ISTITUTO DI INGEGNERIA DEL MARE

Le sfide della ricerca per lo sviluppo del Floating Offshore Wind

Claudio Lugni
(CNR-INM)
italian delegate of the IWG (Offshore) Wind (SET Plan)

2019

from:
SET PLAN DoI

Look at the future, but …

from BFOWT
(North Sea)
…
to Floating WT
(Mediterranean Sea)

Wind Energy in EU (I)

Wind energy is the renewable energy technology expected to provide the largest contribution to the RE targets for 2020 and beyond.

Installed wind power capacity in the EU is currently around 140 GW:

- approx 127 GW of the capacity is onshore
- 13 GW is offshore.

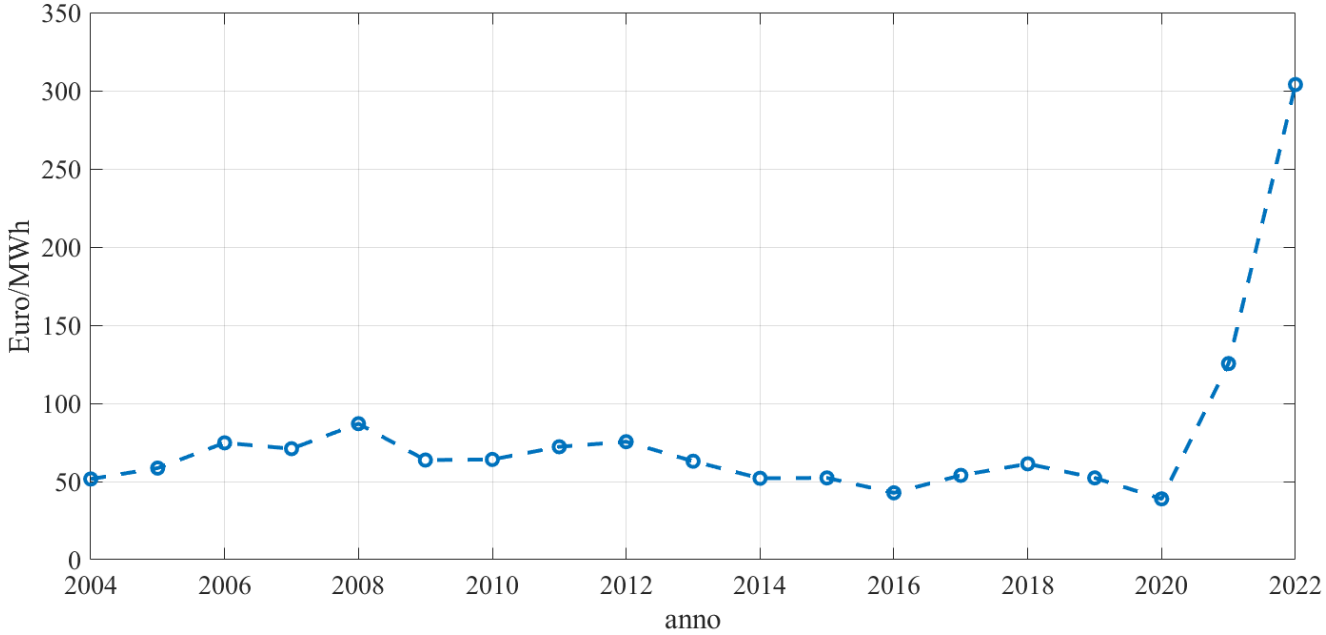
By 2020 total installed wind energy capacity could reach 210 GW (14% of elect. Demand)

1 - Offshore wind costs must be reduced through, but not only, increased performance and reliability

