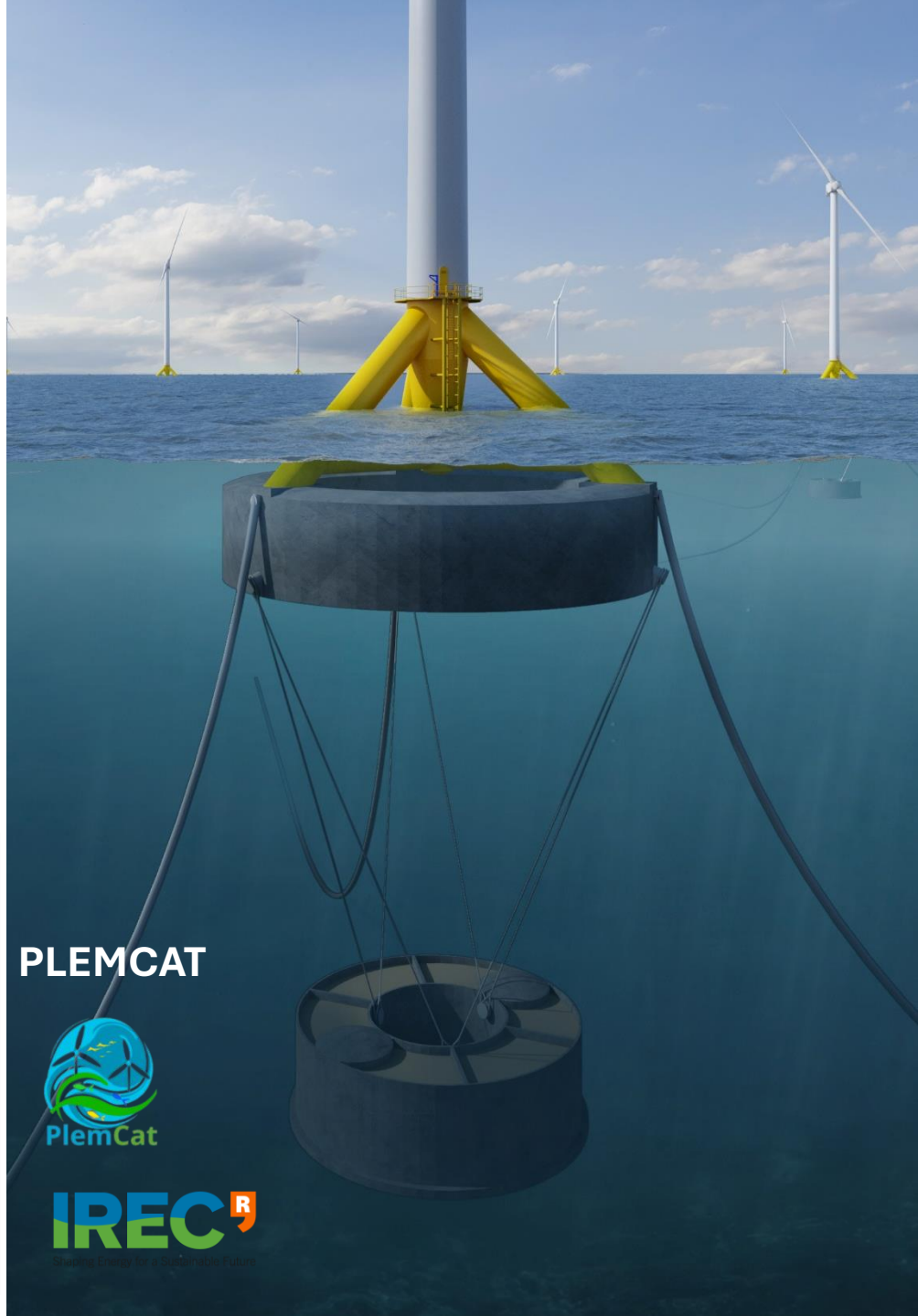
WHEEL prototype in PLEMCAT

ESTEYCO

PLEMCAT

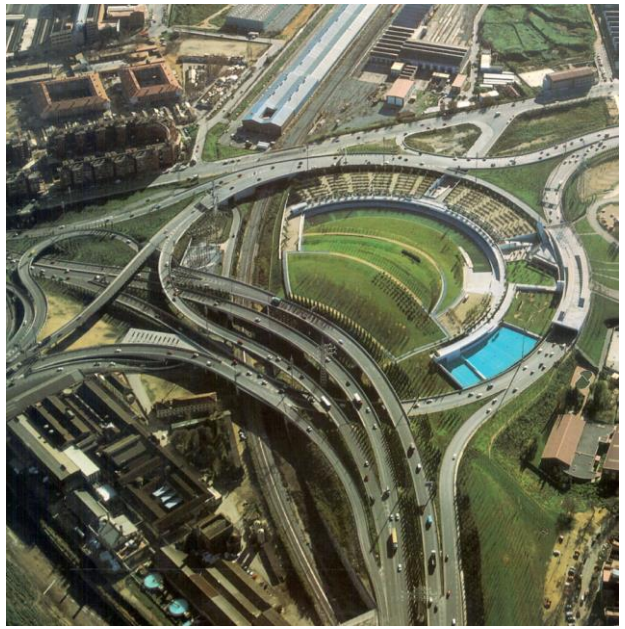


Enginyers Industrials de Catalunya

Barcelona
13 de març 2025

ESTEYCO

+50 years experience in engineering and architectural consulting



ROADS

RAILWAYS

GEOLOGY AND GEOTECHNICS

PORTS AND LOGISTIC

NAVAL

STRUCTURES

ARCHITECTURE

SUSTAINABILITY

STRUCTURAL MECHANICS

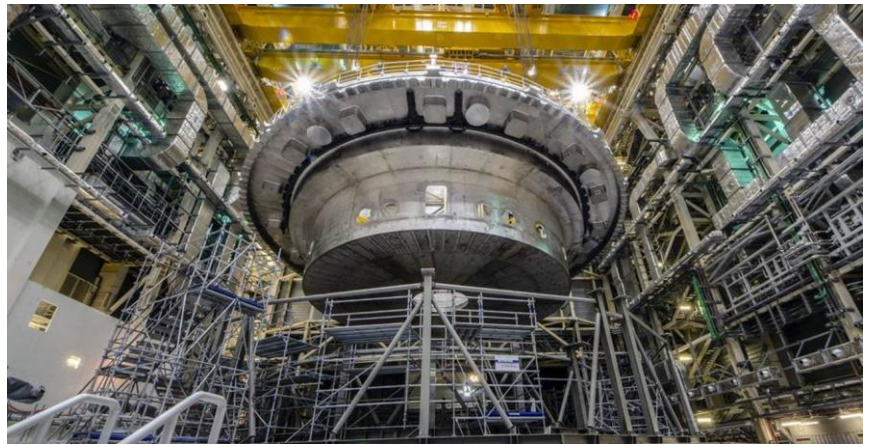
ESTEYCO

30 years ago, extension to energy sector

ONSHORE WIND

SOLAR PV

LNG



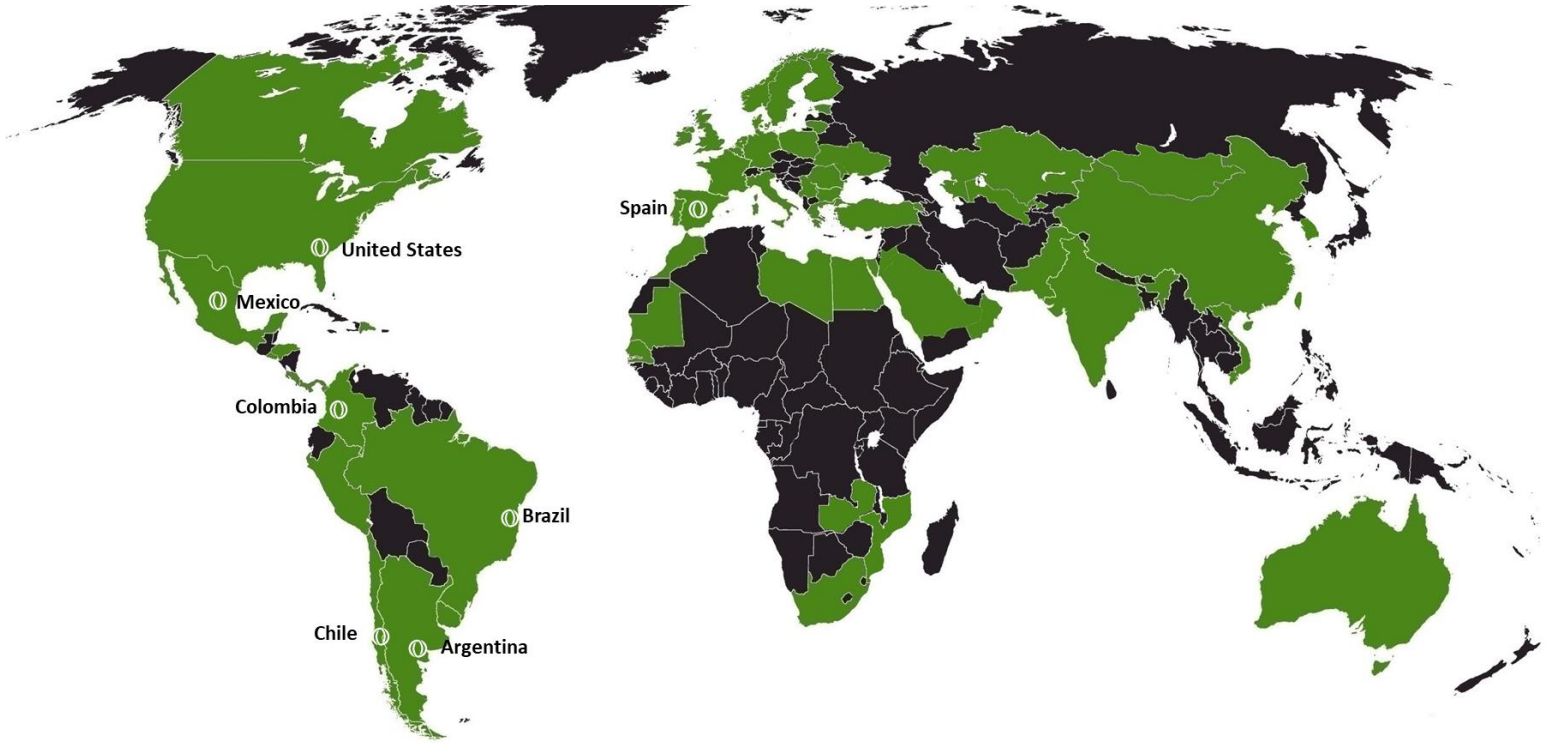
NUCLEAR FUSION

OFFSHORE WIND

ESTEYCO

Working all around the world

Since 2005, and beyond the activity generated by the implementation of our products, our strategy and positioning allows us to offer engineering and consultancy services in all the phases of a project.



countries in which ESTEYCO has carried out onshore renewable projects in the last years

+ 450 WIND FARMS
+ 60 GW
+ 45 COUNTRIES

- Geotechnical Works: +95 WWFF
- Detailed engineering of foundations: +250 WWFF
- Detailed engineering of civil Works: +100 WWFF
- Detailed electrical engineering: +40 WWFF
- Detailed engineering of concrete wind towers: +3.000 WTG
- Wind Resource Assessment: +15 WWFF
- Development engineering (early stages): +250 WWFF

+200 SOLAR PLANTS
+ 22 GW
+ 15 COUNTRIES

- Pull out tests and geotechnical surveys +25 PSFV
- Hydrological and flood studies +40 PSFV
- Detailed engineering of foundations +15 PSFV
