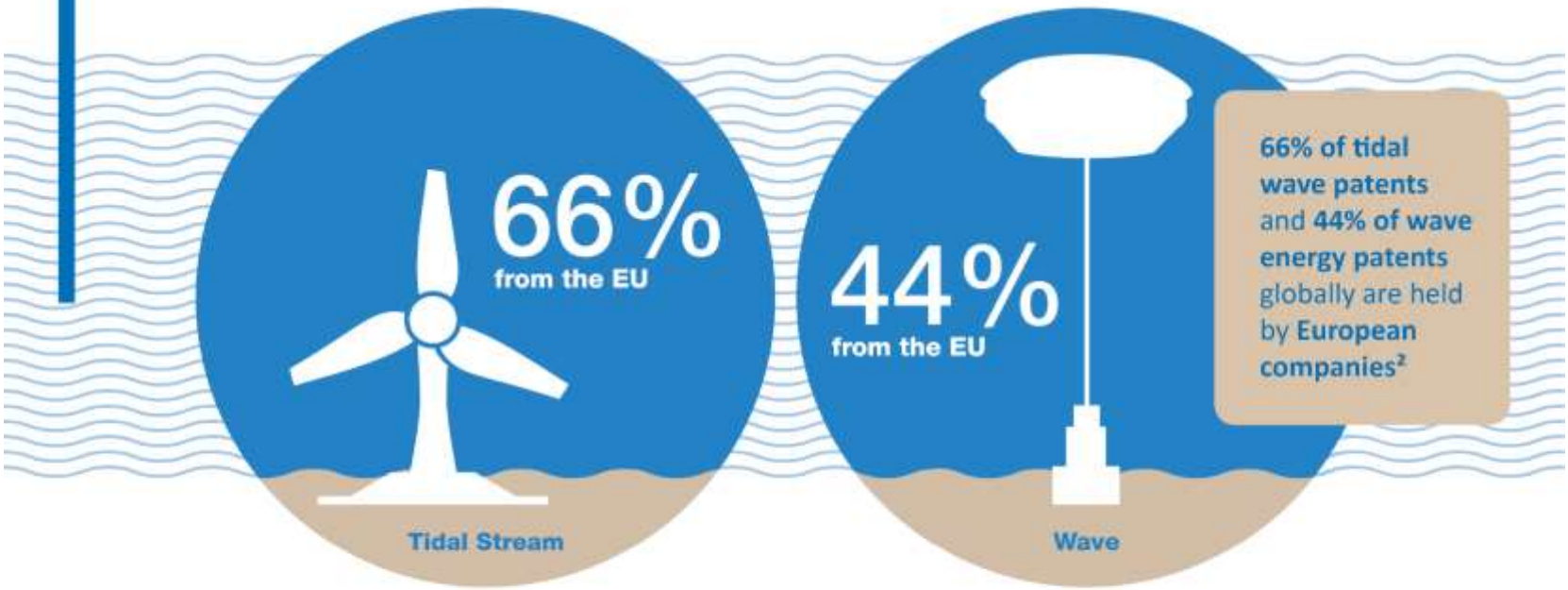
Some reasons why we need ocean energy: #2



Some reasons why we need ocean energy: #3

Ocean Energy
turns European technology leadership into export market dominance

European companies are the clear global leaders in ocean energy. They are in prime position to capture a global market estimated to be worth **€53bn annually in 2050**[1].



Ocean Energy Europe

[1] Source: Carbon Trust
[2] Source: IRENA

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Some reasons why we need ocean energy: #4

Ocean Energy
helps secure Europe's energy supply and reduce its €400bn fossil fuel import bill

Ocean energy production offers **a solution for Europe's overreliance on fossil fuel imports,** by providing an indigenous, secure source of energy.

