Japan and Spain Collaboration:
Opportunities in Offshore Wind Energy

Offshore Wind Resource Analysis of a service of a company

HYDRAULICS ENVIRONMENTAL INSTITUTE
UNIVERSITY OF CANTABRIA

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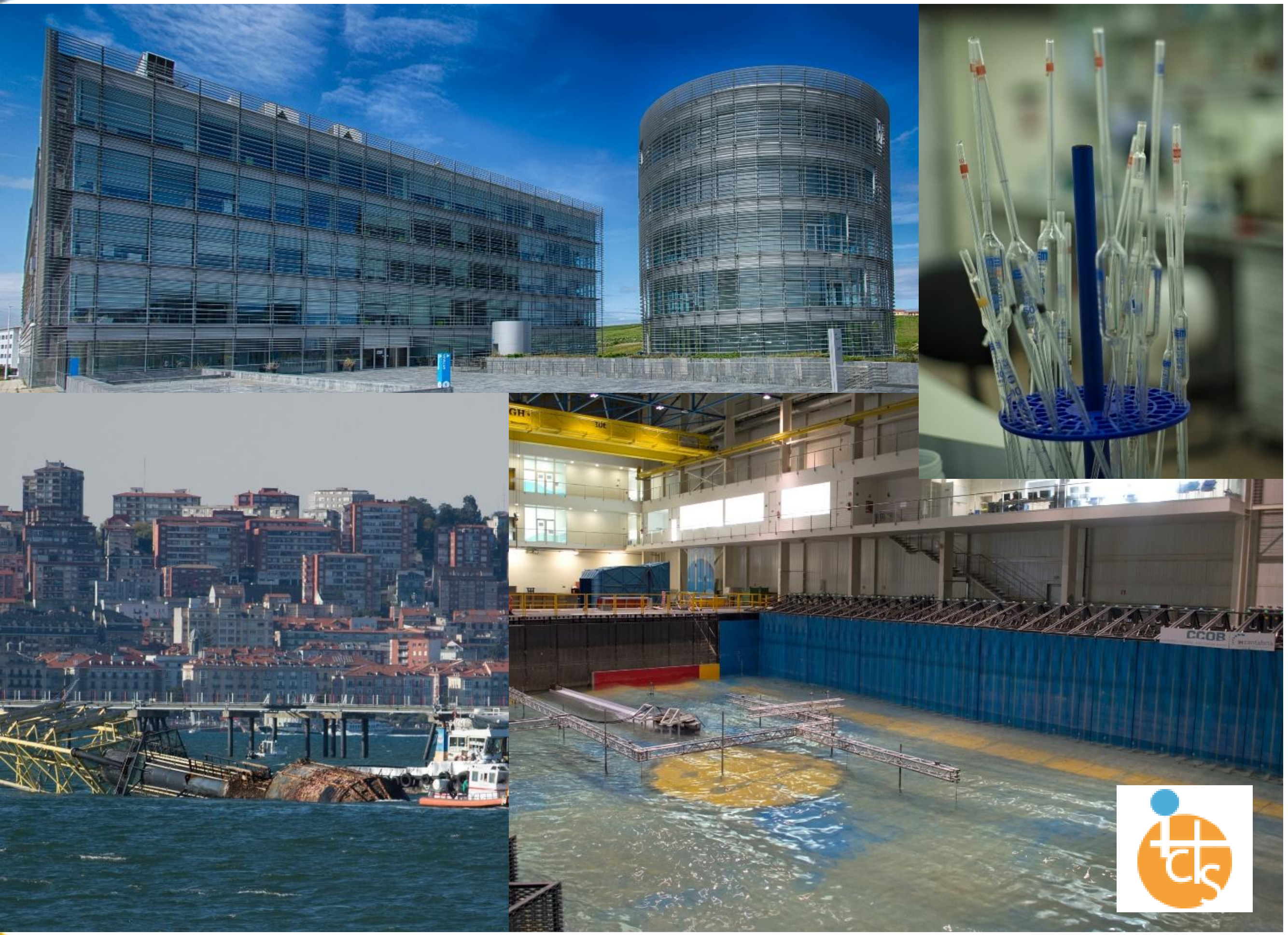
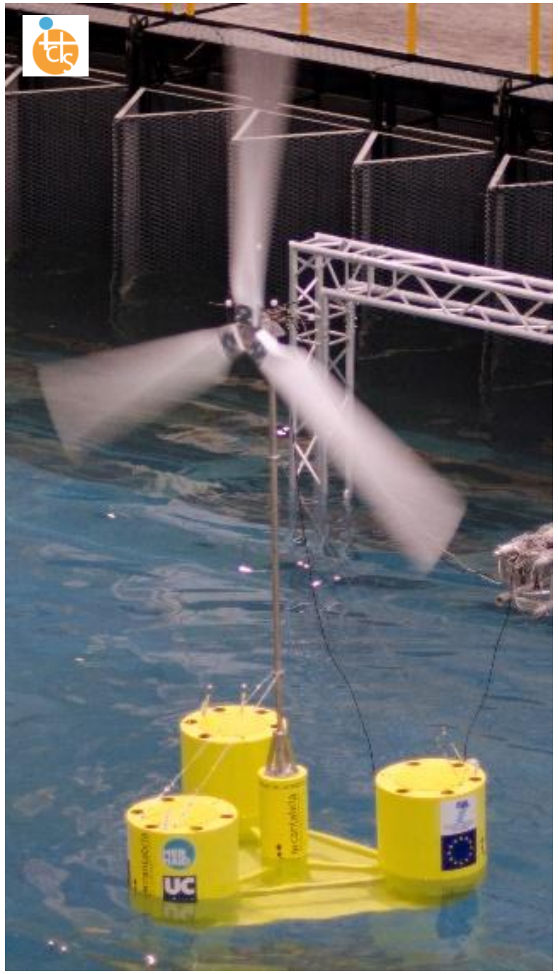


IHCantabria is a research center specialized in basic and applied research and in the development of methodologies and tools to adequately manage aquatic systems.

This work has placed **IHCantabria** in national and international elite area of scientific and technological knowledge related to the water cycle in its various facets.

IHCantabria was founded on the 22nd of March 2007, the International Water Day.

IHCantabria was created by the union of two Research Groups from the University of Cantabria's Civil Engineering Faculty which had been working for over 20 years.



PhysicalModeling
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Offshore Wind at Deep Waters

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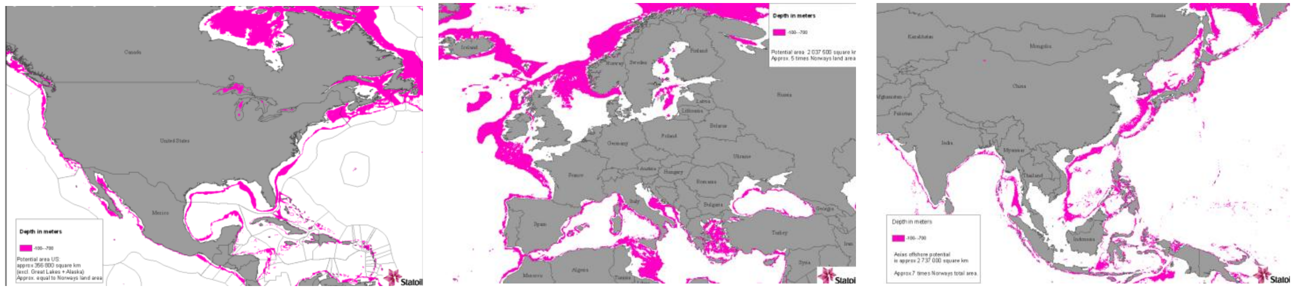
Offshore Wind at Deep Waters

Very deep water potential



Source: Statoil, 2011.

