



Sea trials of W2Power prototype with FRP towers

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CONTENT

- ✓ About us
- ✓ FRP towers design and manufacturing
- ✓ FRP towers installation on W2Power prototype
- ✓ Monitoring system
- ✓ Verifications and load-out
- ✓ Sea trials
- ✓ Conclusions

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✓ **About us**

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ENEROCEAN

- ✓ Lean R&D company based in **Málaga, Spain** (est.2007) and **Canary Islands**
- ✓ Specialised in **Marine Energy Engineering**
- ✓ Owner and developer of the **W2Power solution**
- ✓ **First** multiturbine floating solution to reach sea testing **in the world**
- ✓ Our industrial owners list comprises:
 - **ENI PLENITUDE** (main shareholder)
Fully owned by ENI, one of the biggest energy companies in the world (32000 employees, active in 69 countries)
 - **GHENOVA** INGENIERÍA
Biggest naval engineering company in Spain (>800 employees around the World)
 - **ISATI** ENGINEERING SOLUTIONS
Leading engineering company with more than 100 engineers supporting wind turbine OEMs
 - **INRIGO** AS
Norwegian O&G SME company
 - **1-TECH** BV
Belgian energy consulting company

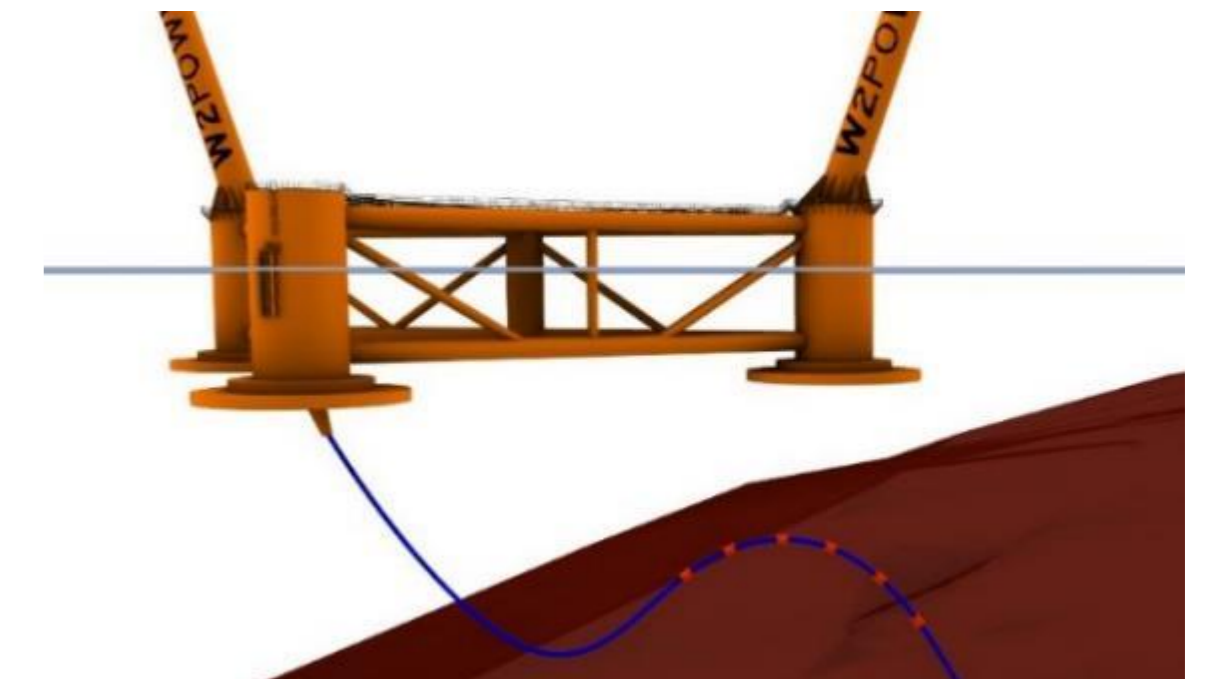
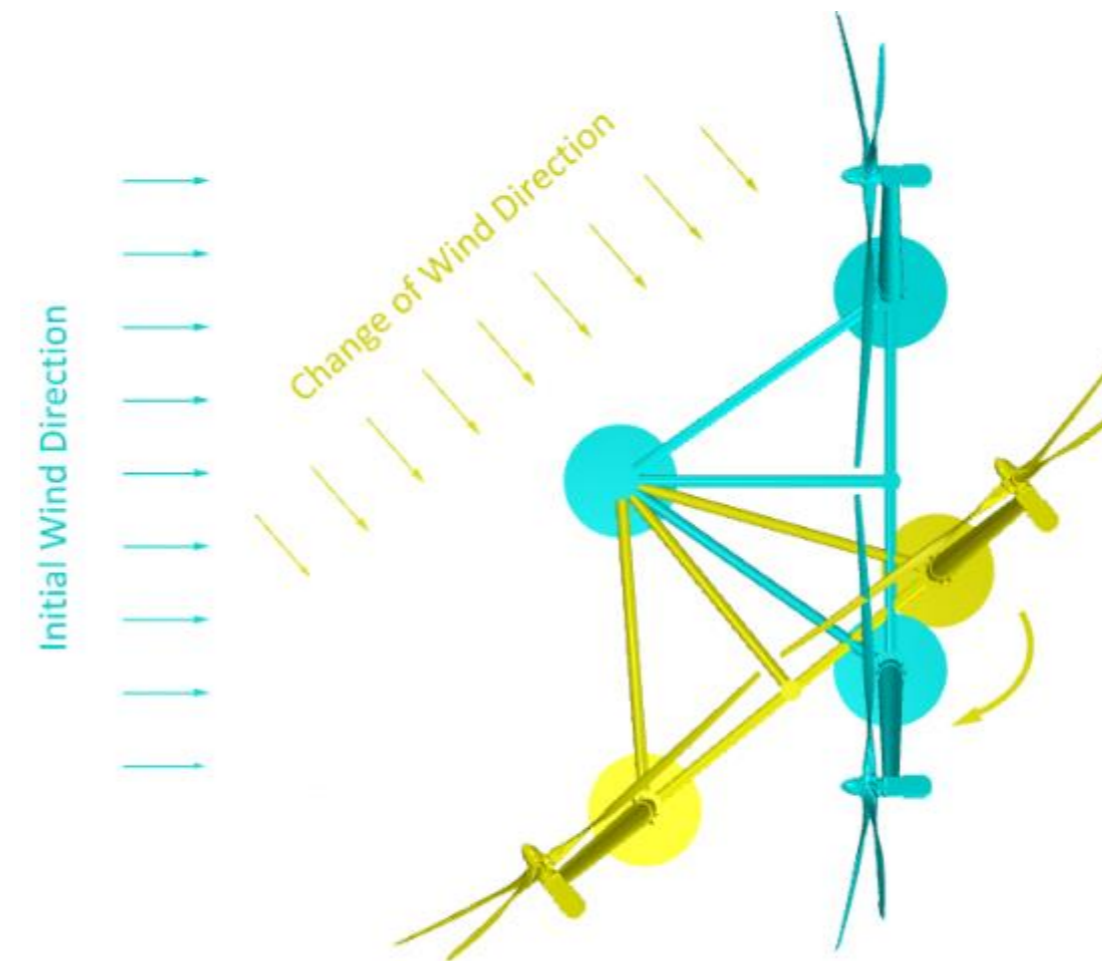
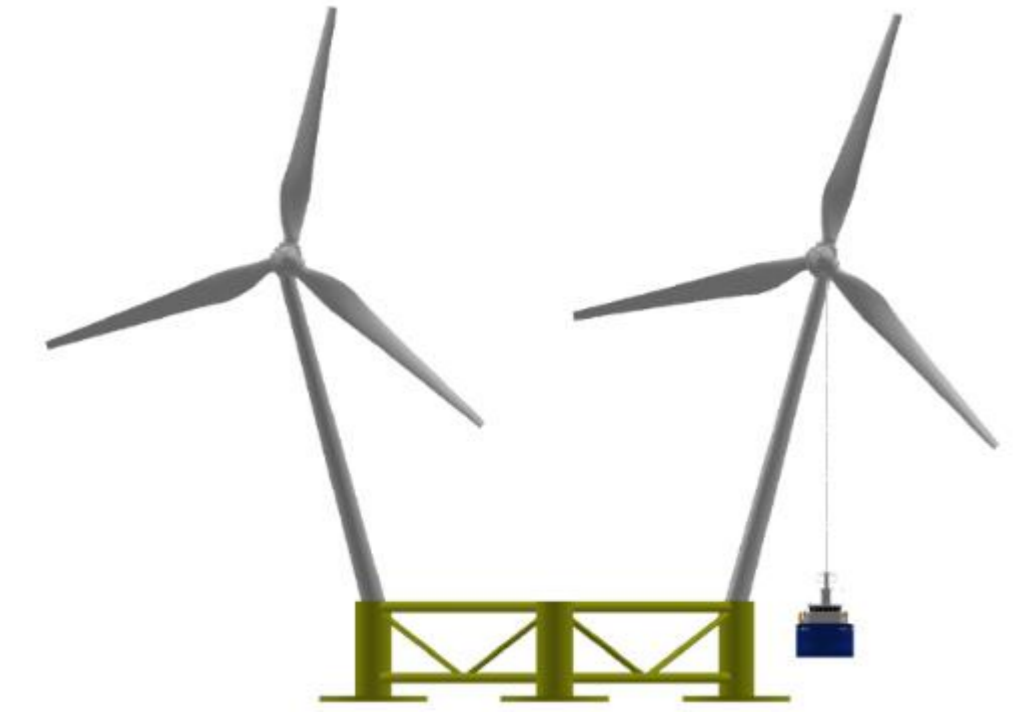
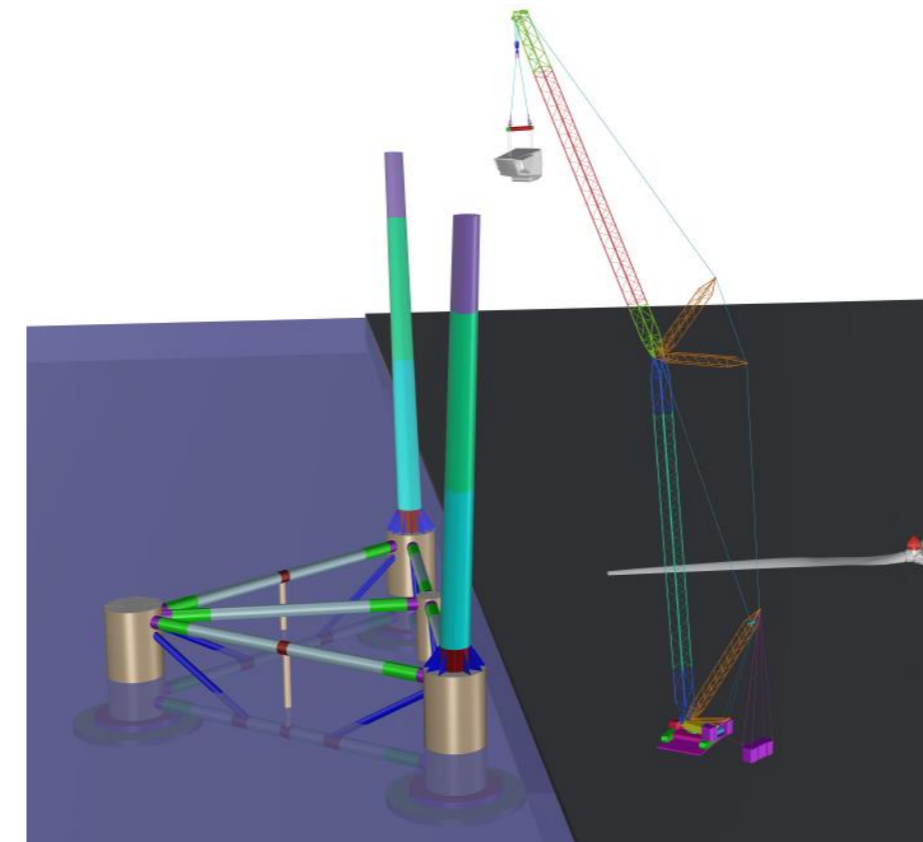


