COLLABORATION OPPORTUNITIES BETWEEN SPAIN AND JAPAN IN THE OFFSHORE TECHNOLOGY

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REOLTEC.NET
I+D+i PLATAFORMA EÓLICA TECNOLÓGICA

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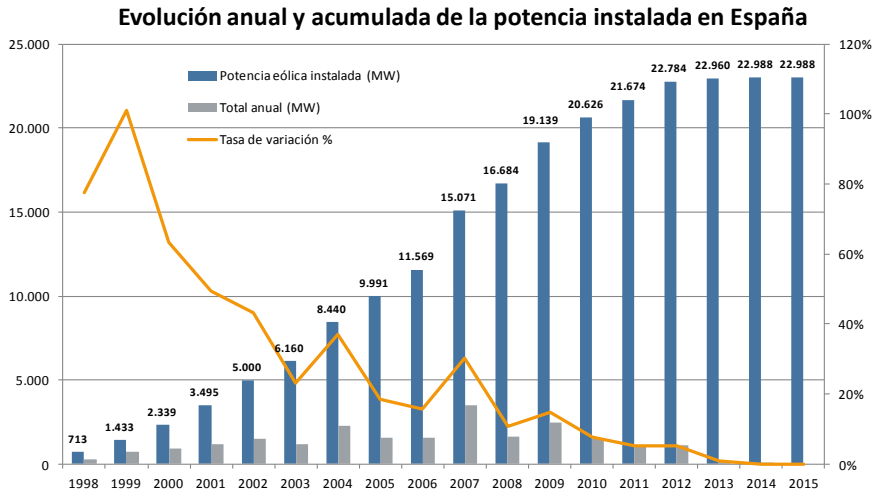
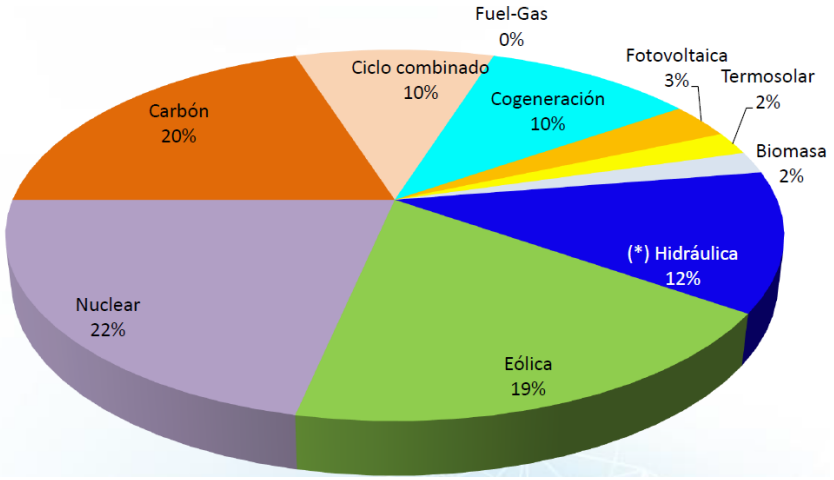
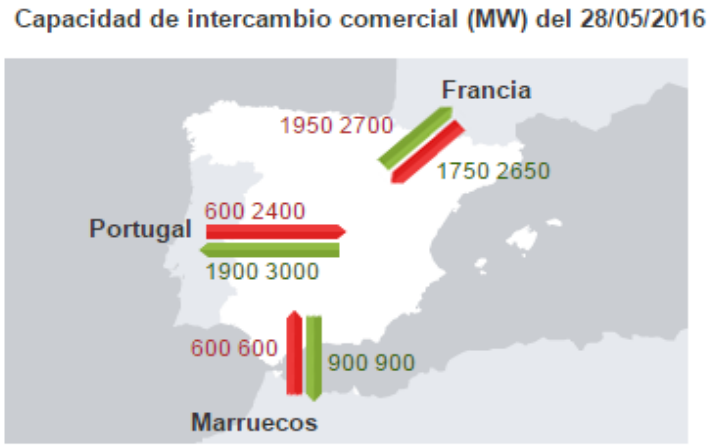
OFFSHORE WIND MARKET IN SPAIN

SPAIN HAS A STRONG POSITON IN ONSHORE WIND SECTOR AS WELL AS IN THE SHIPING AND BOATS PRODUCTION



Record	Valor	Fecha
Potencia instantánea:	**17.553 MW** 45,9% cobertura de la demanda 76% de potencia instalada	29/01/2015 19:27h
Producción diaria	**367 GWh** 47,7% cobertura de la demanda	12/02/2016
Producción Mensual	**6.537 GWh** 29,6% cobertura de la demanda	01/2014
Cobertura Instántanea de demanda	**70,4%** 15.293 MW	21/11/2015 04:50h
Cobertura de demanda diaria	**52,3%** 343.000 MWh	21/11/2015
Cobertura de demanda mensual	**30,2%** 6.091 GWh	02/2016





A SOLID INDUSTRIAL NETWORK TO ATTEND THE DOMESTIC AND INTERNATIONAL MARKETS

More than 700 companies, involved in the wind sector from manufacturers to financial services.

Spanish wind power sector industrial centres

NEVERTHELESS OFFSHORE MARKET HAS NOT YET STARTED

1. Remuneration was approved in 2007 using a pool+premium scheme that it was never applied.
2. Projects were neither approved even if a strategical environmental plan was defined and in spite of the goals of power of the different RE plans.
3. Several R&D initiatives were launched to resolve the main challenges: lack of continental platform, reduction of costs, higher reliability, grid integration, ..
4. Spanish Companies, as Iberdrola and EPDR are among the main promoters of off-shore wind farms.
5. Manufacturers are also supplying WTGs and specific components.