USA (East coast) *USA Strategy 54 GW (2/3 in deep waters)* Fuente: NREL 2010

Asia: Japón *265 GW,* ***China*** *30 GW ,* ***Korea*** *25 GW* *Fuente: Azure International, Garrad Hassan, 2011*

Europe *40 GW*

Unlocking offshore wind at deep waters

- New construction methods
- New materials
- Development of new technologies
- Longer validation procedures

Research and Innovation

Reduction of uncertainties

New technologies to exploit offshore wind energy potential

Norway

Portugal

Japan

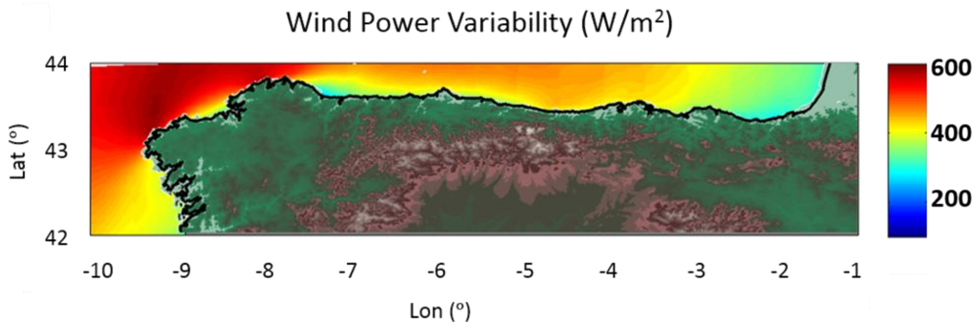
Scotland

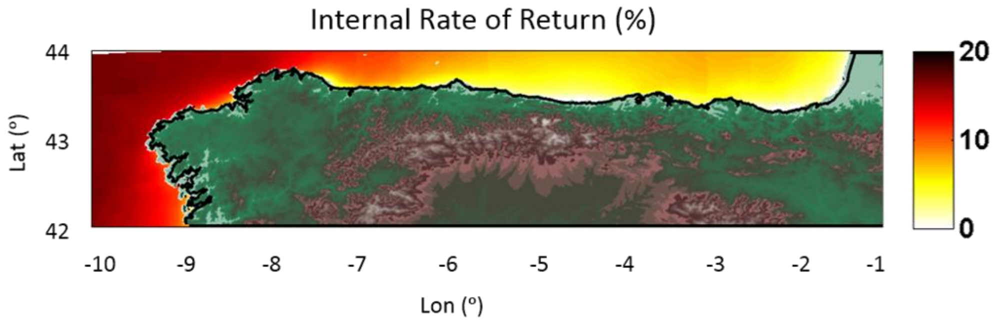
Etc…

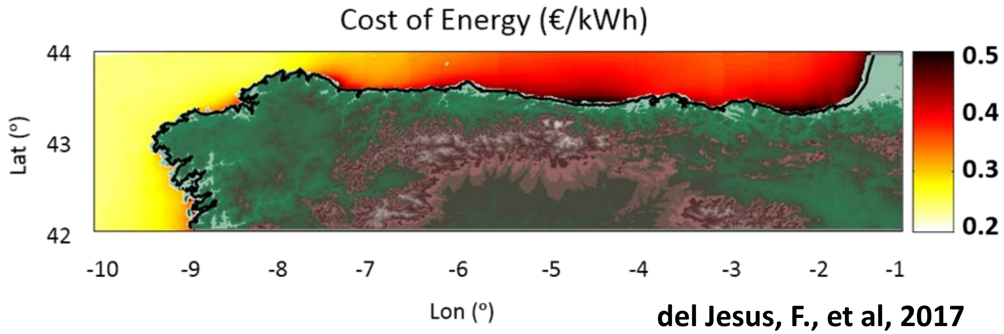
Wind resource variability

The **uncertainty** related to offshore wind resource due to the lack of field measurements may affect to all the steps of the design of any project.

Wind variability, in time and space, will influence over the return of the investment. Therefore, detailed wind assessment studies are highly recommended.







del Jesus, F., et al, 2017

IH Data: http://www.ihcantabria.com/es/software/item/719-ihdata

Wind resource assessment: impact over an offshore wind farm project

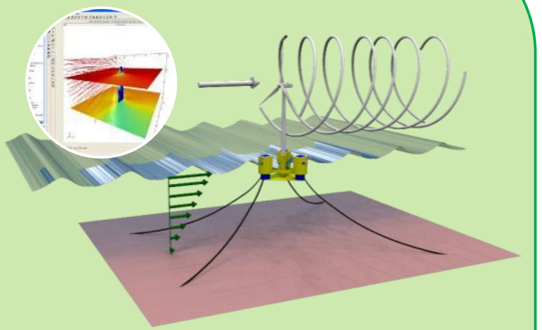
Objective: reduce project uncertainties

→ Met-ocean parameters measured: Wind, waves, current, barometric pressure, temperature, rain, visibility, etc.

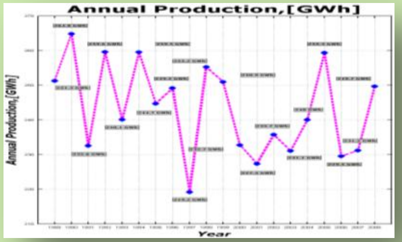
Wind assessment is basic for:

Design and Construction

Design Loads for:
- Floating platform
- Wind Turbine
- Mooring system



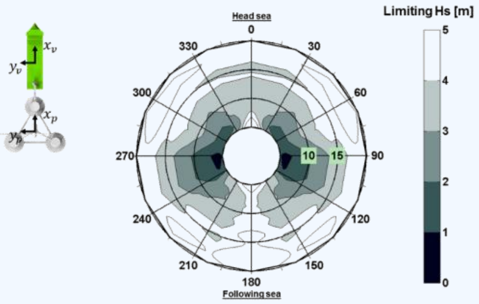
Design versus finance:
- AEP
- Costs
- O&M



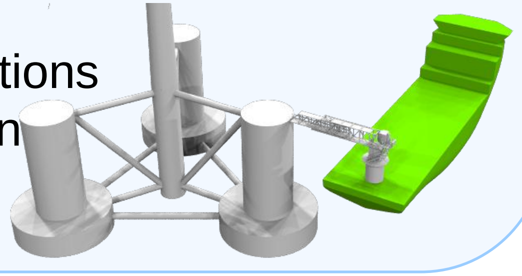
Guanche, R., et al, 2014. OMAE

Operation & Maintenance

Design of O&M strategies:
- Preventive
- Corrective



Forecasting:
- Met-ocean conditions
- Power Production
- Security Stops



Guanche, R., et al, 2016. Ocean Engineering
Martini, M., et al, 2016. Energy Procedia