W2Power. The technology

- ✓ **Lightweight but large semi-sub**
 - Sea proven hydrodynamic stability
 - Optimized steel weight per MW
 - Smaller column volume, less draft

- ✓ **Smaller lighter turbines at a lower height**
 - Multiple vendors with proven models
 - Cheaper assembly
 - Lower OPEX (no advanced vessel needed)
 - Lower CAPEX (less steel needed)

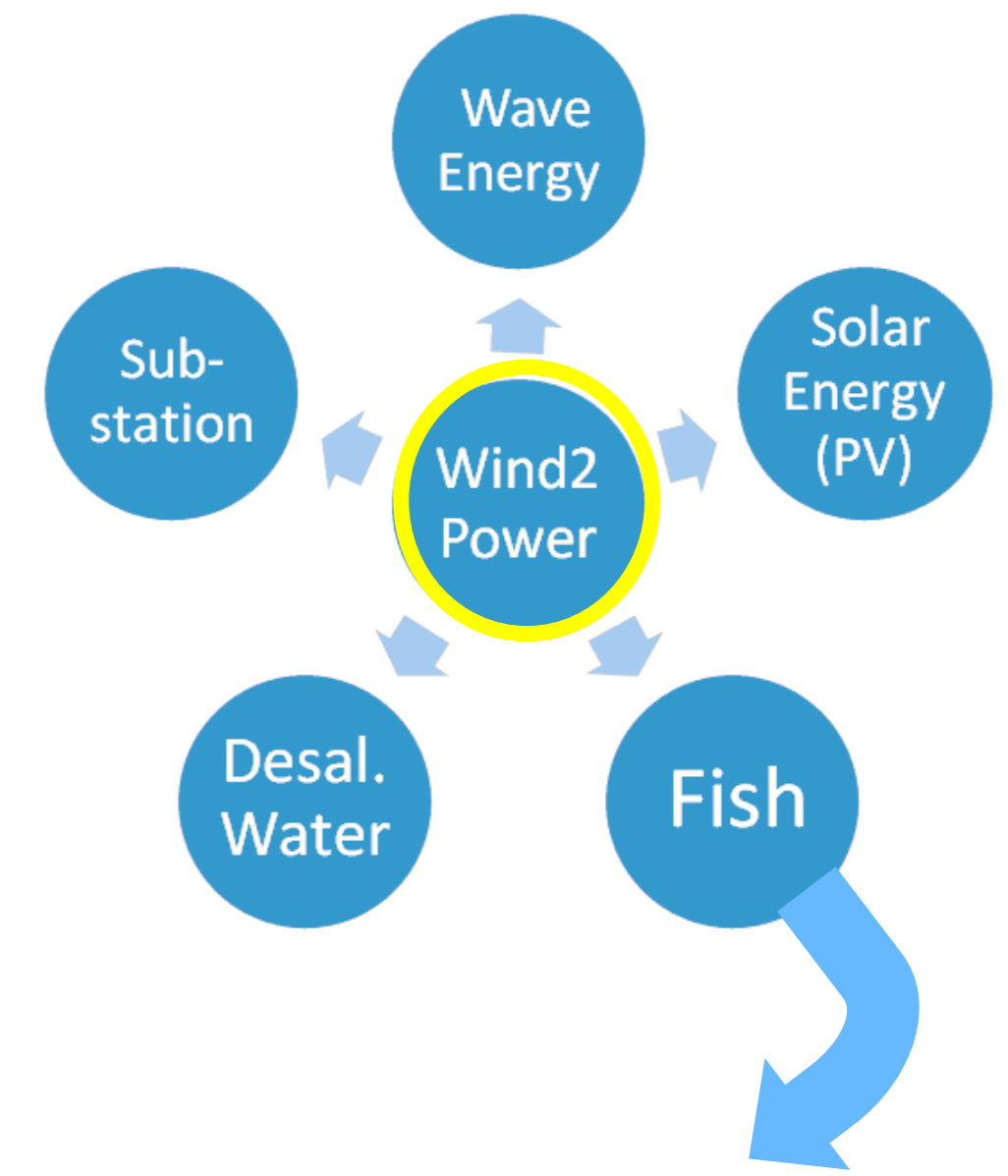
- ✓ **W2Power self-orientation**
 - Proven at sea
 - Allows closely spaced turbines
 - Turbine yaw sub-systems not required
 - Accurate even in low winds



W2Power. Multi-use capabilities

Fish cage protected by, and anchored to, platform. Unique to W2Power.
(no other suggested design can match its accessible moon-pool size)

