Researcher training in four innovative training networks in wind energy

Charlotte Hasager, Jakob Mann, Gregor Giebel, Tuhfe Göçmen (DTU),
Sandrine Aubrun (EC Nantes) and Axelle Viré (TU Delft)
Daniel Hatfield (DTU), Craig White (WavEC), Thomas Messner (UOL),
Alessandro Sebastiani (DTU), Priscila Orozco (UL Solutions),
Shokoufeh Malekmohammadi (UiB), Isadora Coimbra (UPorto)

EERA DeepWind conference, 18-20 January 2023
Presenting the best offshore wind R&I since 2004

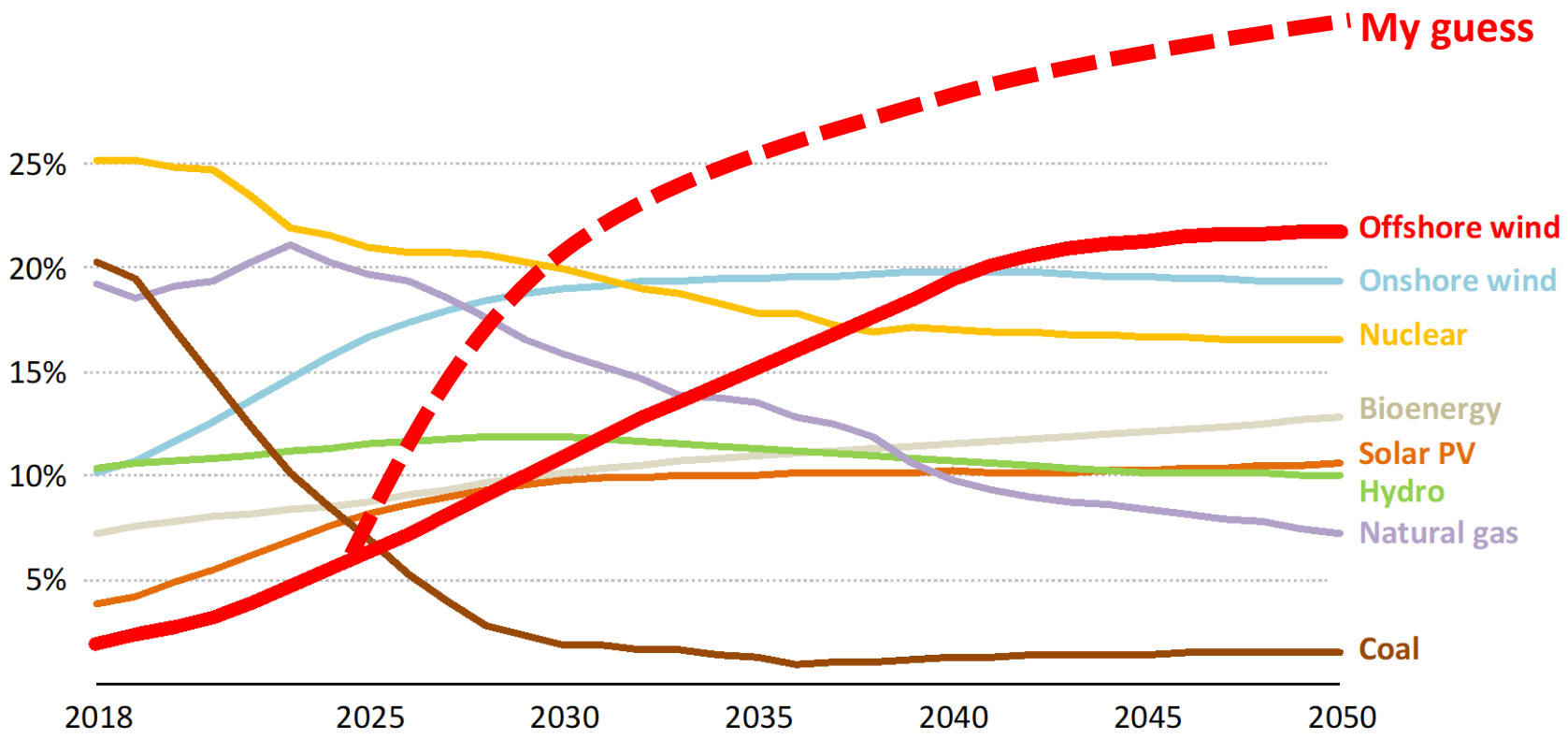
Content

- ✓ Motivation
- ✓ Four Innovative Training Networks
- ✓ Research highlights
- ✓ Career plans and impact of the PhDs

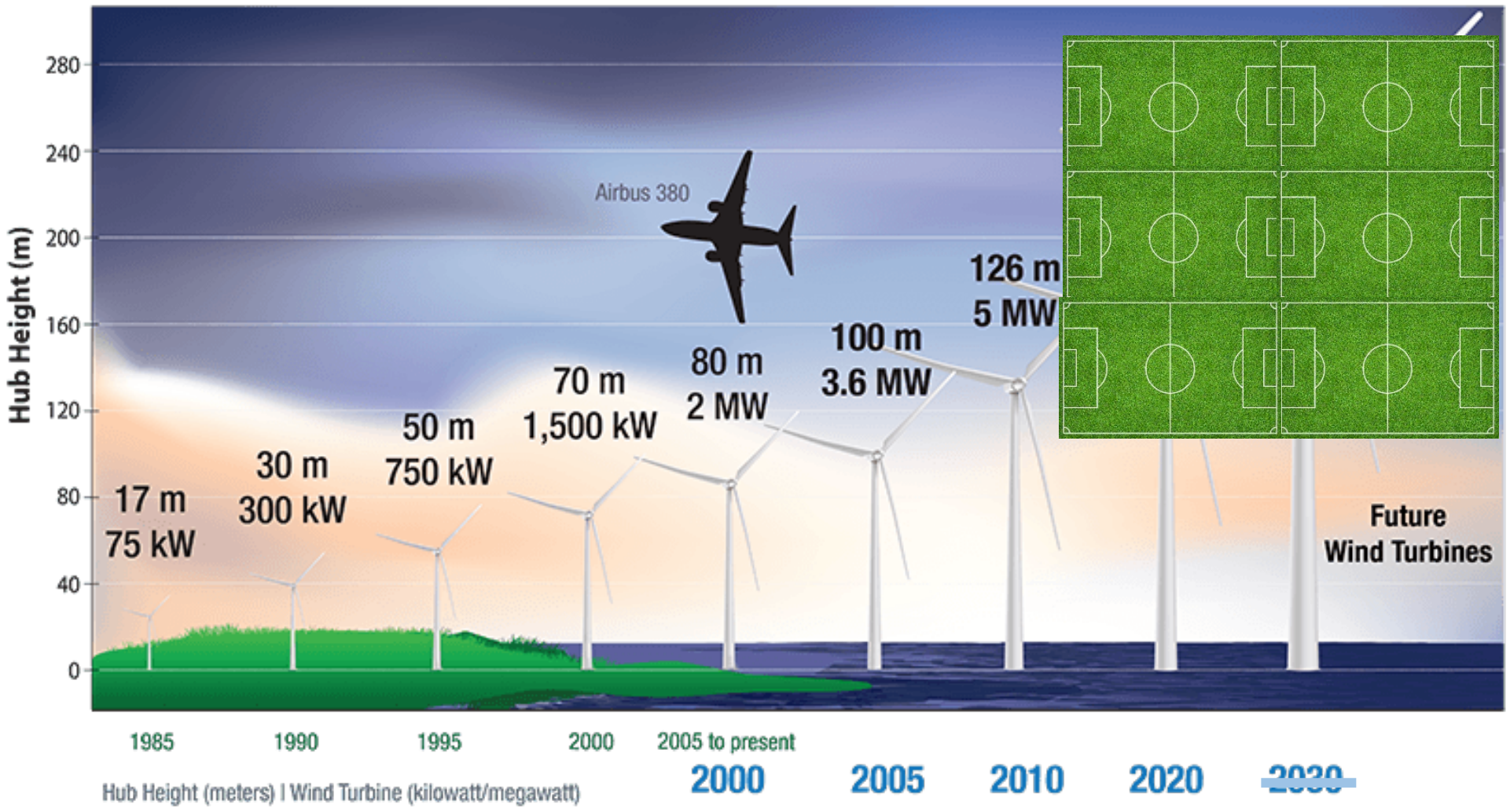
Motivation

- The EU Green Deal requires a major expansion of wind energy over the next 30 years, growing from 15% of Europe's electricity today to 50% by 2050[1]. In the *next four years, Europe will build 105 GW of new wind capacity*[2].
- The dramatic increase will demand *new skilled persons*.
- The European wind industry currently employs 300,000 people.