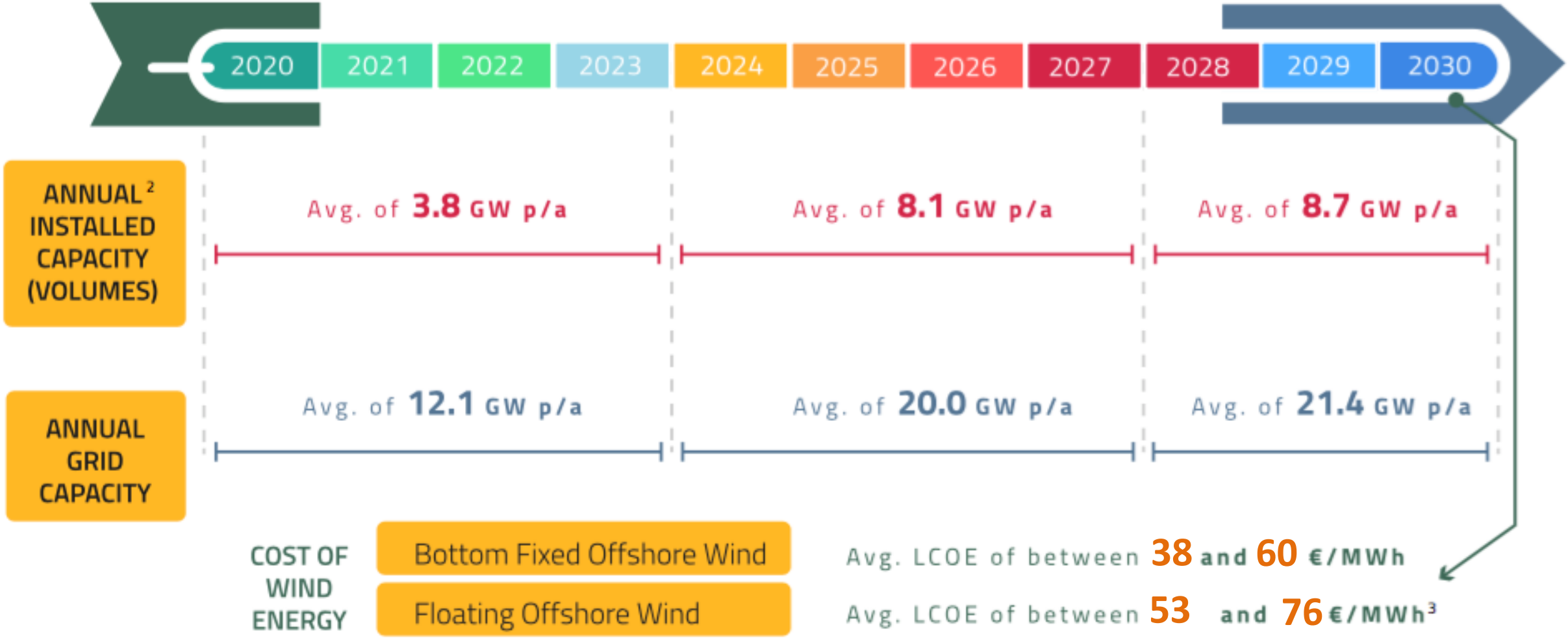
2 - There is a need to develop (floating) substructures or integrated floating wind energy systems for deeper waters and wind energy systems for use in other marine climatic conditions, to increase the deployment possibilities and to improve the European position in the global market.

Dai vecchi obiettivi… (2019)

Costo annuale di acquisto dell'energia (PUN)
(fonte: GME)

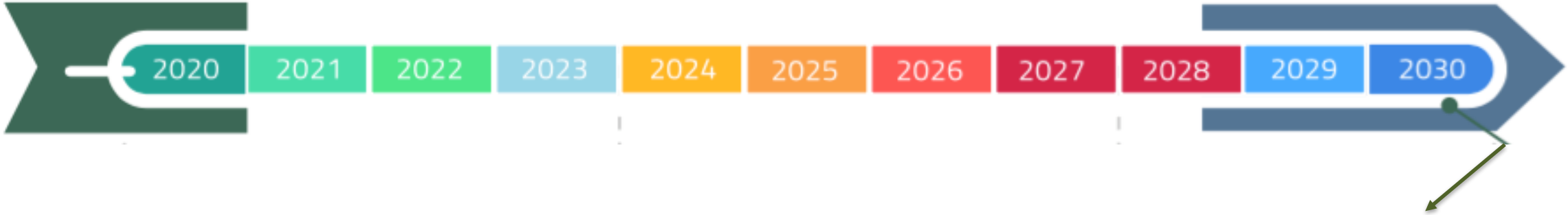


Verso nuovi obiettivi… (2022)



Source: Getting fit-for-55, ETIPWIND 2021

Gli obiettivi del nostro Paese… (PNIEC)



PNIEC

Wind	10GW	20 GW (28 GW)
Offshore Wind	0GW	0.9 GW (2.1 GW)

- Potenzialità stimata Eolico Offshore galleggiante in Italia: ***207 GW*** *(fonte: Politecnico di Torino)*

- Secondo il GWEC (Global Wind Energy Council) l'Italia è il ***3° mercato*** *per potenziale di eolico galleggiante nel mondo, dopo Norvegia e Irlanda (fonte: fondazione Ambrosetti)*

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 842231.