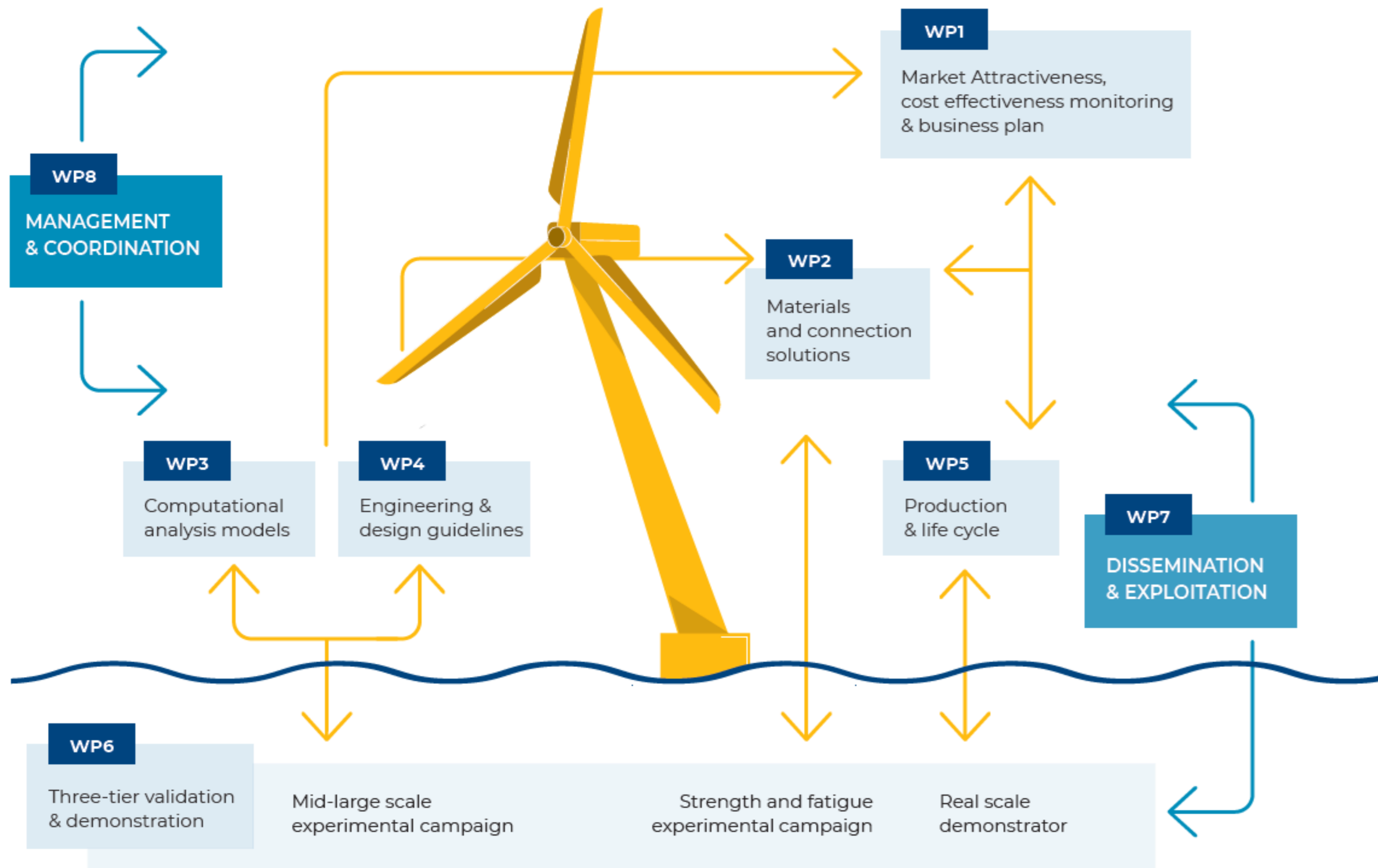
Some multi-use capabilities:



can hold
c.1250 tonnes
Salmo salar
c.1500 tonnes
Seriola spp.

140m circumference cage
(adapted for 30 m depth)

ENEROCEAN. FIBREGY project



1:6 scale W2Power prototype



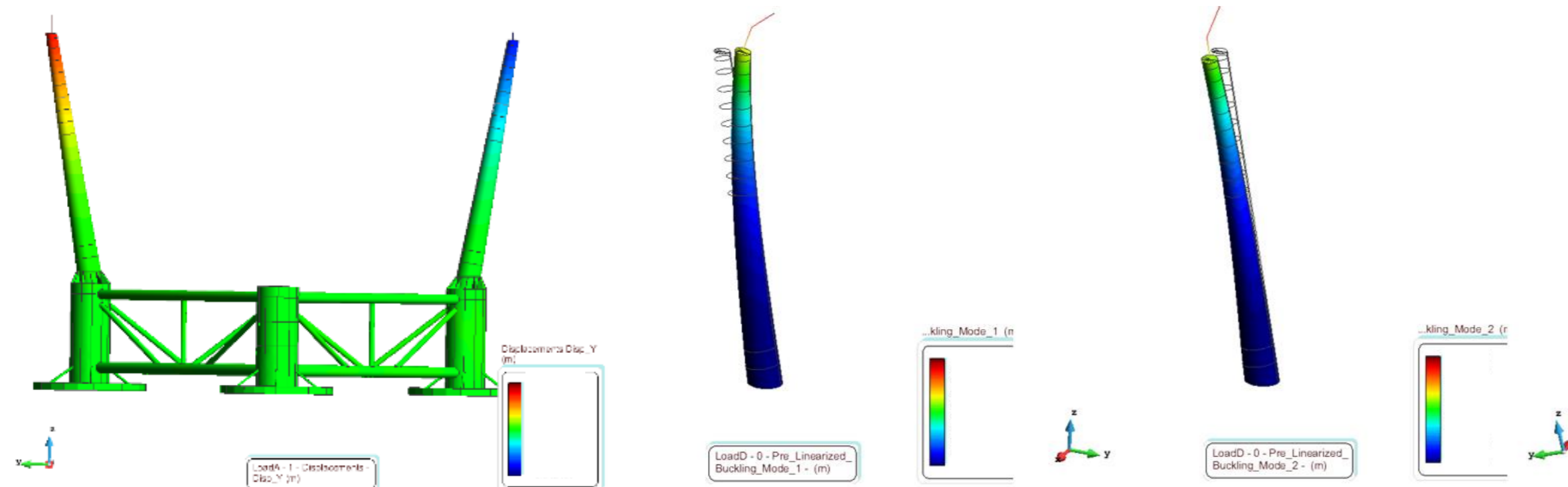
This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 952966.

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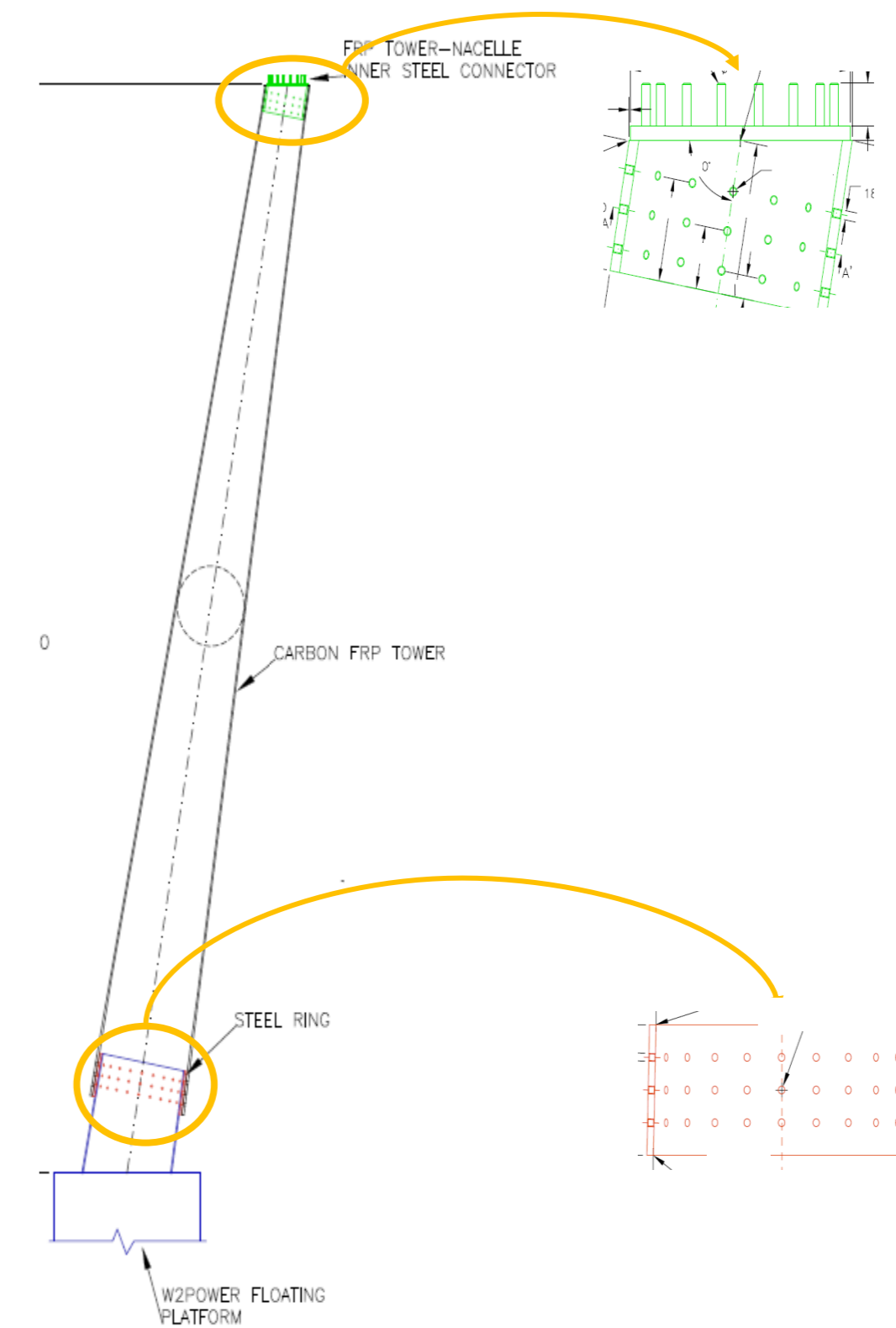
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FRP towers (and connectors) design