Wind Resource Assessment

Numerical data bases
Field measurements

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Numerical Wind Databases

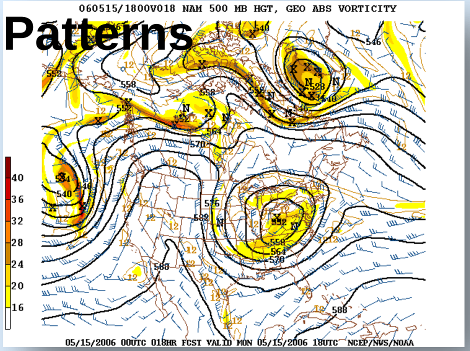
Numerical simulation of offshore wind dynamics

Long time series (>20 years)

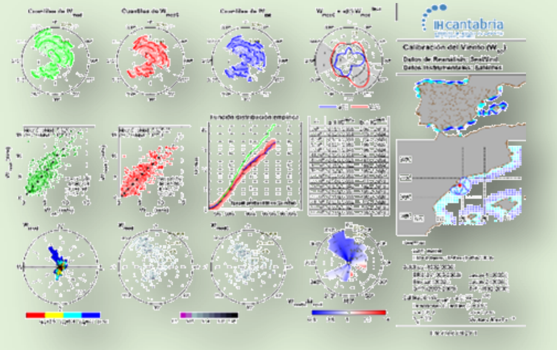
Long-term assessment

Lack of accuracy

Simulation of the Atmospheric Patterns

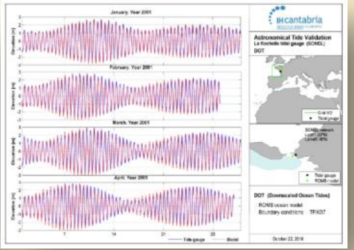


Calibration/Validation of the databases

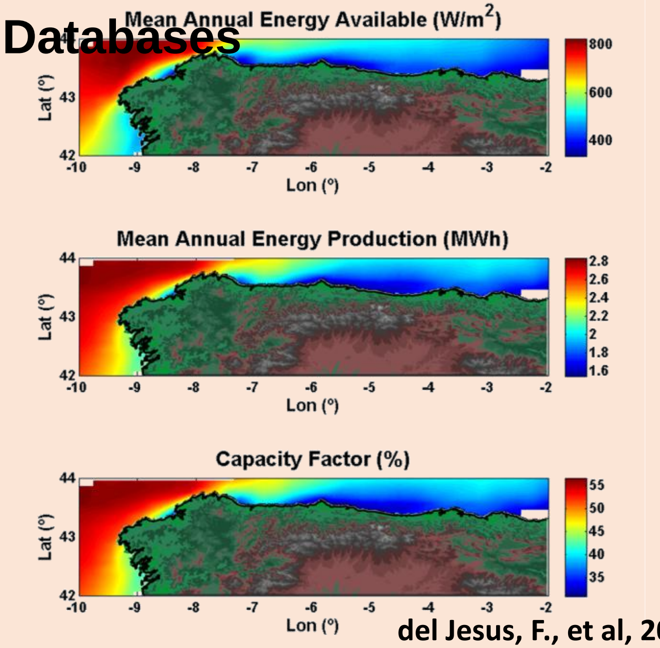


Minguez, R., et al 2011, J. Atmos. Oceanic Technol

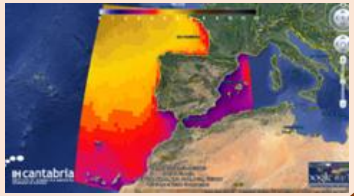
Field Measurements



Met-Ocean Variables Databases



del Jesus, F., et al, 2017



Camus, P., et al 2011., Coastal Engineering

FIELD MEASUREMENTS ARE STILL NEEDED

Field measurements

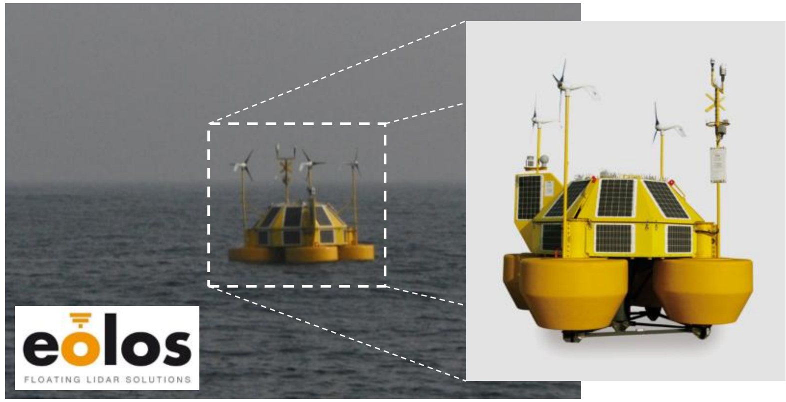
- **New** measuring **techniques** should be developed to assess the wind and wave conditions at wind farm locations.
- The new devices should be fitted to **deeper waters** and **harsh met-ocean conditions**.

Meteorological masts

- Fixed met-masts up to 40 m → Expensive at deep and very deep waters
- Future developments require the installation of floating devices. Main advantages:
    - Stability under extreme conditions
    - Wind speed at several heights with certified anemometry
    - Other meteorological variables at several heights and depths
    - Possibility of long periods with no maintenance: self powered

Buoys and Lidars

- Modern technology applied to offshore sites
- Less volume and material required
- LIDAR technology allows measuring at several heights from low levels.
- Lower inversions required