SET Wind

The SET Plan Implementation Working Group for Offshore Wind

2nd SET Plan Implementation Plan for offshore wind

March 2022

The Mediterranean

This area consists of the Mediterranean Sea and seven neighbouring seas and basins. The wind resources are generally medium to low, at an average of 400 W/m^2, with a few places with high wind resources due to local weather phenomena, e.g. in France at the Mediterranean Sea, where the mistral gives 1300 W/m^2; Croatia at the Adriatic Sea, with the bora at 750 W/m^2; the Aegean Sea with the etesian winds at approx. 950 W/m^2). The Mediterranean is, in general, a very deep sea at approximately 5500 m. 80% of the area is deeper than 1000 m, while 15% is in the range of 60 to 1000 m. This makes floating wind the only option for large-scale deployment of wind power in the area.

Specific challenges call for research, development and innovation towards 2030 and 2050

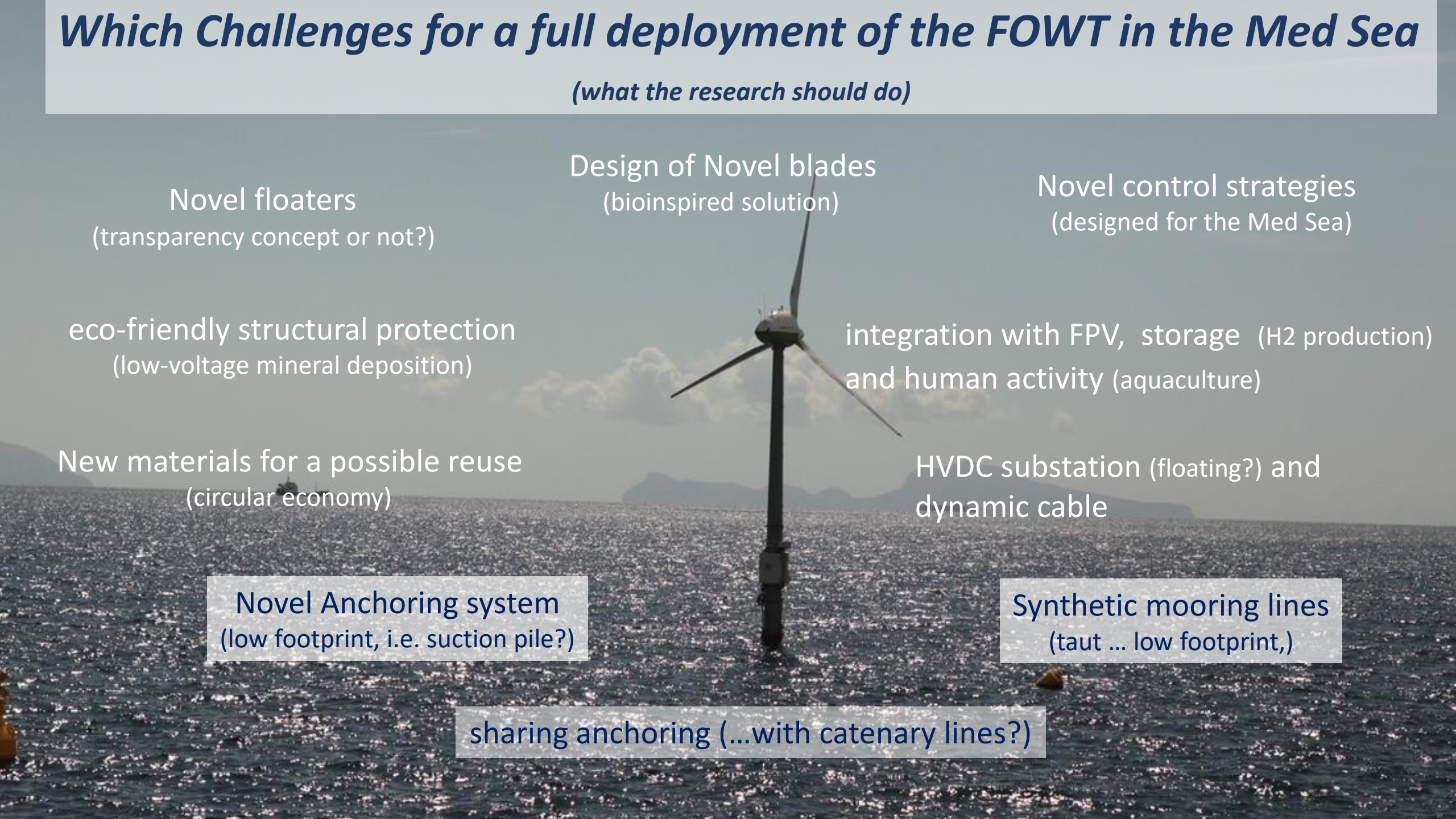
The Mediterranean area is important due to its historical heritage. There is consequently a need for careful planning to establish a peaceful *co-existence with tourism, archaeological sites and the environment*.