- Basic and detailed engineering +75 PSFV
- Owner's engineering and Due diligence +9PSFV
- Study of Solar Resource +30 PSFV
- Technical co-development +3 PSFV

ESTEYCO

Leaders in structures and BoP design in wind energy sector

+1000 WIND FOUNDATIONS PER YEAR

+500 BRACED HYBRID TOWERS

NEW DISRUPTIVE PRODUCTS

+3500 CONCRETE WIND TOWERS

+60GW INSTALLED POWER IN +450WF

ASSET MANAGEMENT IN +2.800WTG IN 150WF

ESTEYCO

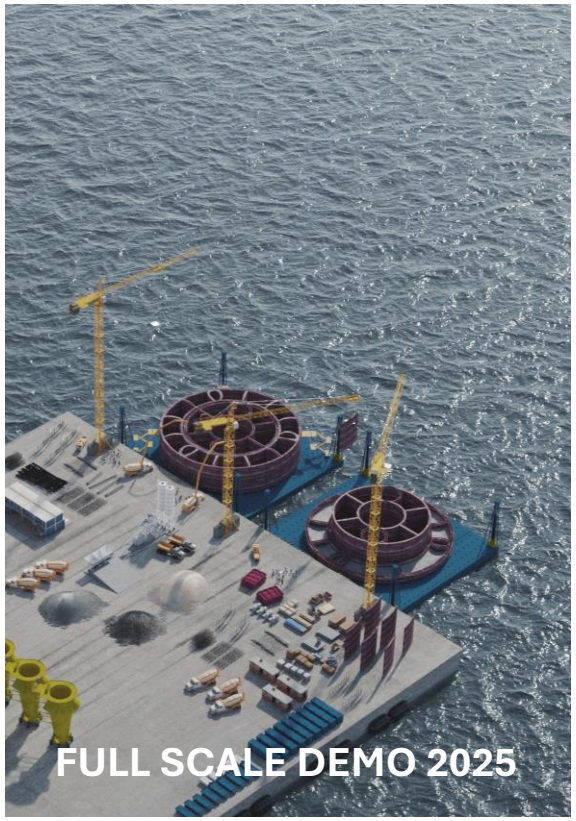
Offshore wind proprietary technologies

ELISA GBS technology

First and only bottom-fixed solution allowing for the installation of OWT without heavy-lift vessels

ATOMS O&M System

Solution for large corrective maintenance of bottom-fixed or floating WTGs with no need for jack-ups



AIRBARGE construction barge

Cost-effectively turn conventional modular pontoons into submersible barges suitable for floaters construction/assembly and float-off.

WHEEL floating evolution

Floating concept for unparalleled reduction in floater width, harbour draft, material usage and carbon footprint

ELISA technology

ELICAN OWT

Full-scale prototype of Elisa technology, with a 5MW SiemensGamesa turbine, installed at 30m depth.

Starting date: January 2016

Installation: Summer 2018. In PLOCAN (test site in Canary Islands)

COD: Q1 2019. Today in operation (by Esteyco)

First offshore wind turbine in Spain (Gran Canaria).

First bottom fixed substructure in South Europe.

