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Ocean Energy

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Offshore Wind and Wave Seminar
Lisbon 24th November 2008



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Berria Beach. Santoña. Cantabria, Spain

1. TECNALIA: About us

TECNALIA Technology Corporation is a European representative agent in the **Technological Innovation** world whose aim is to contribute to Economic and Social Development, through the development and dissemination of **Research**.

TECNALIA is made up of seven Spanish Technology Centres: AZTI, ESI, FATRONIK, INASMET, LABEIN, NEIKER and ROBOTIKER.

Europa
España
Francia
Bulgaria

América
EE.UU.
Chile
Argentina
Brasil
Ecuador
México

Asia
China

Oceanía
Australia

TECNALIA KEY FIGURES

- **People: over 1,350 researchers**
- **Turnover: 95 million euro**
- **Customers: more than 3,500 per annum**
- **FP6: 170 projects (contracts amounting nearly €40m)**



1. TECNALIA Energía

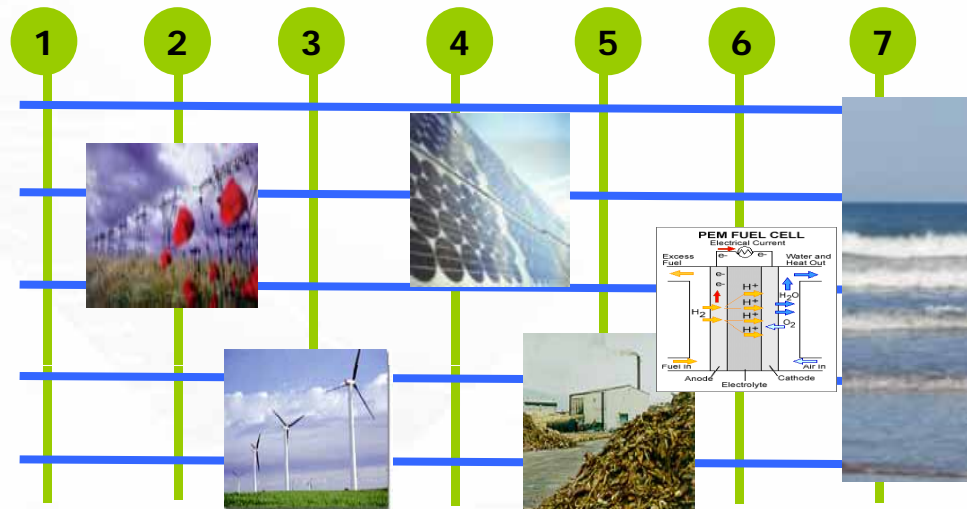
Staff 2007: 120 researchers

4 Sites:
 • Derio
 • Zamudio
 • San Sebastián
 • Barakaldo

Turnover 2007: 12 M€

ENERGY SECTOR

- ❖ Electrical eng.
- ❖ Electronics
- ❖ ICTs
- ❖ Materials
- ❖ Mechanics



- Electrical Equip. Test 1
- Photovoltaic 2
- Electrical Networks 3
- Wind Energy 4
- Biomass - Bioenergy 5
- Hydrogen & Fuel Cells 6
- Ocean Energy 7

2. TECNALIA & Ocean Energy

**Design of marine
energy farms**

**Electrical equipment
for grid connection of
wave energy
converters**

**Development of a
High Performance
Wave Energy
Converter**

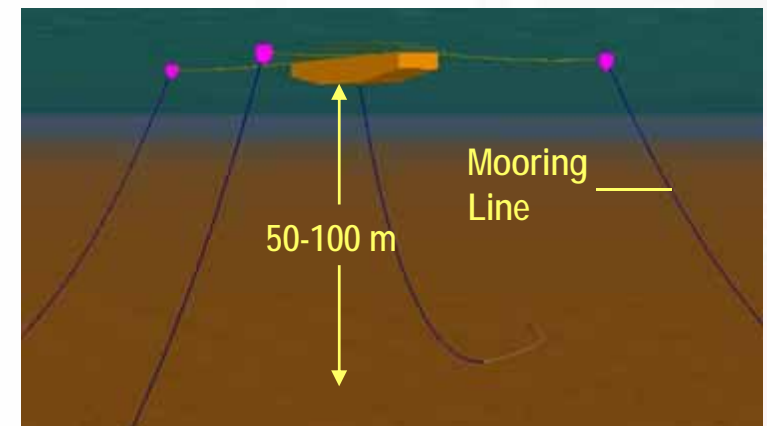
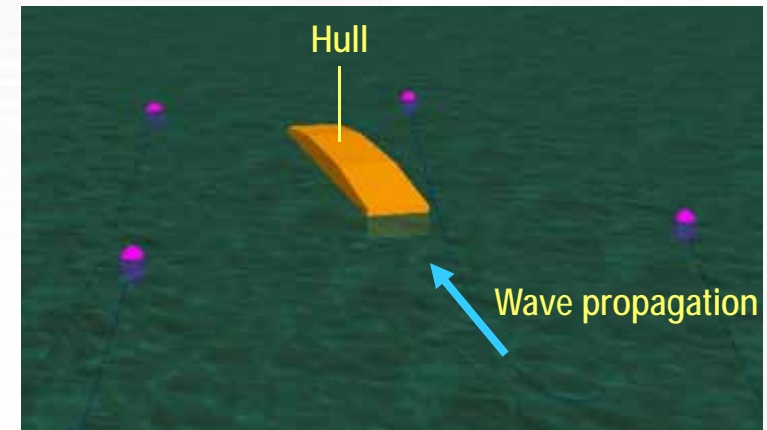
2. TECNALIA & Ocean Energy