Electricity in the EU



Shares of electricity generation by technology in the EU, Sustainable Development Scenario



Source: NREL The Leading Edge: April 2020 Wind Energy Newsletter

Research themes

4-ITNs

Offshore

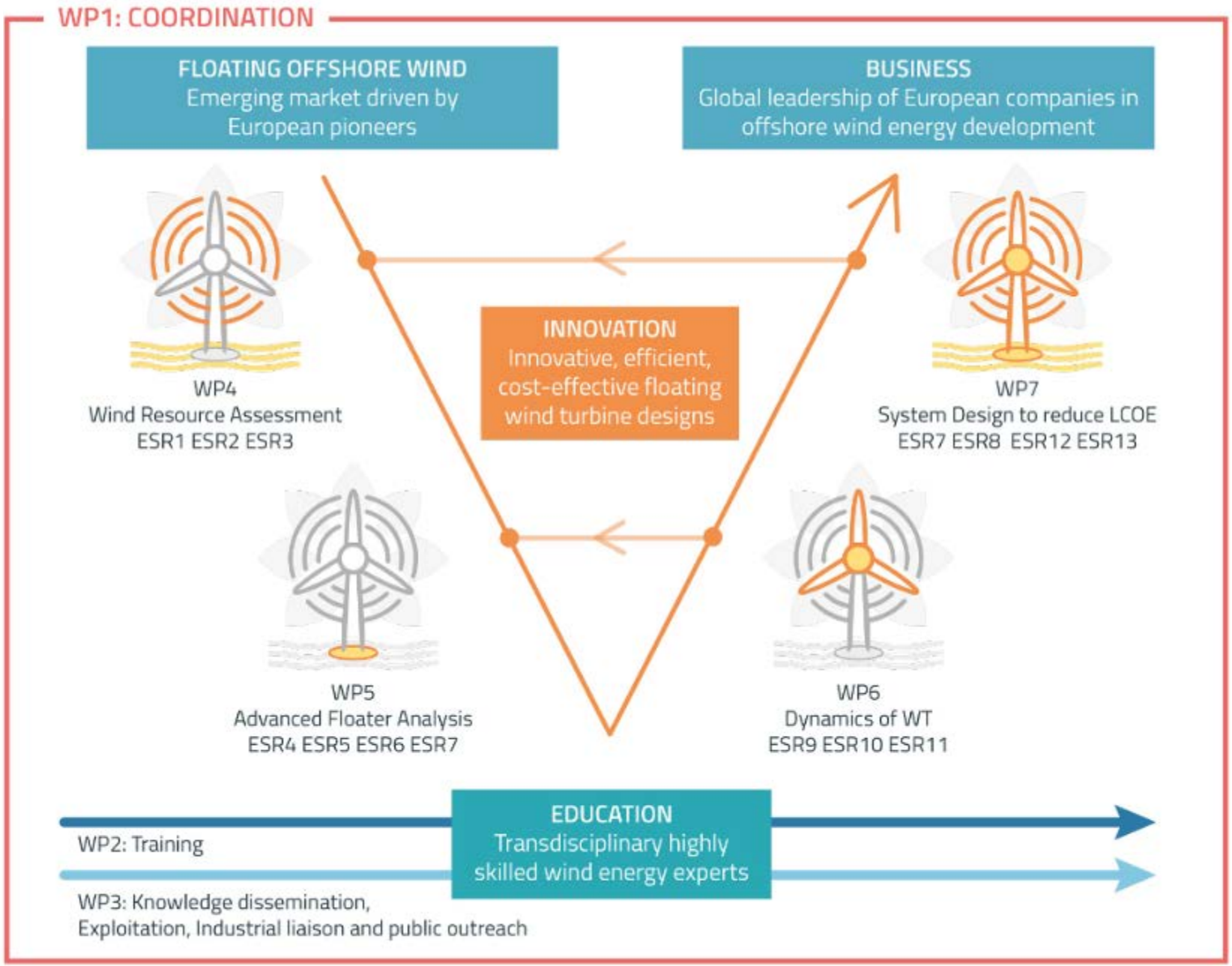
Land and offshore

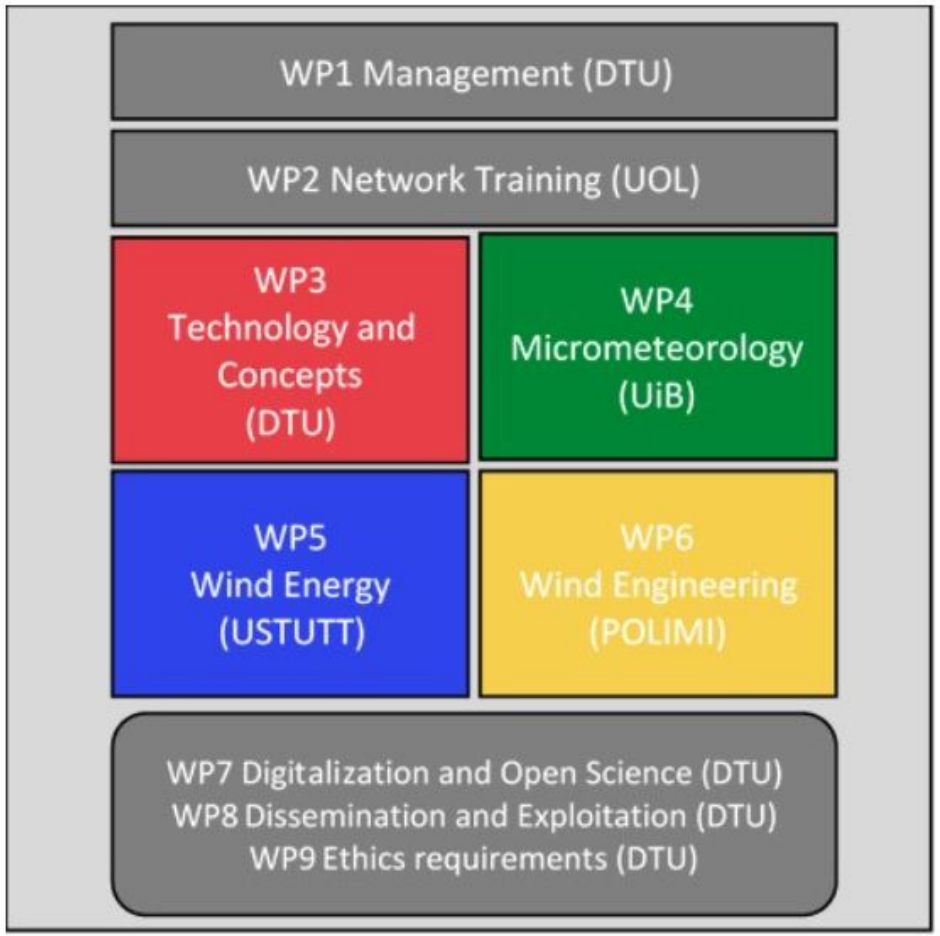
Lidar knowledge Europe: Lidar wind measurement technologies