EVOLUTION OF THE THEORETICAL FORECASTED CAPACITY TO BE INSTALLED IN THE 2020 HORIZON

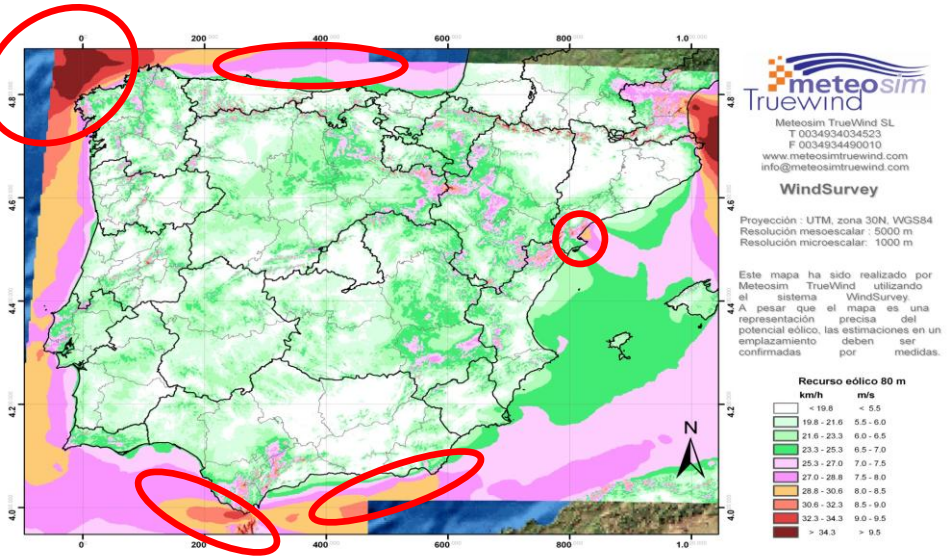
ZURBANO
5.000 MW

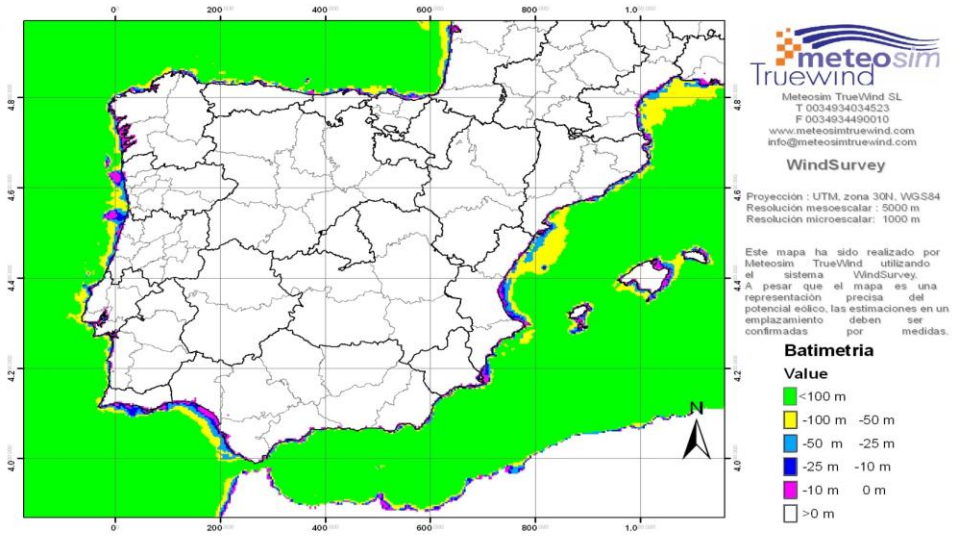
Draft NREAP
3.000 MW

NREAP (UE)
3.000 MW

Proposal for state agreement: 500 MW

Renewable Energy Plan 2011/2020
750 MW





5 GOOD WIND SPOTS BUT A TOO DEPTH SEABED NEARSHORE.

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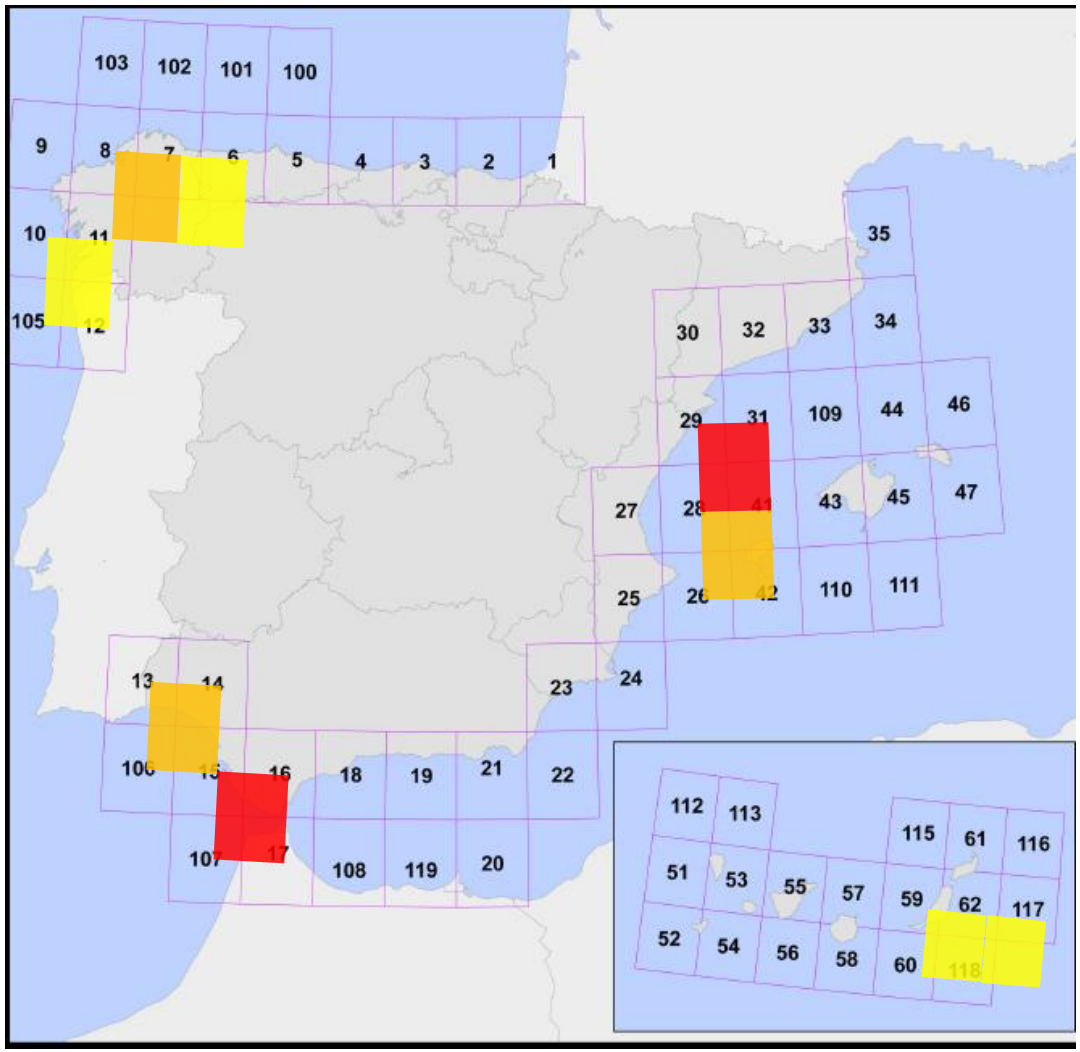
OFFSHORE PROJECTS WITH INITIATED PERMITTING PROCEDURE