- **Design of marine energy farms**
 - Site and resource assessment
 - Performance evaluation of wave energy converters
 - Environmental impact assessment
 - Grid integration of marine farms
 - Modelling of mooring systems
- **Electrical equipment for grid connection of wave energy converters**
 - Power conversion / Power quality / Reactive compensation
 - Design of connectors / transformers
 - Design of umbilical cables
 - Energy storage
- **Development of a High Performance Wave Energy Converter - OCEANTEC**

2.1 OCEANTEC: Technology Description

MAIN FEATURES	
Location	<ul style="list-style-type: none"> Off-shore Floating structure
Shape & orientation	<ul style="list-style-type: none"> Attenuator (lineal absorber) Slender hull shaped body
Capture principle	<ul style="list-style-type: none"> Relative inertial movement Based on a gyroscopic system

- The **floating body** oscillates due to the wave excitation in its main DOF: pitch mode.
- The **mooring system** allows the body to weathervane so that it is faced to the main wave propagation direction.
- The main advantage of the design is that the capture system is **completely encapsulated and not in contact with the sea water**.



INTERNATIONAL PATENT REGISTERED IN 2006

3.1 OCEANTEC: Development Plan

		Phase	Objetives	Main Results	
2005	2005	Phase 1 (28m)	Baseline Technology Development	<ul style="list-style-type: none"> • Requirement definition • Technical solution selection • Numerical modelling • WEC conceptual design • Experimental validation 	<ul style="list-style-type: none"> • Technical Specification • Numerical model of performance • 3D WEC design • PCT Patent registered • Mechanical laboratory test • Wave tank tests
2006	2006				
2007	2007	Phase 2 (29m)	Scaled Prototype 1:4	<ul style="list-style-type: none"> • Adjust numerical models • Prototype Detailed design • Further laboratory tests • Prototype manufacture • Installation & validation at sea 	<ul style="list-style-type: none"> • Num. model "wave-to-wire" • 3D design of the 1:4 prototype • Experimental models • Deployment permissions at sea • Scaled prototype 1:4; • Further Patents
2008	2008				
2009	2009				
2010	2010	Phase 3 (24m)	Industrial Phase	<ul style="list-style-type: none"> • Improve the scaled prototype • Industrialization Plan • Detailed design of 1:1 prototype • Construction of the prototype • Installation and tests at sea • Homologation by CCSS 	<ul style="list-style-type: none"> • 3D Design of the 1:1 prototype • Patents of improvement • Permissions for prototype installation • Pre-commercial product
2011	2011				
2012	2012	Phase 4 (> 12m)	Pilot Plant	<ul style="list-style-type: none"> • Definition of the project • Pilot plant construction • Commercial validation of several devices 	<ul style="list-style-type: none"> • Pilot Operation Plant • Commercial product