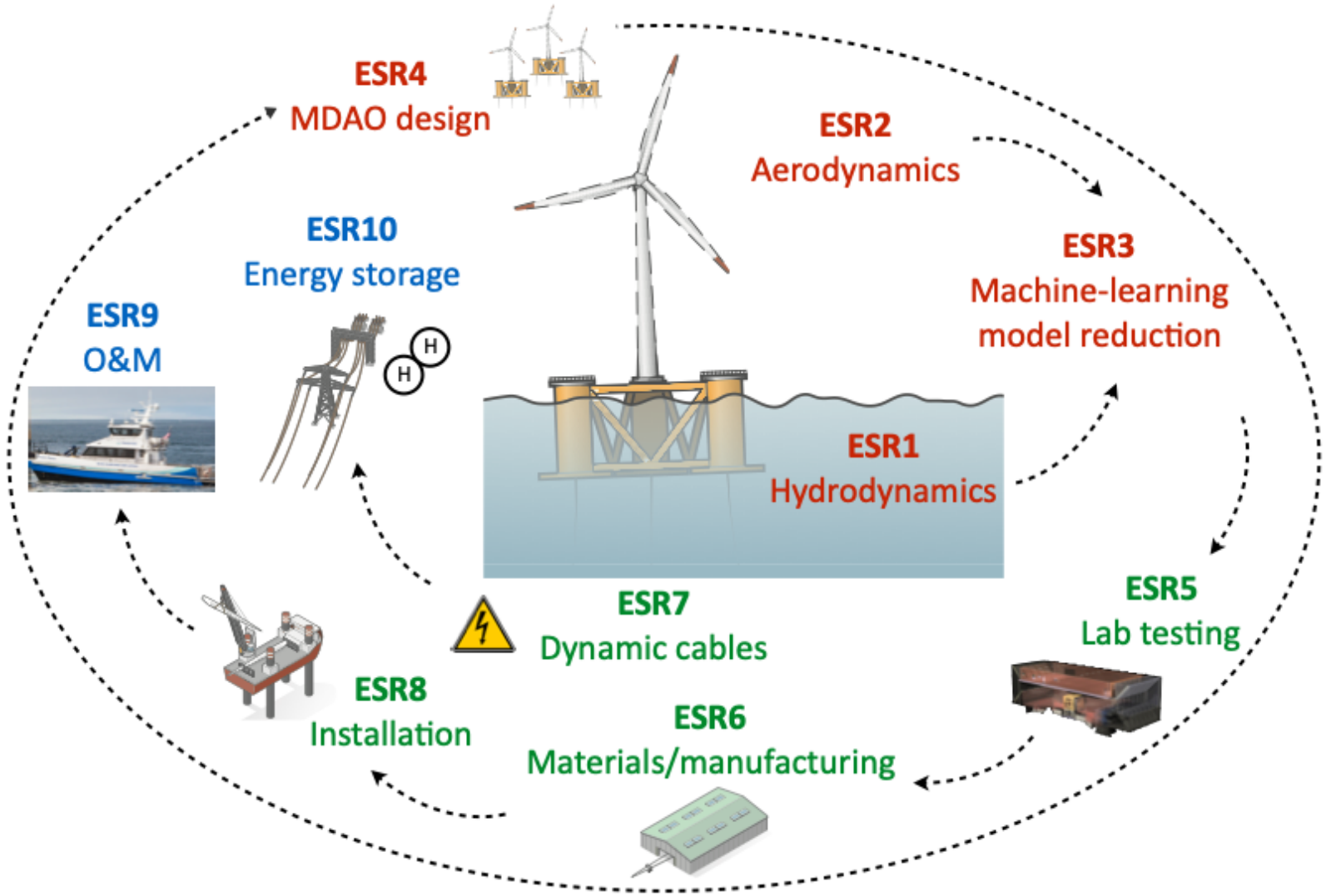
Floating wind energy network for designing higher performance, economically viable floating wind turbines

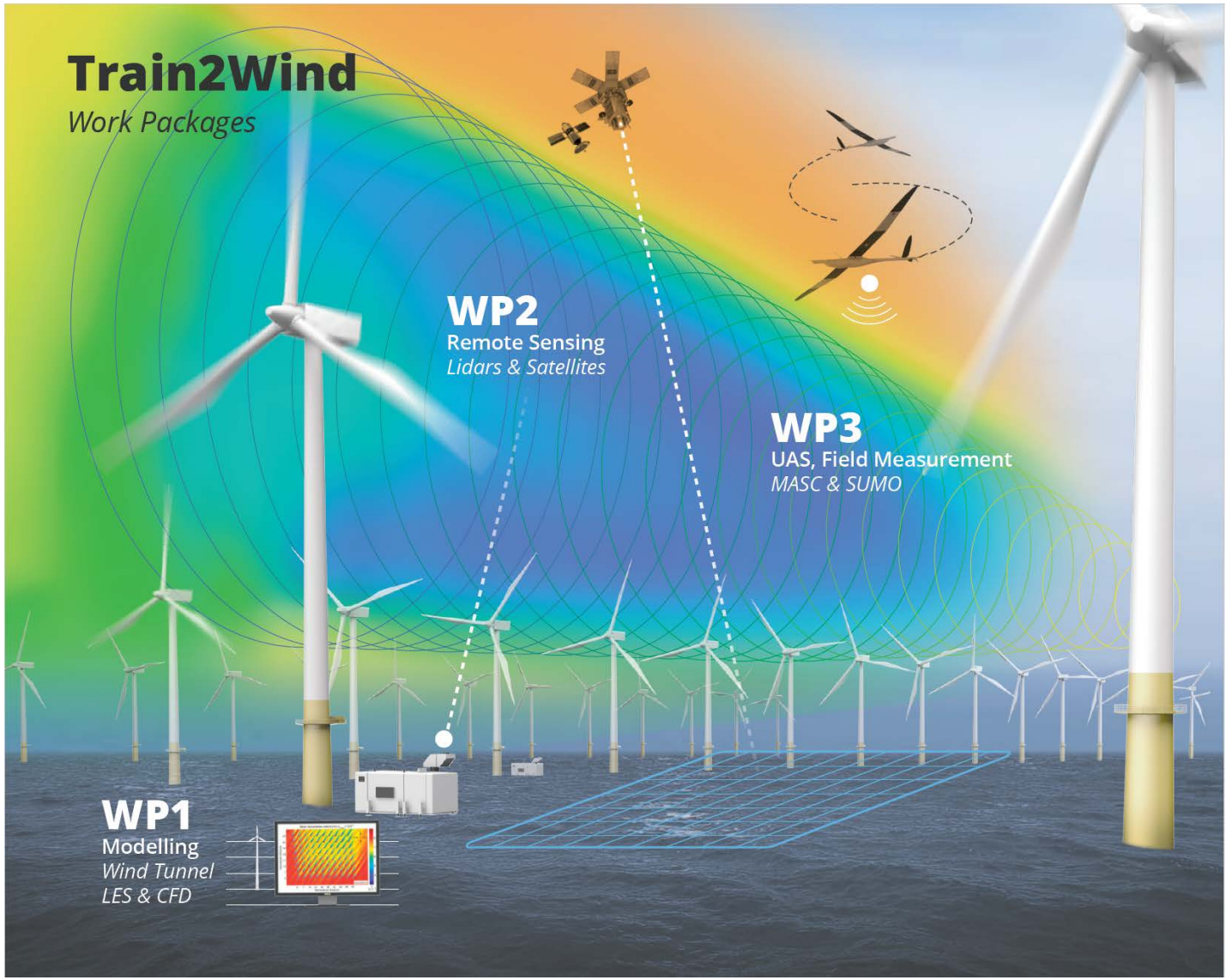
Entrainment in offshore wind energy

Novel design, production and operation approaches for floating wind turbine farms


WP1: COORDINATION
FLOATING OFFSHORE WIND
Emerging market driven by
European pioneers
BUSINESS
Global leadership of European companies in
offshore wind energy development
INNOVATION
Innovative, efficient,
cost-effective floating
wind turbine designs
WP4
Wind Resource Assessment
ESR1 ESR2 ESR3
WP7
System Design to reduce LCOE
ESR7 ESR8 ESR12 ESR13
WP5
Advanced Floater Analysis
ESR4 ESR5 ESR6 ESR7
WP6
Dynamics of WT
ESR9 ESR10 ESR11
EDUCATION
Transdisciplinary highly
skilled wind energy experts
WP2: Training
WP3: Knowledge dissemination,
Exploitation, Industrial liaison and public outreach


WP1 Management (DTU)
WP2 Network Training (UOL)
WP3 Technology and Concepts (DTU)
WP4 Micrometeorology (UiB)
WP5 Wind Energy (USTUTT)
WP6 Wind Engineering (POLIMI)
WP7 Digitalization and Open Science (DTU)
WP8 Dissemination and Exploitation (DTU)
WP9 Ethics requirements (DTU)


ESR4
MDAO design
ESR2
Aerodynamics
ESR10
Energy storage
ESR3
Machine-learning
model reduction
ESR9
O&M
H
H
ESR1
Hydrodynamics
ESR7
Dynamic cables
ESR5
Lab testing
ESR8
Installation
ESR6
Materials/manufacturing


Train2Wind
Work Packages
WP2
Remote Sensing
Lidars & Satellites
WP3
UAS, Field Measurement
MASC & SUMO
WP1
Modelling
Wind Tunnel
LES & CFD

