PURE WIND: imPact of soUnd on maRine Ecosystems from offshore WIND energy generation

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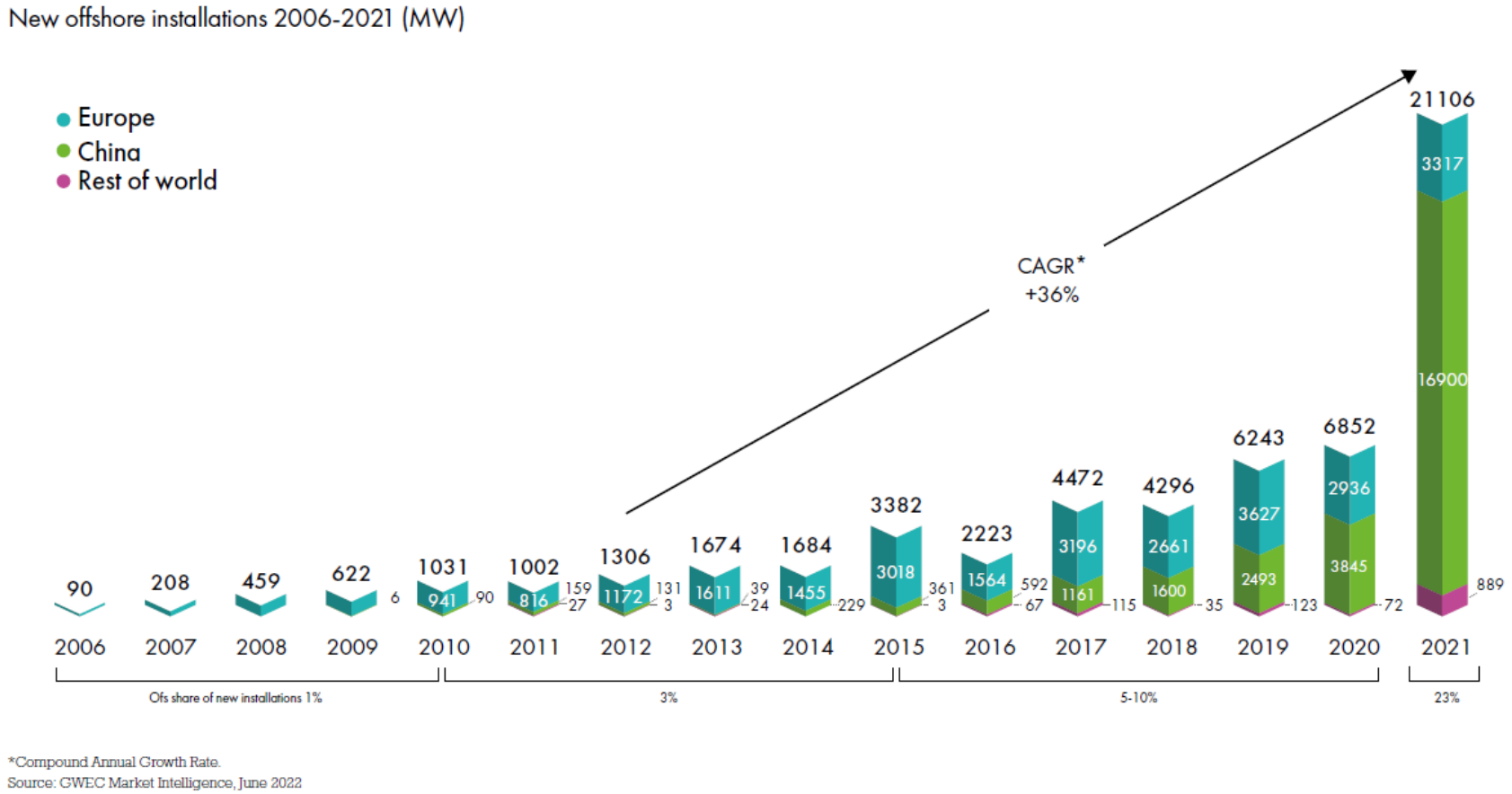
11 partners from Belgium, Germany, Ireland, Italy, Norway, Poland and Spain