2.1 OCEANTEC: Phase 1

TIME DOMAIN NUMERICAL MODEL

MECHANICAL LAB. TESTS

WAVE TANK TESTS

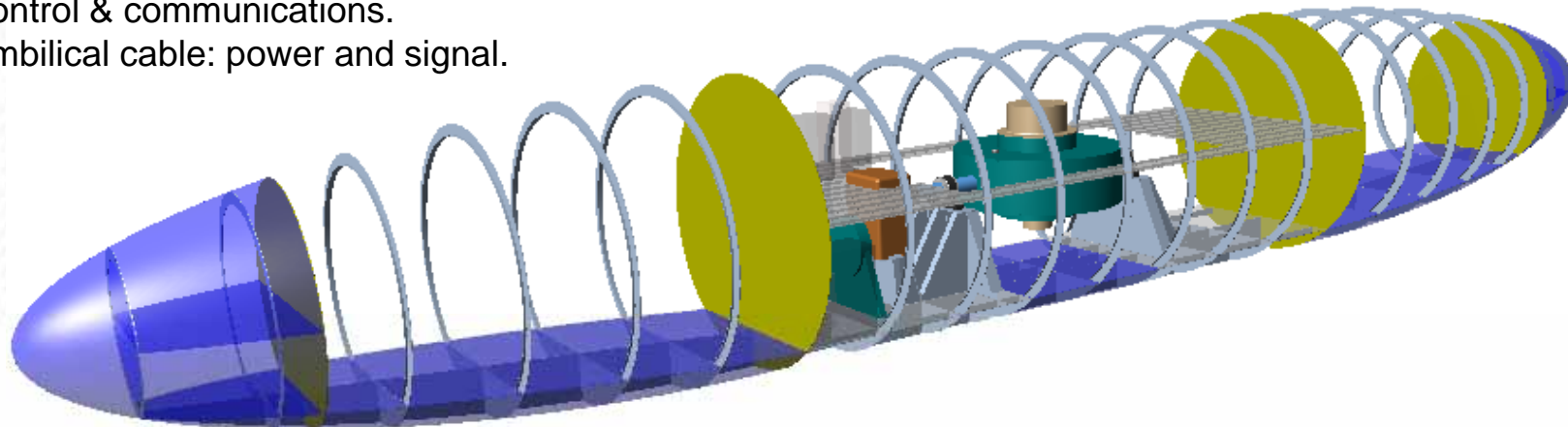
3D CONCEPTUAL DESIGN

Main systems

- Modular design and construction.
- General structural arrangement.
- Mooring lines: 4 mixed (chain+ steel rope) and floating buoy.
- PTO and conversion module.
- Power generation and electrical systems.
- Control & communications.
- Umbilical cable: power and signal.

Main Particulars

L = 45-50 m
B = 7.50 m
T = 4.75 m (approx.)
 Δ = 1,300 ton (approx.)
P = 500 – 800 KW



2.1 OCEANTEC: Phase 2

Joint-venture



March 2008

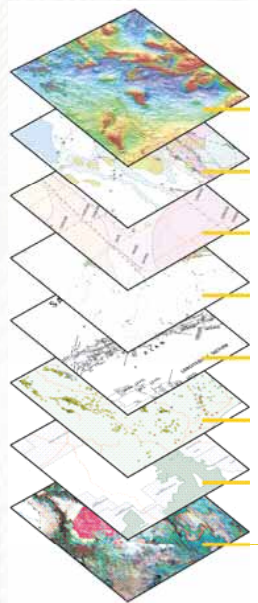
**Scaled Prototype 1:4
Sea trials
September 2008**



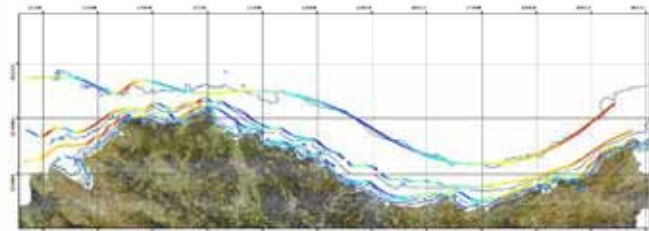
2.2 European Projects

- **WAVEPLAM** – Wave Energy Planning and Marketing
 - Removing non-technological barriers for Wave Energy development
 - Funded by Intelligent Energy – Europe, start: November 2007. Leader: EVE
- **CORES** - Components for Ocean Renewable Energy Systems
 - new concepts and components for floating OWC systems
 - Funded by FP7, start: April 2008
 - Leader: HMRC, University College Cork
- **EquiMar** - Equitable Testing and Evaluation of Marine Energy Extraction Devices in terms of Performance, Cost and Environmental Impact
 - Pre-normative research for Ocean Energy: equitable evaluation of marine energy converters (tidal and wave)
 - Funded by FP7, start: April 2008. Leader: University of Edinburgh
- **WAVETRAN 2** - Initial Training Network for Wave Energy Research Professionals
 - Marie Curie initial training network for Wave Energy
 - Funded by FP7, start: October 2008. Leader: WavEC

3. Ocean Energy in the Basque Country



1	THEORETICAL ENERGY POTENTIAL	Wave energy atlas
2	FEASIBLE ENERGY POTENTIAL	Bathymetry and seabed morphology
3	AVAILABLE ENERGY POTENTIAL	Environmental and socio-economic restrictions
4	TECHNICAL ENERGY POTENTIAL	Performance and size limitations of WECs