Due to the extreme water depth in the area, there are significant challenges with *the spatial footprint of floating mooring systems*, as these will extend far out from the floating foundations. Innovative solutions are required to tackle these challenges.

De-risking the floating wind projects requires precise predictions of the energy yield, which requires *the development of atmospheric models that can tackle land-sea transitions*, including thermic flows and complex terrain. It is necessary to model the mistral, bora and etesian winds specifically.

Which Challenges for a full deployment of the FOWT in the Med Sea

(what the research should do)



Design of Novel blades
(bioinspired solution)

Novel floaters
(transparency concept or not?)

Novel control strategies
(designed for the Med Sea)

eco-friendly structural protection
(low-voltage mineral deposition)

integration with FPV, storage (H2 production) and human activity (aquaculture)

New materials for a possible reuse
(circular economy)

HVDC substation (floating?) and dynamic cable

Novel Anchoring system
(low footprint, i.e. suction pile?)

Synthetic mooring lines
(taut … low footprint,)

sharing anchoring (…with catenary lines?)

Challenge: The first sealab for de-risking

MaRELab:
Marine Renewable Energy seaLab
(UNICAMPANIA-CNR)

a sea lab for the novel marine technologies finalized to the energy archipelago

Breakthrough:

- First Multidisciplinary lab (wind-sun-wave) of the Mediterranean sea.

- Available for testing novel marine renewable energy devices

- Ready to host the first energy archipelago prototype

Funding:

- Italian RP (Ministero della Transizione Ecologica,
  Ministero dello Sviluppo Economico),
  2.5 MEuro (2019-2021) – 2.7 Meuro (2022-2024)

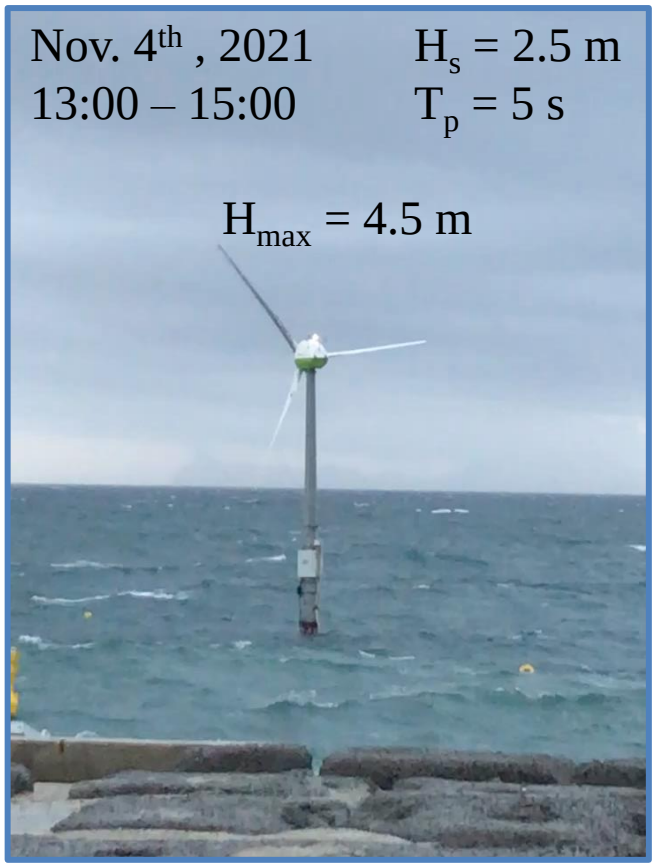
Challenge: Construction of the FEA

The «only existing» FOWT of the Med: (CNR-Saipem cooperation)

Prototype at MaRELab
(scale factor 1:6.8 of a 5 MW)
Turbine:
Tozzi Nord TN535 - 10 kW, rotor diam = 13 m

Floater:
Hexafloat (Saipem patent), pendulum system
max diam.: 13 m,
max draft: 3.8 m,
pendulum draft = 17 m

