

# Off-shore Renewable Energy Sources

CARMEN M<sup>a</sup> ROA TORTOSA  
Hydroelectric, Sea Energy and Geothermal Department - IDAE  
Ministry of Industry, Tourism and Trade



## 1. INTRODUCTION

## OCEAN AS AN ENERGY SOURCE

Ocean's energy as an alternative source



Energy Field

Ocean is the most field of Energy

Never-ending Energy Source, quite wasted at present

It works as a Energy Battery

Area: 361 M sKm ( Km<sup>2</sup>)

Volume: 1370 M cKm ( Km<sup>3</sup>)



INSTITUTO PARA LA DIVERSIFICACIÓN Y AHORRO DE LA ENERGÍA

**CARMEN M<sup>a</sup> ROA TORTOSA**  
Hydroelectric, Sea Energy and Geothermal Department  
**HARNESSING WORLD OCEAN ENERGY**

**THE OCEAN AS A SOURCE OF ENERGY**

**SEA ENERGY**






TIDAL

CURRENTS


WAVE

THERMAL GRADIENT







SALINITY GRADIENT

BIOFUEL FROM ALGAE



OFF-SHORE WIND ENERGY

Renewable Energy and the Sea- Technological Innovation  
Off Shore Renewable Energy Sources

Pag. 3

INSTITUTO PARA LA DIVERSIFICACIÓN Y AHORRO DE LA ENERGÍA

**CARMEN M<sup>a</sup> ROA TORTOSA**  
Hydroelectric, Sea Energy and Geothermal Department  
**HARNESSING WORLD OCEAN ENERGY**

**THE OCEAN AS A SOURCE OF ENERGY**

**SEA ENERGY**







TIDAL  
300 TWh/per year

CURRENT  
800 TWh/per year

UNDIMOTRIZ  
8.000-  
80.000 TWh/py

THERMAL GRADIENT (OTEC)  
10.000 TWh/py

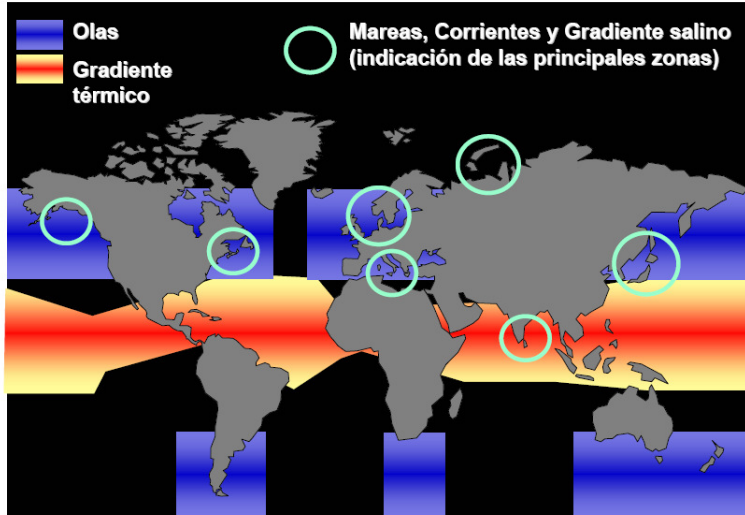
SALINITY GRADIENT  
2.000 TWh/per year

Renewable Energy and the Sea- Technological Innovation  
Off Shore Renewable Energy Sources