BASQUE COUNTRY WAVE ATLAS
 Identification of feasible sites
 Gross potential: 12 TWh/year.
 Technical potential: 1.5 TWh/year
 (about 10% of electricity demand of the Basque Country)

3. Ocean Energy in the Basque Country

- **Mutriku Breakwater (Basque Country)**



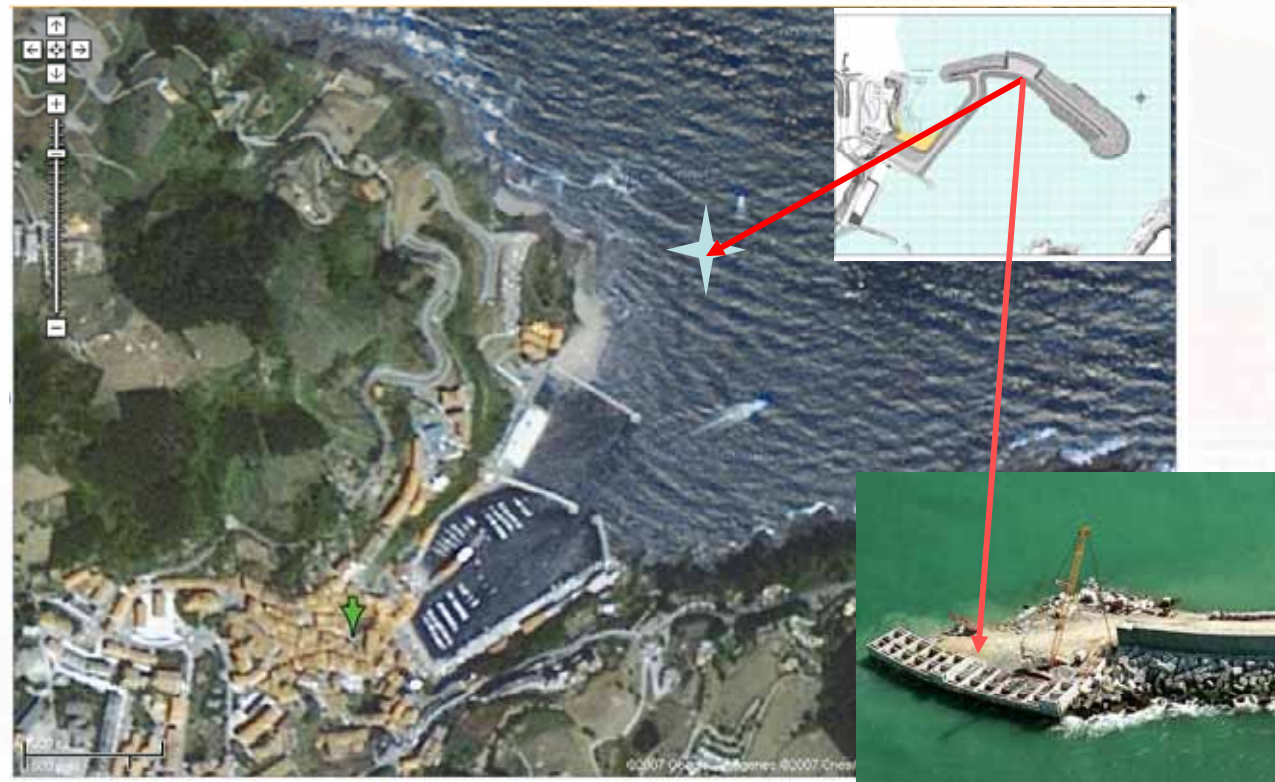
Under construction. Promoter: EVE (Basque Government). Total power: 296kW

Technology:

Onshore OWC (Wavegen)
16 turbines – 18,5 kW each

Investment:

5,73 M€
Partially funded by EC
under FP6
(NEREIDA MOWC project)