Challenge: The first sealab for de-risking

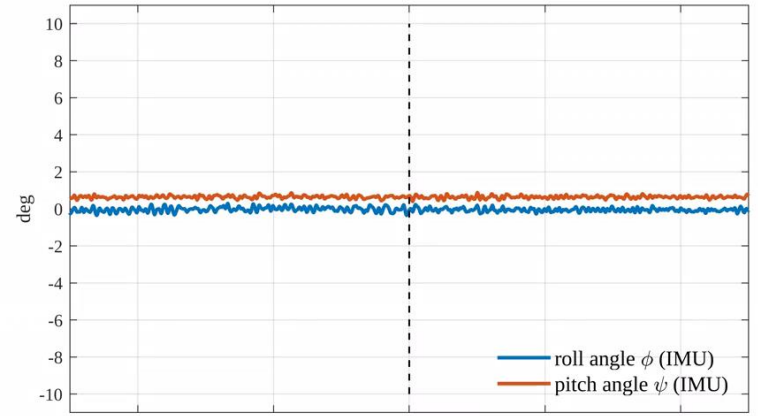


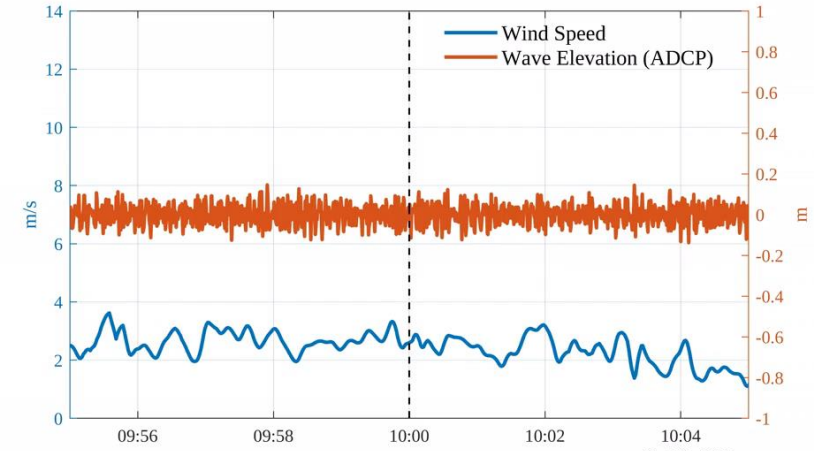
The «only existing» FOWT of the Med: (CNR-Saipem cooperation)

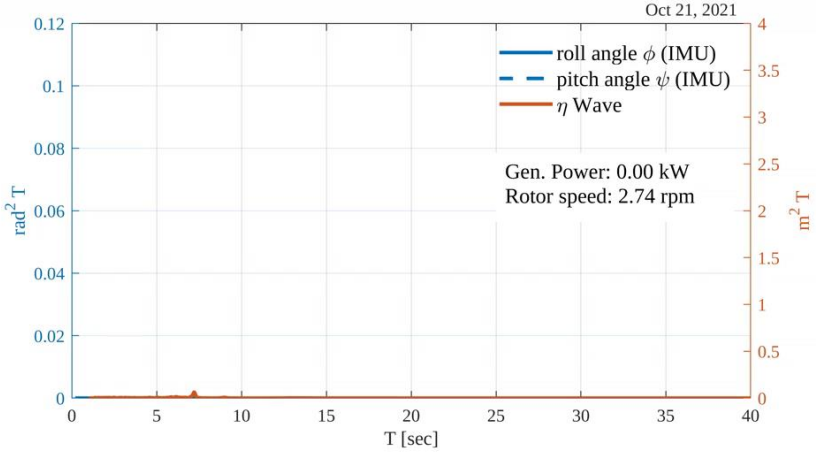
Prototype at MaRELab (scale factor 1:6.8 of a 5 MW)