The EU spends more than **€1bn per day** on fossil fuel imports, **€400bn annually**[1]

Ocean Energy Europe

[1] Source: European Commission

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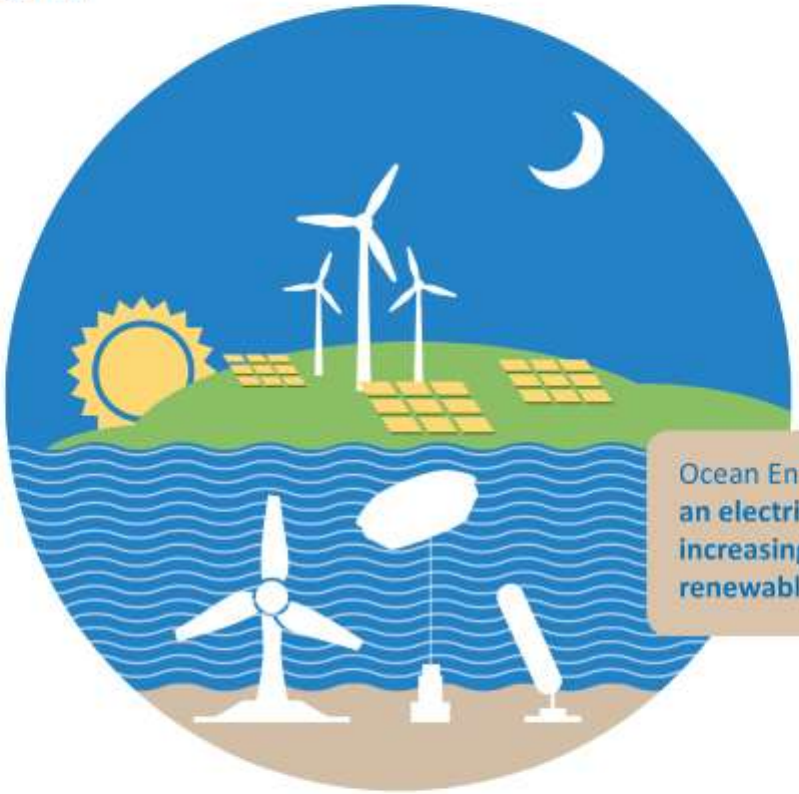
Some reasons why we need ocean energy: #5

Ocean Energy
is predictable and works well with other renewables

Ocean energy works well with other forms of **renewable energy** generation, such as wind and solar, by **generating electricity at different time periods.**



Ocean Energy can help **stabilise an electricity grid** based on **increasing amounts of variable renewables**

Ocean Energy Europe

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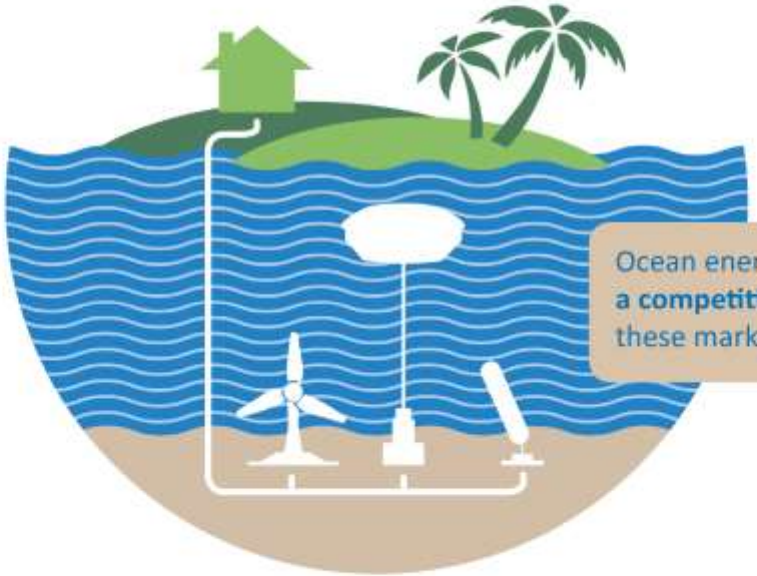
Some reasons why we need ocean energy: #6