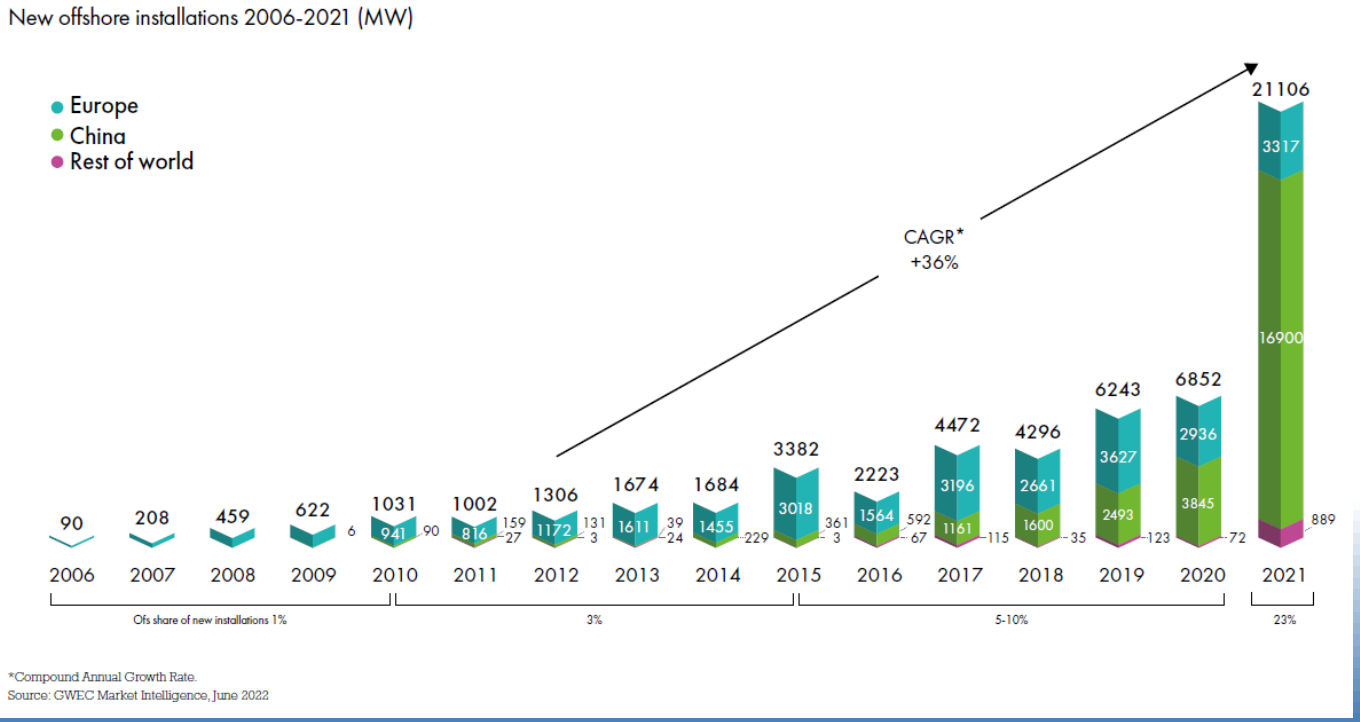
Why offshore wind?

- Need for carbon-neutral energy: green transition relies on rapid and extensive offshore wind farms (OWF)