- ✓ Towers re-designed in FRP
- ✓ FRP – steel connectors designed for tower-platform and tower-nacelle joints
- ✓ Validated thanks to structural assessment based on FEA for different load cases



FEA results: maximum tower deformation (left) and tower buckling mode (right)



Final drawings of FRP tower (left) and steel connectors (right)

FRP towers (and connectors) manufacturing

✓ FRP towers (EXAIL)



✓ Tower connectors (ASTICAN)



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FRP towers installation

✓ FRP towers reception at ASTICAN



✓ Wind turbines disassembly



FRP towers installation

- ✓ Steel towers cut and removed from platform



FRP towers installation

- ✓ Assembly of new FRP towers to the platform



- ✓ Turbine assembly



FRP towers installation

- ✓ Installation completed

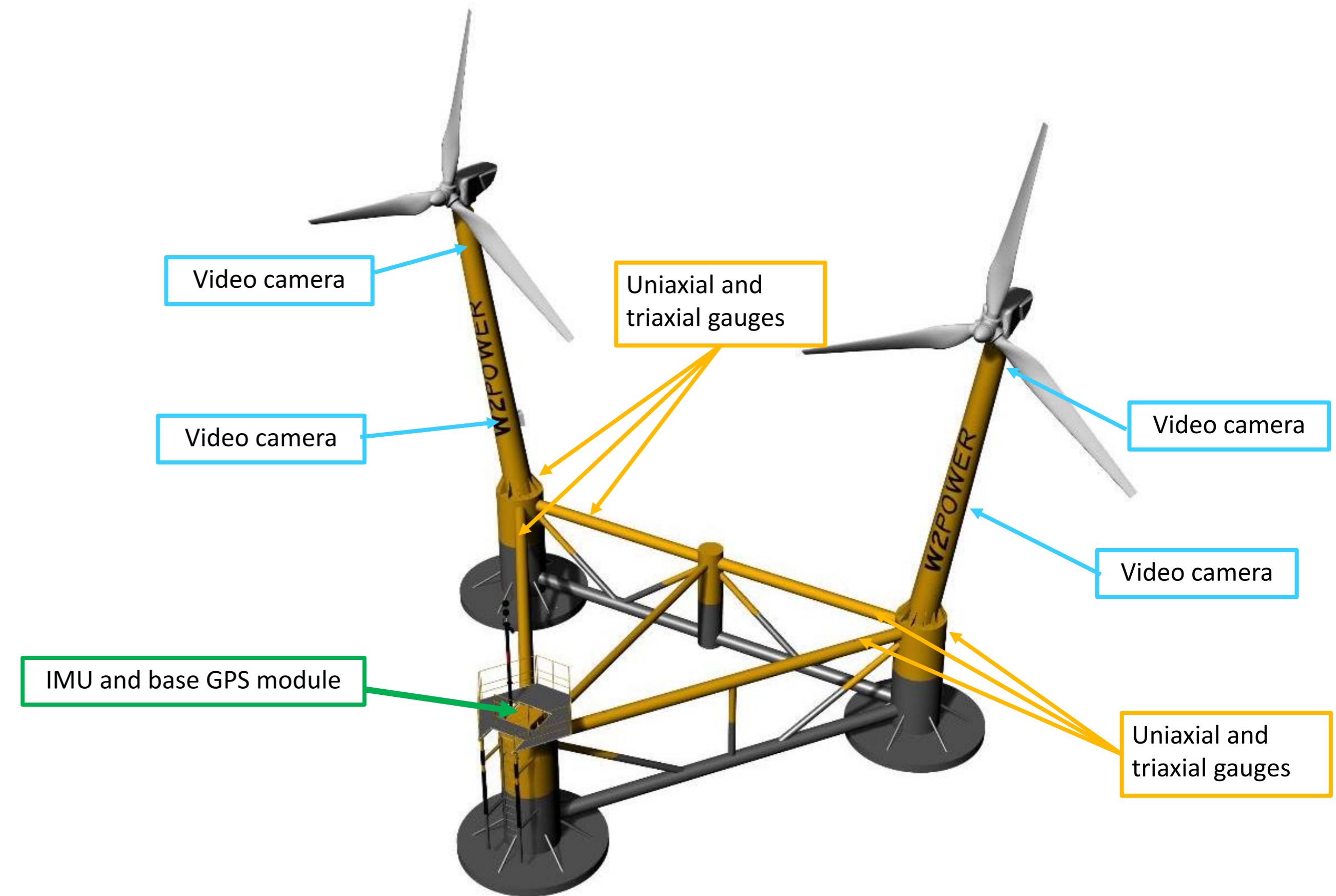


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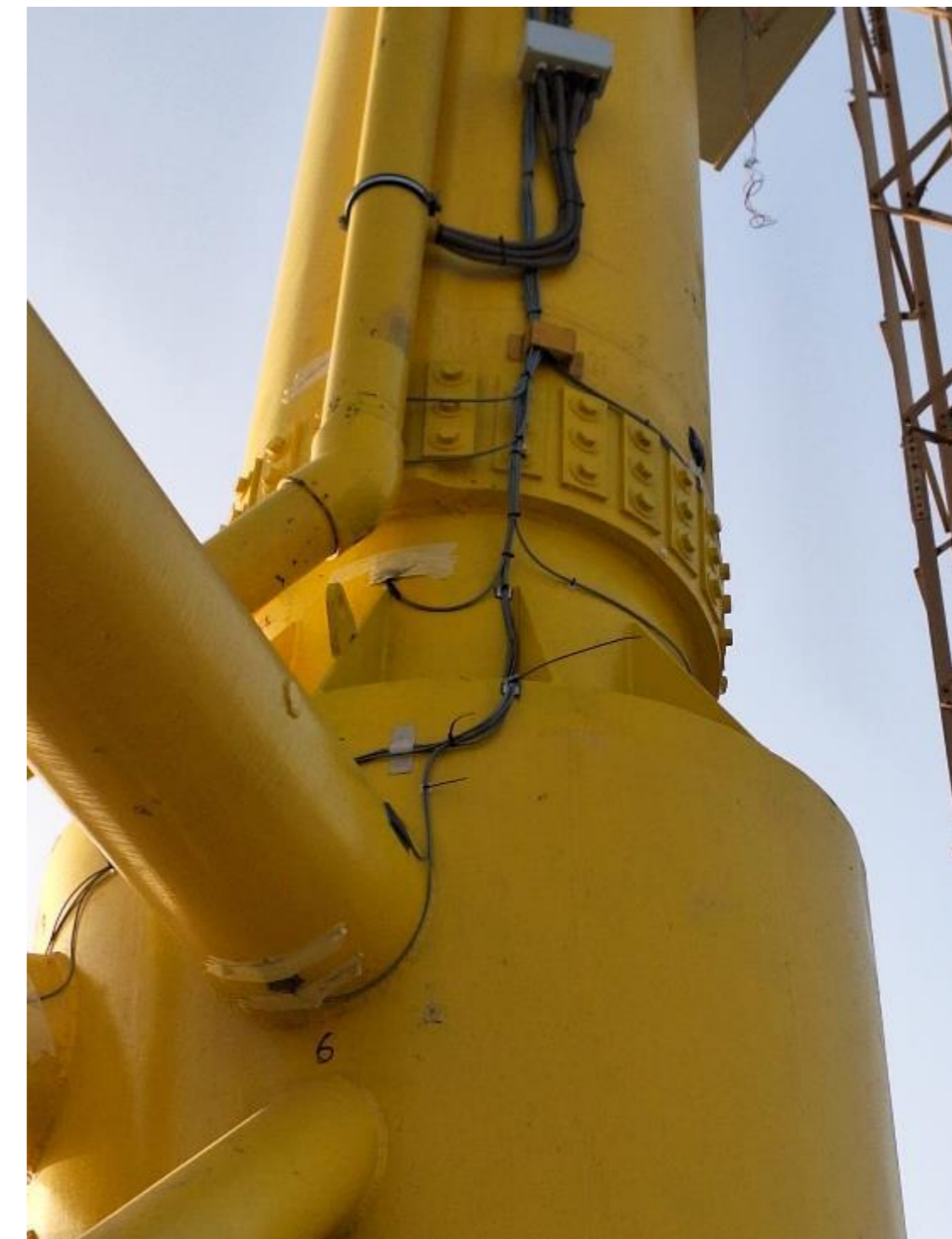
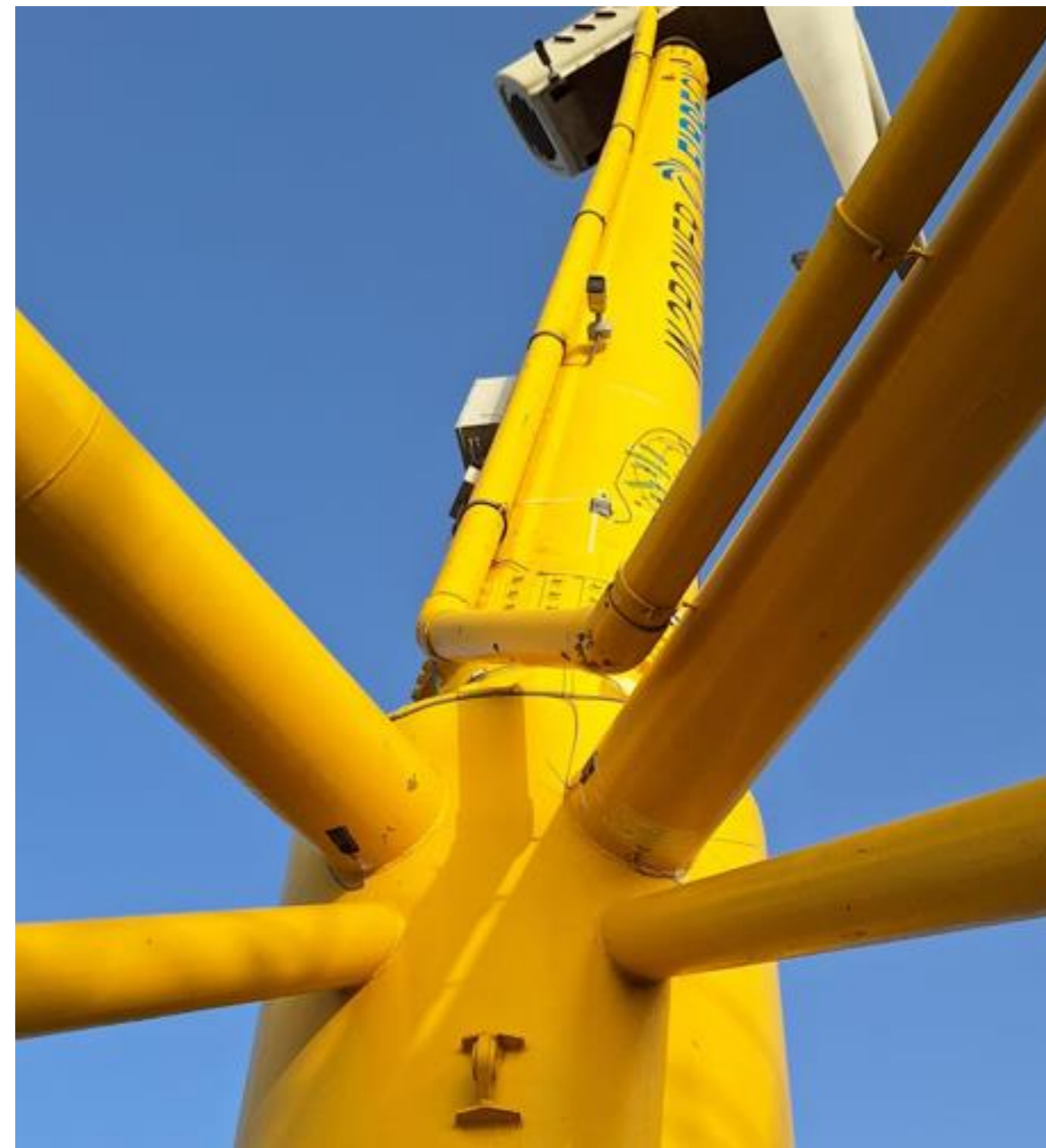
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Monitoring system