Research highlights

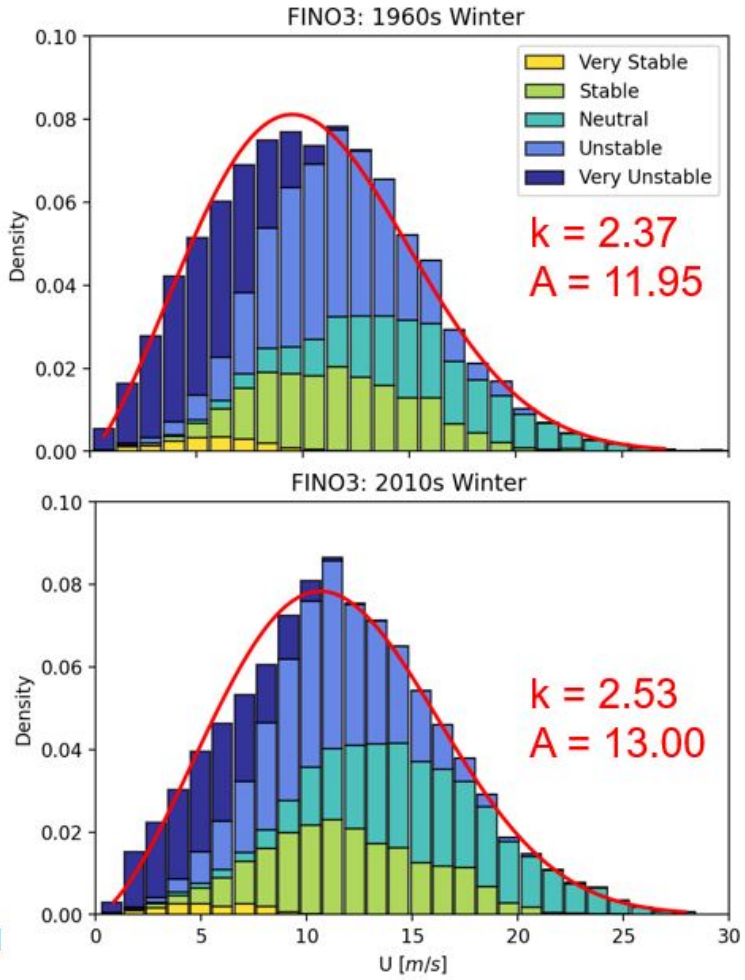
Wind resource in deep sea sites using remote sensing and numerical models

Daniel Hatfield

Wind speeds

ERA5 data analysis comparing two decades, the 1960s vs. the 2010s at

- FINO3
  - Increase in Weibull -A and –k



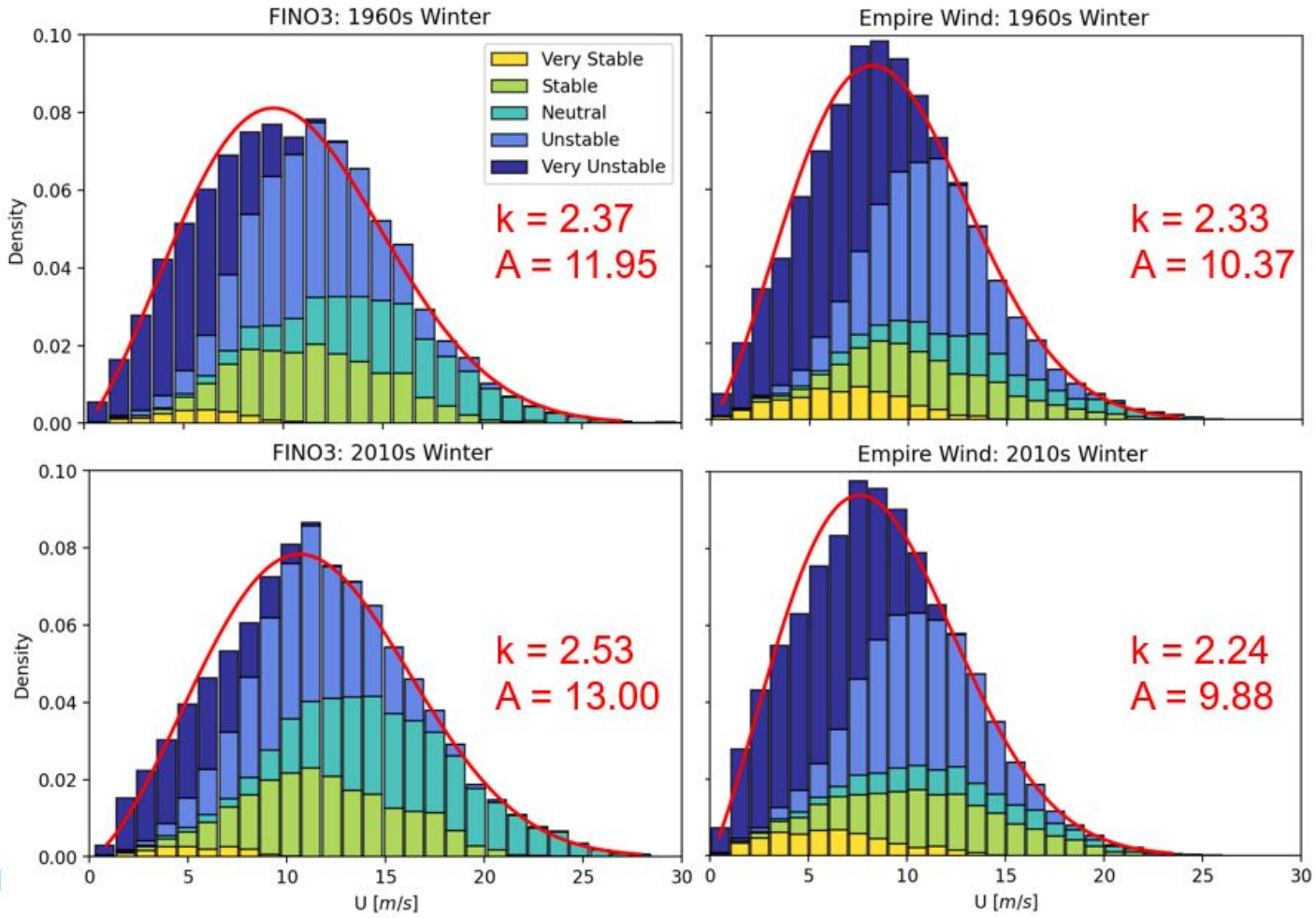
Wind resource in deep sea sites using remote sensing and numerical models

Daniel Hatfield

Wind speeds

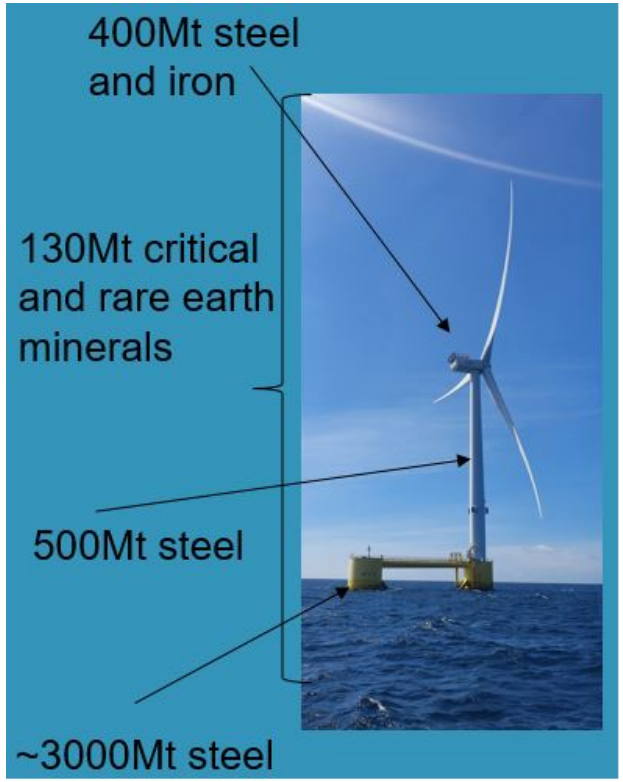
ERA5 data analysis comparing two decades, the 1960s vs. the 2010s at

- FINO3
  - Increase in Weibull -A and –k
- US East Coast
  - Decrease in Weibull –A and –k