Around 40 potential projects for around 14 GW.

28 projects are in the licensing phase, representing 9.540 MW.



More than 7 projects

2 to 7 projects

Under 2 projects

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MARKET HAS NOT YET TAKEN OFF, BUT SPANISH COMPANIES ARE SUPPLIERS FOR EU WIND FARMS

- ADWEN a GAMESA affiliated company has installed a total of 630 MW in the North Sea area.
- NAVANTIA has manufactured the jackets for the Wikinger Wind Farm.
- ORMAZABAL has supplied many MT switchgear boxes.
- VICINAY: chains and fixing components.

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ADWEN, BRIEF PRESENTATION

Born a leader in offshore wind

Overview

- **Joint-venture** merging parent companies' offshore wind businesses
- **700 people**
- **630 MW** installed capacity at sea
- **2.5GW** installed capacity by 2021
- Fully operational industrial base (Germany)
- Renowned **offshore R&D & technological know-how**: Engineering centers in Germany, Spain and France
- Access to **best-in-class wind know-how** in cost optimization, component supply platform and long-standing operation & maintenance expertise

Shareholding

AREVA — 50/50 — Gamesa

Adwen
AN AREVA GAMESA COMPANY

Product portfolio

Adwen 5MW	Adwen 8MW

lote that AREVA and Gamesa have reached agreement pursuant to which Gamesa would acquire AREVA's 50% shareholding in dwen, subject to authorization by the German competition authority. Closing is expected in January 2017

Adwen
AN AREVA GAMESA COMPANY

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Invaluable experience

18.2% market share in Europe 2015

120 5 MW turbines commissioned at two flagship projects during the summer of 2015

Global Tech I
Customer: Global Tech I Offshore Wind GmbH
Turbine: AD 5-116
Installed capacity: 400 MW
Electricity supply: 445,000 households

Trianel Windpark Borkum
Customer: Trianel Windkraft Borkum GmbH
Turbine: AD 5-116
Installed capacity: 200 MW
Electricity supply: 200,000 households

Adwen
AN AREVA GAMESA COMPANY

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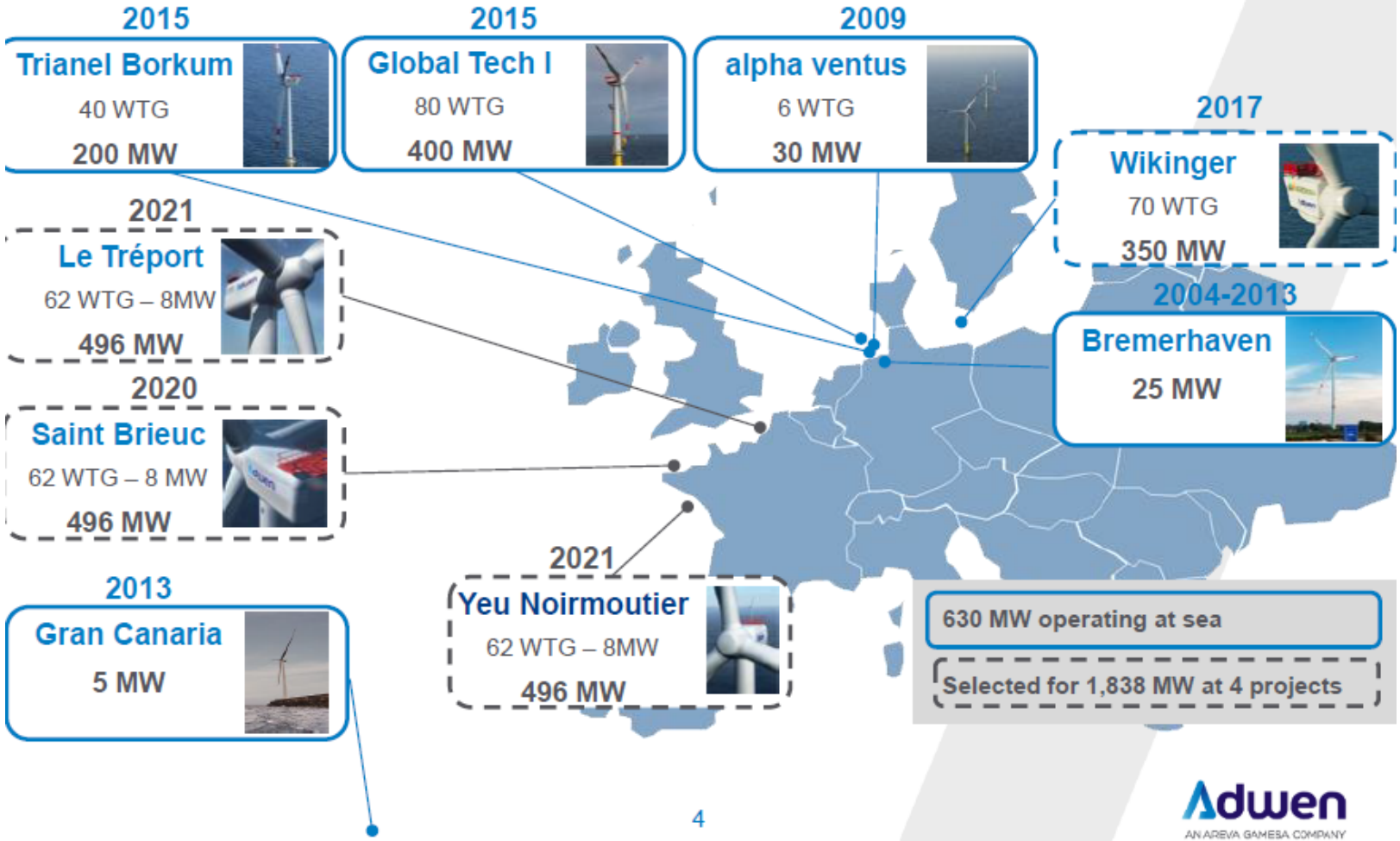
Recognition of proven technology and experience