First bottom fixed substructure in the world installed with no need of heavy lift vessels.

Permitting successfully achieved in a relatively short time (15 months).

80% of the budget (excl. WTG supply) performed with Canarian companies.

Development, technology, design and construction by ESTEYCO.

video: https://www.youtube.com/watch?v=y1HaokUSulw

European Commission
Horizon 2020
European Union funding
for Research & Innovation

PLOCAN
Plataforma Oceánica
de Canarias

ESTEYCO

Offshore wind proprietary technologies

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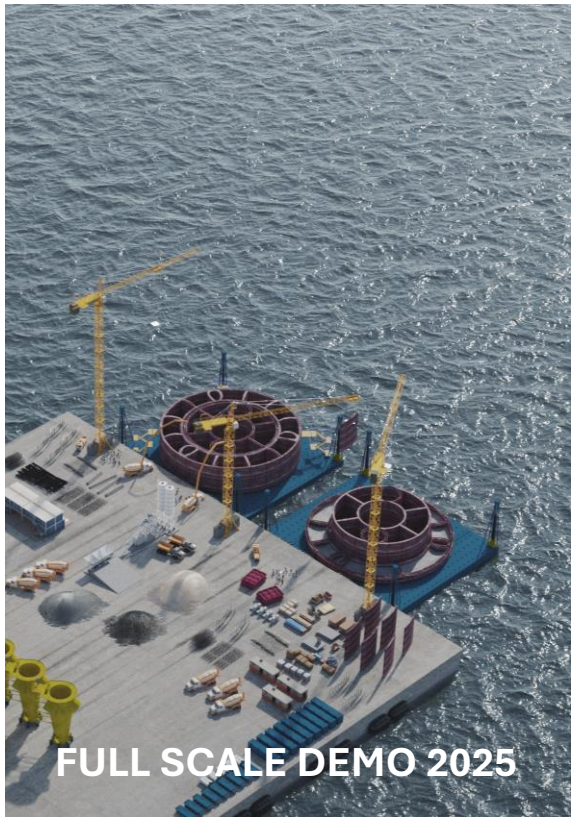

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WHEEL floating evolution

Floating concept for unparalleled reduction in floater width, harbour draft, material usage and carbon footprint

ESTEYCO

More than a 15 years of commitment to R&D and blue economy

2009-2010
CDTI – PID ADO1
ELISA ENGINEERING 0,7M€

2012-2014
CDTI – PID ADO 2
ELISA TANK TEST 0,8M€

2012-2014
ACCIO
ELISA LAB TEST 0,1M€

2013-2014
EUROSTARS
TELESCOPICA 2M€

2014-2015
EEA GRANTS
JABALCONES 0,4M€

2014-2015
EEA GRANTS
LAB TEST 0,4M€

2020 – 2022
CDTI – MISIONES
ALTERA – 0.5M€

2021 – 2024
CDTI – MISIONES
DONES – 1M€

2015-2017
MINECO - RETOS
RECOEF 0,5M€

2015-2016
CDTI - CIEN
G.I.C. 0,2M€

2015-2017
HORIZONTE 2020
ELISA 3,5M€

2015-2018
CDTI - CIEN
FLOCAN 5,9M€

2015-2018
HORIZONTE 2020
TELWIND 3,5M€

2016-2018
HORIZONTE 2020
ELICAN 17M€

2024-2026
DEOMAR
WHEEL 4M€

2023-2024
FLOWIN
WHEEL 0,6M€

2016-2017
CDTI - CIEN
ACTECA 7,5M€

2017-2018
EUROSTARS
ELITYRE 0,5M€

2017-2020
INTERREG
ARCWIND 2,9M€

2017-2019
CDTI - PID
TIM 2,4M€

2018-2019
CDTI - INNOGLOBAL
TA-EST 0,25M€

2018-2019
HAZITEK (SPRI)
B-LUZATU 2,4M€

2024-2026
PERTE NAVAL
AIRBARGE 2M€

2024-2026
PERTE NAVAL
ATOMS 2M€

2019-2022
HORIZONTE 2020
FLOTANT 4,9M€

2019-2022
HORIZONTE 2020
COREWIND 4,9M€

2020 - 2022
EMFF – Blue Economy
ATOMS 3,5M€

2020 - 2022
CDTI - MISIONES
LEAF 2,7M€

2021 - 2022
NYSERDA PON 4476
ELISA 15MW 1,1M€

2021 - 2022
NYSERDA PON 4476
TELWIND USA 0,3M€

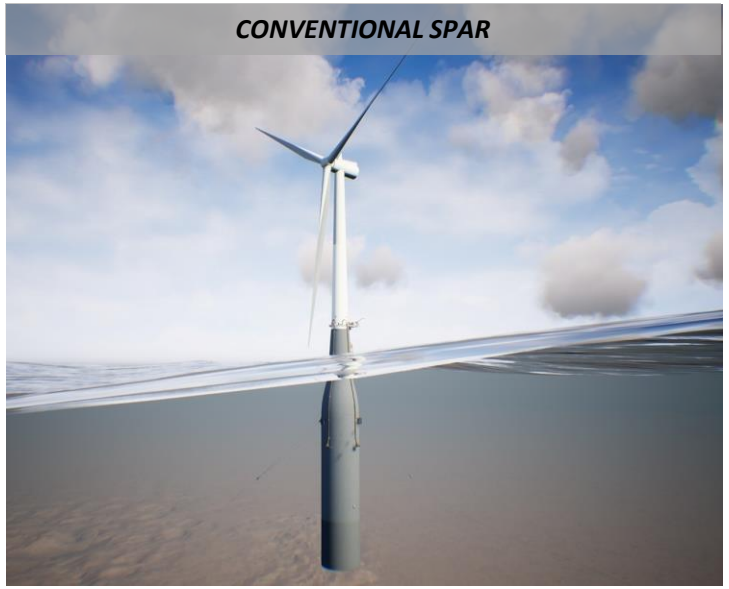
2023-2027
HORIZON EUROPE
WHEEL 25,5M€

2023-2027
HORIZON EUROPE
H2HEAT 0,8M€


WHEEL floating
technology
in PLEMCAT

WHEEL technology

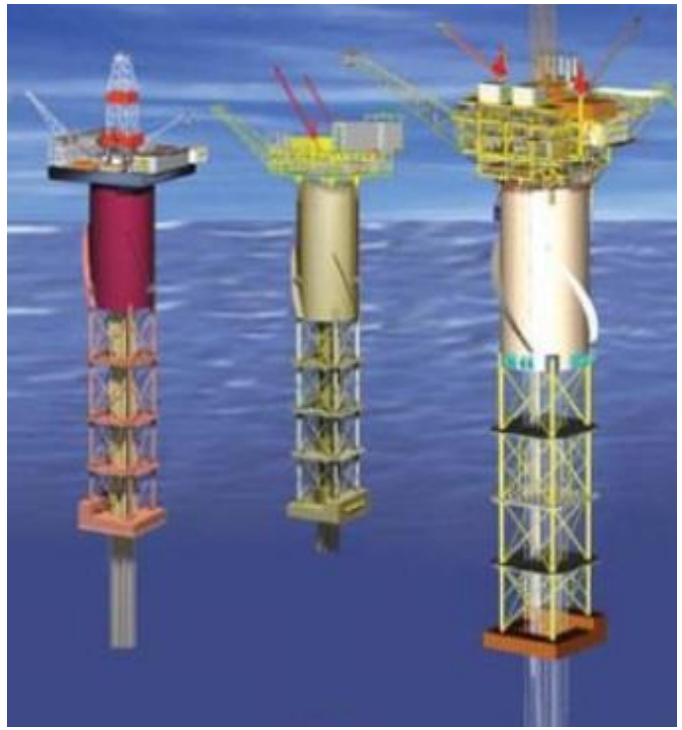
Current technologies: qualitative summary of pro & cons