Pag. 4

SEA ENERGY WORLD DISTRIBUTION



DEVELOPMENT PHASES

Phase 1: concept formulation

Phase 2: validation and design model

Phase 3: process model

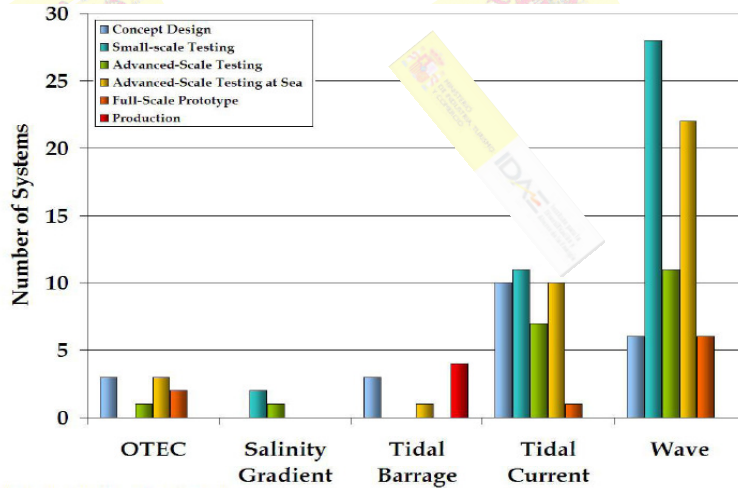
Phase 4: full scale prototype

Phase 5: Commercial demonstration



**MATURITY OF TECHNOLOGIES**

*Different Stages of Development*



(C) PowerTech Labs Inc., Surrey, BC, Canada

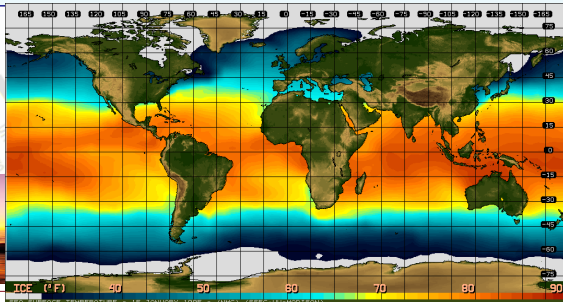
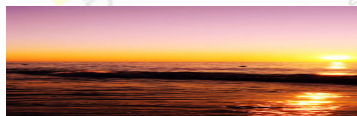
Fuente: IEA-International Energy Agency, 2006

**OCEAN THERMAL ENERGY**

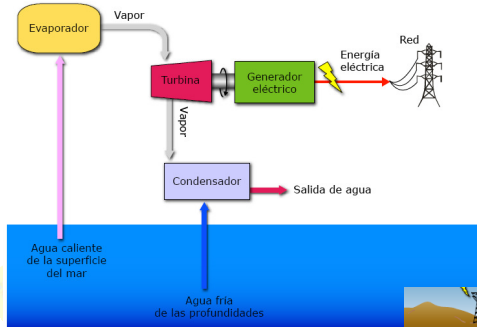
**THERMAL GRADIENT:** The temperature difference between surface and bottom is the result of solar radiation incident on the sea water.

**OBJET:** Energy generation from OTEC.

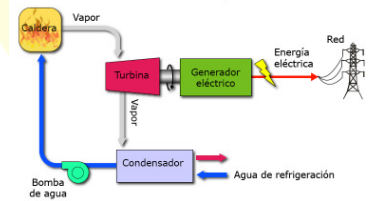
**Rankine Thermodynamic Cycle:** Thermal energy conversion needs at least 20°C water difference.



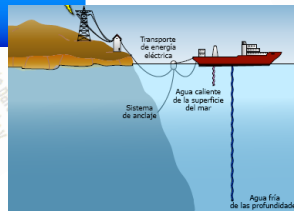
OCEAN THERMAL ENERGY



Thermal Power Plant conceptual scheme



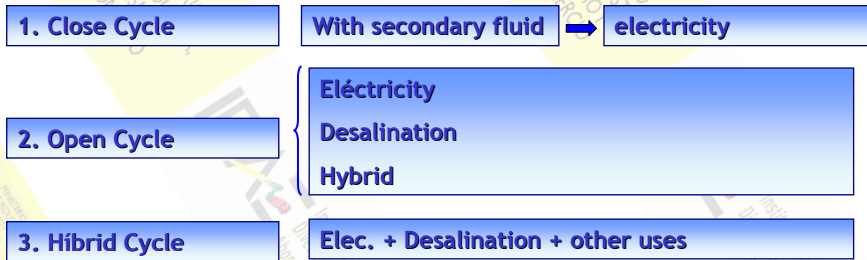
OTEC Plant Conceptual Scheme



OCEAN THERMAL ENERGY

CLASSIFICATION

OTEC Conventional:

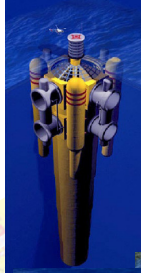


High Temperature OTEC:

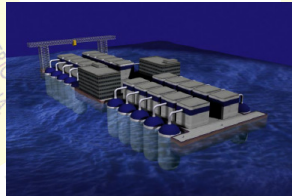
OCEAN THERMAL ENERGY

TECNOLOGY TYPES

Flotante Lockheed Self mounted tower



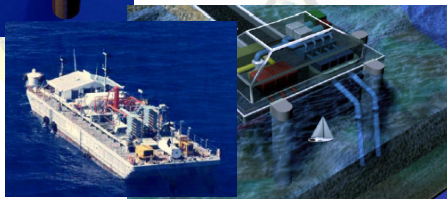
Platform OTEC plant



Central Maremotérmica TRW



Floating vessel plant



On shore land based



CURRENT ENERGY

Harnessing of the Kinetic energy of the sea currents

- High water density versus wind.
- Less room size for turbines and blades.
- Flows > 8m/s.
- Complex designs.