2,5 GW installed capacity by 2021



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ADWEN: THE RIGHT OEM TECHNOLOGICAL PARTNER

TECHNOLOGY
A versatile and comprehensive products portfolio suitable for specific projects requirements

PIPELINE
Pole position in an attractive market as recognition of our proven technology and experience

PEOPLE
700 experienced and talented people working under the highest standards of health and safety

OPERATIONAL EXCELLENCE
From manufacturing to operations and maintenance

Adwen
AN AREVA GAMESA COMPANY

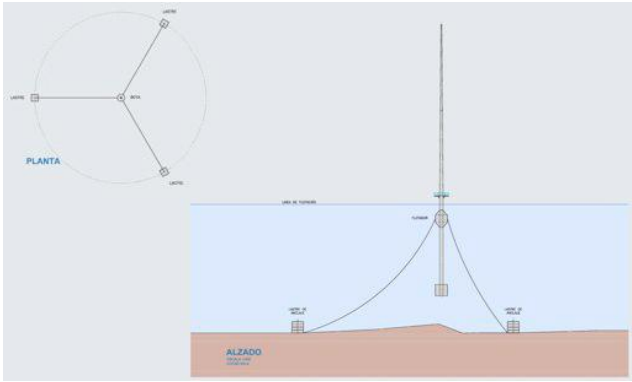
RESEARCH AND DEVELOPMENT ACTIVITIES

OFFSHORE FOUNDATIONS

1. **Company: NAUTILUS Floating Solutions S.L**
   - **Project Title:** Development of cost competitive **semisubmersible platforms for 5 to 10 MW** floating offshore wind applications, easy to be built in conventional shipyards, easy to be assembled in conventional ports and easy to be towed by conventional ships to the operation site.
2. **Company: ESTEYCO Energía S. L.**
   - **Project title:** Experimental demonstration and certification of offshore technology foundation with self-erecting telescope tower.
   - **Project Title:** Cost reduction for Offshore wind. (ReCoEFF)
3. **Company: IBERDROLA Ingeniería y Construcción S.A.**
   - **Project title:** Development of optimum technical solutions for tensioned mooring systems for TLP platforms applicable to offshore wind.
4. **Company: DRAGADOS S.A.**
   - **Project Title:** Floating platform of concrete for deep waters wind power exploitation. (MENHIR Project)
5. **Company: ENEROCEAN S.L.**
   - **Project Title:** Wind integrated platform for 10+ MW power per foundation.
   - **Project Title**: MD500 WIND - Robotic Submarine Geotechnical Site Investigation for Offshore Wind Project. Wind integrated platform for 10+ MW power per foundation.

R&D IN OTHER AREAS OF ACTIVITY

- And gaining experience in several others areas:
  - O&M in offshore wind farms.
  - Floating foundations.
  - Multi-purpose platforms: wind power and marine renewable energies.
  - Resource assessment through floating met towers (Idermar).



NOW NEED FOR A DEMONSTRATION PLANT TO TEST COMERCIAL PRODUCTS

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TEST FACILITIES

Field Test:

1. BIMEP **BISCAY Marine Energy Platform S.A.**
2. PLOCAN **Plataforma Oceánica de Canarias.**

Physical Model test:

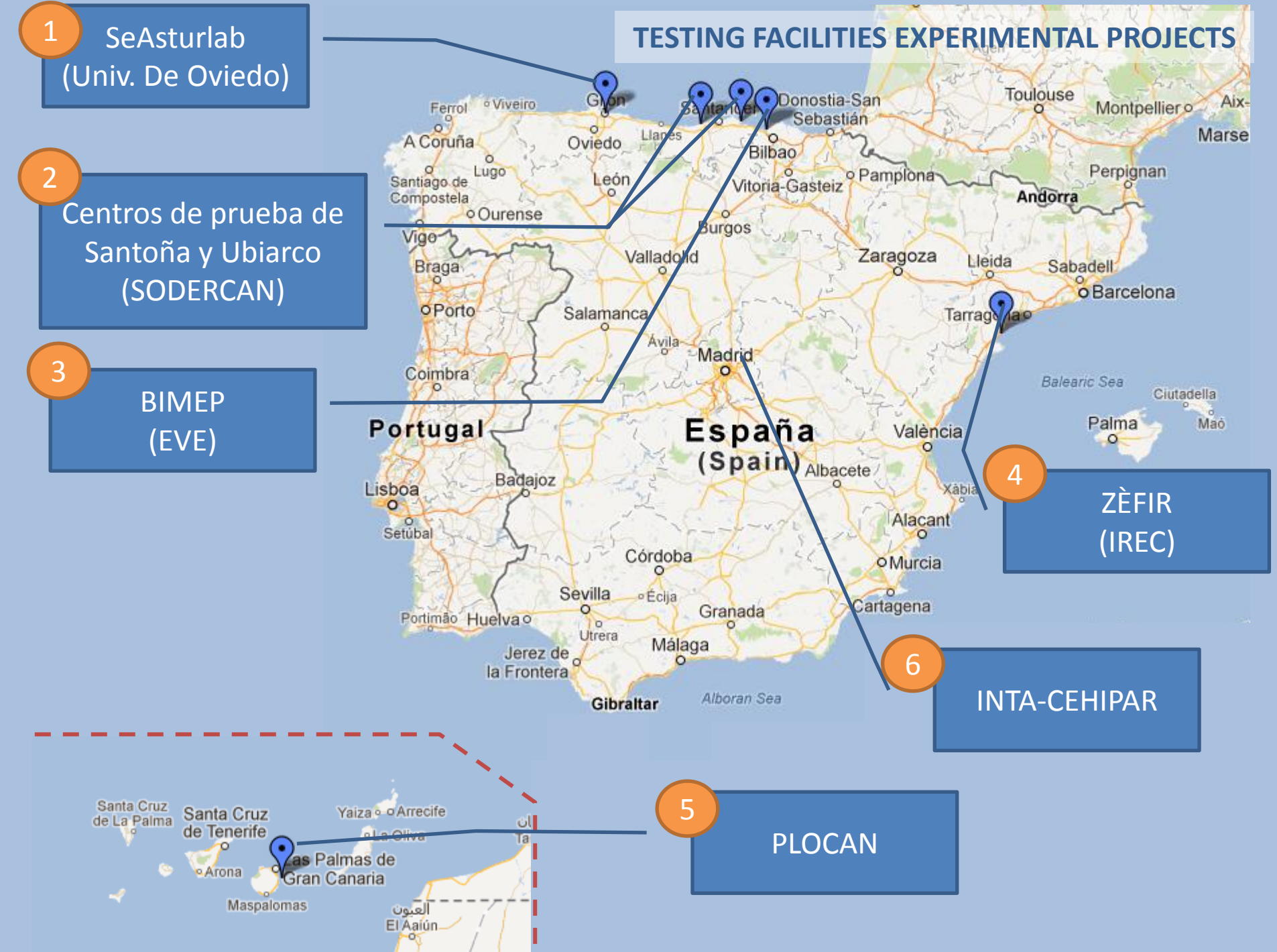
1. IHCantabria **Instituto de Hidráulica Ambiental de la Universidad de Cantabria.**
2. INTA-CEHIPAR **Canal de Experiencias Hidrodinámicas del Pardo.**

Large Wind Turbine Component's Test:

1. CENER

TESTING FACILITIES EXPERIMENTAL PROJECTS

1. SeAsturlab (Univ. De Oviedo)
2. Centros de prueba de Santoña y Ubiarco (SODERCAN)
3. BIMEP (EVE)
4. ZÈFIR (IREC)
5. PLOCAN
6. INTA-CEHIPAR



What is MARINET?

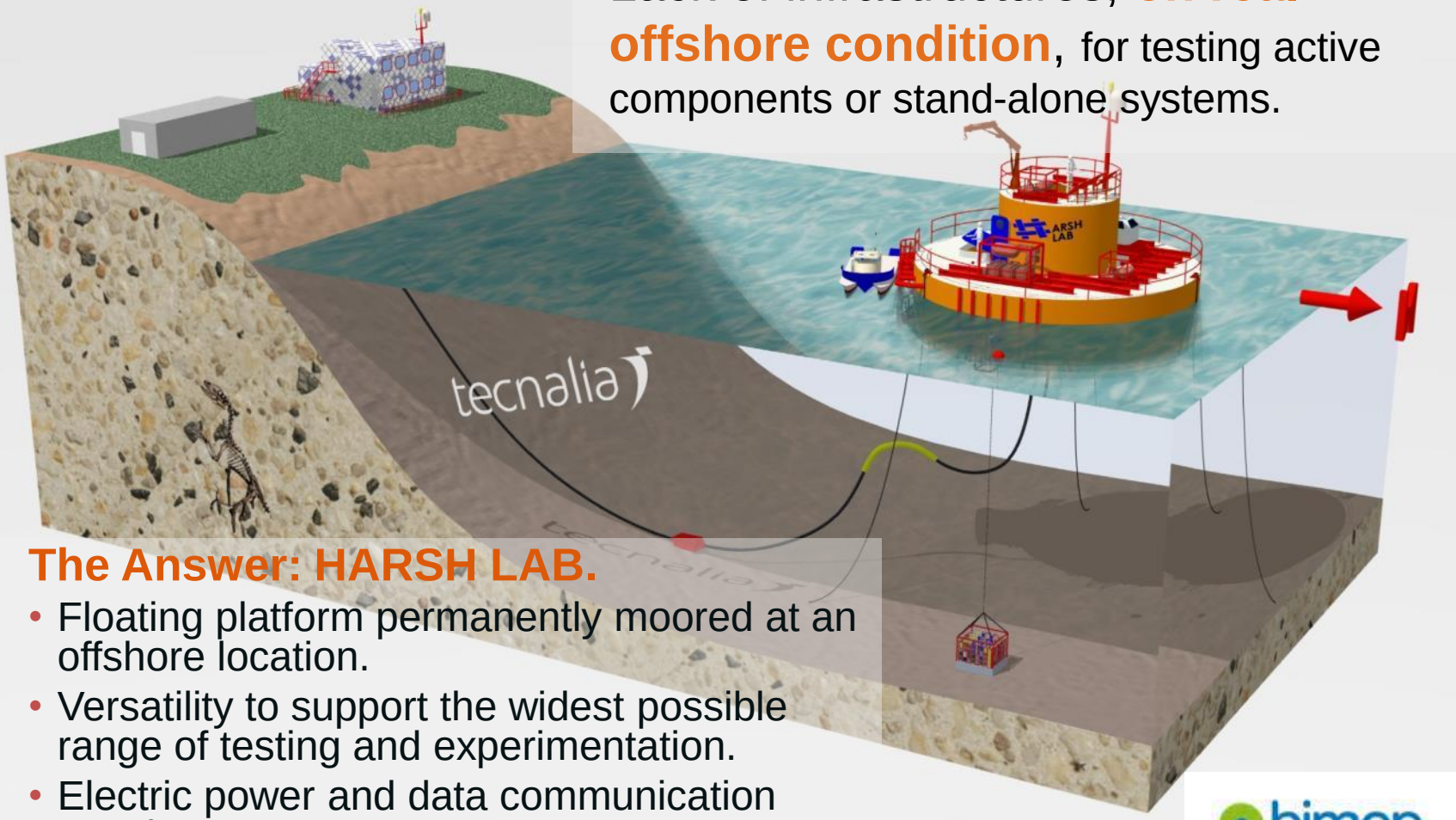
INITIATIVE TO COORDINATE EUROPE'S MARINE RENEWABLE ENERGY TEST INFRASTRUCTURE.