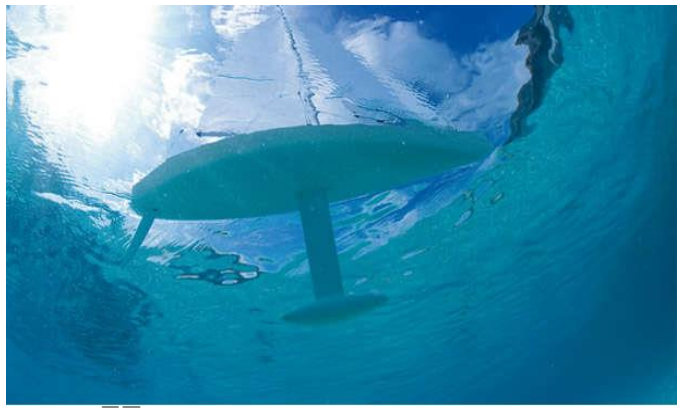


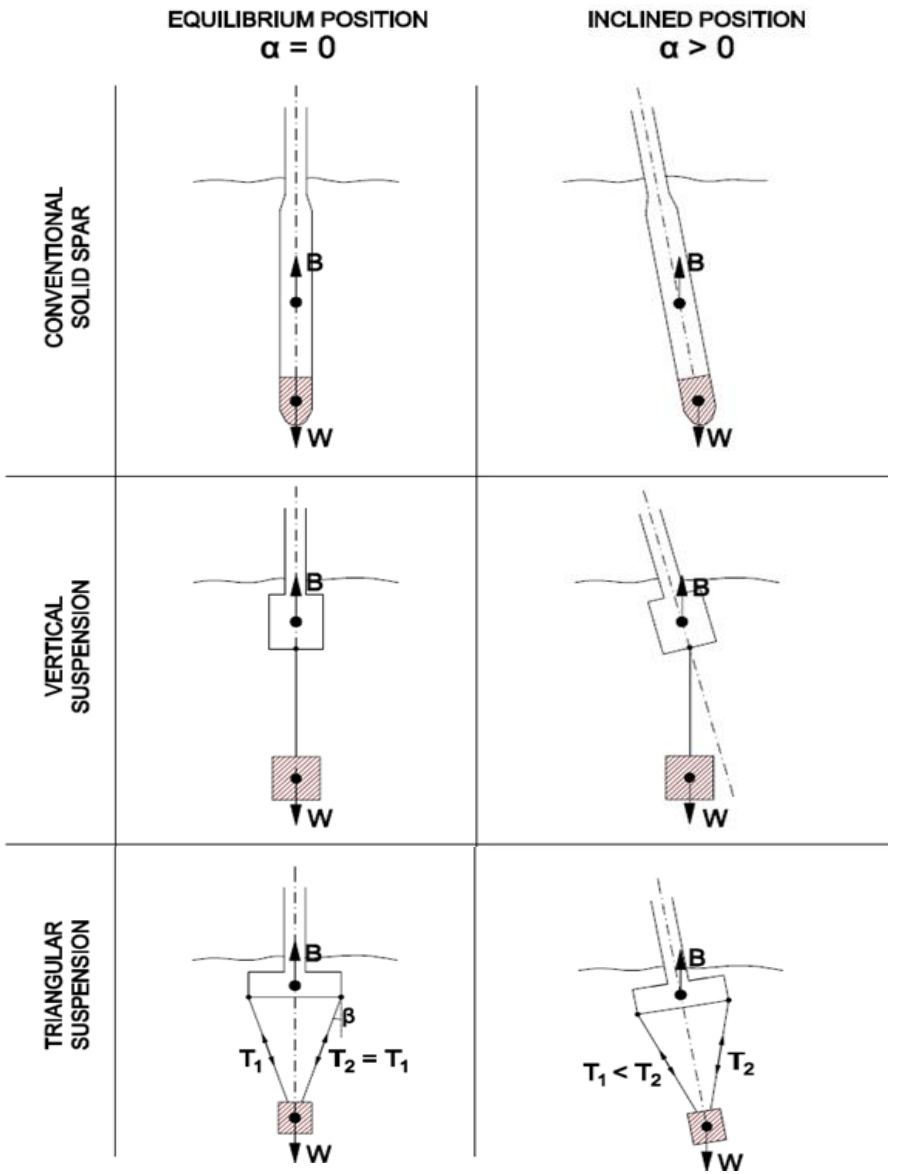
	MATERIAL USAGE	CONSTRUCTION SIMPLICITY	WTG ASSEMBLY PROCESS	FORCES ON MOORING	TRANSPARENCY TO WAVE LOADING	NATURAL PERIODS FAR FROM ACTIVE WAVE PERIODS	REDUCED SIZE AND DRAFT FOR LOAD-OUT / FLOAT-OFF
CONVENTIONAL SPAR	√	X	X	√	√	√	X
SEMI	X	≈	√	≈	≈	≈	X
BARGE	≈	√	√	X	X	≈	≈

WHEEL technology

Background







WHEEL technology. Wind Hybrid Esteyco Evolution for Low-Carbon Solutions

General overview of the technology

Evolved spar floating foundation for unparalleled **reduction in floater width, harbour draft, material use and carbon footprint**

Solidary suspended ballast tank

Patented by ESTEYCO © 2014

Barge Type configuration in harbour:

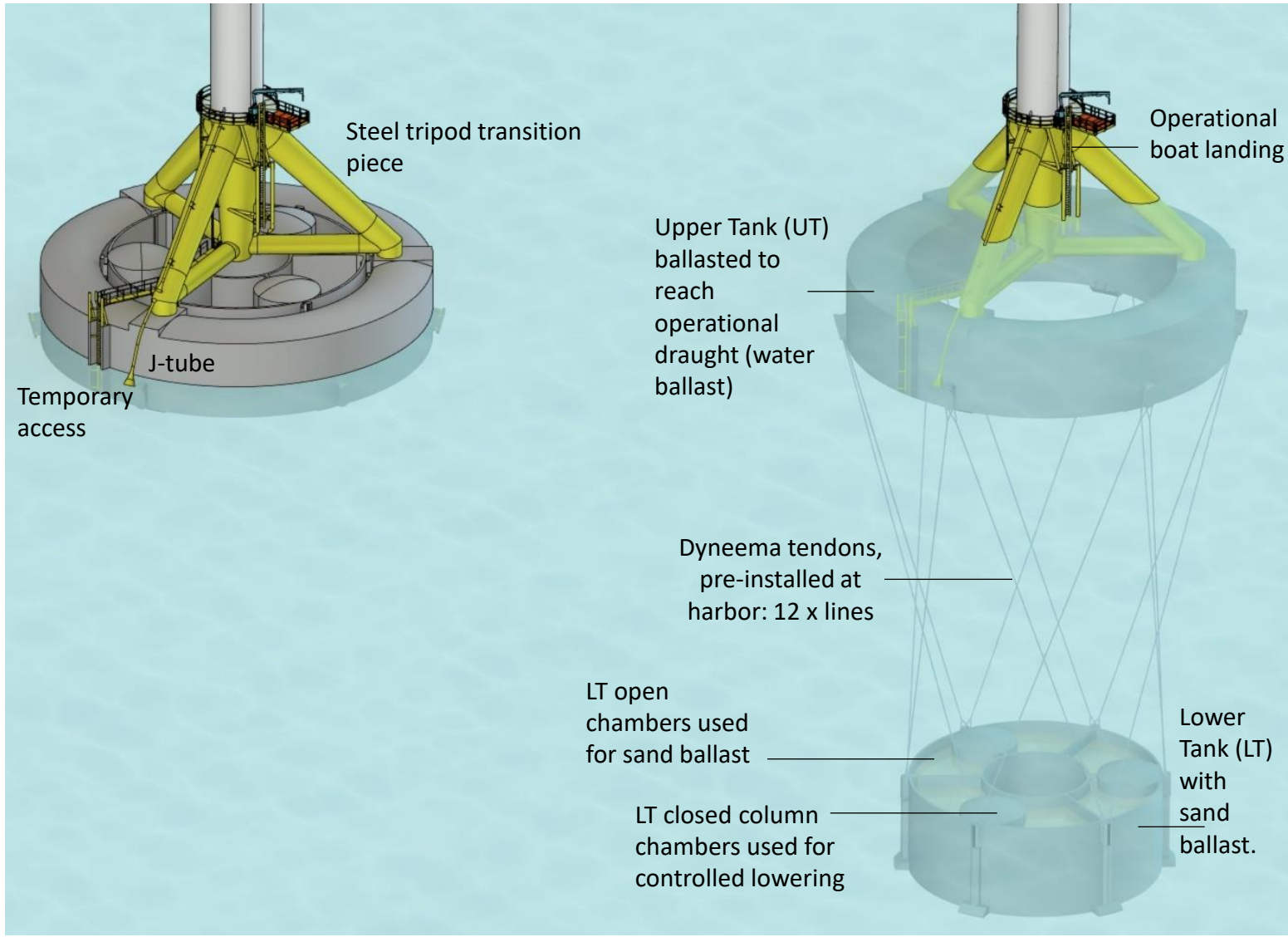
- Full onshore assembly like semisubs…
- …with much lower width, draft and material
- Caisson type configuration

Ultra stable Spar configuration in operation:

- Transparency to sea loading
- Lower mooring costs
- Large mass inertia and very high natural periods for excellent seakeeping performance and very slow motions

BARGE CONFIGURATION IN HARBOUR AND TOW-OUT

SPAR CONFIGURATION FOR OPERATION



WHEEL technology

Competitive advantages

WHEEL delivers simultaneously the two key advantages of the two main existing floater concepts:

- **full on-shore assembly of the floater & WTG (like semisubs)**
- **high transparency** with very low water plane area (like spars) for reduced motions, loading and mooring.

Reduced mooring as compared to equivalent concrete semisub or barge solutions.

Slow motions:

- **Provide high mass inertia in operation leading to slow motions and high pitch/roll/heave natural periods in excess of 40s**
- **Deliver maximum accelerations and inclinations comfortably below design thresholds (in the vicinity of 50% of the typical limit values)**

Reduced material usage: Less than half than a concrete semisub!

Fast industrialized production: simple geometries in the concrete tanks, well-suited for industrialized low-cost concrete construction strategies and allow for barge-based construction processes

Compact and low-draft: Maintain reduced beam (50m for 15MW) and low draft in harbour (5m for 15MW) for harbour selection flexibility and simplified yard & load-out requirements and means. Also, very relevant for **scalability**

High stability and hydrostatic stiffness: ABS is not required

Very Low Carbon Footprint (Less than half that a steel semisub)

Allows for **on-site Large Corrective Maintenance** (LCM)

	MATERIAL USAGE	CONSTRUCTION SIMPLICITY	WTG ASSEMBLY PROCESS	FORCES ON MOORING	TRANSPARENCY TO WAVE LOADING	NATURAL PERIODS FAR FROM ACTIVE WAVE PERIODS	REDUCED SIZE AND DRAFT FOR LOAD-OUT / FLOAT-OFF
CONVENTIONAL SPAR	√	X	X	√	√	√	X
SEMI	X	≈	√	≈	≈	≈	X
BARGE	≈	√	√	X	X	≈	≈ √

WHEEL

WHEEL technology

Manufacturing and assembly

Lower tank & upper tank: CONCRETE

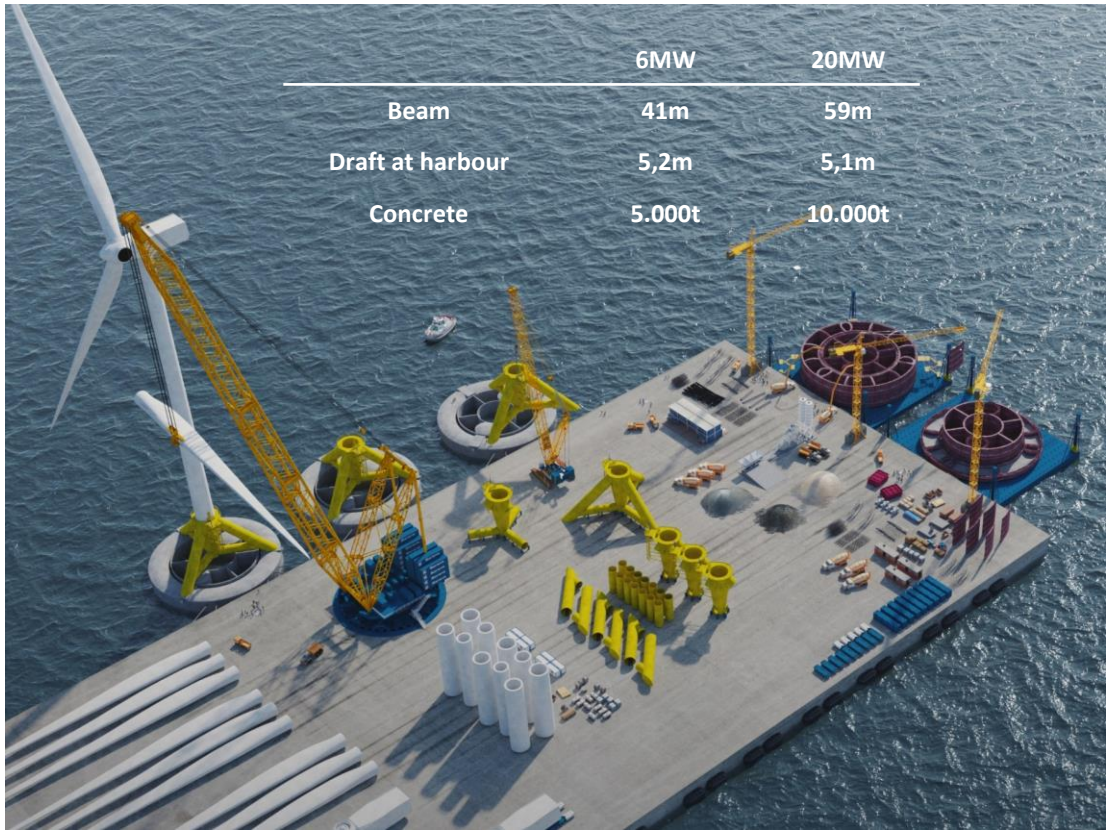
- Compact and Low Draft
- Both tanks built together at the same level
- Simple caisson like geometry for low-cost industrialized construction & load-out strategies (commercial semisub barges adapted / AIRBARGE© modular barges)
- Reduced construction yard area
- 3 unit/month construction delivery rates (with 2 production lines)
- Suitability of most harbours
- Very Intensive in Local Content