Ocean Energy
provides energy independence for coastal areas

Providing islands and remote coastal areas with their own source of competitive energy **replaces expensive diesel-powered generators.**



Ocean energy can quickly become **a competitive source of energy** in these markets

Ocean Energy Europe

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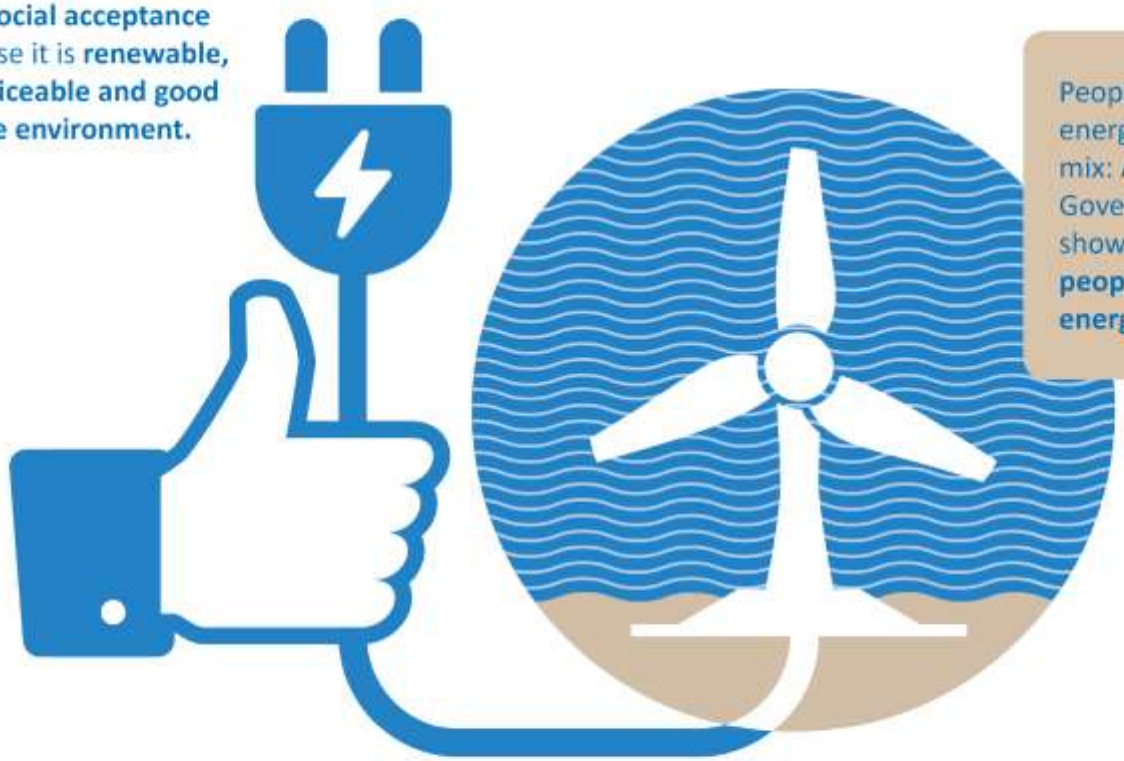
Some reasons why we need ocean energy: #7

Ocean Energy
enjoys high public support

Ocean energy enjoys **high social acceptance** because it is **renewable, unnoticeable and good for the environment.**



People want ocean energy in their energy mix: A 2016 UK Government survey showed that **77% of people support ocean energy development**[1]