AIM IS TO ACCELERATE THE COMMERCIALISATION OF MARINE RENEWABLE ENERGY.

- Network of world-class marine renewables testing facilities at all scales
- Funded by the EC (FP7) to:
  - Offer periods of **free access** to all
  - Coordinate **research**
  - **Standardise** testing
  - Organise **industry networking**
  - Provide **training** in testing techniques

The Necessity:

Lack of infrastructures, **on real offshore condition**, for testing active components or stand-alone systems.



The Answer: HARSH LAB.

- Floating platform permanently moored at an offshore location.
- Versatility to support the widest possible range of testing and experimentation.
- Electric power and data communication supply.

A four-columns semi-submersible platform for Floating Offshore Wind

nautilus floating solutions

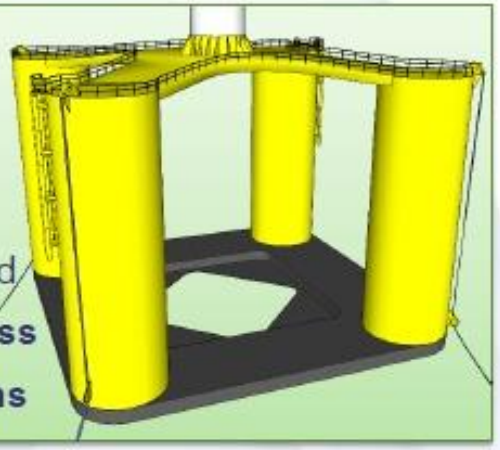
Reducing LCoE in Floating Offshore Wind Energy

Nautilus Floating Solutions, S.L.
Parque Científico y Tecnológico de Bizkaia
Edificio 700
E-48160 Derio, Bizkaia, Spain
nautilusfs.com

80% of the offshore wind resource in Europe is located in Deep Waters > than 60 m

NAUTILUS:

A **simple concept** featuring a **well proven hydrodynamic behaviour** and a **simple manufacture process** that will allow **LCoE reductions**



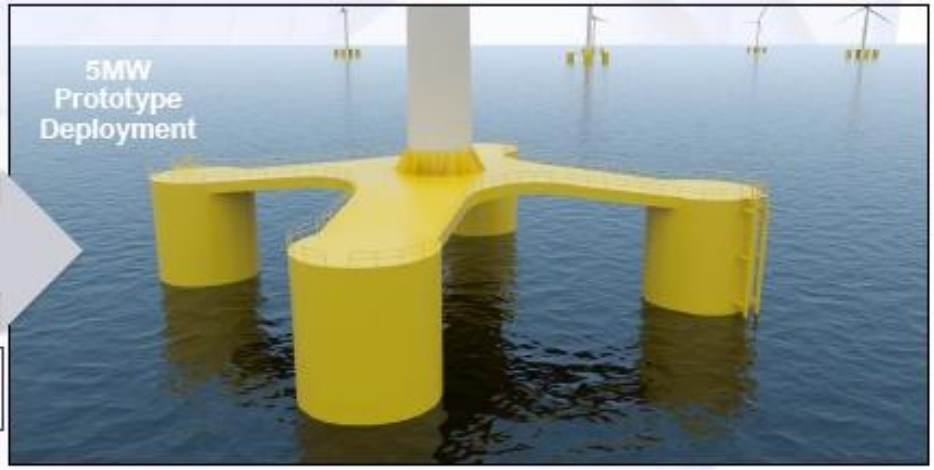
Floating solutions are required to harvest the wind resource

NAUTILUS Roadmap

Concepts Definition	Concept Evaluation	Conceptual Design	Validation Tank tests	Detailed Engineering

IP protection Certification

Q4-2016



H2020 – LCE2: EERA Wind LIFES 50+ Project

Qualification of innovative floating substructures for 10MW wind turbines and water depths greater than 50m

Grant Agreement: H2020-LCE-2014-1-640741

OBJECTIVES:

- Optimize and qualify to a TRL 5, of two innovative substructure designs for 10MW turbines
- Develop a streamlined KPI-based methodology for the evaluation and qualification process of floating substructures

FOCUS:

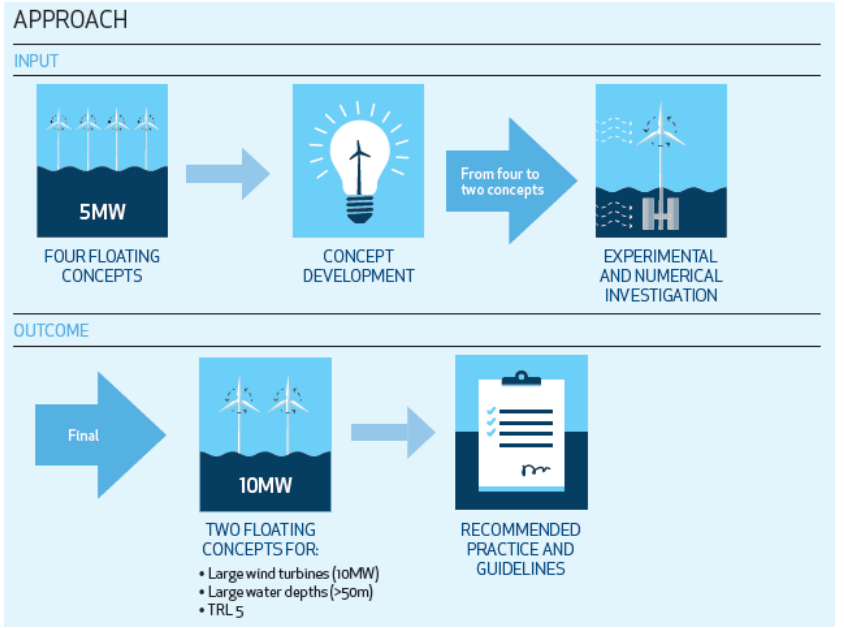
- Floating wind turbines installed in water depths from 50m to 200m
- Offshore wind farms of large wind turbines (10MW) – identified to be the most effective way of reducing cost of energy in short term

BUDGET:

- 7.3 MM€

40 months duration staring June 1, 2015

Project leader MARINTEK, Partners:



www.lifes50plus.eu

GENERAL DESCRIPTION

Cost effective and groundbreaking, the solution uses a gravity based foundation configured to act as a buoyant platform which integrates an autolift telescopic tower together with the complete wind turbine. Each complete unit can be fully assembled onshore, conventionally towed to the site and completely installed with no need for costly and scarce heavy-lift vessels.