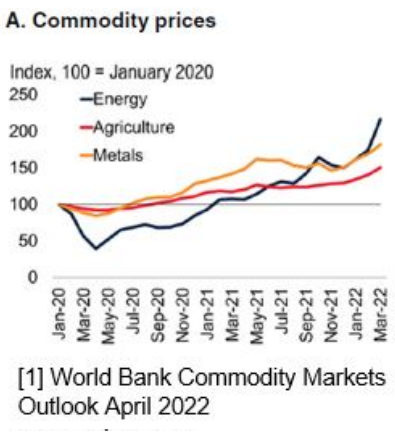


A levelized cost of energy analysis of changing global commodity markets and the impact on floating offshore wind

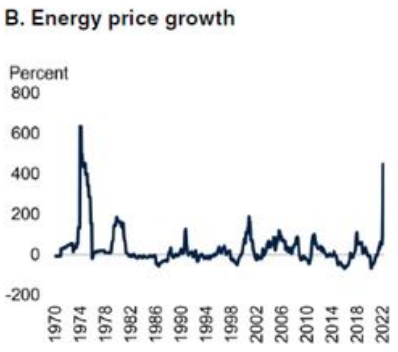
Craig White

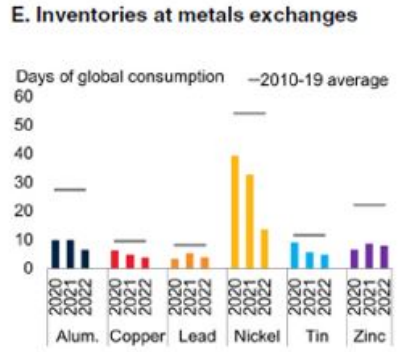


- Post-pandemic surge increased prices in 2022
- Conflict has added supply constraints and market uncertainty
- Domestic prices remain high with currency depreciations
- Energy crises led to prices in March 2022 double 2021 level



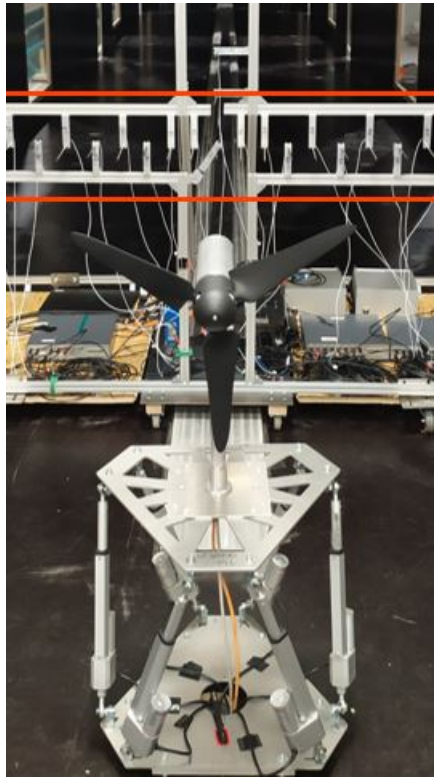
[1] World Bank Commodity Markets Outlook April 2022



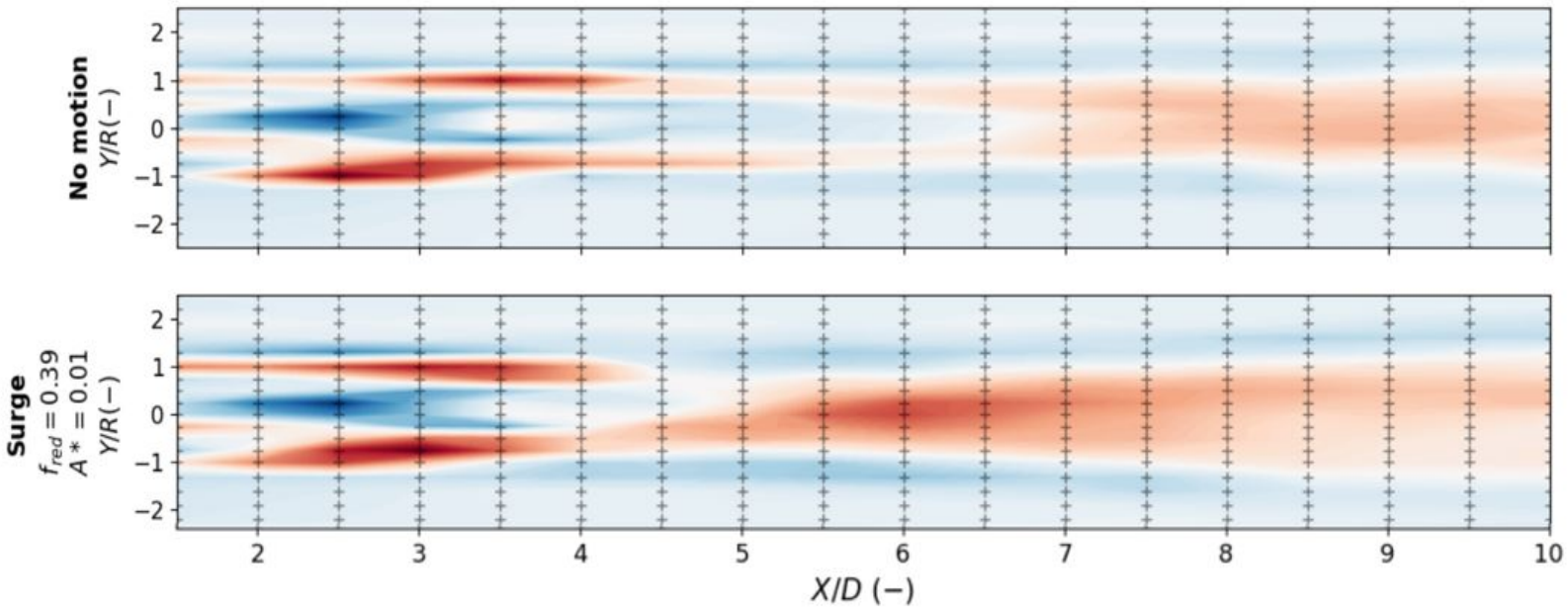


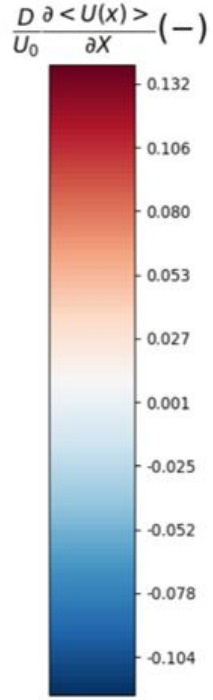
Wind tunnel investigation of the wake of a floating offshore wind turbine under idealized surge motion submitted to laminar wind

Thomas Messmer



Wake recovery rate





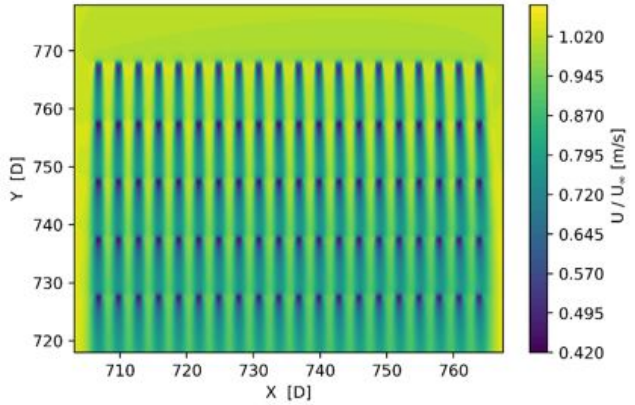
Correcting for the effect of both wakes and blockage on power performance