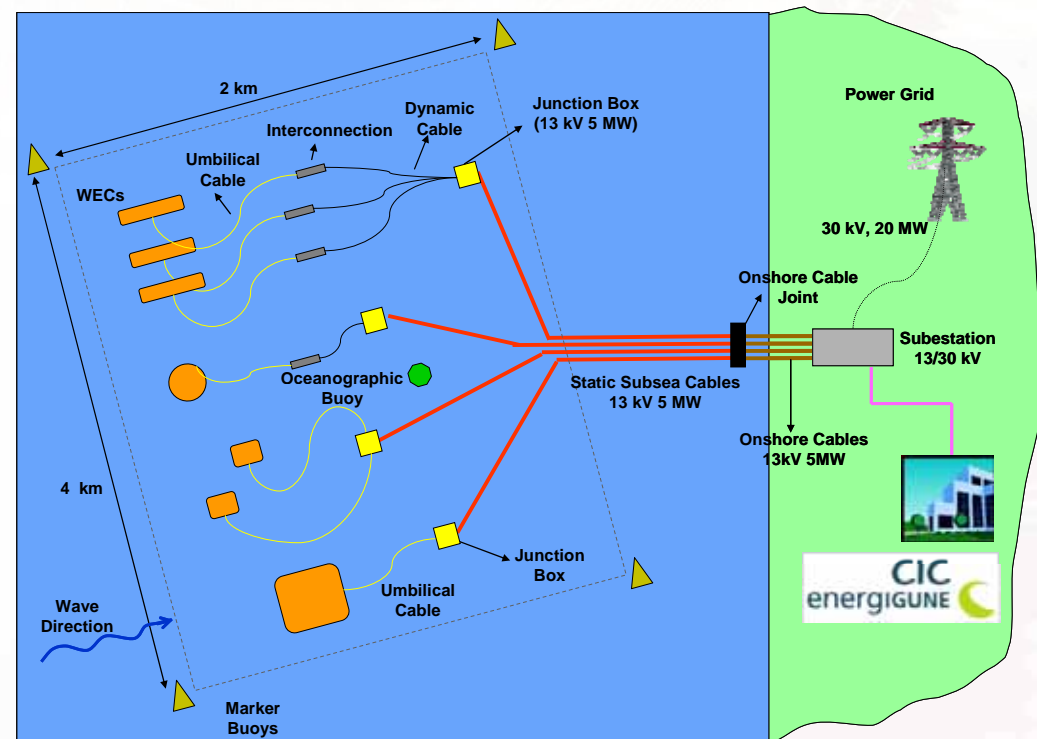
3. Ocean Energy in the Basque Country

bimep: Bizcay Marine Energy Platform

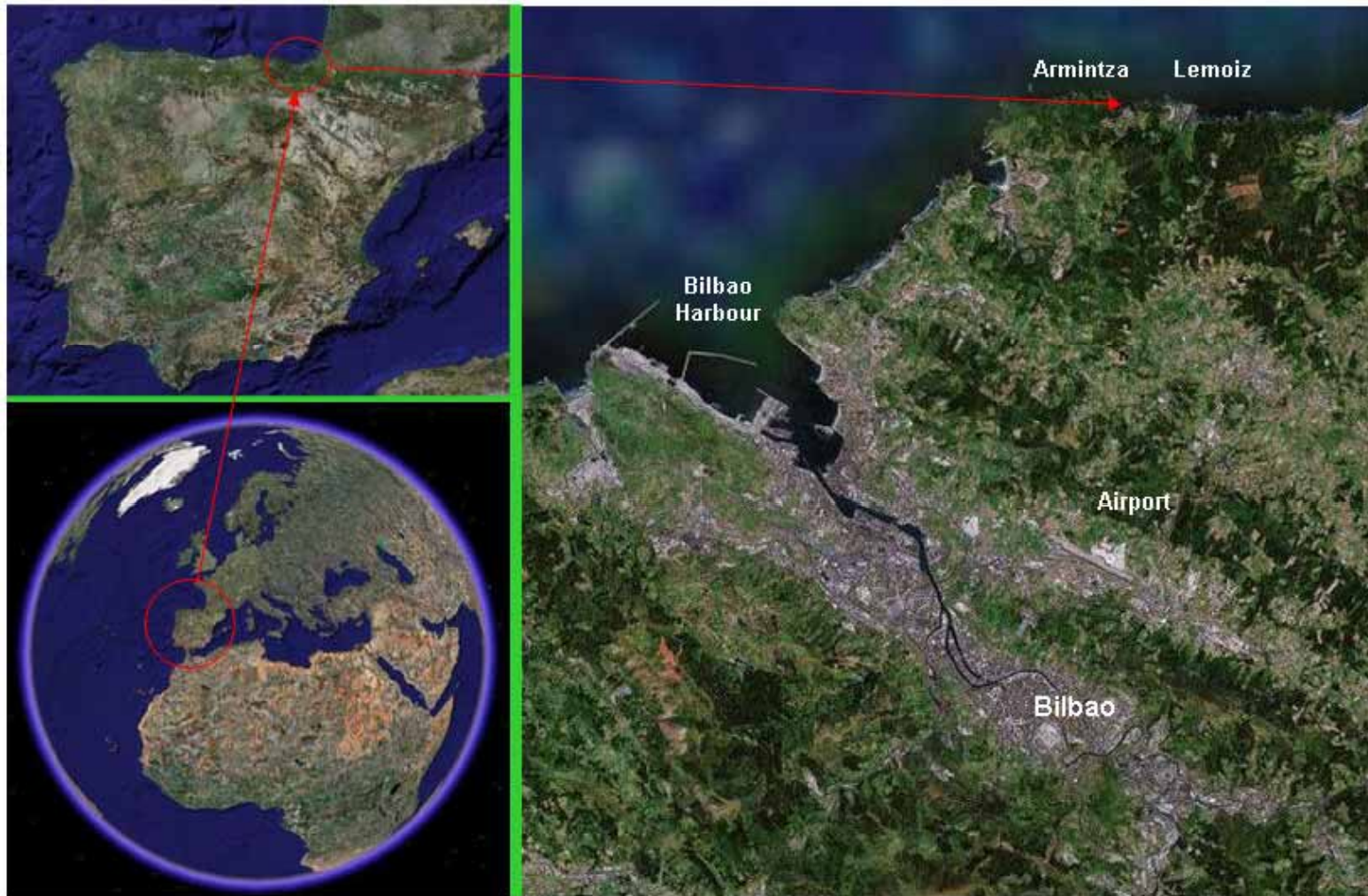
Infrastructure for research, demonstration and operation of offshore Wave Energy Converters.