www.eolossolutions.com

Floating met masts

IDERMAR experience

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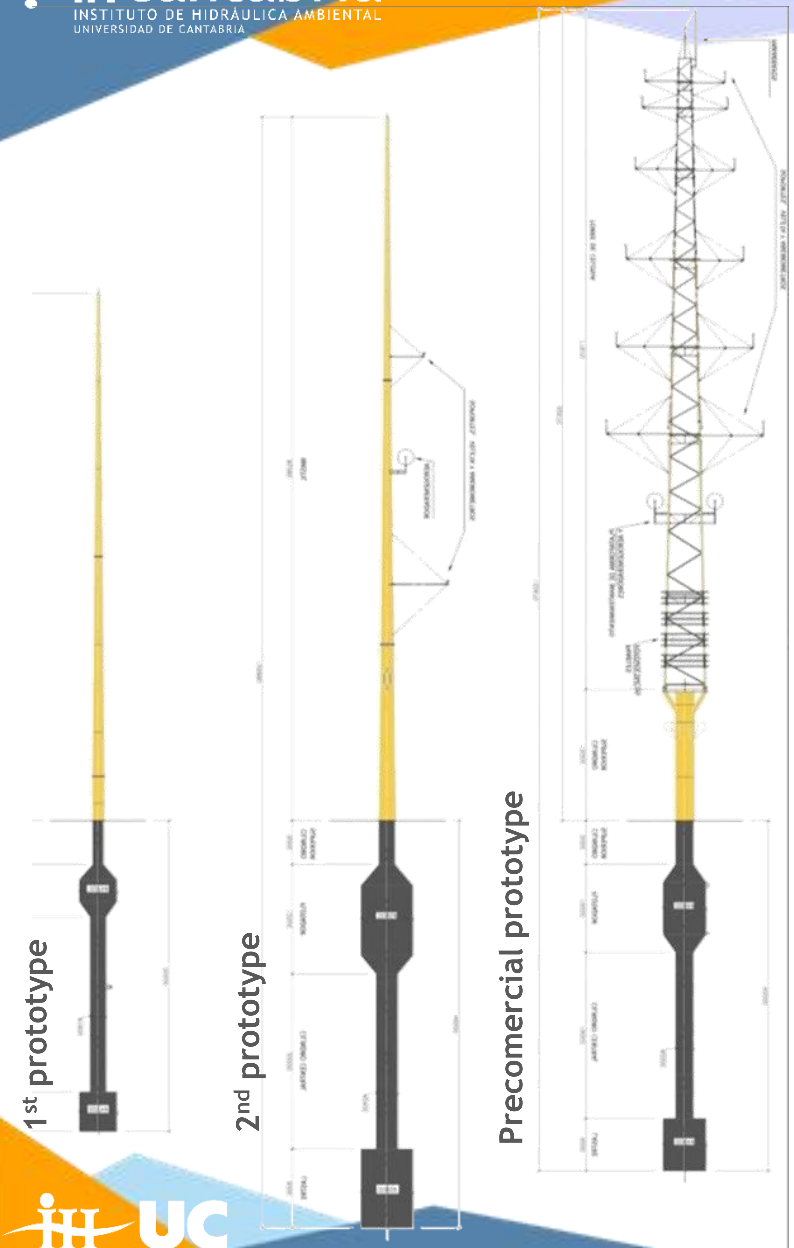
IDERMAR

Offshore wind assessment at deep and very deep waters

IDERMAR is a mixed private-public company set up by the Cantabria Government through SODERCAN, ACTIUM, an Investment company of the APIA XXI Group, the Hydraulics Institute (HI) of the University of Cantabria (UC) and the Helium Company.

IDERMAR

Offshore wind assessment at deep and very deep waters



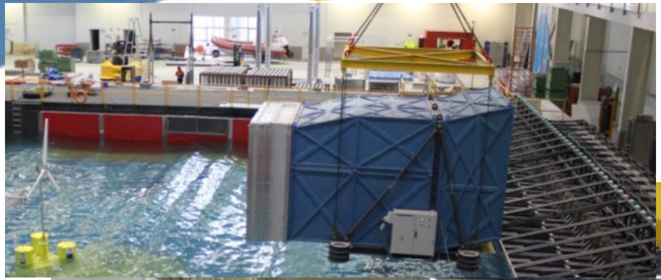
1st prototype: depth=55m, distance from shoreline=3km

2nd prototype: depth=186m, distance from shoreline=16km

Precomercial prototype: depth=55m, distance from shore=4.8km

19th December 2011, H_s=3 m, T_p=10 s, V_m (z=10m)=14 m/s

Tested and validated



- Extensive testing in in-house facilities
- Validation and analysis of :
  - Mast motions
  - Mooring motions and loads
  - Fairlead positions
  - Transportation and erection strategies

Eight laboratory campaigns have been conducted: Scales 1/40 y 1/50

-7 campaigns were conducted at IH Cantabria facilities

-1 campaigns was conducted at MARIN (NE)

A total amount of 338 tests has been conducted

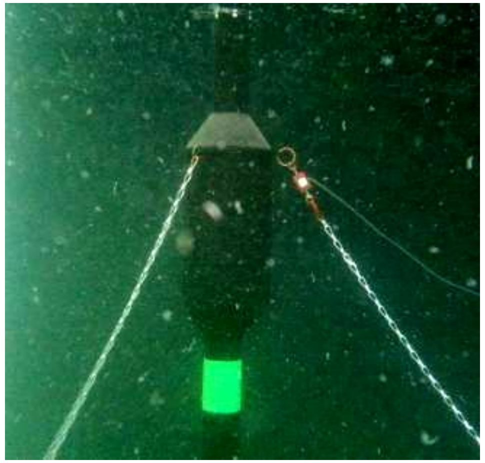
-Medium and low energetic sea states: operation

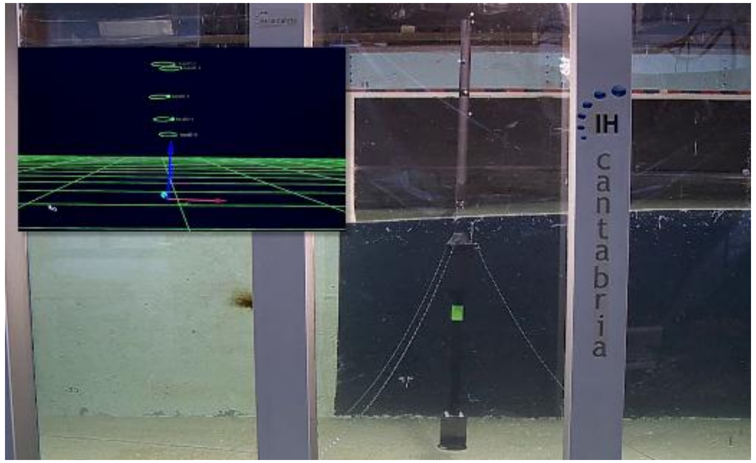
-High energetic sea states: survival

-Wind

-Currents

-Deployment procedure



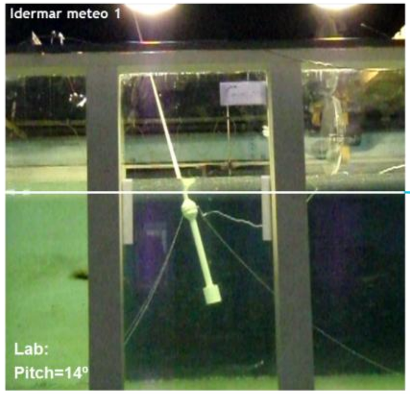


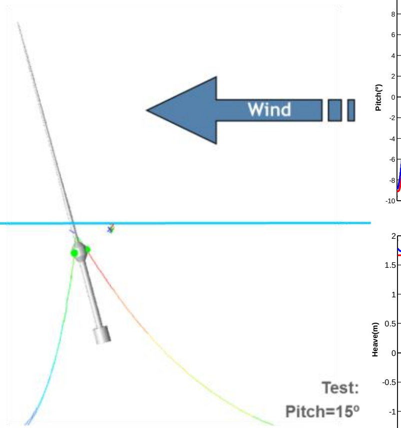
IDERMAR

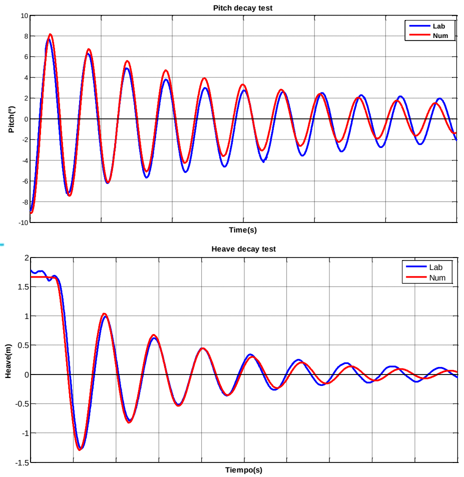
Offshore wind assessment at deep and very deep waters