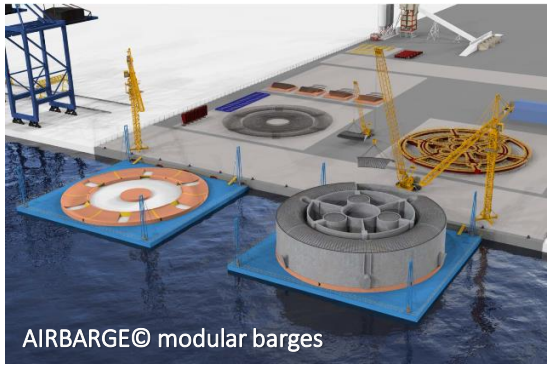
Transition Piece: STEEL TRIPOD

- Tubular Tower-like elements: 6MW ~ 200t; 20MW ~ 600t
- Preassembled on yard
- Robust Maintenance-free connection

Assembly:

- Barge configuration: fully assembled on harbour in vertical position
- Suspension tendons completely pre-assembled
- Tripod, tower, WTG could be installed in a single operation with the same crane





WHEEL technology

Transport & Installation

Fully assembled units are towed-out with conventional tugboats

In tow-out configuration, buoyancy forces press vertically one tank against the other, ensuring solidary behavior

Deployment of lower tank is performed with ballast water with full control of lowering speed.

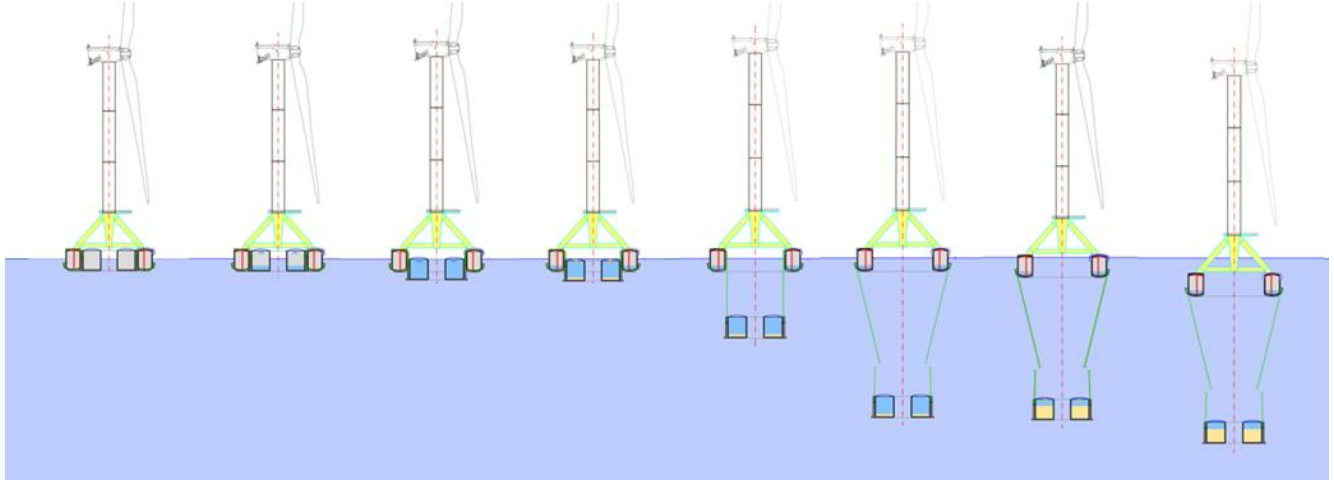
Lower Tank Deployment is a weather restricted operation (Hs<2m)

During Lower Tank deployment:

- the Upper Tank remains on the surface with large freeboard.
- Robust guiding fenders are provided between tanks
- Tendons self-deploy (no need for any external equipment).

Additional ballast weight is provided by partially filling the open chambers of the Lower Tank with sand

The complete operation, processes and means have been analyzed in detail and validated by Boskalis



WHEEL technology

Operation

Ultra Stable Spar configuration

High transparency with very low exposed area on the surface for reduced loading and mooring costs

Excellent seakeeping performance and slow motions

- Very high mass inertia leading to high pitch natural periods ~ 40s
- Low water plane area leading to high heave natural periods ~ 50s

Synthetic lines for suspension tendons

- Highly proven for multiple offshore applications
- Durable and maintenance-free
- Outstanding fatigue performance
- Redundant

Large water depth range (70m and beyond)

High stability and hydrostatic stiffness: No need for Active Ballast Systems

Low-carbon and circularity enhancement.

Compatible with ATOMS technology for on-site Large Corrective Maintenance

Tetraspar Demonstrator (licensed by Esteyco)

WHEEL technology

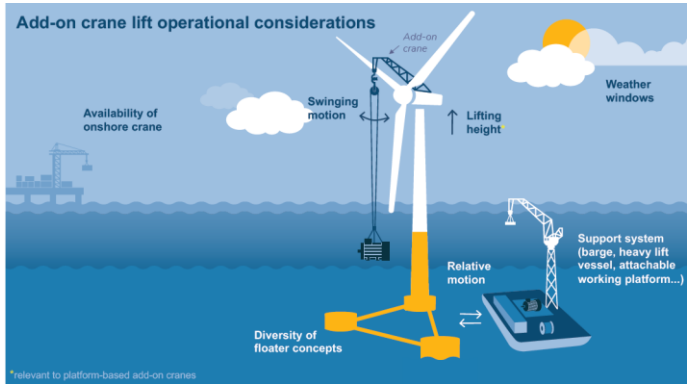
Maintenance strategy >Linked to ATOMS

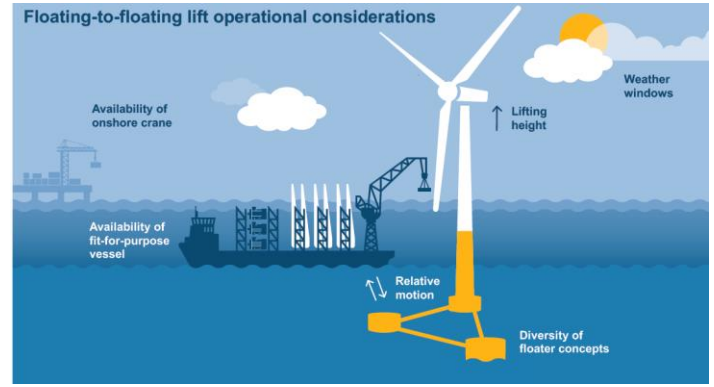
TODAY

- **O&M** costs: **~30% of the total** of OW energy costs.
- MCR costs: **~25% of O&M costs**
- Only commercial option for **bottom fixed → jack-ups**
- Average **duration** of jack-up: **3 days** (up to 6)
- Only commercial option for **FOW: tow-to-port**
- Average **duration** of tow-to-port**: up to 40 days**

CHALLENGES

- **Bottom fixed OW:**
  - **Lead time** / mobilization costs of jack ups
  - **Deeper waters** using larger HH / soil conditions
  - **Emerging OW markets** / new investments
- **Floating OW:**
  - Tow-to-port may hold back FOW projects
  - **No commercial solution for on-site MC**