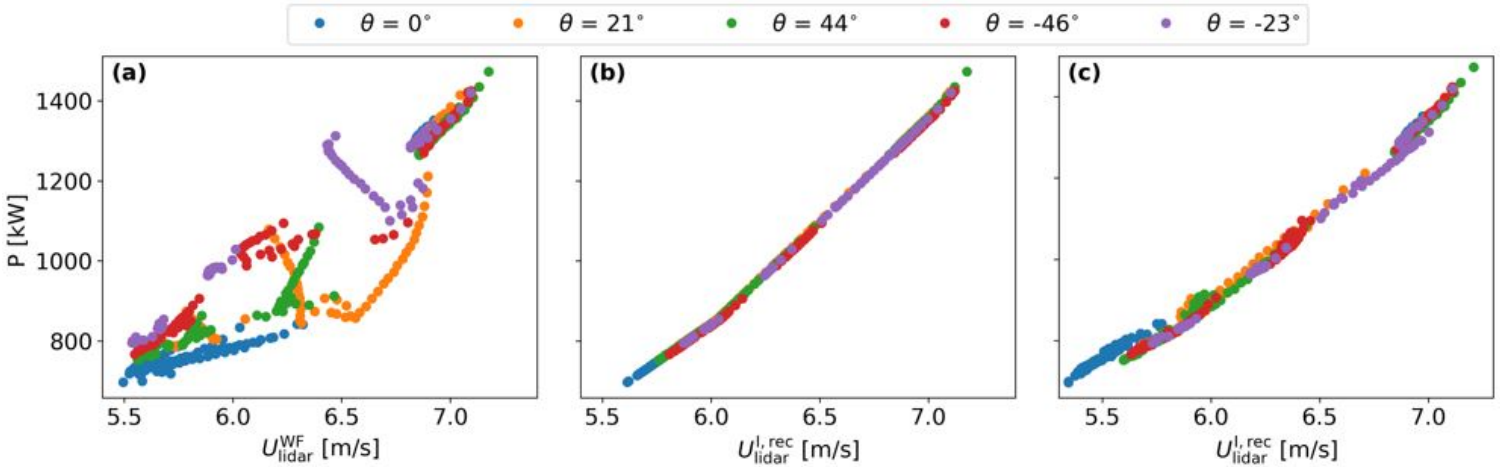
Alessandro Sebastiani

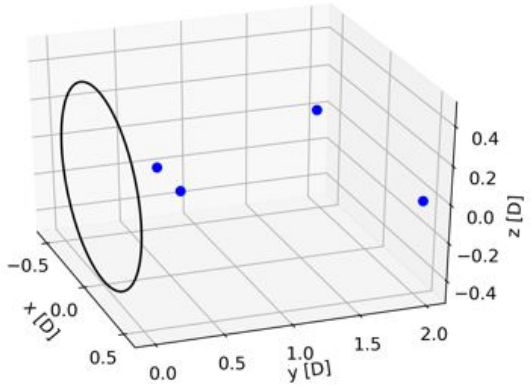
Supervisors: Alfredo Peña (DTU), James Bleeg (DNV)

- RANS simulations in a conventionally neutral atmospheric boundary layer (5 wind directions from −45º to +45º)
- Virtual lidar measurements
- Correcting method:

$$U_{lidar}^{I,rec} = U_{lidar}^{WF}\left(\frac{U_{rotor}}{U_{lidar}}\right)^{WF}\left(\frac{U_{lidar}}{U_{rotor}}\right)^{I}$$





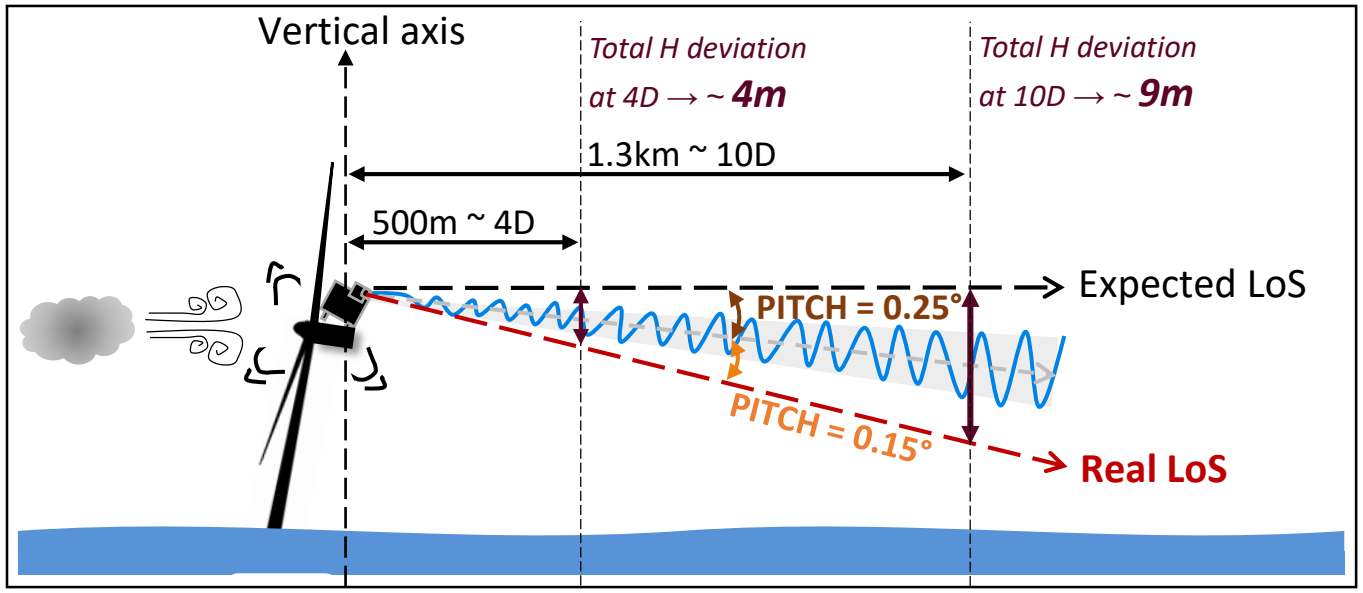


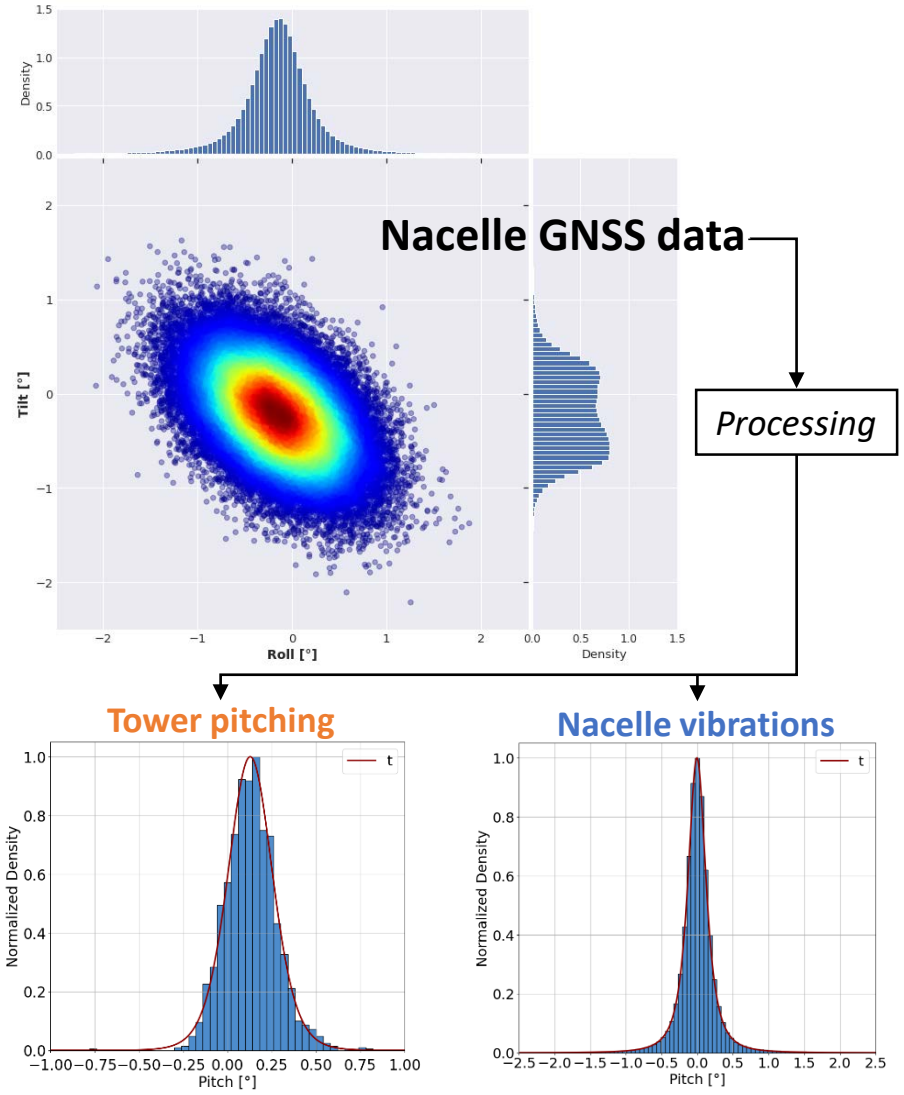
Uncertainties in nacelle-mounted scanning lidar measurements in wake due to wind turbine movements