Ocean Energy Europe

[1] Source: DECC

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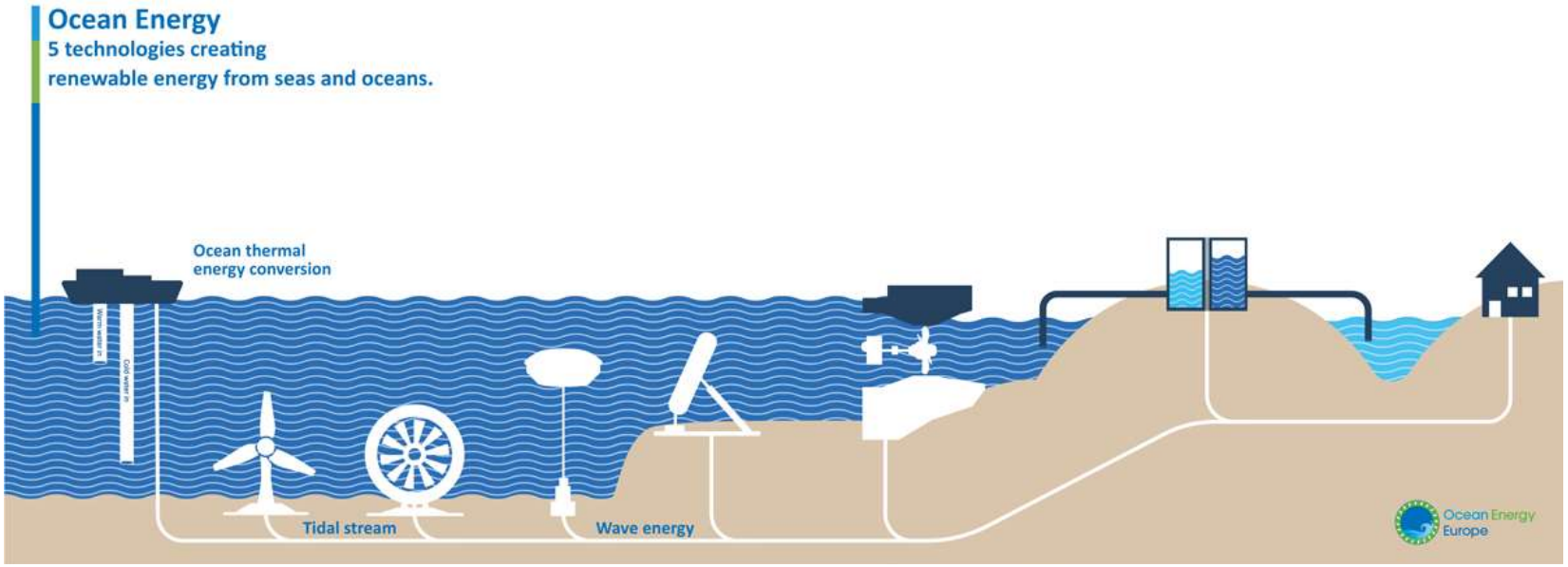
EU Commission Recommendation

Technology convergence needed



EU Commission Recommendation

The Plan recommends to concentrate efforts on a **limited number of promising technologies** for energy conversion from tidal streams and waves, targeting a reduction in the LCoE for tidal stream energy converters to at least **15 ct€/kWh by 2025** and **10 ct€/kWh by 2030**, and a similar, although slower, reduction in the LCoE for wave energy converters to **20 ct€/kWh by 2025**, 15 ct€/kWh by 2030 and **10 ct€/kWh by 2035**.

BlueEne Med Cluster

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Faculty of Mechanical Engineering
and Naval Architecture

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Maritime Institute of Eastern Mediterranean

PELAGOS aims to develop smart and sustainable growth by enhancing a transnational MED Cluster in the Blue Energy sector and by facilitating the distribution of targeted solutions and products specifically calibrated for the Mediterranean region.

PELAGOS offers support to the relevant stakeholders by promoting knowledge sharing in R&D, and by enhancing social acceptance. It inter-connects technology and service providers, large enterprises, power distributors, financial operators, policy makers, administrative bodies, NGOs, and citizens.

Project partners

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Italian R&D activities: Position paper published

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