Turbine: Tozzi Nord TN535 - 10 kW, rotor diam = 13 m

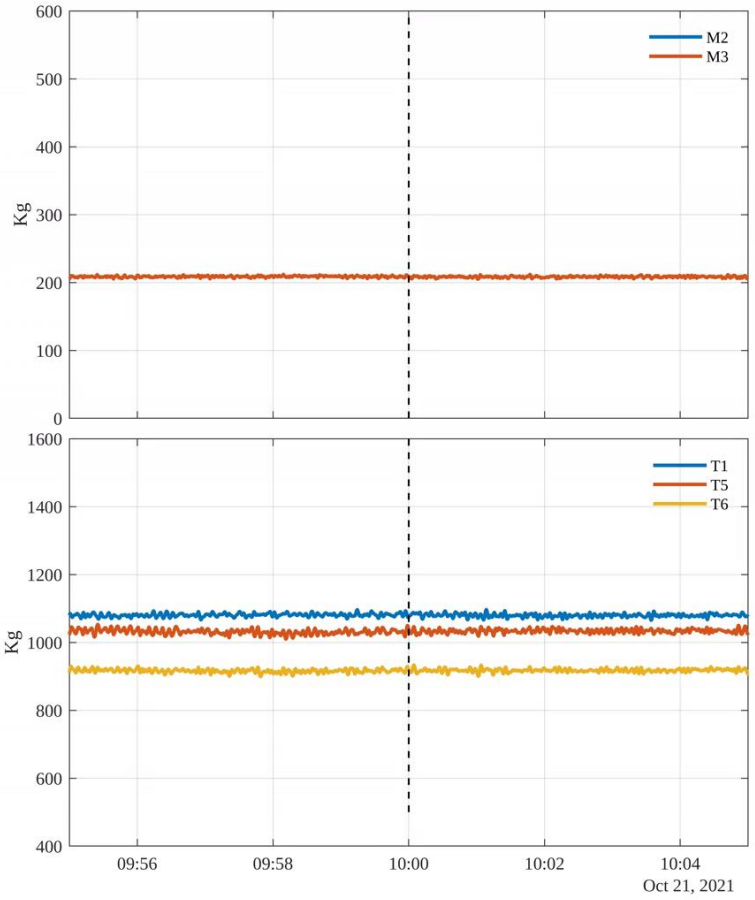
Floater: Hexafloat (Saipem patent), pendulum system
(max diam. 13 m, max draft 3.8 m, pendulum draft = 17 m)


deg
roll angle ϕ (IMU)
pitch angle ψ (IMU)

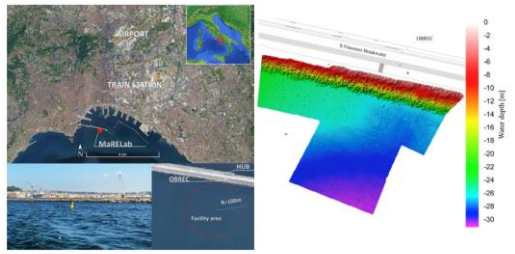

Wind Speed
Wave Elevation (ADCP)
m/s
m
09:56
09:58
10:00
10:02
10:04
Oct 21, 2021

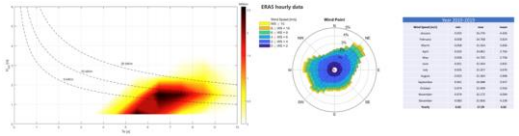

roll angle ϕ (IMU)
pitch angle ψ (IMU)
η Wave
Gen. Power: 0.00 kW
Rotor speed: 2.74 rpm
rad^2 T
m^2 T
T [sec]


ezviz
21-10-2021 12:00:00 (S)