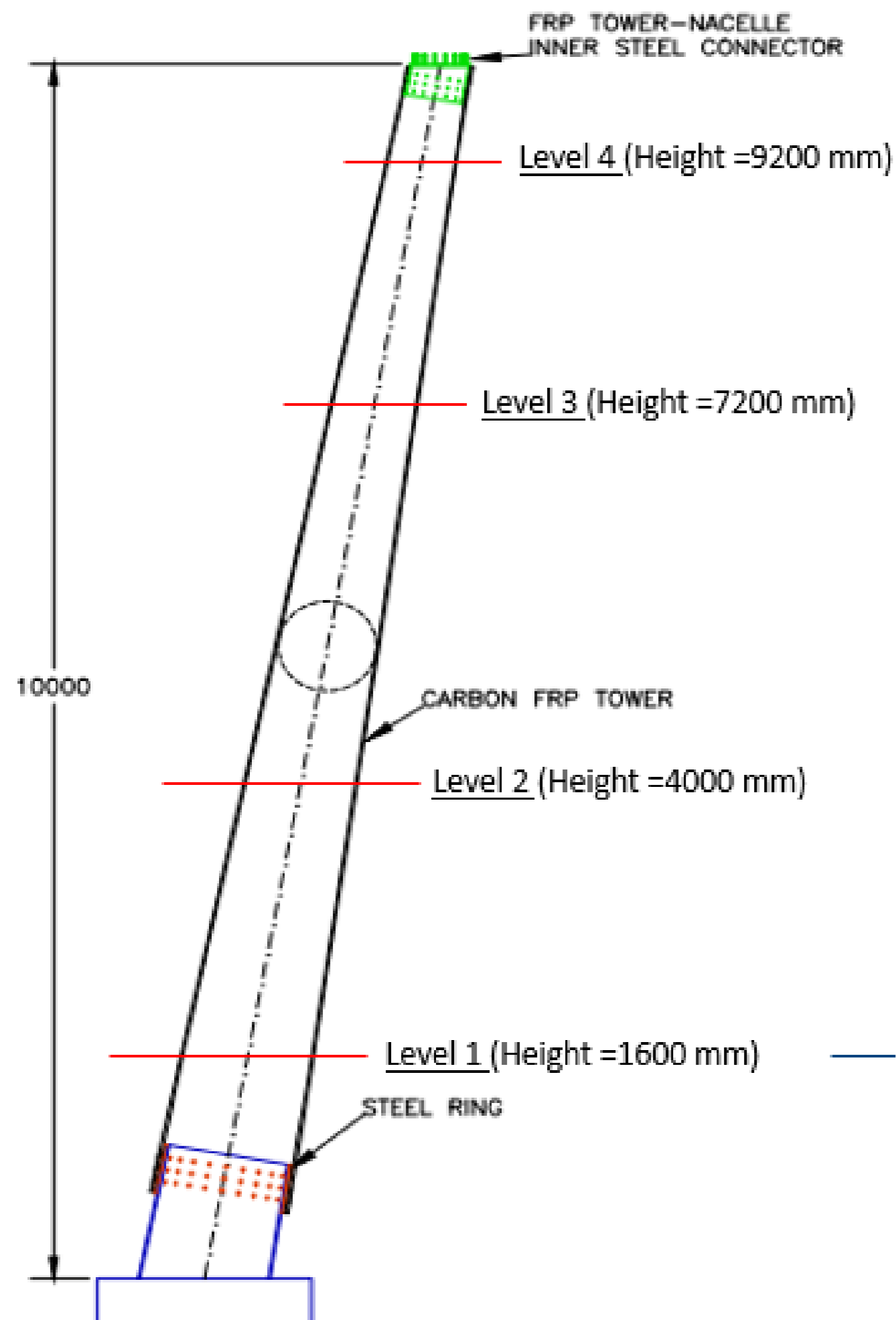
- ✓ Strain gauges on the whole structure
- ✓ Video cameras
- ✓ IMU (Inertial Measurement Unit)



Monitoring system



Monitoring system



Level 1 → 1.6m

- o 8 strain gauges
- o 1 triaxial MEMS accelerometer
- o 4 Fiber Optic sensors (1 temperature, 3 strain sensors)
- o 1 Inclinometer