4 x 2 km area located on the Basque Coast

- Water depth between 50-90 m.
- Closest point to the land: 750 m
- 4 berths, 13 kV & 5 MW: 20 MW.
- Sub-sea cables for each berth
- Designed to facilitate the connection / disconnection of WECs.
- Onshore substation.
- Research and data centre: CIC energyGUNE
- Estimated budget: 15 M€
- Expected to be in operation mid-2010

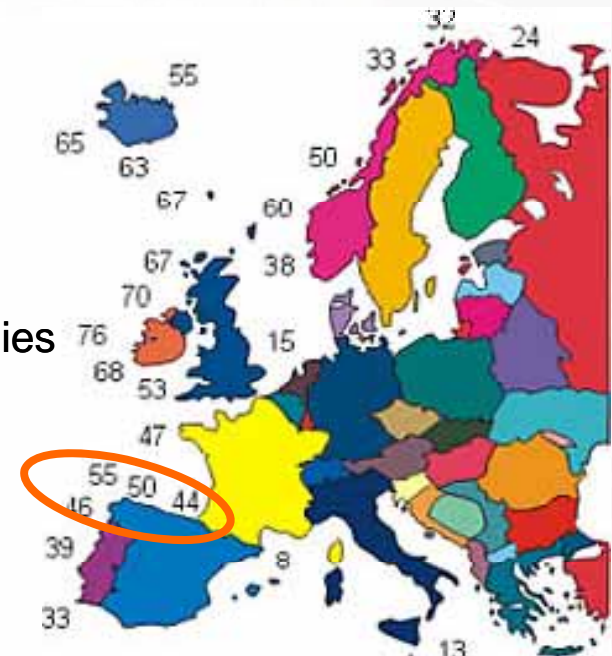


3. Ocean Energy in the Basque Country



4. Ocean Energy in Spain

- Tidal range resource:
 - Spain has no appropriate sites (tidal range > 6m) except some commercial harbours with huge environmental impact and restrictions for other uses.
- Marine Currents:
 - Theoretical resource in the South (i.e. Strait of Gibraltar) and some river mouths not available due to navigation and other use restrictions
- OTEC (temperature gradient)
 - Insufficient thermal difference
- Salinity gradient:
 - Theoretical resource at river mouths
 - Important environmental impact, immature technologies
- Waves:
 - 40-55 kW/m on Atlantic and Cantabrian coastlines
 - Available resource: 21GW (source APPA)



Source: EC (CA-OE project)

Commercial-in-confidence

4. Ocean Energy in Spain

- Feed-in tariffs for ocean power (Royal Decree 661/2007 - May 25th)
 - 6.89 c€/kWh (first 20 years), 6.51 c€/kWh thereafter
 - About 6 times lower than for photovoltaic, similar to onshore wind energy and lower than for offshore wind.
 - Possibility of negotiating a particular tariff for each ocean power installation though a comprehensive description is required
 - New legal framework is expected, 2009?
- Procedures (Royal Decree 1028/2007 - July 20th)
 - This establishes the administrative procedure to apply for authorisation for electricity generation installations at sea.
 - It is mainly focused on offshore wind, but it also includes a simplified procedure for other marine technologies.
- Targets:
 - So far there are no national targets for ocean power.
 - Only one region in Spain, the Basque Country, has considered targets in its energy strategy: 5MW of installed wave power by 2010.