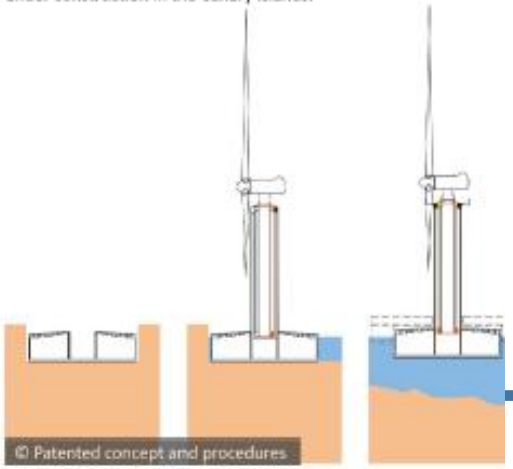
The telescopic configuration of the tower brings down the center of gravity during the towed self-floating transport, allowing the bottom foundation platform to temporarily act as a self-stable floating barge over which the complete system can be preassembled inshore, key to a highly industrialized manufacturing process with fast production rates and improved risk control.

Once ballasted to rest on the seabed, the tower can be lifted to its final position by means of cables and conventional heavy-lift strand jacks which are reused to lift one tower level after the other. The recoverable jacks that lift each level are supported by the one below, which also guides the hoisted tube as it rises, in a self-installing procedure in which the tower itself is the only supporting structure required. All works are carried out from a single access platform.

Ballasting is assisted by a dedicated low-cost reusable AFS (Auxiliary Floating System) which ensures high stability and allows optimization of each unit for service life, avoiding substructure over-dimensioning linked to this momentary operation. Construction yard requirements are minimized profiting from low draft and low height works, self-flotation and wet storage (8-10 Ha suffice for 60 unit/year production rate).

EXPERIMENTAL DEVELOPMENT AND DEMONSTRATION

Extensive tank and lab experimental demonstration have already been completed during the development and certification process, which also included a full scale testing prototype of the telescopic tower for the tuning and demonstration of the autolift system. All these experimental derisking initiatives shall be culminated with the fully operative 5MW prototype currently under construction in the Canary Islands.



© Patented concept and procedures

ELISA PROJECT: SELF INSTALLING PRECAST TELESCOPIC FOUNDATION/TOWER

SUPRAPOWER

R&D PROYECT, FUNDED FROM THE EU 7Th PROGRAMME.

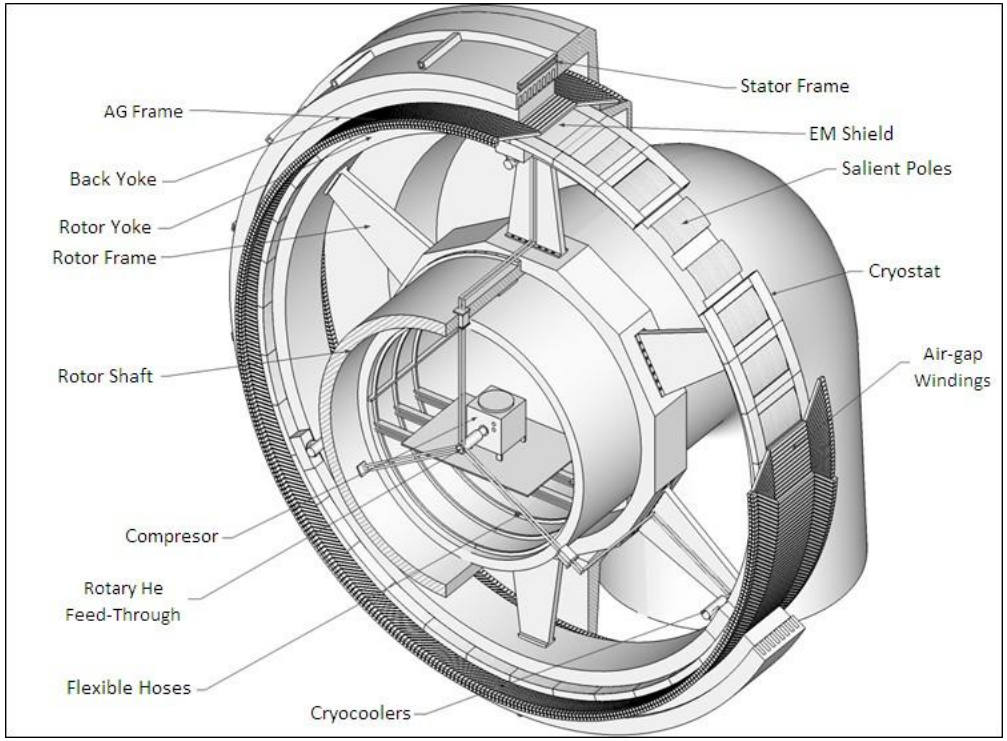
SUPERCONDUCTIVITY APPLICATION FOR ACHIEVING MORE RELIABLE, LIGHTWEITH AND HIGHER POWER RATE GENERATOR FOR THE OFFSHORE MARKET.

TWO MAIN OBJETIVES:

- TECNO-ECONOMICAL VIABILITY ANALYSIS CONCERNING A NEW POWER SOLUTION BASED ON A LOW COST SUPERECONDUCTOR MATERIAL.