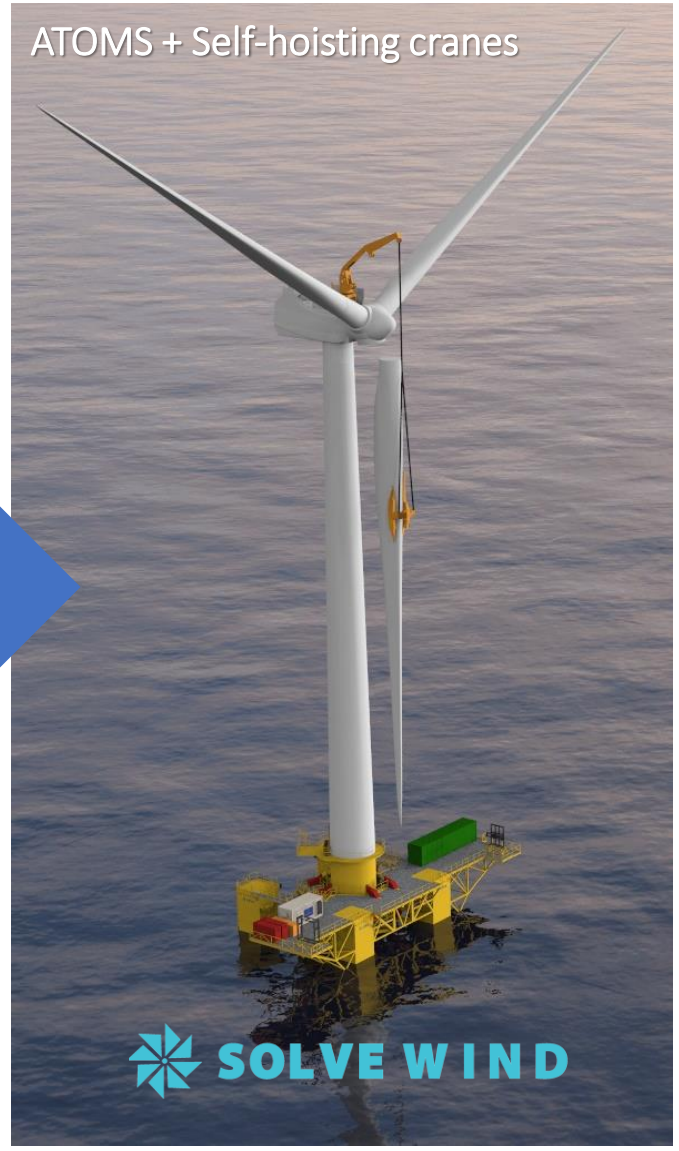




Source: PEAK wind

WHEEL technology

Maintenance strategy >Linked to ATOMS



FOW Major Component Replacement strategies:

Only commercial option for FOW: **tow-to-port** (average duration 40 days + very high cost)

As other floater concepts, **WHEEL is compatible with tow-to-port strategies**.

But we do believe that **tow-to-port** for MCR **may hold back FOW projects**

Today, there is **no other commercial solution** for on-site MCR. Working lines:

- Floating-to-floating lift → relative motion & availability of fit-for-purpose vessel
- Add-on crane lift → relative motion & support system

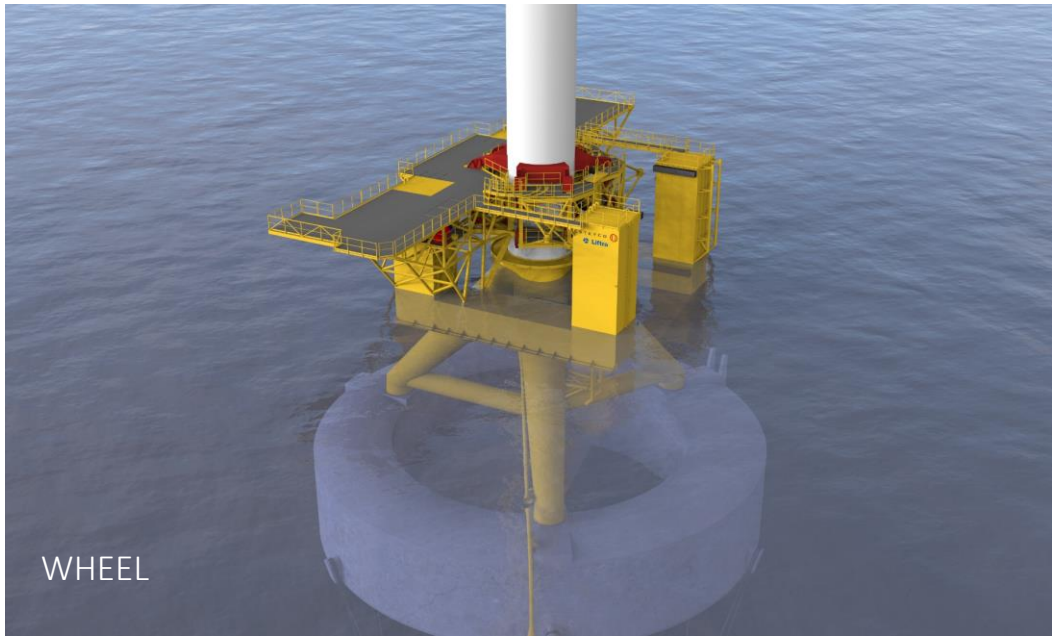
ATOMS (ESTEYCO) + self-hoisting cranes (LIFTRA) on-site MCR:

ATOMS gives the capacity to **couple to the substructure a solidary working deck** from which proven commercial **SELF-HOISTING CRANES** can be installed and operated to service the turbine.

ESTEYCO and LIFTRA have created **SOLVE WIND** to join forces to provide the market a competitive solution for onsite MCR for offshore wind, both for bottom fixed and floating.

Applicability

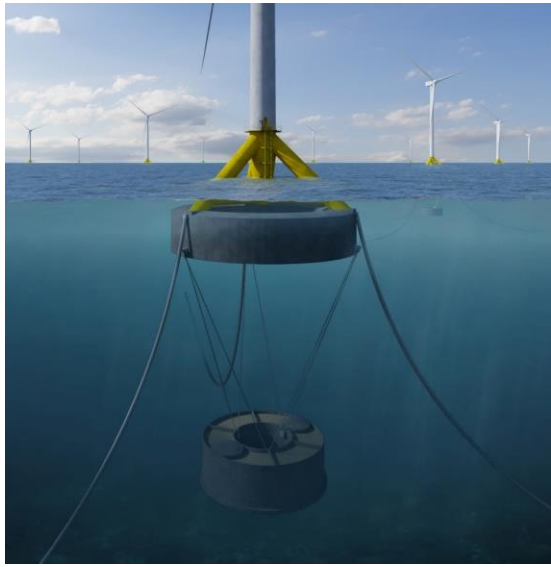
ATOMS next generation



WHEEL technology

Main Competitive Advantages

- ✓ **Significant CAPEX reduction compared with other floating solutions**
  - Based on well-known concrete construction techniques, available in almost all the countries
- ✓ **Compact and low-draft: no more than 60m diameter and around 5m draft for float-off for 20MW WTG**
  - Wide range of ports availability
- ✓ **Fast industrialized production: caisson type configuration**
  - Low-cost concrete construction strategies (barge-based)
  - Reduced construction yard area (less than 10Ha). 3 units/month construction delivery rates (2 production lines)
  - Overcome expected bottlenecks in floaters supply chain (steel and concrete)
- ✓ **Ultra stable configuration: excellent seakeeping performance and slow motions**
  - Very high mass inertia leading to high pitch natural periods ~ 40s
  - Low water plane area leading to high heave natural periods ~ 50s
- ✓ **High stability and hydrostatic stiffness: no need for Active Ballast Systems**
- ✓ **Compatible with ATOMS technology for on-site Major Component Replacement**
  - Also compatible with tow-to-port strategies, but available for a more competitive and de-risky alternative
- ✓ **Low-carbon and circularity enhancement**
  - Less than a half material than a concrete semisubmersible and significant reduction compared to steel solutions
  - Marine life regeneration strategies linked to all lifetime cycle, including decommissioning (sanctuaries)
  - Reduced dimensions (floater and mooring) provide more beneficial context for other activities (as fishery)