4. Ocean Energy in Spain

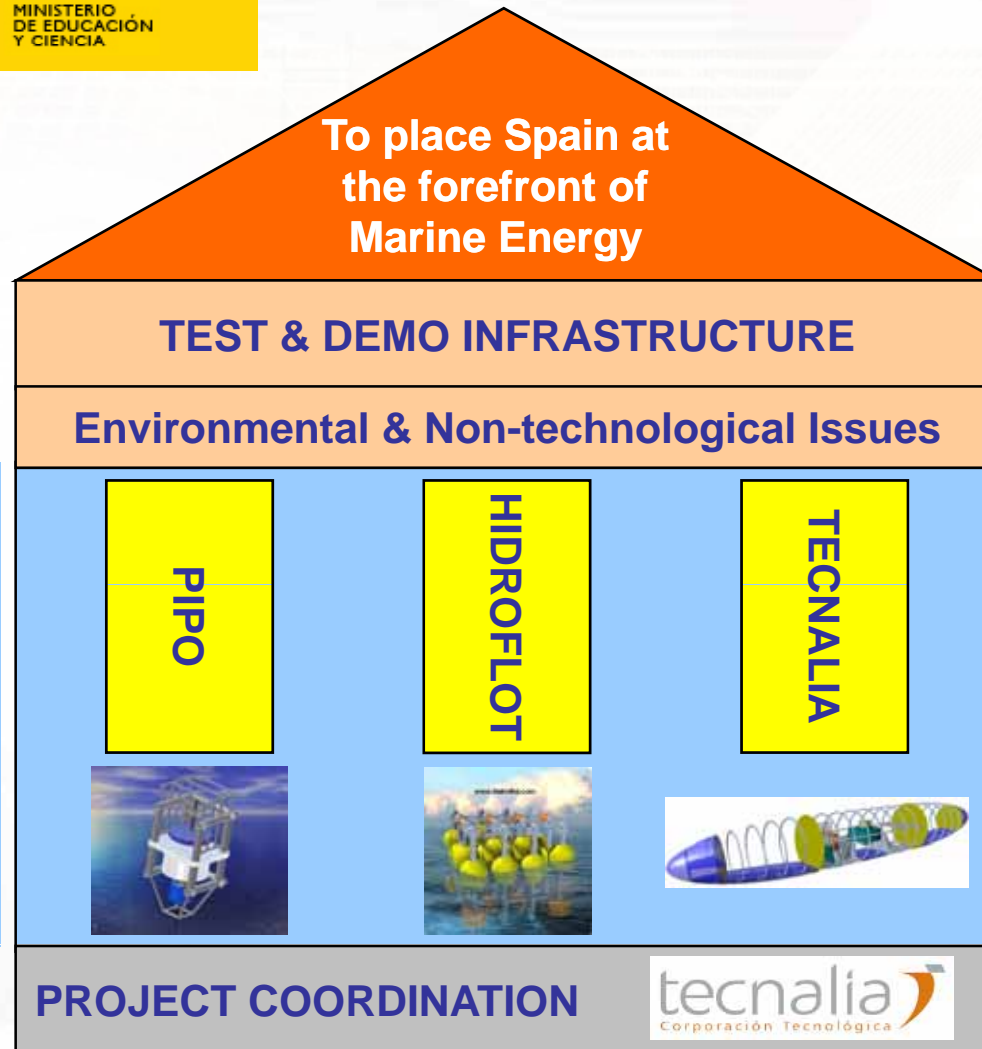
PSE-MAR

Main Spanish initiative in ocean energy research.

Total Budget:
25M€ (2005-2009)



Development of the three most promising Spanish technologies for wave energy converters.