Level 2 → 4m

- o 2 uniaxial load accelerometers

Level 3 → 7.2m

- o 2 uniaxial load accelerometers

Level 4 → 9.2m

- o 1 triaxial MEMS accelerometer
- o 1 inclinometer

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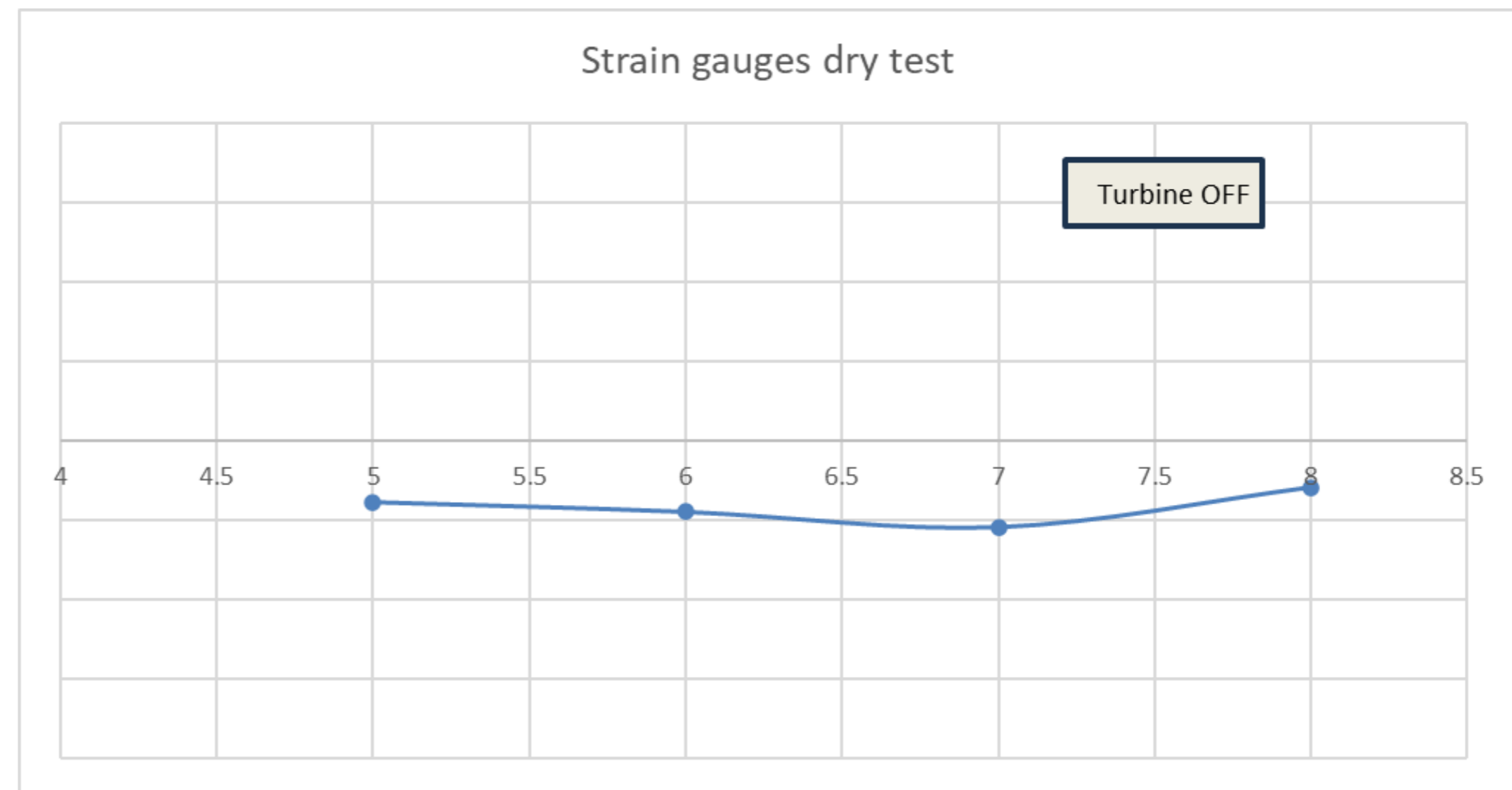
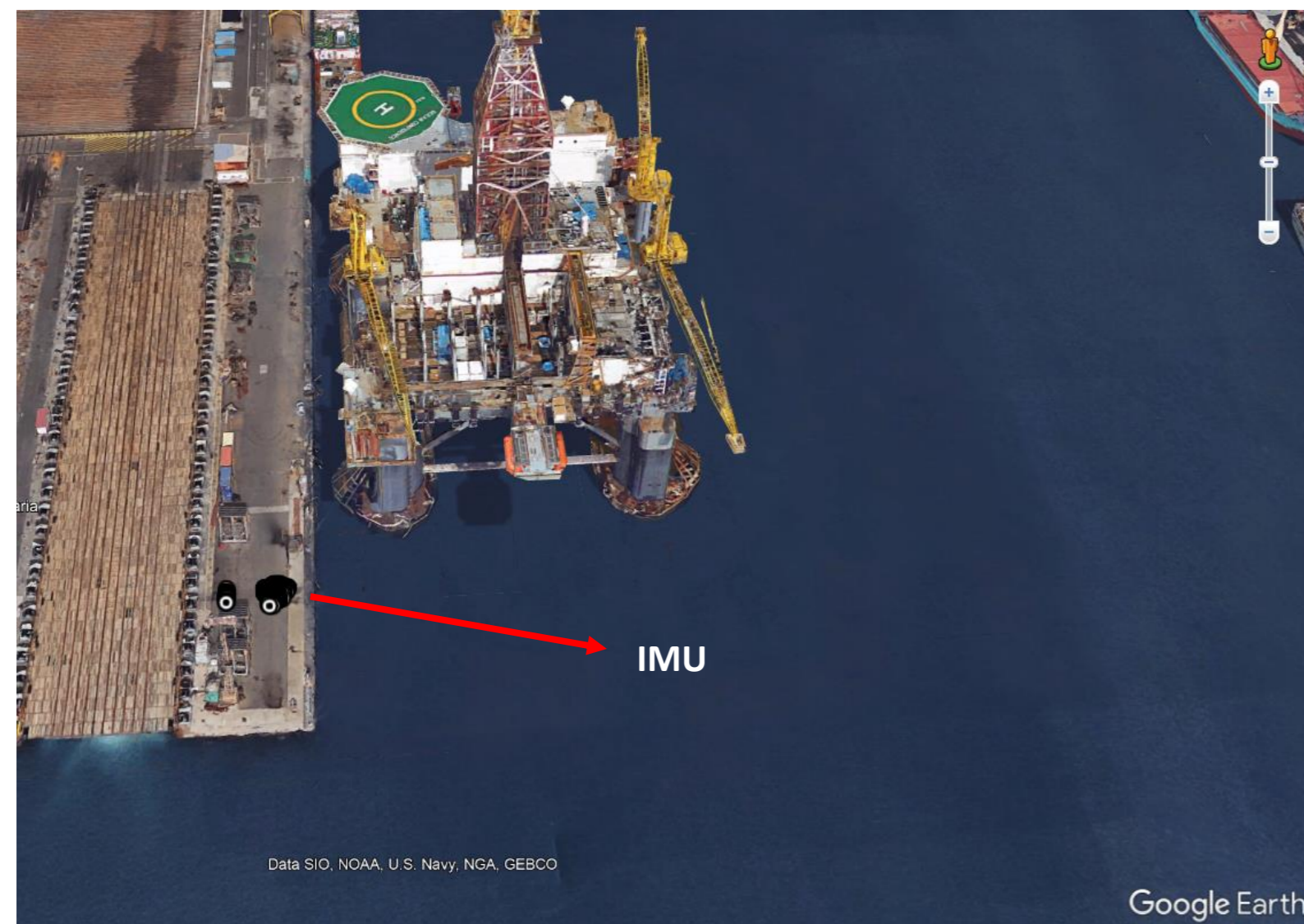
Verifications and load-out

- ✓ Ballast filling with dense fluid by Magellan & Barents to compensate for FRP towers' weight reduction