Priscila Orozco

- Uncertainties in wake lidar measurements due to WT movements:

  I. **Tower pitching due to thrust;**
  II. **Nacelle vibrations due to rotor;**
  III. **Lidar mounting error**



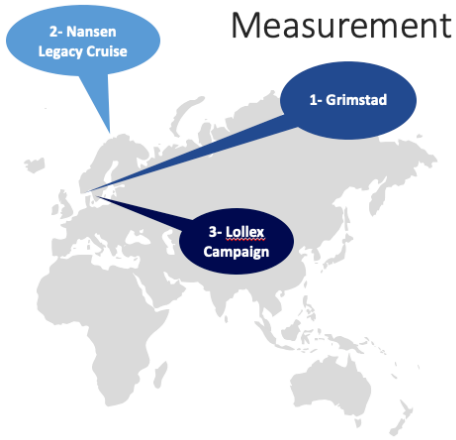


Performance of Two Ship-based Lidars Under Different Motion Scenarios and Correcting the Motion Effect

Shokoufeh Malekmohammadi

UNIVERSITY OF BERGEN

Measurement Campaigns



100%

Grimstad
Grimstad-Norway-2011

Data Collection and data analysis finished

80%

Nansen Legacy Cruise
Barents Sea-Norway-2022

Data Collection had finished
Data analysis ongoing

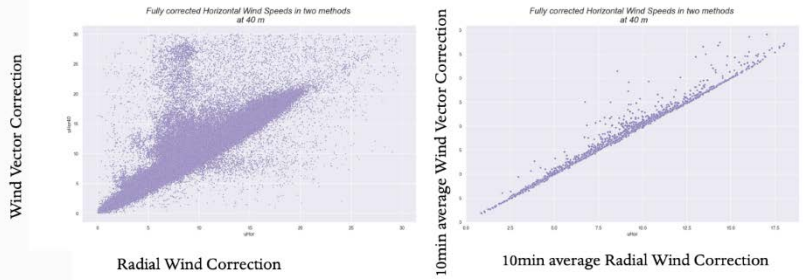
20%

Lollex Campaign
Rødsand-II Wind Farm
Denmark- Ongoing

Data Collection ongoing

8

Wind Vector Correction vs Radial Wind Correction at 40 m



One Example: Motion Correction Nansen Legacy Cruise

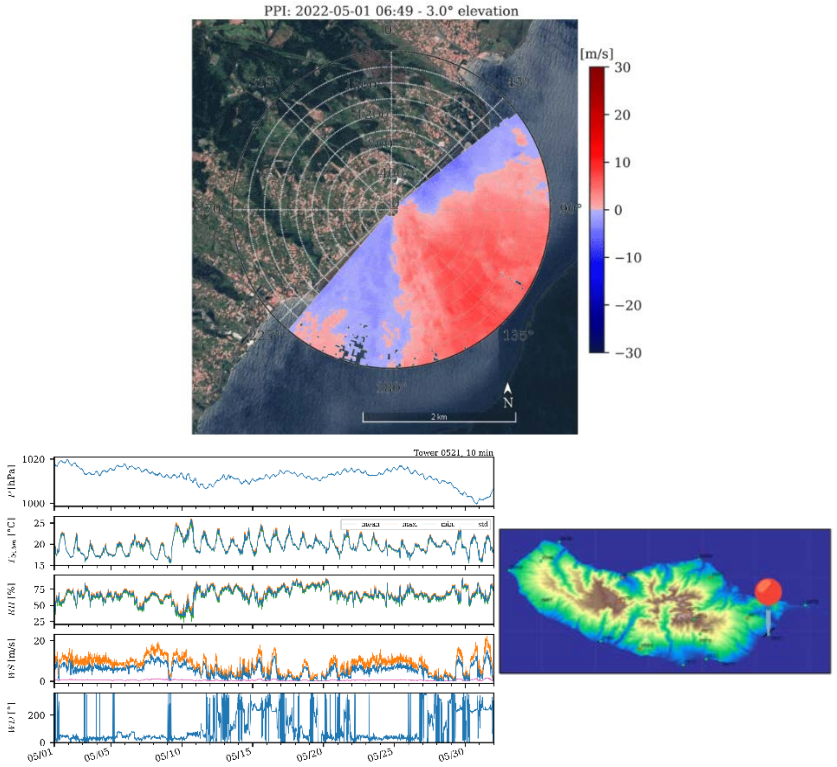
- Full Correction of Translatory and Rotational motion
- WindCube V2 internal motion Correction for rotational motion
- WindCube V2 is not capable of correcting translatory motions
- Development of full motion correction is necessary

Measurement and modelling of the airflow at Madeira Airport

Isadora Coimbra

- Located in Madeira: a volcanic island with complex terrain
- Recurring flight cancellations and delays due to weather = safety and economic issues

Measurements: lidar and met-mast



Modelling: WRF + VENTOS/M

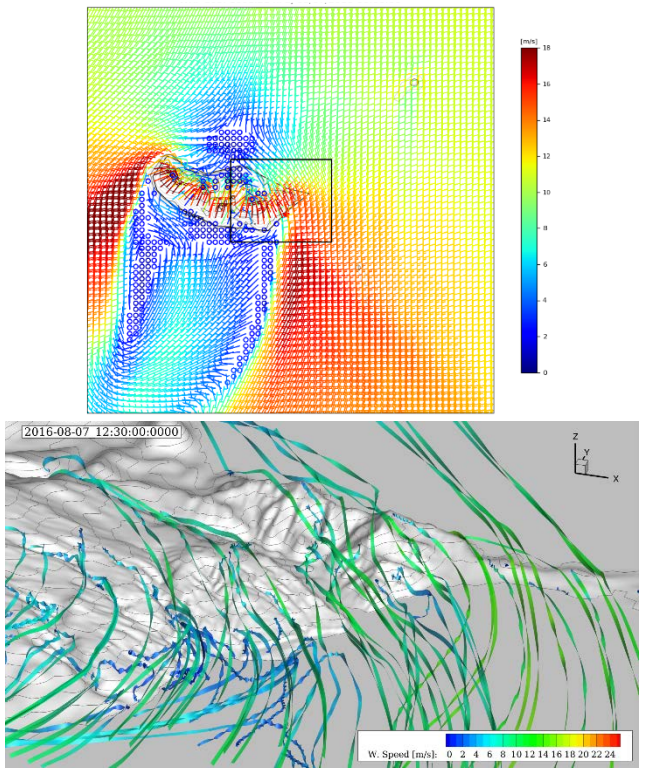
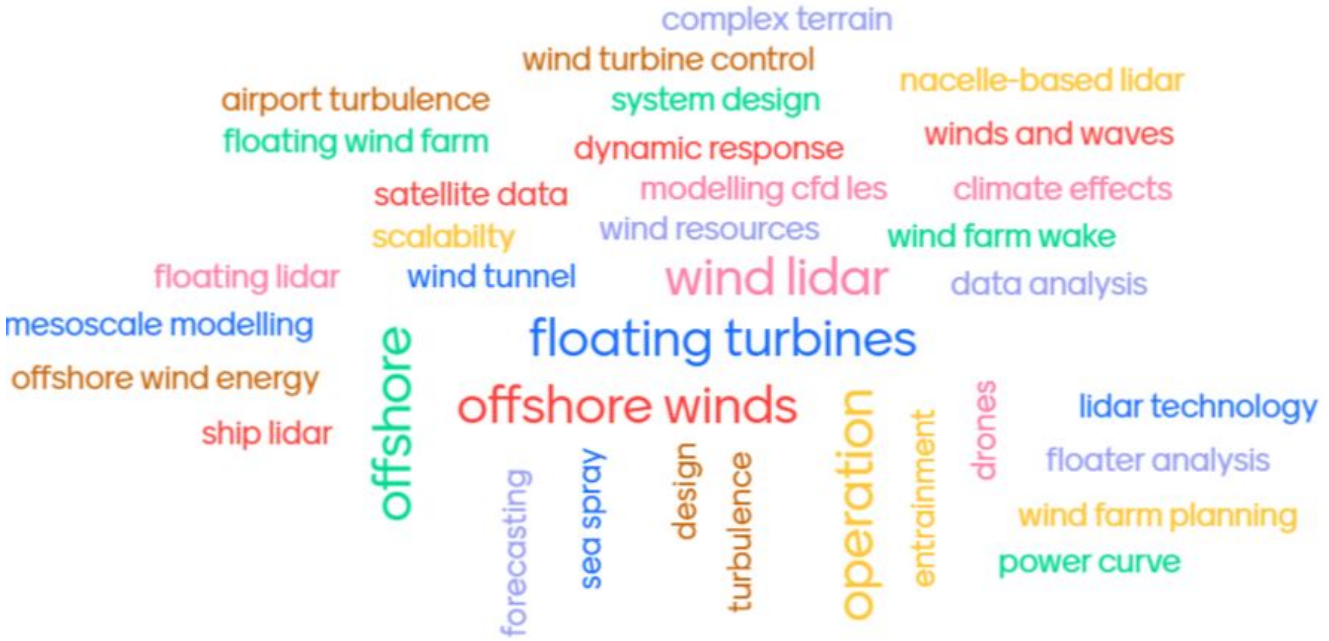