4. Ocean Energy in Spain

- **Santoña (Cantabria)**



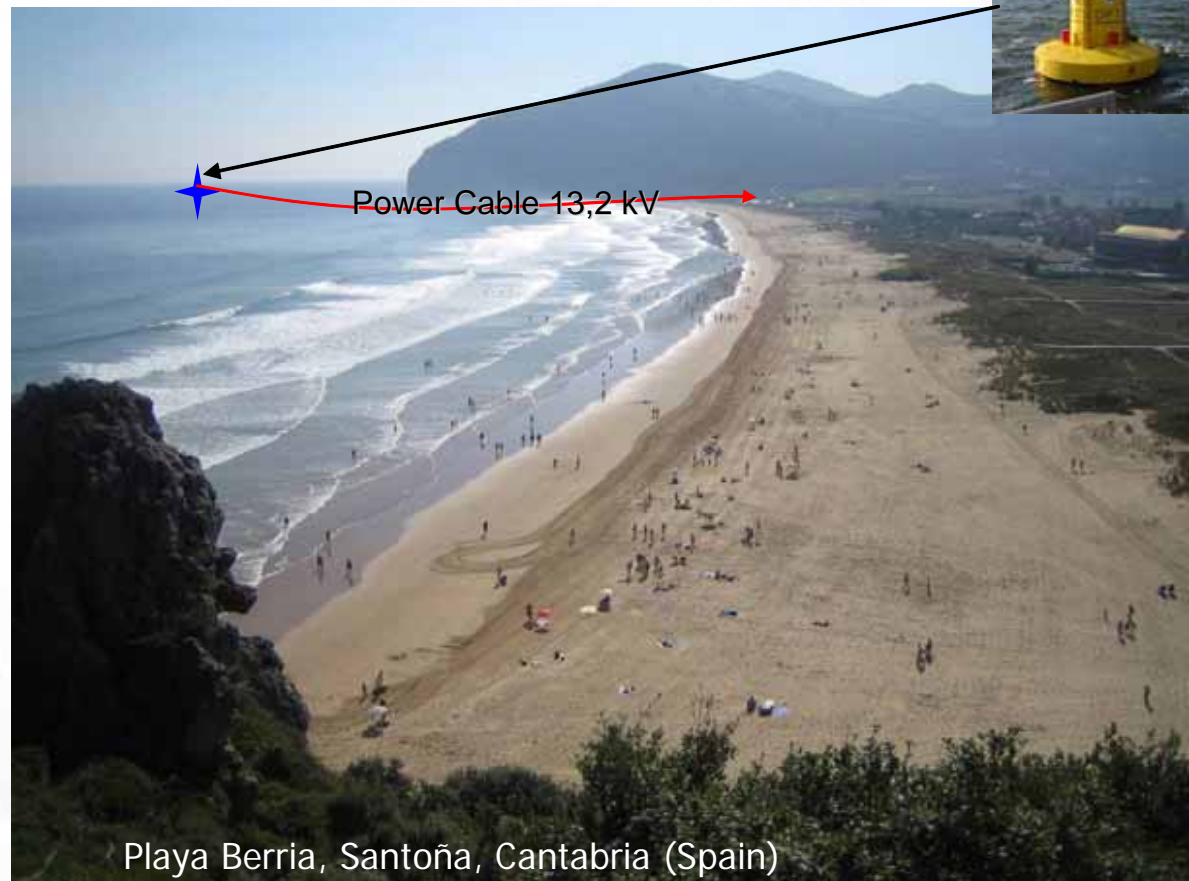
Under construction. Promoters: IBERDROLA, IDAE, SODERCAN, TOTAL and OPT. 1.4MW



Technology:
Offshore Buoy (OPT)

1st stage:
1 buoy 40kW
2nd stage:
9 buoys 150kW each

Investment:
5.8M€



Playa Berria, Santoña, Cantabria (Spain)

4. Ocean Energy in Spain

- **Other projects in the pipeline:**

- Sea-port A Guarda, Galicia
 - Onshore OWC (Wavegen)
 - Promoter: Sea Energy
 - Power capacity: 600 kW
 - Investment: 1.5M€



- Granadilla, Tenerife

- Onshore OWC
- Promoters: Cabildo de Tenerife, La Laguna University, Aut. Portuaria, Santa Cruz, Iter

- Muxía, Galicia
 - Offshore PELAMIS
 - Promoter: NORVENTO
 - Power: 2.25 MW (2x750kW)





4. Ocean Energy in Spain



- Member of European Ocean Energy Association EU-OEA, www.eu-oea.com
- Spanish delegate and vice-chair for IEA-OES “International Energy Agency - Ocean Energy Systems” Implementing Agreement. www.iea-oceans.org
- Participation in standardisation committee IEC-TC114 “Marine Energy – Wave and Tidal Energy Converters”. Chair of Spanish mirror group SC114.
- Member of the marine energy section of Spanish Renewable Association APPA www.appa.es

International Events



- Participation at ICOE 2008 “Scientific Committee” (International Conference on Ocean Energy), Brest (France) October 2008.
- Hosting of the coming edition of ICOE, October 2010, Bilbao:
 - Conferences: EVE, TECNALIA & Scientific Committee
 - Fair: EU-OEA
- Third International Meeting on Ocean Energy (associated to the IEA-OES meeting), Bilbao, 2nd April 2009.

- Relevant **wave energy resources** exist although no other types
- Regional **wave atlas** developed or under development
- New **legal framework** is expected, which could include:
 - National **targets** for installed power by 2020
 - Medium-term system for higher **feed-in tariffs**
 - Specific support for **demonstration projects**
- Important **R&D activity**, coordinated with European partners
- **Spanish Technology** for Wave Energy Converters under development
- New **test & demonstration facilities** also under development
- 2 **demonstration projects** under construction and several in the pipeline
- TECNALIA is nowadays the prime technology reference on Wave Energy

*Passion for
the Future*

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www.tecnalia.info

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