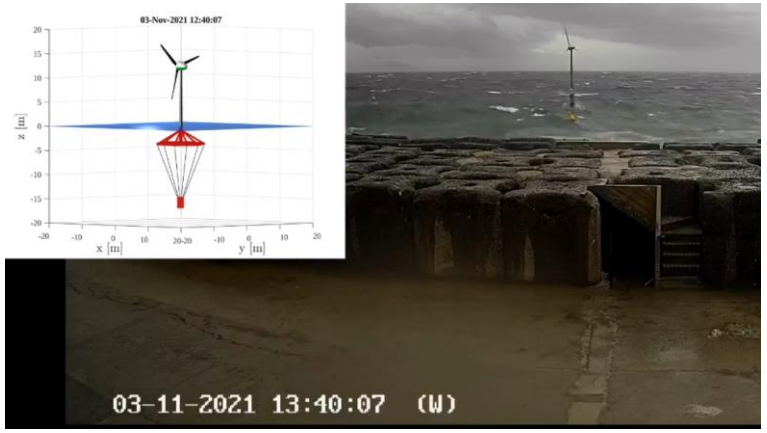

M2
M3
T1
T5
T6
Kg
09:56
09:58
10:00
10:02
10:04
Oct 21, 2021

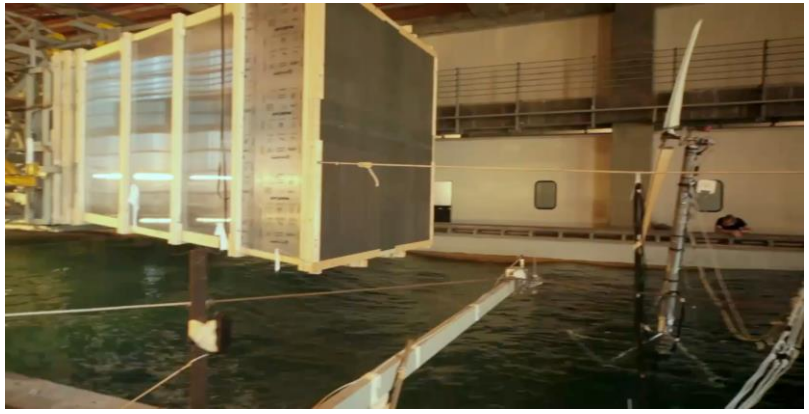
Challenge: Integrated research approach



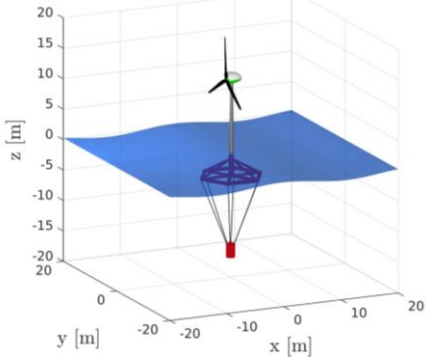


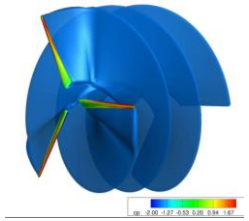
Prototyping in real environment

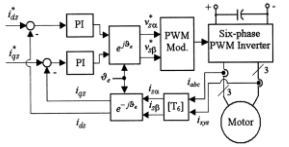




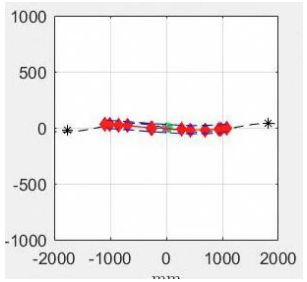
Digital Twin & AVR



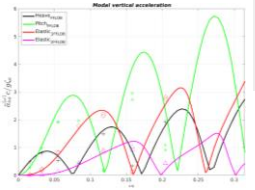


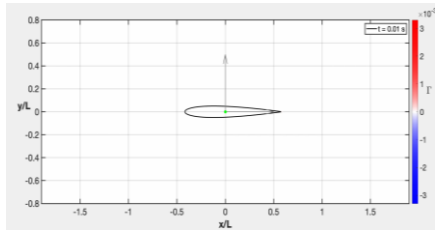


Experimental Study in indoor lab



Numerical Study

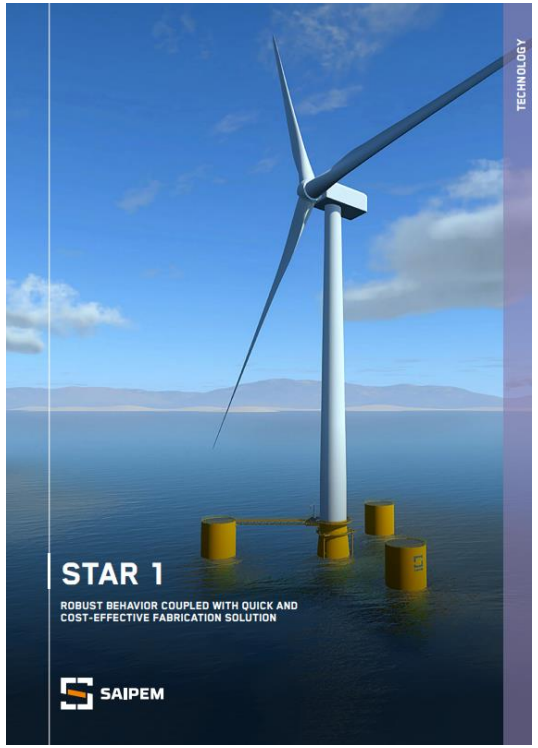




Progetto EU-Horizon FloatFarm

Call: HORIZON-CL5-2023-D3-01 (Sustainable, secure and competitive energy supply)
Topic: HORIZON-CL5-2023-D3-01-05