Selection among European technologies



**CURRENT ENERGY**

**TECNOLOGY TYPES**

*Lunar Energy*



*Hammerferst*



*Seaflow, Costa de Lynmouth*

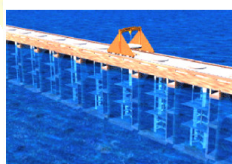
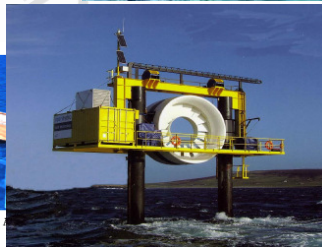


Fig VII.16. Planta en dique, y

*Blue Energy*



*Open Hydro*



*Seagen, Costa de Lynmouth*



European Maritime Day - 20 May

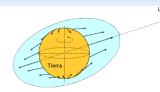


**TIDAL ENERGY**

TIDAL: the water coming and going is due to the Sun and Moon gravity forces. El ascenso y descenso de las aguas del mar es producido por las acciones gravitatorias del sol y la luna.

**Requirements:**

- >Wide Tidal > 5 m.
- >Enough wide bay or estuary.
- >Fasy dike erection.



La instalación de una central maremotriz es sólo posible en lugares con una diferencia de al menos 5 metros entre la marea alta y la baja. Hay pocos puntos en el globo donde ocurre este fenómeno. Estos son los principales:



Energy  
Tidal  
Potential  
Harnessing



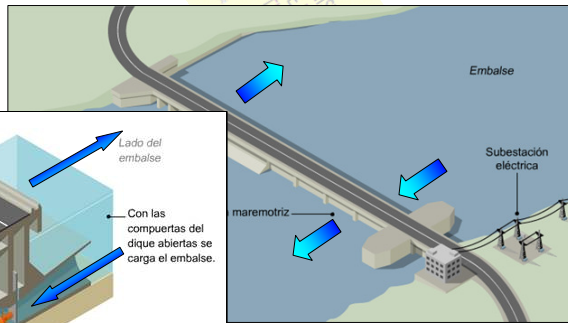
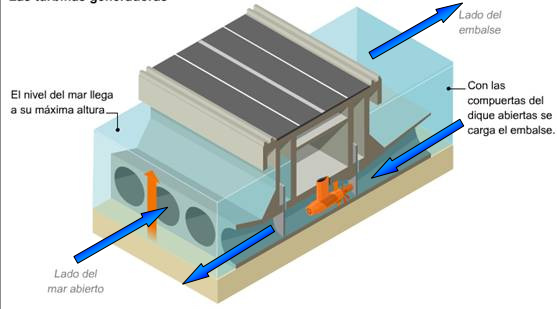
European Maritime Day - 20 May



**TIDAL ENERGY**

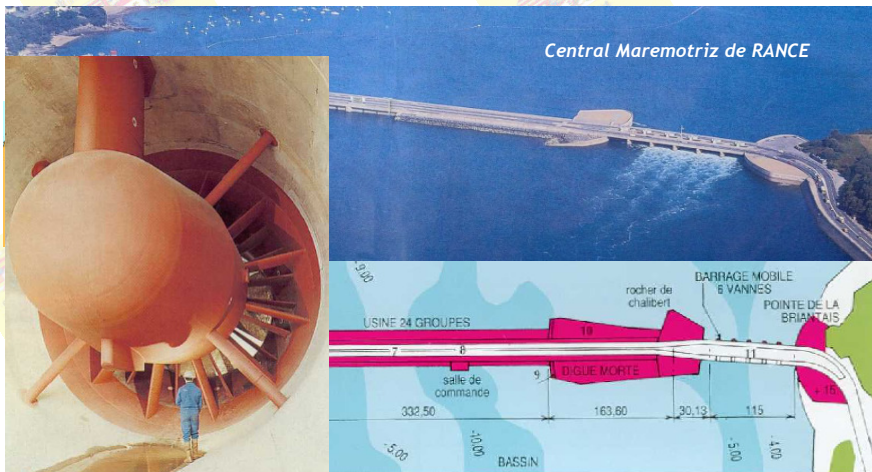
- Simple effect cycle
- Double effect cycle
- Pumped storage