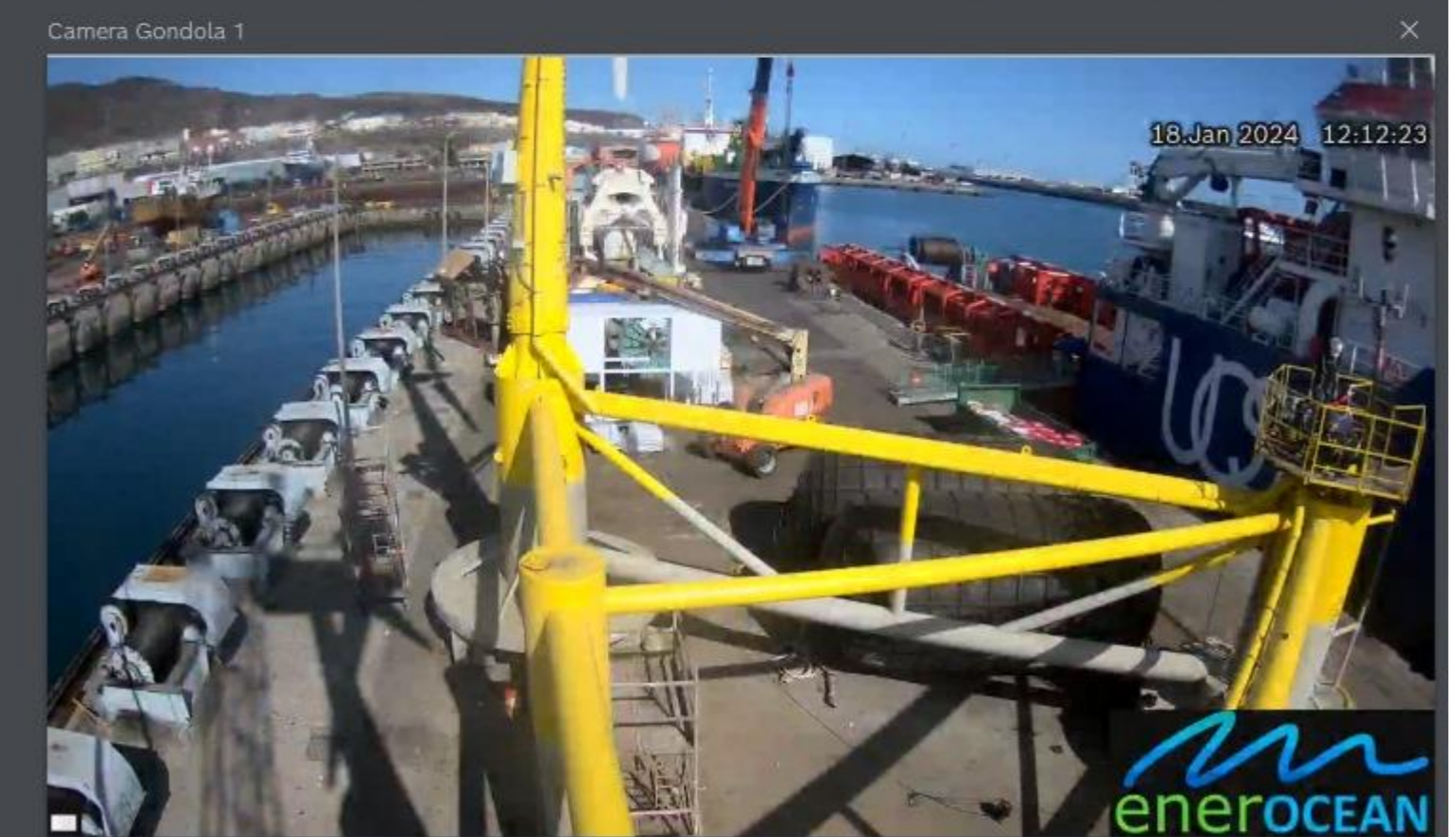
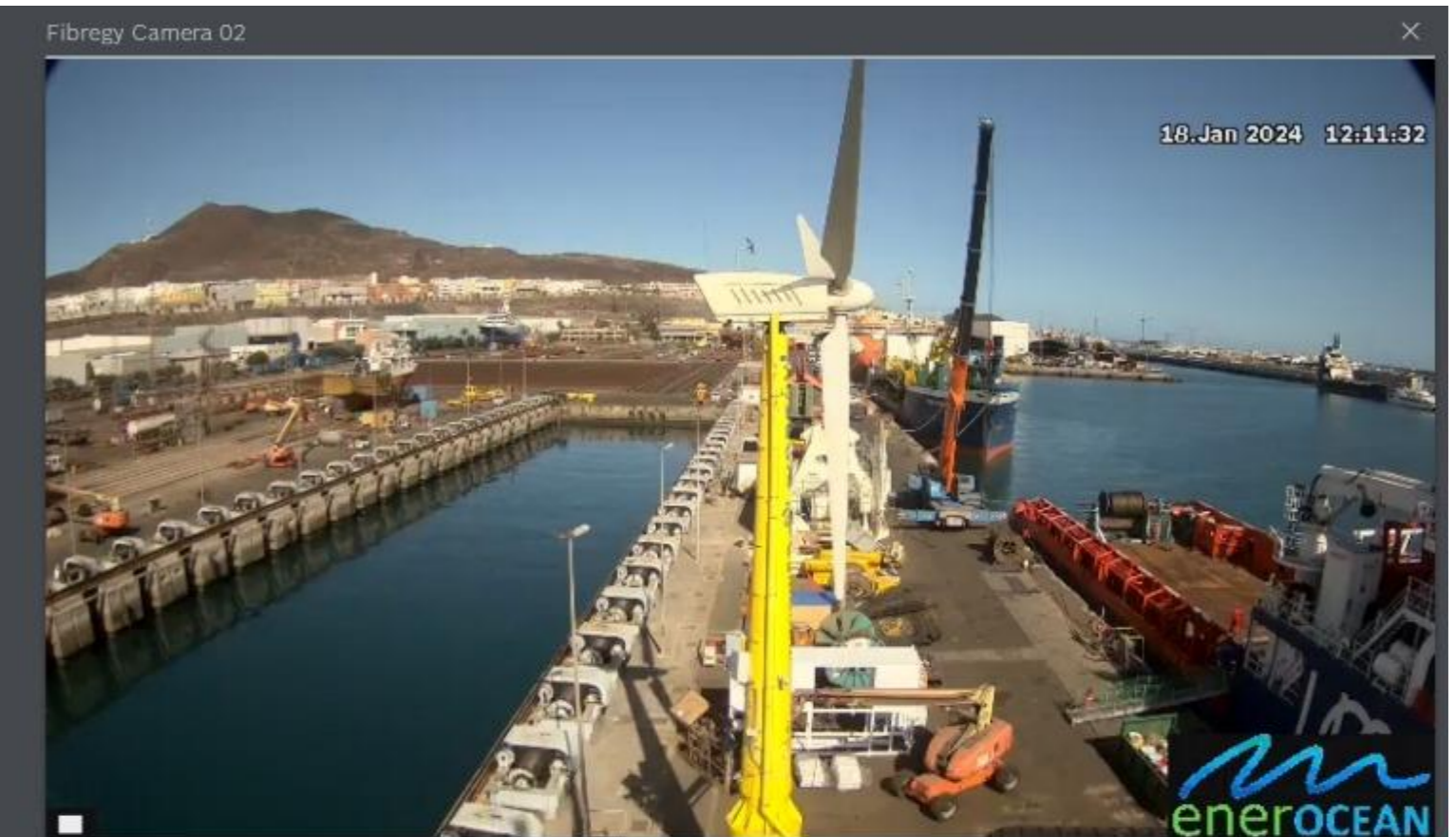
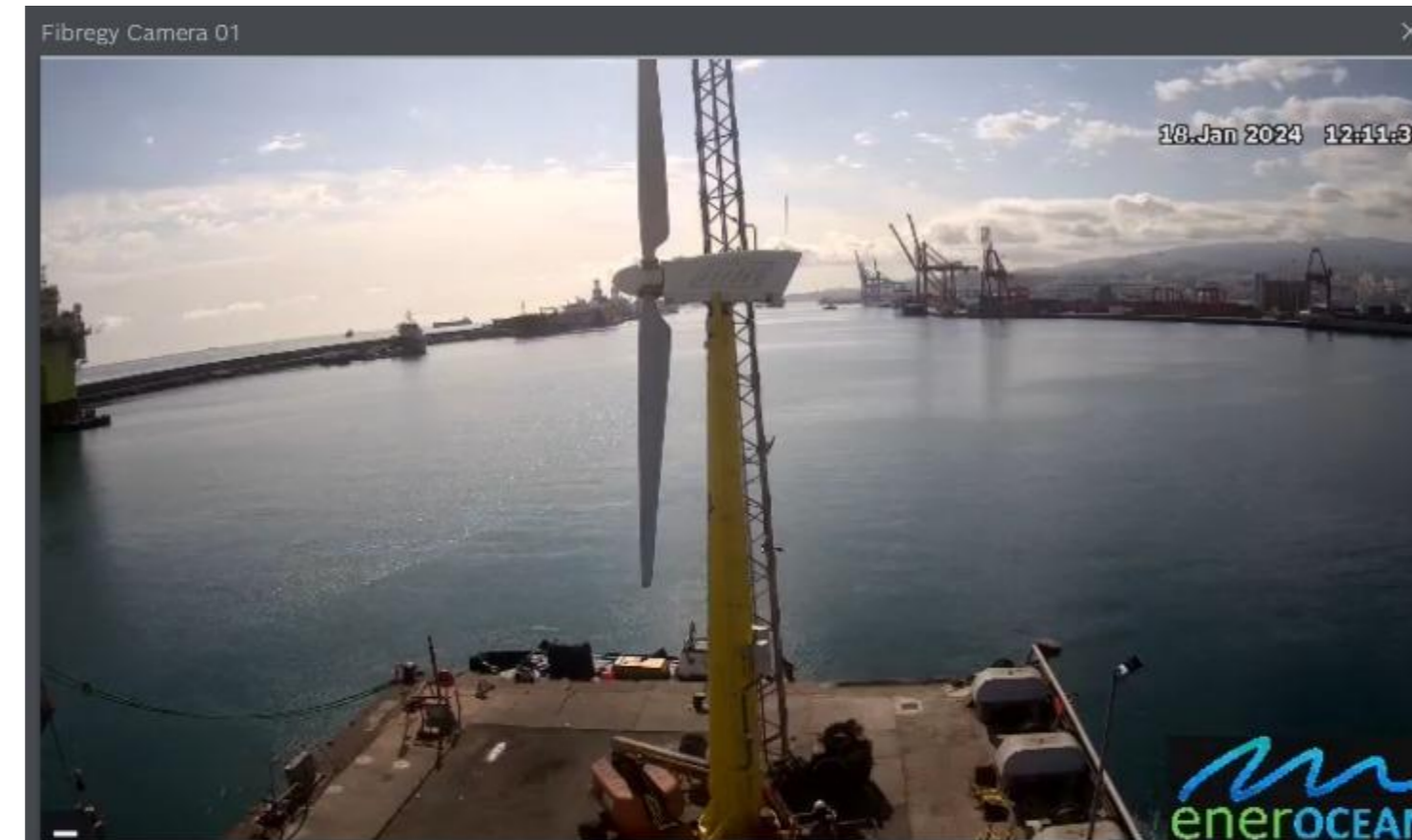
Verifications and load-out