Finanziamento: ***6 Meuro***
Coordinatore: ***TU Berlin***
Paesi Partecipanti: ***Germania, Italia, Francia, Olanda, Danimarca, Portogallo, Svezia, Belgio***
Isitituti Partecipanti : ***18***
Partners italiani ***(~1.5 Meuro)***: ***UoF, Seapower, CNR***



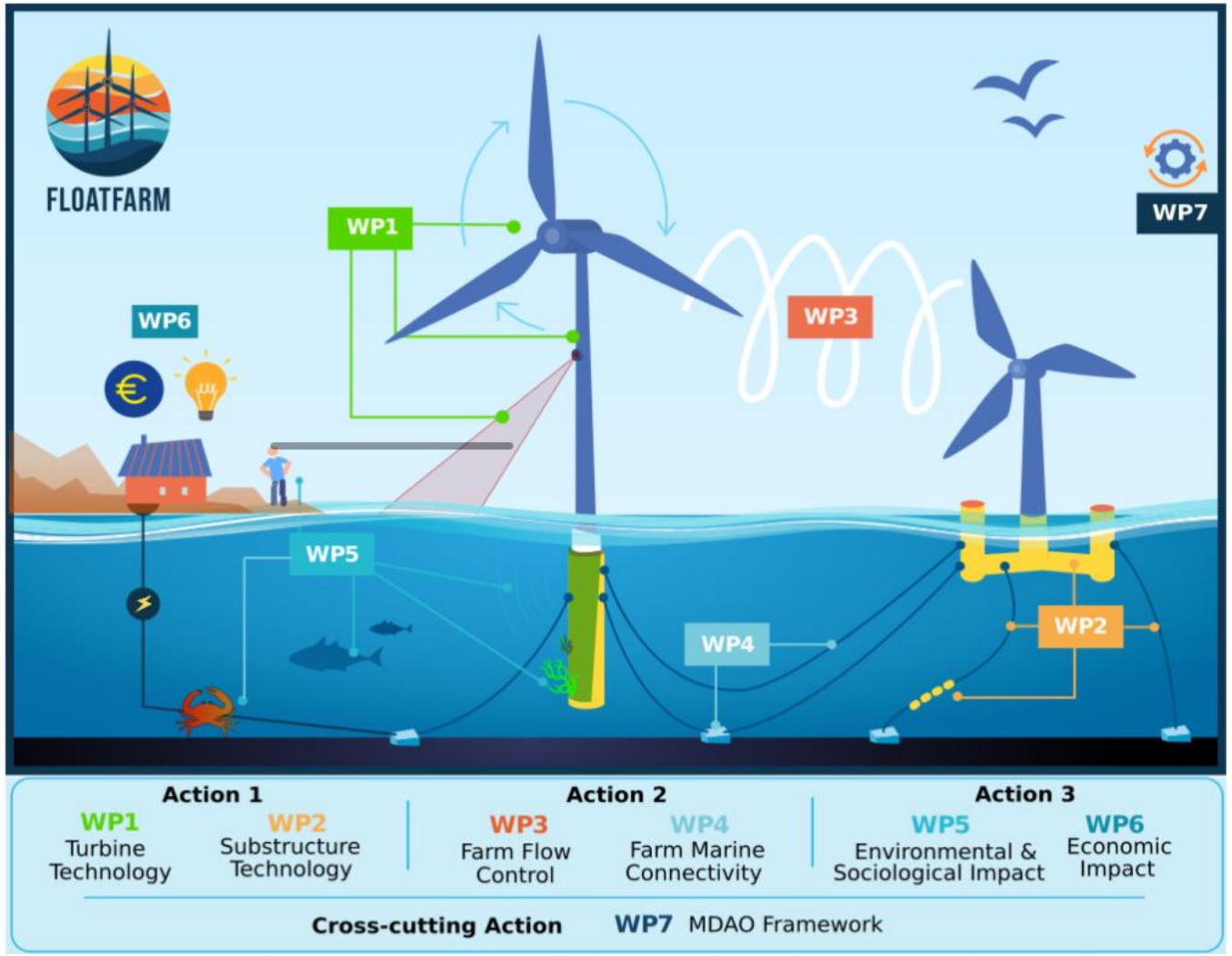


Figure 1: Graphical abstract for the FLOATFARM Project

To face with new challenges…

Fresh water

Energy demand

…Avoiding the errors of the past.

RRI is an approach that anticipates and assesses potential implications and societal expectations with regard to research and innovation, with the aim to foster the design of inclusive and sustainable research and innovation.