Image source: ana.pt

4-ITNs: Research topics summary



4-ITNs: Career plan of the PhDs

	Industry			Academia			Not decided yet			
%	10	20	30	40	50	60	70	80	90	100
FLOAWER										
LIKE										
STEP WIND										
Train²Wind										

4-ITNs: Impact in Europe and wind energy

- ✓ EU Green Deal
- ✓ Skill sets missing
- ✓ Offshore wind farm plans and its implementation
- ✓ Innovative capacity
- ✓ European excellence

Challenge:

"Greatest technical challenge in the 21st century:
The offshore wind energy realisation"

Citation from John Olav Tande

4-ITNs: Human ressource and network

4-ITNs: Conclusion

Successful training and research activities are on-going

The output of more than 50 PhD doctorates in wind energy is high and increasing

Research results from each of the PhD studies provide further insight to the many challenges in (offshore) wind energy

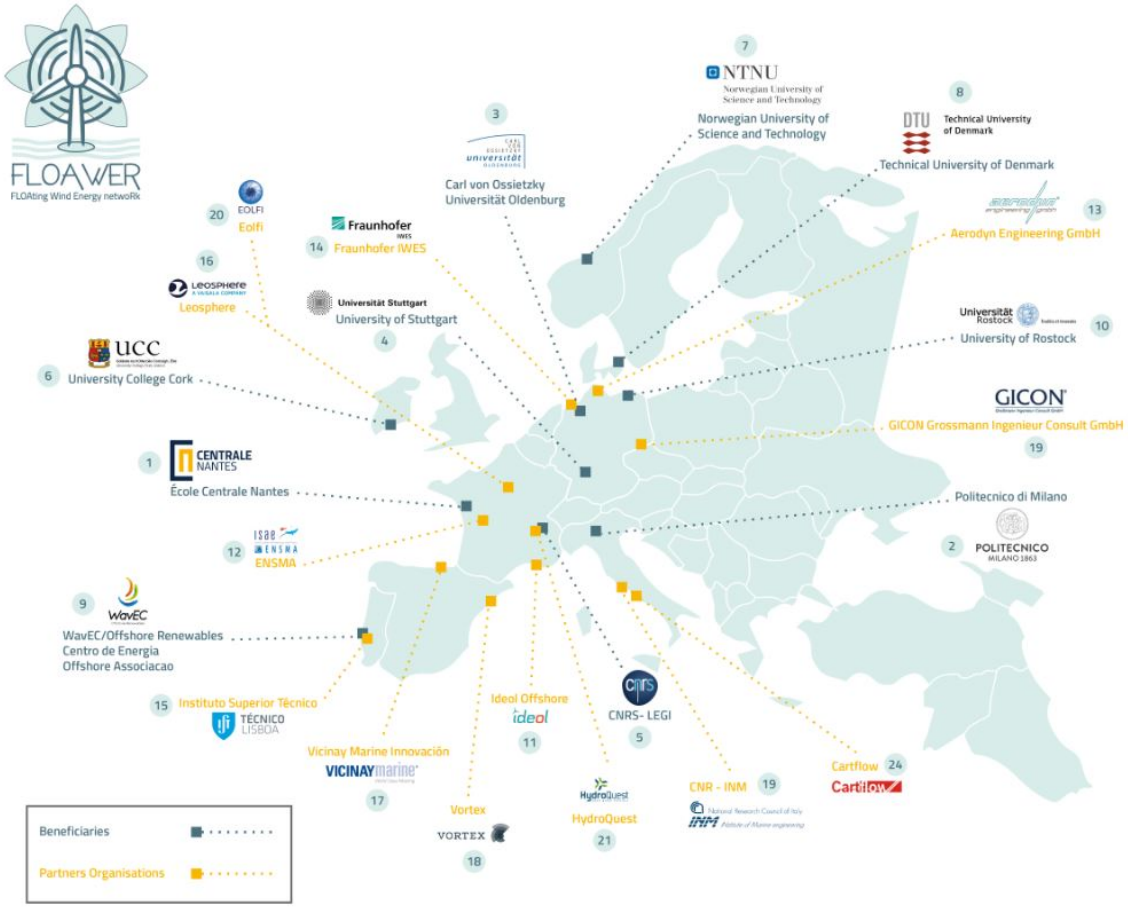
Contributions to academic and industrial perspectives in wind energy are sustained

Further information

- FLOAWER https://www.floawer-h2020.eu/
- LIKE https://www.msca-like.eu/
- Step4Wind https://www.step4wind.eu/
- Train2Wind https://www.train2wind.eu/

Acknowledgements:
H2020-MSCA-ITN-2019 grant agreements:
FLOAWER 860579,LIKE 858358, Step4Wind 869737 and Train2Wind 861291.

Beneficiaries and Partners



Beneficiaries and Partners

DTU	DTU Wind Energy
Hochschule Flensburg University of Applied Sciences	Flensburg University of Applied Sciences
Fraunhofer IWES	IWES Fraunhofer
POLITECNICO MILANO 1863	Politecnico di Milano
UL	UL International GmbH

UNIVERSITAS BERGENSIS	University of Bergen
CARL VON OSSIETZKY UNIVERSITÄT OLDENBURG	University of Oldenburg
U.PORTO	University of Porto
Universitetet i Stavanger	University of Stavanger
Universität Stuttgart	Universität Stuttgart

DNV·GL	DNV GL SE
FORCE TECHNOLOGY	FORCE Technology
KITEMILL	Kitemill
KJELLER VINDTEKNIKK Part of Norconsult	Kjeller Vindteknikk
	KNMI
LEOSPHERE A VAISALA COMPANY	Leosphere
METEK Meteorologische Messtechnik GmbH Germany	METEK GmbH
Meteorologisk institutt	Norwegian Meteorological Institute

natural power	Natural Power
NREL	National Renewable Energy Lab
res	Renewable Energy Systems Ltd
SIEMENS Gamesa	Siemens Gamesa Renewable Energy
sowento	sowento GmbH
TNO innovation for life	TNO

Beneficiaries and Partners

- Delft University of Technology
- Politecnico di Milano
- University College Cork
- Siemens Gamesa Renewable Energy
- Offshore Renewable Energy Catapult
- Eire Composites Teoranta
- Stichting Maritiem Research Instituut Netherlands
- National University of Ireland, Galway
- National Renewable Energy Laboratory, US
- Technical University of Denmark
- INSA Rouen Normandie
- Ideol
- Gavin and Doherty Geosolutions
- Siemens Gamesa Renewable Energy Denmark
- European Academy for Wind Energy
- International Network on Offshore Renewable Energy

Beneficiaries and Partners

DTU	DTU Wind Energy
EPFL ÉCOLE POLYTECHNIQUE FÉDÉRALE DE LAUSANNE	École Polytechnique Fédérale de Lausanne
UNIVERSITÄT TÜBINGEN	Eberhard Karls University Tübingen.
UNIVERSITAS BERGENSIS	University of Bergen
UNIVERSITY OF COPENHAGEN	University of Copenhagen

equinor	Equinor
RWE	RWE Renewables
JOHNS HOPKINS WHITING SCHOOL of ENGINEERING	Johns Hopkins University
SEATWIRL	SeaTwirl AB
VATTENFALL	Vattenfall

References

1. Wind Europe (2020) WindEurope-Flagship-report-2020.pdf
2. Wind Europe (2021) WindEurope-Wind-energy-in-Europe-statistics-2020.pdf