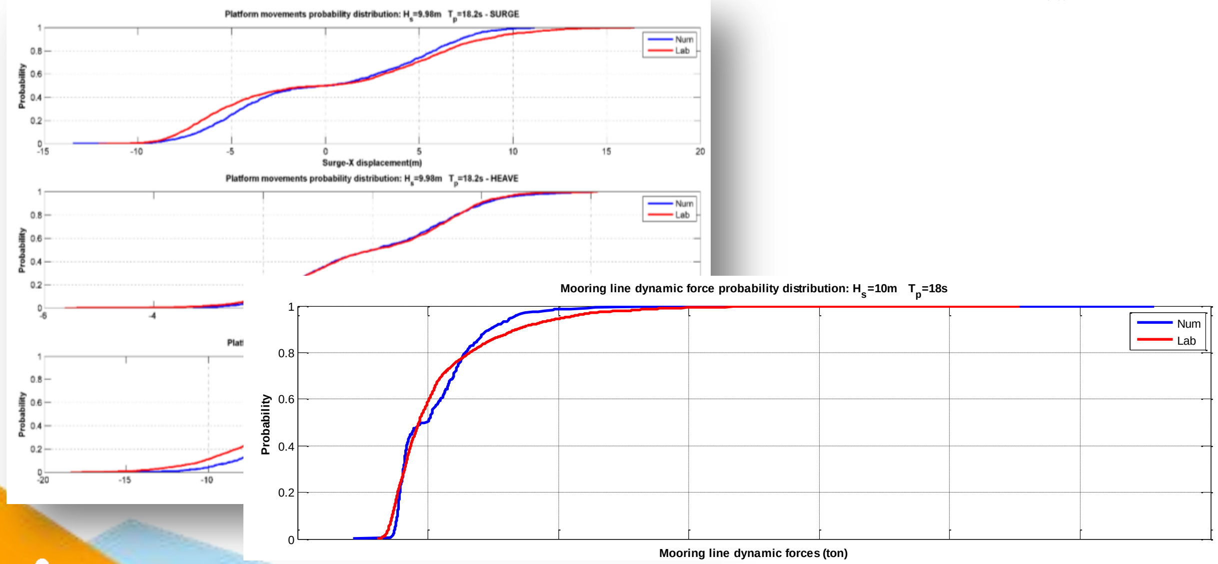
Numerically modeled

Laboratory validation

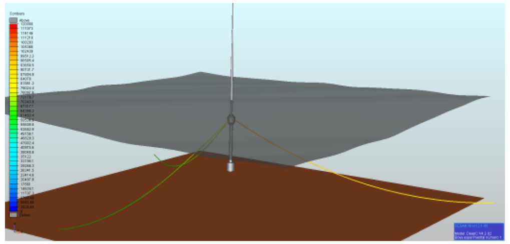








Field validation

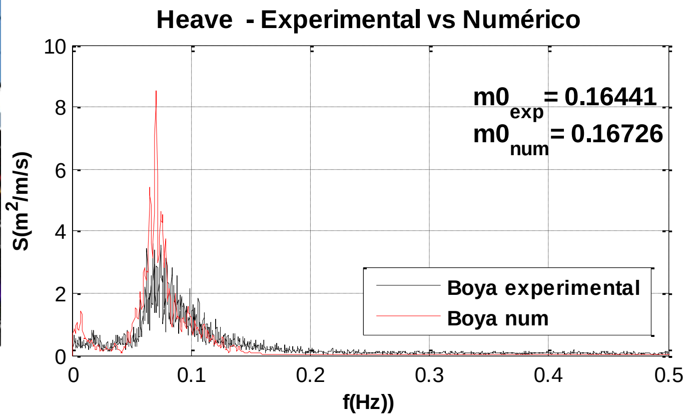


Field data from Idermar meteo

21st of October of 2009

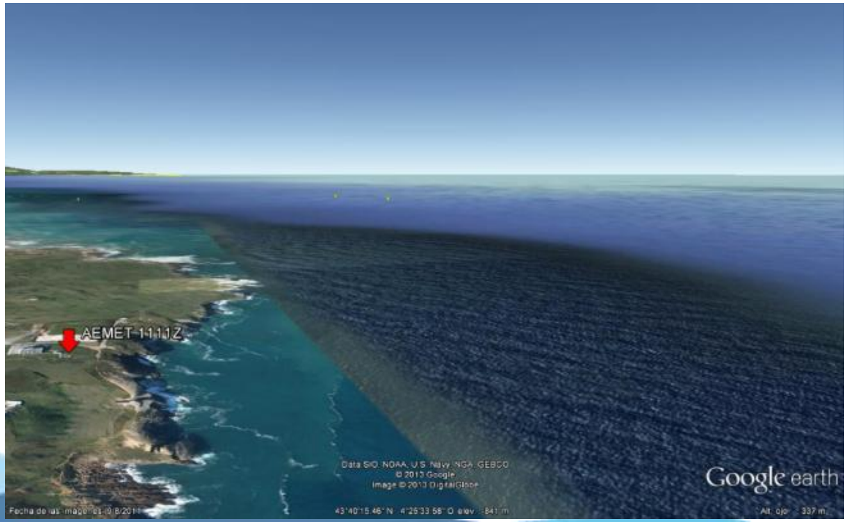
H_s=4m

T_p=15s



Field results

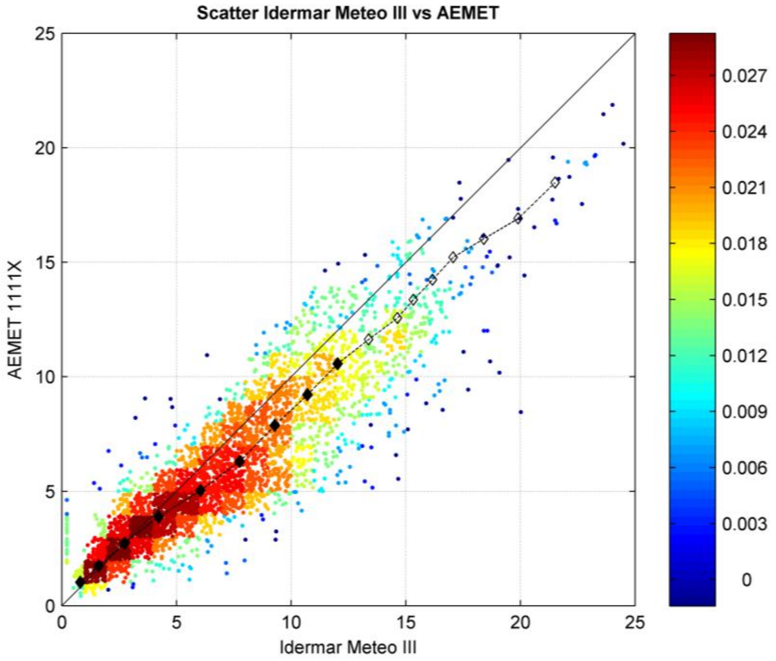
Comparison between different sources of data