- ✓ Dry verifications: data collected from the strain gauges and the IMU GPS module (non-representative)



Verifications and load-out

✓ Video cameras:



Verifications and load-out

- ✓ W2Power load out

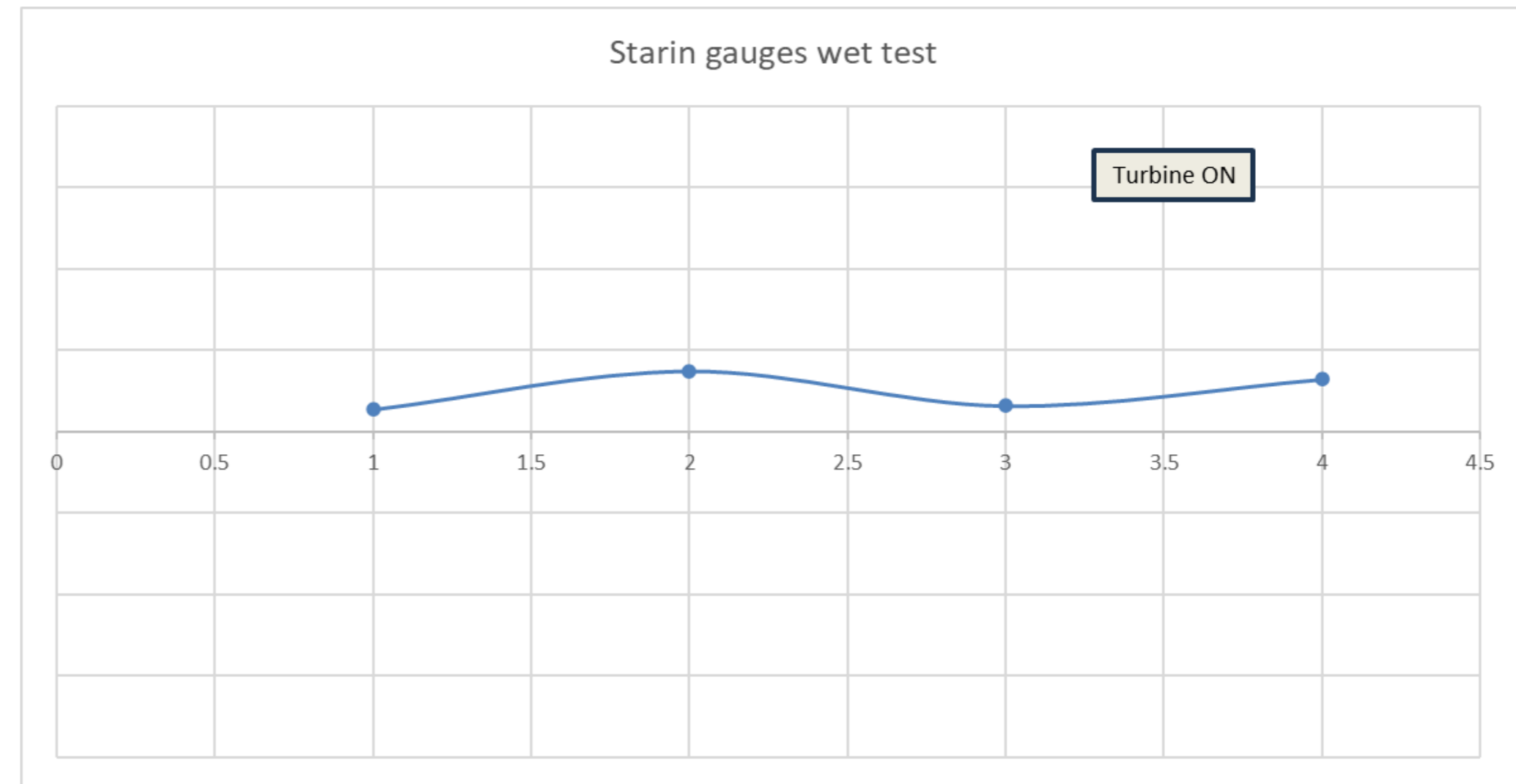
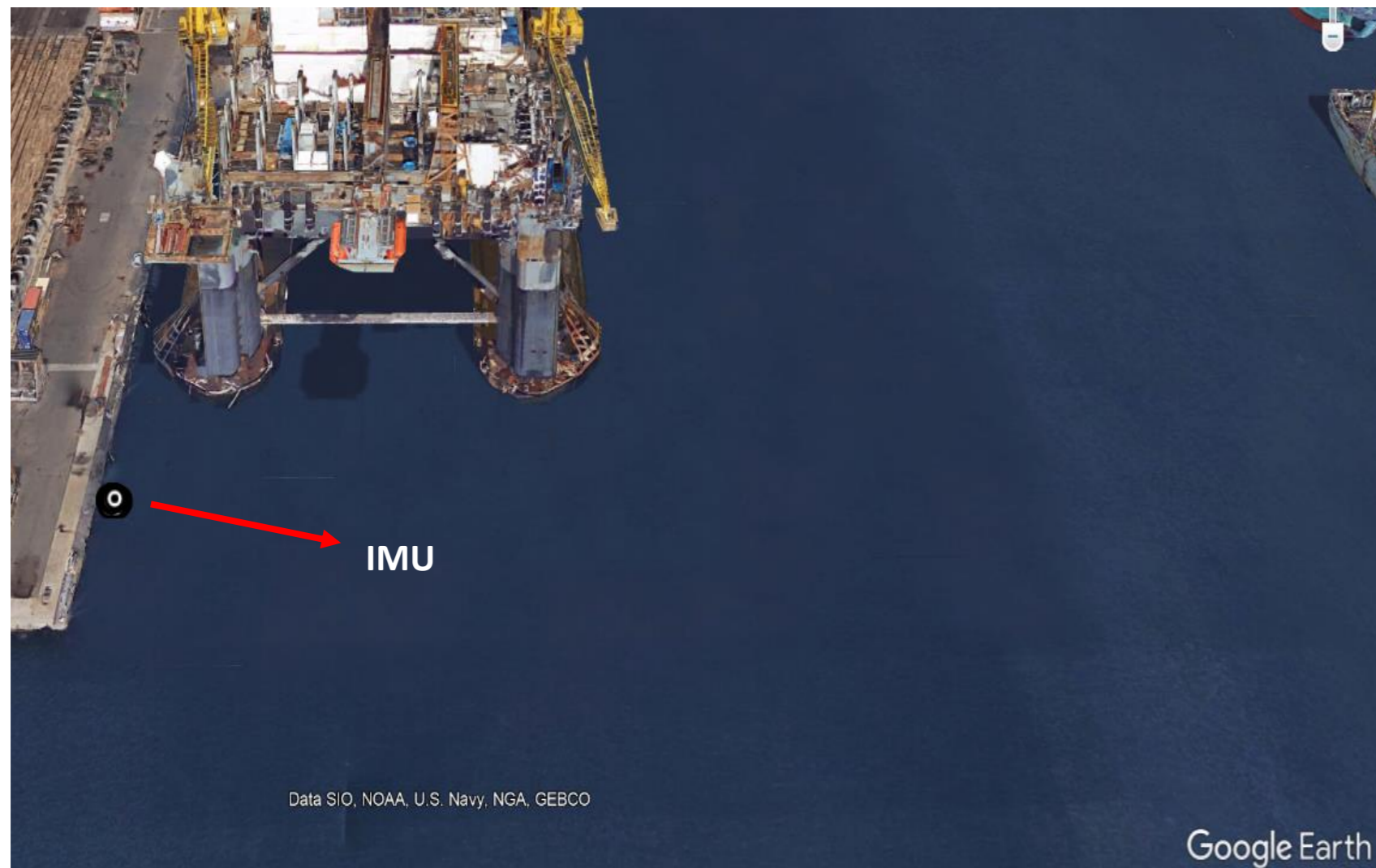


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Sea trials

- ✓ Wet verifications: data collected from the strain gauges and the IMU GPS module (non-representative)



Sea trials

✓ Video cameras:



Sea trials

✓ Turbines:



Validation at sea

1:6 scale prototype

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Conclusions

- ✓ First offshore wind prototype with carbon fibre towers
- ✓ Highly valuable experience working with FRP: design, analysis, manufacturing, assembly...
- ✓ Valuable data from extensive monitoring system
- ✓ Close collaboration with top players in the naval and renewable energy sectors



Thank you for your attention