Las turbinas generadoras



**TIDAL ENERGY**

**TECNOLOGY TYPES**





WAVE ENERGY

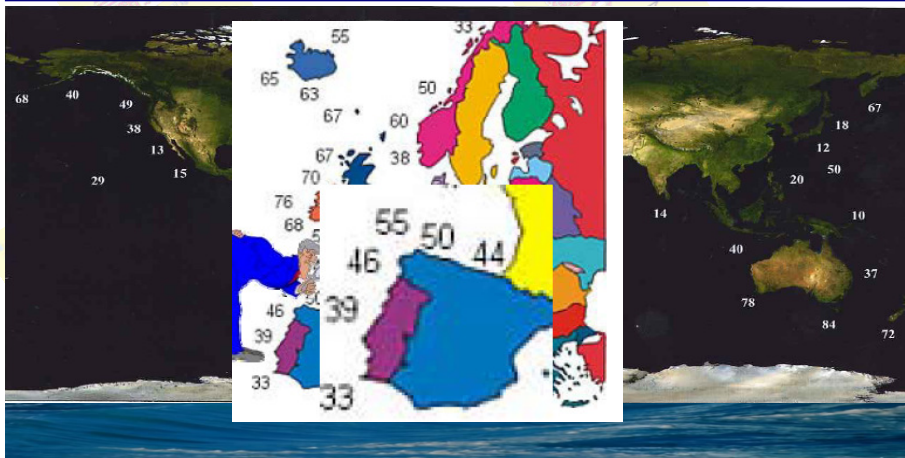
WAVES:

- ✓ Wave energy is produced by wind.
- ✓ Very variable in height.
- ✓ Tertiary derived solar energy.
- ✓ The warming of the Earth's surface generates wind and wind waves general as a result of air friction on the sea surface.
- ✓ The intensity of the waves depends on wind intensity, duration and length over which transmits wave energy.
- ✓ Travel long distances with little energy loss.
- ✓ Global average energy density 8kW / m coastline.



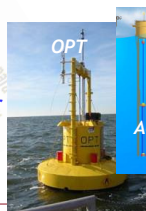
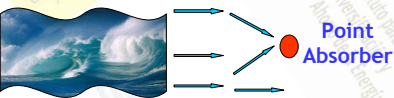
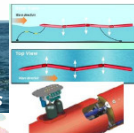
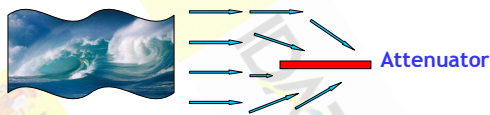
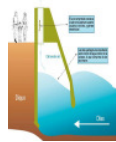
WAVE ENERGY

World Distribution of Annual Average Off Shore (kW/m)



TECNOLOGY TYPES

WAVE ENERGY

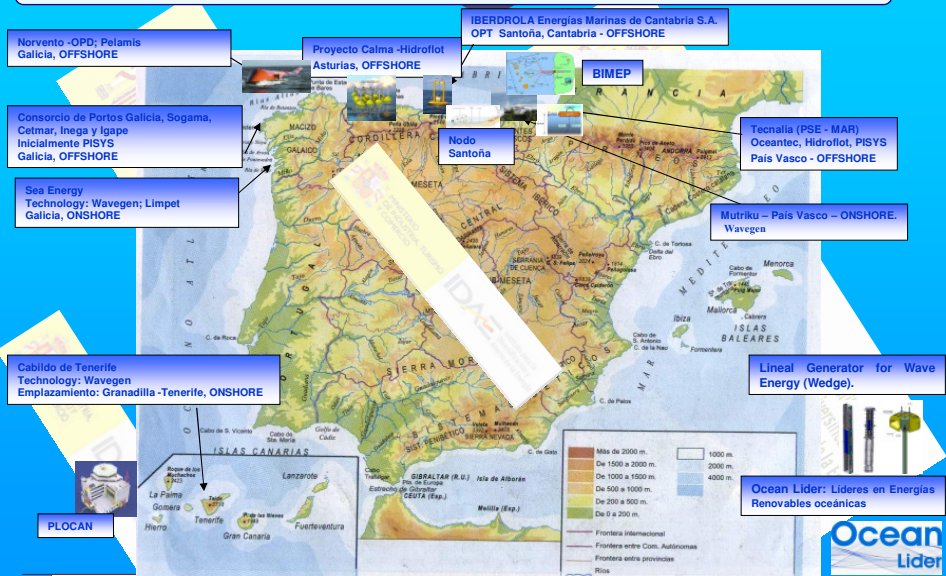


WEDGE

Lineal Generator



OCEAN ENERGY IN SPAIN: Wave Energy Projects



*Thanks for your attention*

INSTITUTO PARA LA DIVERSIFICACIÓN Y AHORRO DE LA ENERGÍA (IDAE)

**Carmen M<sup>a</sup> Roa Tortosa**

**c/ Madera 8 28004 Madrid- España**

**Tel. +0034 91 4564900 Fax. +0034 91 5230414**

**[cmroa@idae.es](mailto:cmroa@idae.es) [www.idae.es](http://www.idae.es)**