- Fixed anemometer key points
  - 50 m cliff
  - 6200 distance

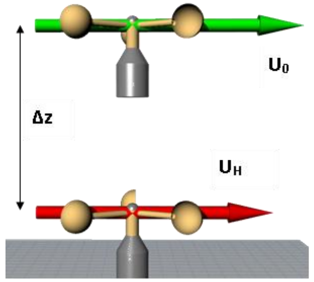
Most Unfavorable scenario

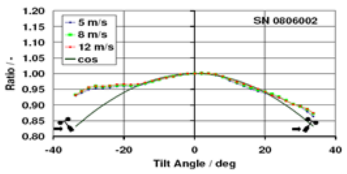
- Expected results based on a certified offshore met mast: Very promising

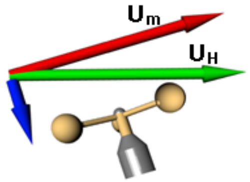


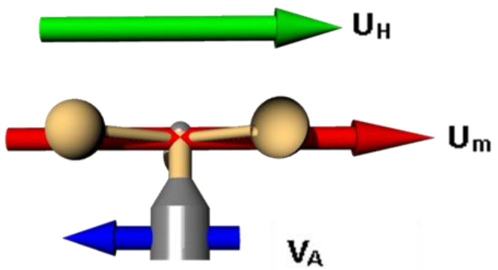
Hybrid modeling verification

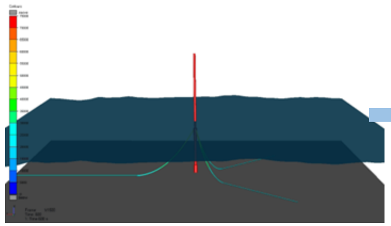
Sources of uncertainty

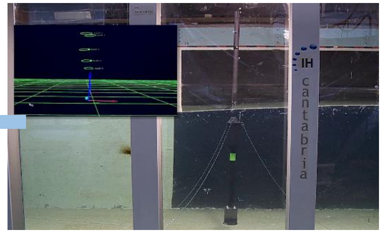


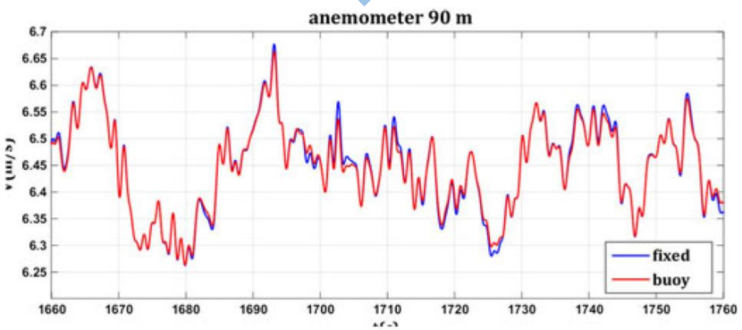


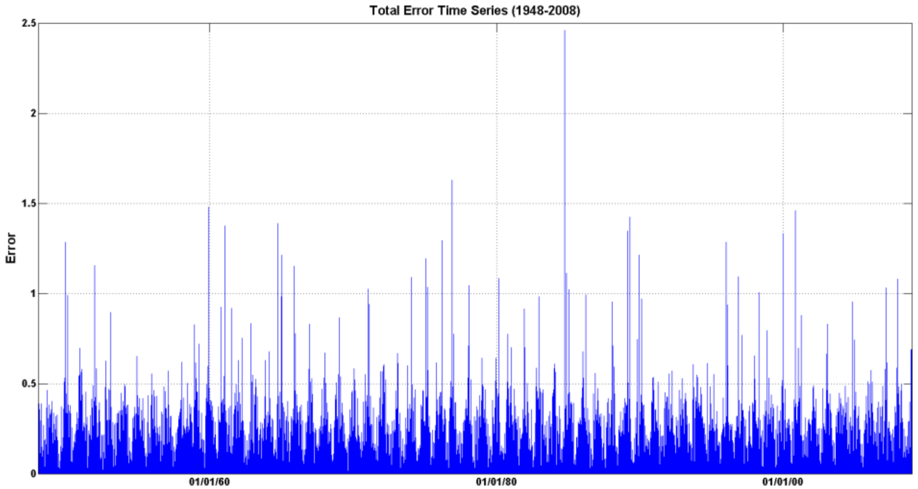




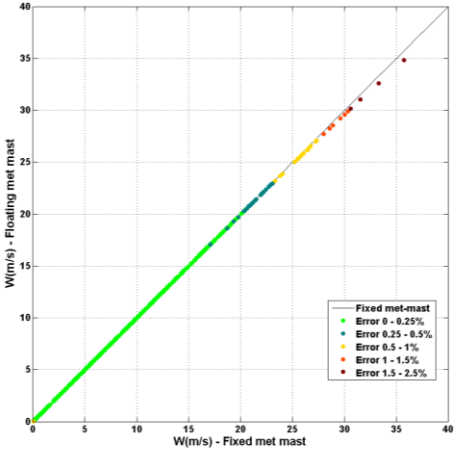




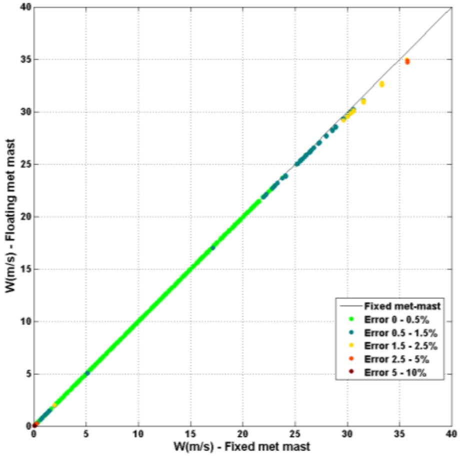




1 hour MRE



10-minute MRE



Guanche, R., et al 2016., Wind Energy

Conclusions

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Conclusions

Market oriented research

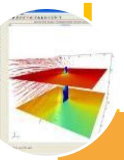
Numerical modelling

Scaled tests – phase 1 (1:30/1:40)

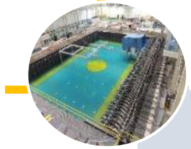
Scaled tests – phase 2 (1:10/1:25)

Field tests – phase 3 (1:1/1:3)