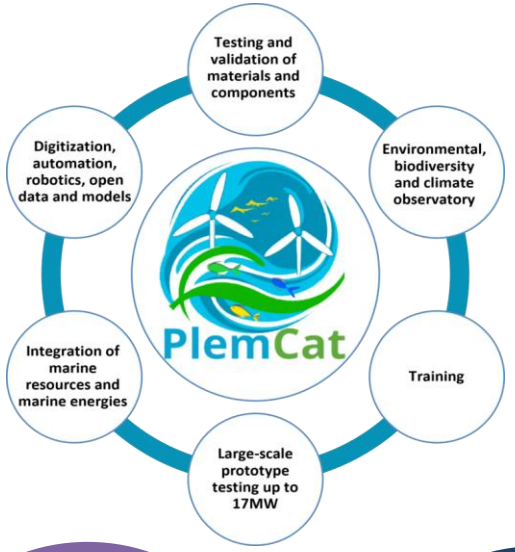


U.S. DEPARTMENT OF ENERGY

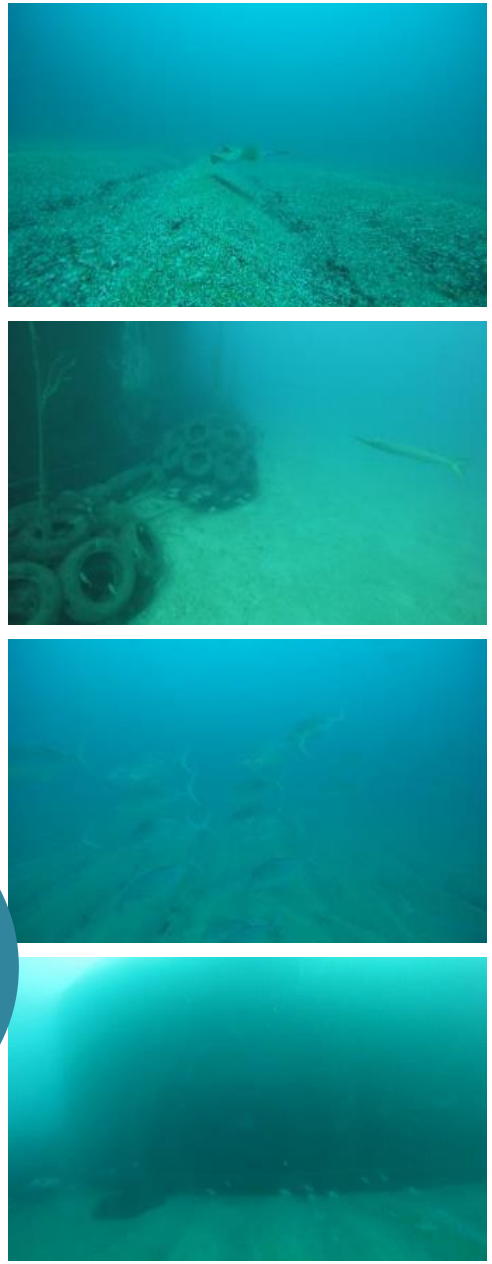
WHEEL technology

Main Competitive Advantages

Beyond technology demonstration: impact assessment and synergies with other activities:

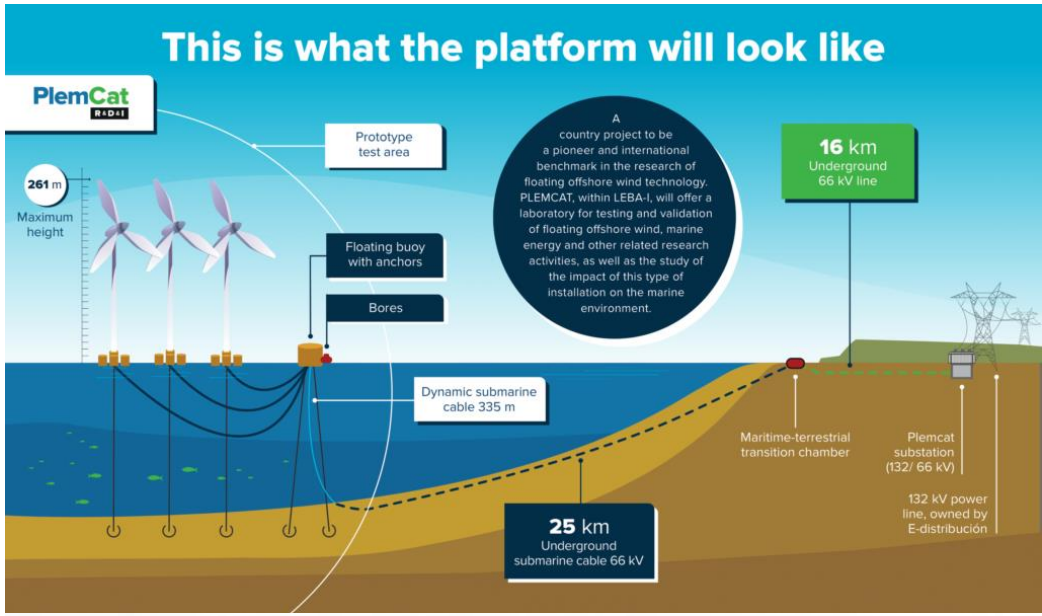


- O&M — linked with Atoms
- Energy managment — linked with energy-intensive consumers
- OW& Aquiculture — (in progress)
- Regenerative strategy — linked with UGI International Consortium



To conclude: the PLEMCAT an opportunity for all

- Spain aspires to be a hub of innovation in floating offshore wind energy
- In 2023 14 of the 51 technologies identified in the world were Spanish.
- To achieve this goal, R&D platforms are a key element
- In addition to technological demonstration, they allow early assessment of the impacts of offshore wind on the environment in which they are installed, which is highly valued by all.
- In this way, measures can be taken to ensure the best implementation of future commercial wind farms (expected in Catalonia/PROENCAT)
- In addition to the price, environmental, social and territorial integration measures will be required of them.
- High value: PLEMCAT is in an area of high potential defined in the POEMs
- The nature of the projects (offshore wind platform and prototypes) means that their processing and implementation is neither 'obvious' nor simple.
- Esteyco offers the project its experience and lessons learned in the installation of other prototypes in PLOCAN
- Since 2018, ELICAN has been the host of numerous R&D projects (valued +20Meur) on an uninterrupted basis.



WHEEL prototype in PLEMCAT

ESTEYCO

Moltes gràcies per la vostra atenció,

Imma Estrada
Directora Desenvolupament
imma.estrada@esteyco.com

Enginyers Industrials de Catalunya

Barcelona
13 de març 2025