- CONCEPTUAL DESIGN OF A BIG GENERATOR ACCORDING TO THE FOLLOWIND REQUIREMENTS:

  - **Direct Drive 10MW**
  - **MgB_2 superconducting field coils**
  - **Cryogen free cooling system**



Patented by TECNALIA (PTC/ES2009/070639)

Best Paths PROJECT

Beyond the state-of-the-art technologies for re-powering AC corridors & multiterminal HVDC systems

DEMO 1:	Multiterminal HVDC links in offshore wind farms
DEMO 2:	Interoperability of Multivendor HVDC converters
DEMO 3:	Uprating of multiterminal interconnectors
DEMO 4:	Innovative repowering of corridors
DEMO 5:	HVDC superconducting cable

Demo 1. HVDC links in offshore wind farms and offshore interconnections.

Aim: Get deeper practical and operational knowledge related to connection of offshore wind farms through VSC HVDC multiterminal links:

- Development of control algorithms for VSC HVDC multiterminal links.
- Stability and faults analysis.
- AC/DC interactions
- Resonances
- Grid code compliance
- Study of DC collector systems.

Partnership

IBERDROLA, RSE, tecnalia, ENERGINET.DK, Gamesa, CARDIFF UNIVERSITY, PRIFYSGOL CAERDYDD, SINTEF, University of Strathclyde Glasgow

tecnalia

SEVENTH FRAMEWORK PROGRAMME

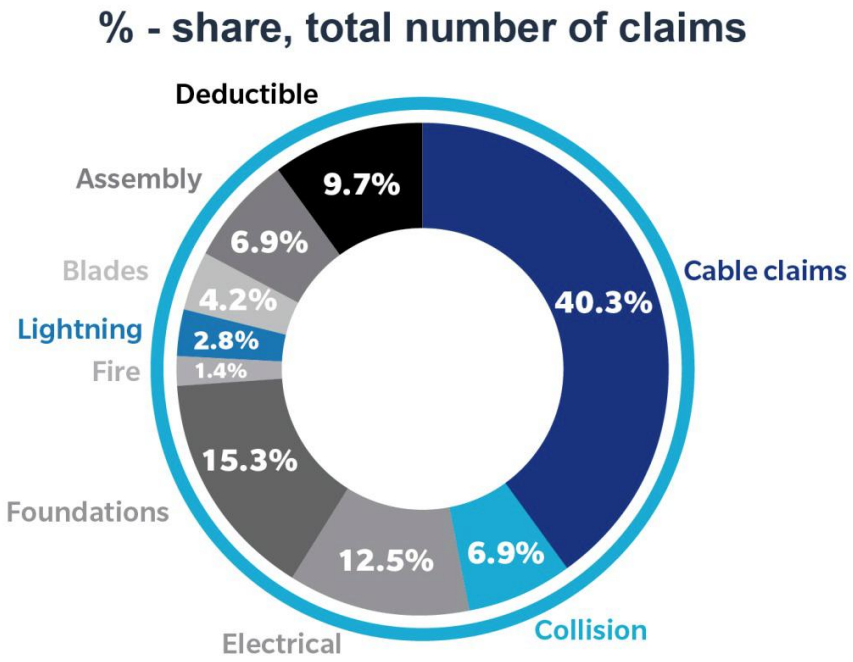
European Commission

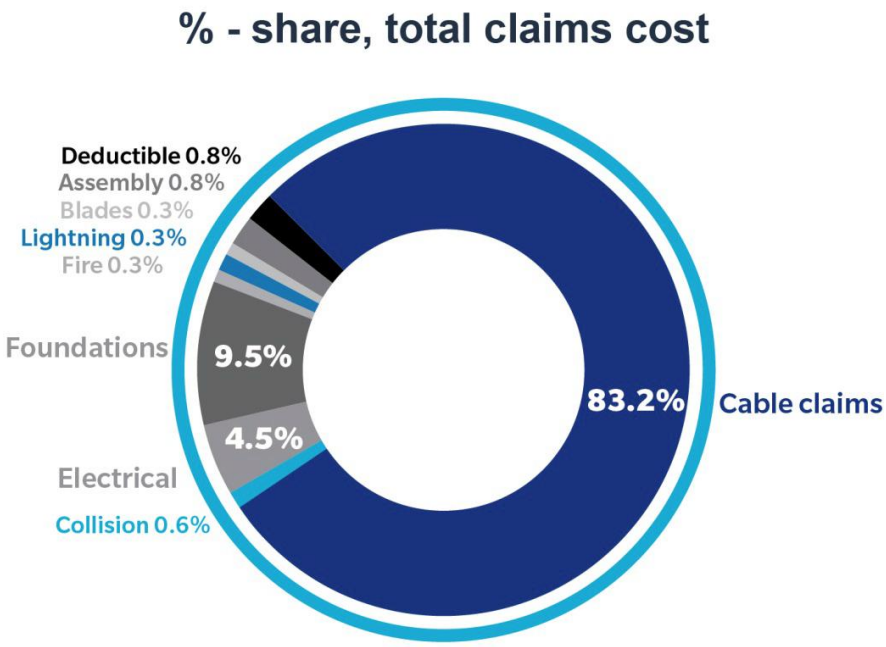
CONCLUSIONS

COLLABORATION OPPORTUNITIES

1. Those are mainly concentrated, but not only, in the development of floating solutions and the implementation of demonstration projects.
2. In this sense opportunities appear in different areas, for instance:
   - Wind data collection and permanent metering using floating systems
   - New floating systems in harmful wind conditions
   - Common testing procedures in different sea conditions
   - Coating and painting advanced products
   - Grid integration and HVDC solutions
   - Chains and tie up solutions
   - Corrosion detection and new solutions to replace the anodes protection
   - Advanced condition monitoring systems
   - Lay on the sea bed the connection cables
   - Maintenance shipping and boats
   - ….

BREAKDOWN OF CLAIMS (CONSTRUCTION)





Source:
Lloyd Warwick & Codan

TOP 5 PRIORITIES FOR PROJECT OWNERS

- Focus on the risk instead of the Capex and involve O&M-team in construction
- Keep contractual hierachy as simple as possible and only use contractors with a strong track record
- Involve a specialist Marine Warranty Surveyor – not a generalist!
- Timeline and Business Continuity Planning strategies are key!
- Involve insurers early