Optimization



TRL 1 - 3



TRL 4 - 5

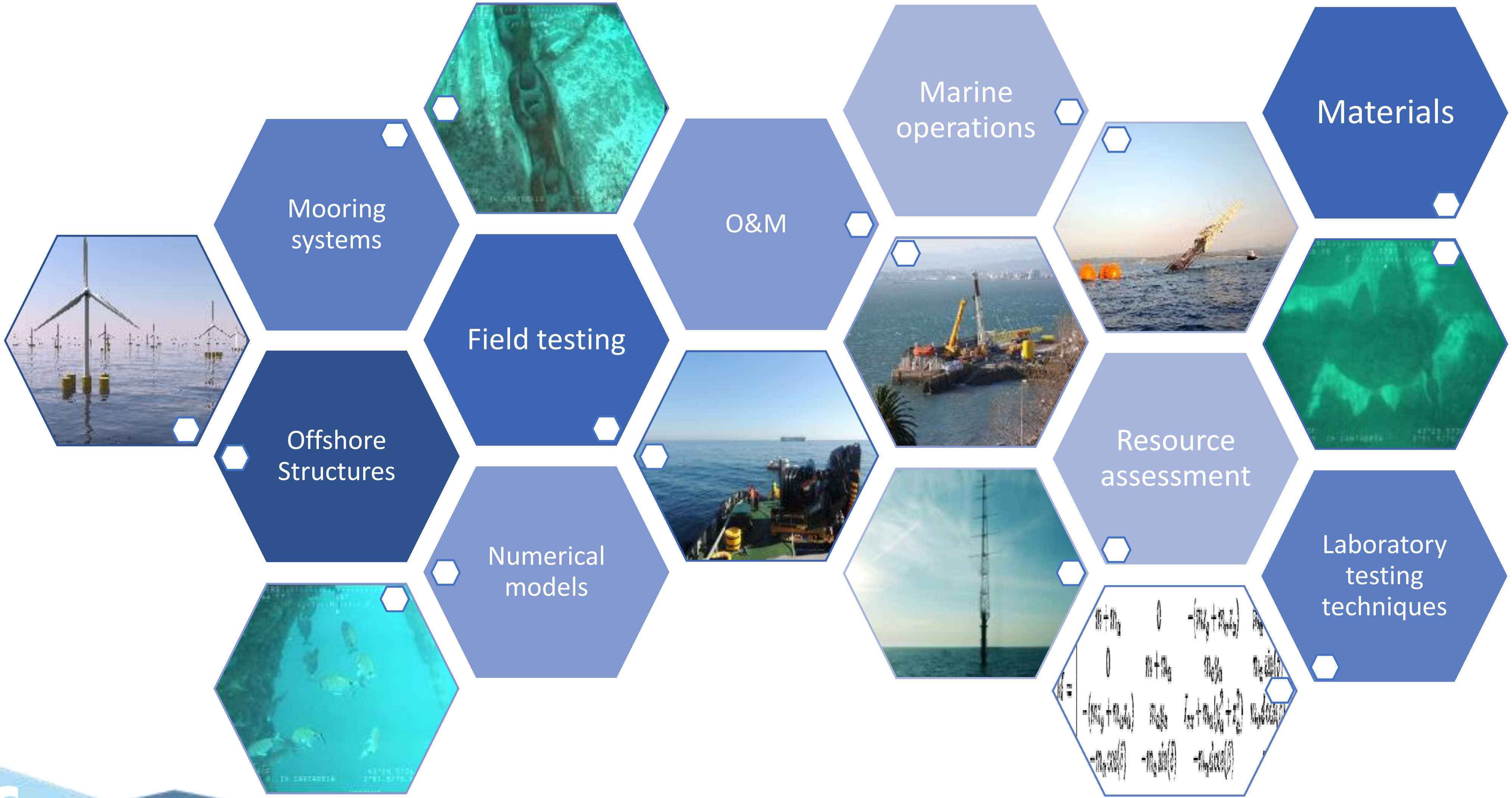
TRL 6 - 8

Final Design Commercialization

TRL 9

Iterative Process: Each step of the design methodology should be used to improve the accuracy of the numerical model which will be used to estimate the response of the device under any met-ocean conditions.

New knowledge and Academia-Industry Technological transfer



Conclusions

Research and industry collaboration
IHCantabria experience

Integrated telescopic tower and evolved spar floating substructure for low-cost deep offshore wind and next generation of 10mw+ turbines

ClassNK → Certification company selected

TEWIND (2016-2019).

H2020-LCE-2015-1, Project ID: 654634

Offshore wind cost reductions: mooring system analyisis

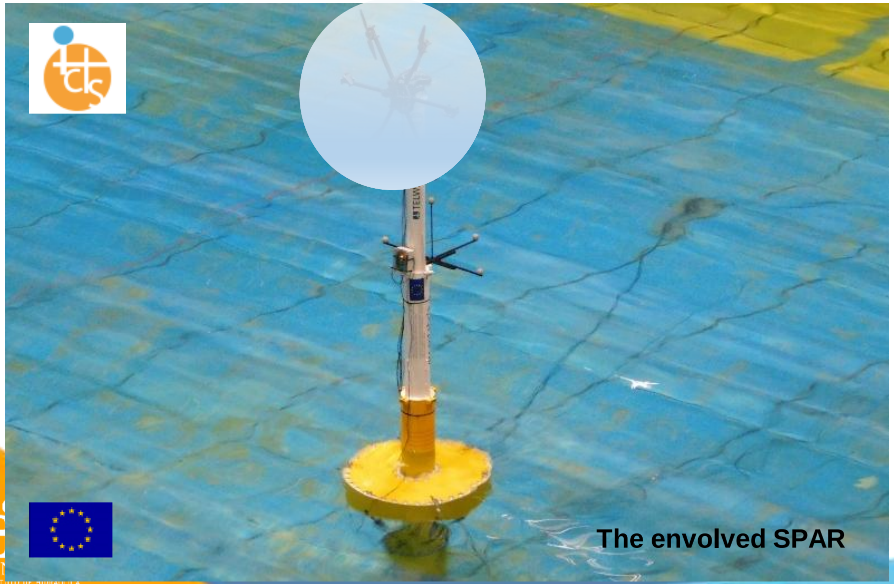
RECOEF (2016-2019)

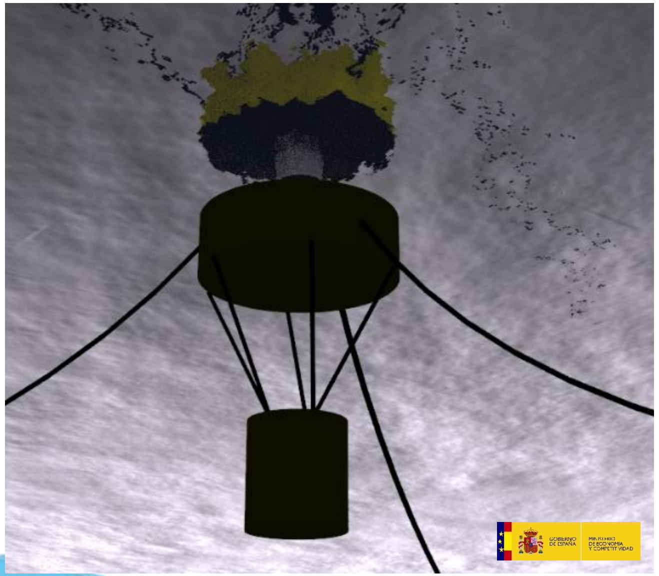
Retos-Colaboración 2015
RTC-2015-4498-3

Gravity base foundation and integrated telescopic tower for offshore wind purposes (ELICAN & ELISA project)

ELICAN (2015-2018)

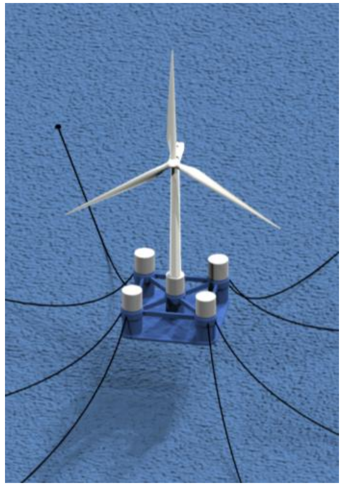
H2020. Project ID: 674741

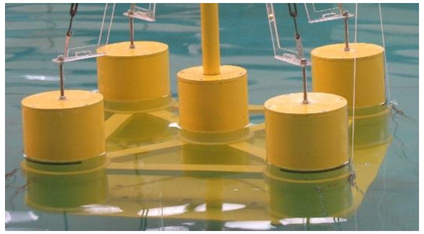




Conclusions

Research and industry collaboration
IHCantabria experience



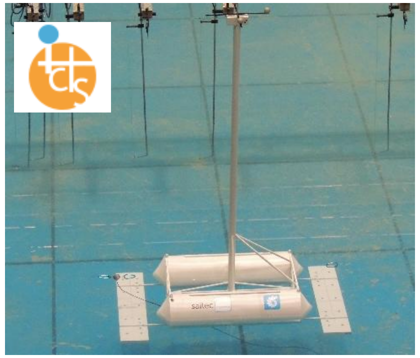


MENHIR (2016-2019)
Retos-Colaboración 2015
RTC-2015-3505-3

Concrete floating offshore wind platform for deep and very deep waters.

DRAGADOS

FHECOR Ingenieros Consultores

DemoWind Delivering cost reduction in offshore wind

SATH Project (2016-2019)
DemoWind -2016

Cost effective offshore wind floating platform

SATH Swinging Around Twin Hull

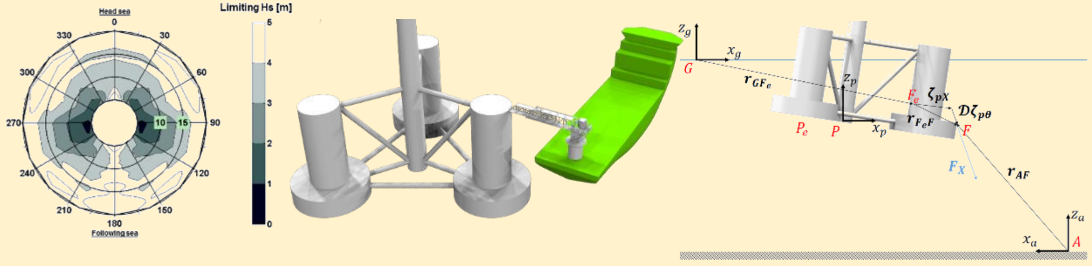
saitec engineering

IH Cantabria CURRENT PROJECTS

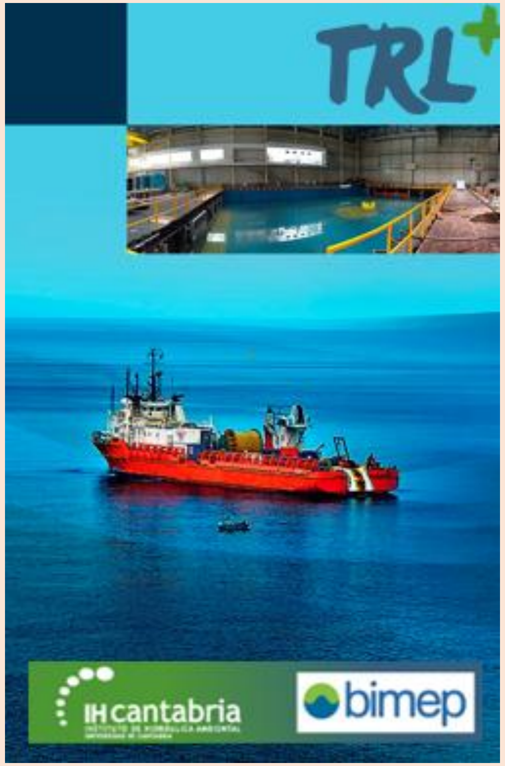
Marine Operations (Transport, installation and O&M)

Poseidom (2016-2019)
Retos-Colaboración 2016

Operation and maintenance strategies modeling and optimization



Climate Services

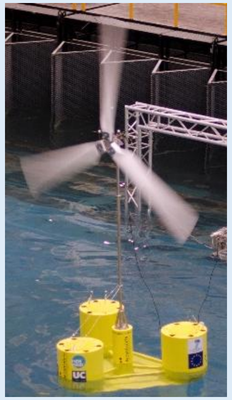


TRL+ (2015-2018)
Retos-Colaboración 2015

New testing methodologies

Smylab (2015-2018)
Retos-Colaboración 2015

Smart Hydraulics Laboratory Systems

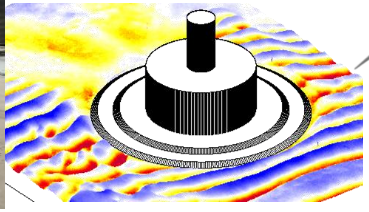


IH Cantabria Coming Projects

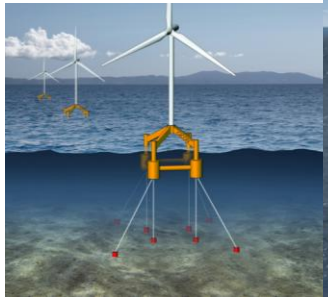
Offshore Wind Technologies

ACCEDE (2017-2018)

I+C=+C

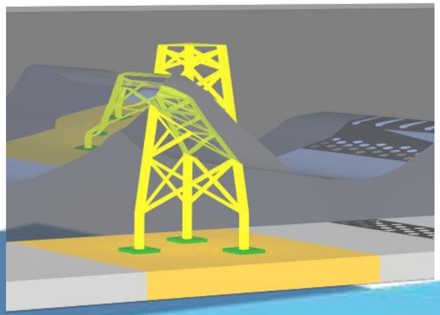


GICON (2017)



SCOUR PROTECTION JACKET (SPJ) (2017-2018)

I+C=+C



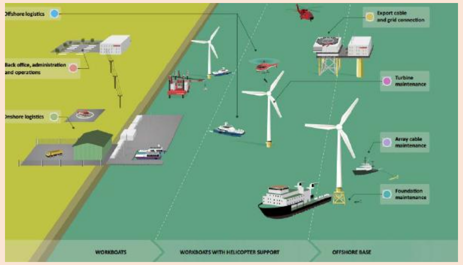
* Estudio de los efectos del fenómeno de socavación en estructuras tipo jacket y optimización de los sistemas anti socavación

Climate Services

CliSMO (2017-2018)

I+C=+C

*Servicios climáticos para operaciones marinas en parques eólicos offshore: CliSMO



Marine Operations

SIMONEER (2017-2018)

I+C=+C

*Sistema Integrado polivalente de MONitorización y caracterización de Estructuras flotantes para Energías Renovables Marinas

Japan and Spain Collaboration:
Opportunities in Offshore Wind Energy

Offshore Wind Resource Analysis of a service of a company

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