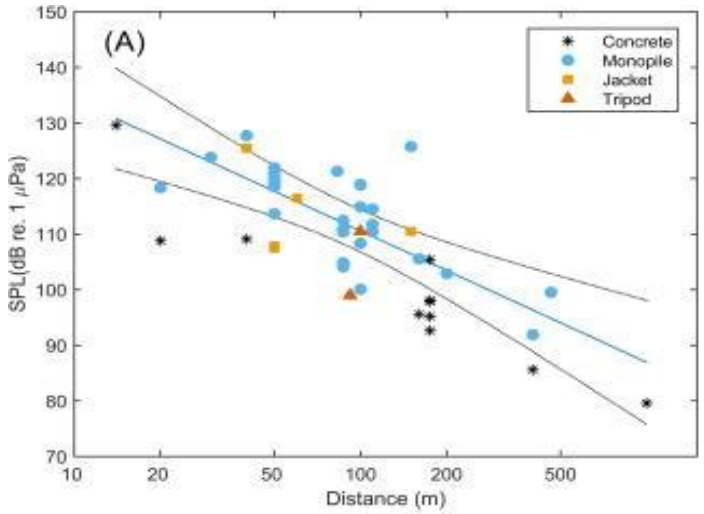


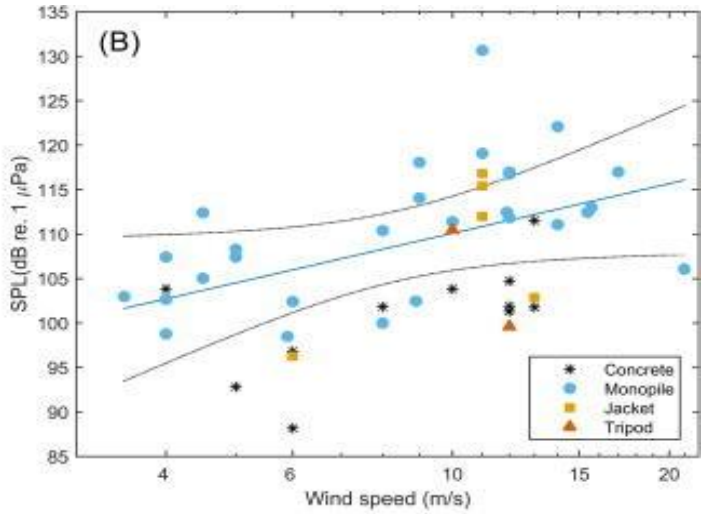
Why offshore wind?

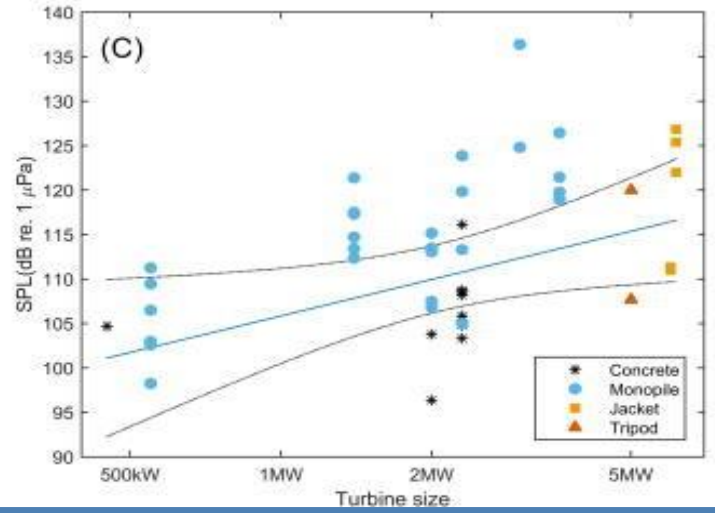
- Need for carbon-neutral energy: green transition relies on rapid and extensive offshore wind farms (OWF)
- Initial focus has been on development-phase noise impacts



Operational noise from OWF less studied







Tougaard *et al.* (2020)

- Operational noise produced by various elements of the OWF
- Effects and risk to marine ecosystems remain unresolved

PURE WIND objectives

I. Describe sound fields around fixed and floating OWF and identify sensitive cross-basin soundscapes

II. Identify impacts from operational OWF on marine ecosystems, including marine mammals, fish, and zooplankton

III. Develop tools for integration of a comprehensive numerical model for OWF noise production and propagation to facilitate assessment of planned OWF expansion

IV. Synthesise knowledge and best practices from with fixed offshore wind and translate for application in the development of floating OWF

V. Broadly share results with policy and management community, & scientific and general public. Train next generation of scientists to work on these problems

PURE WIND partners

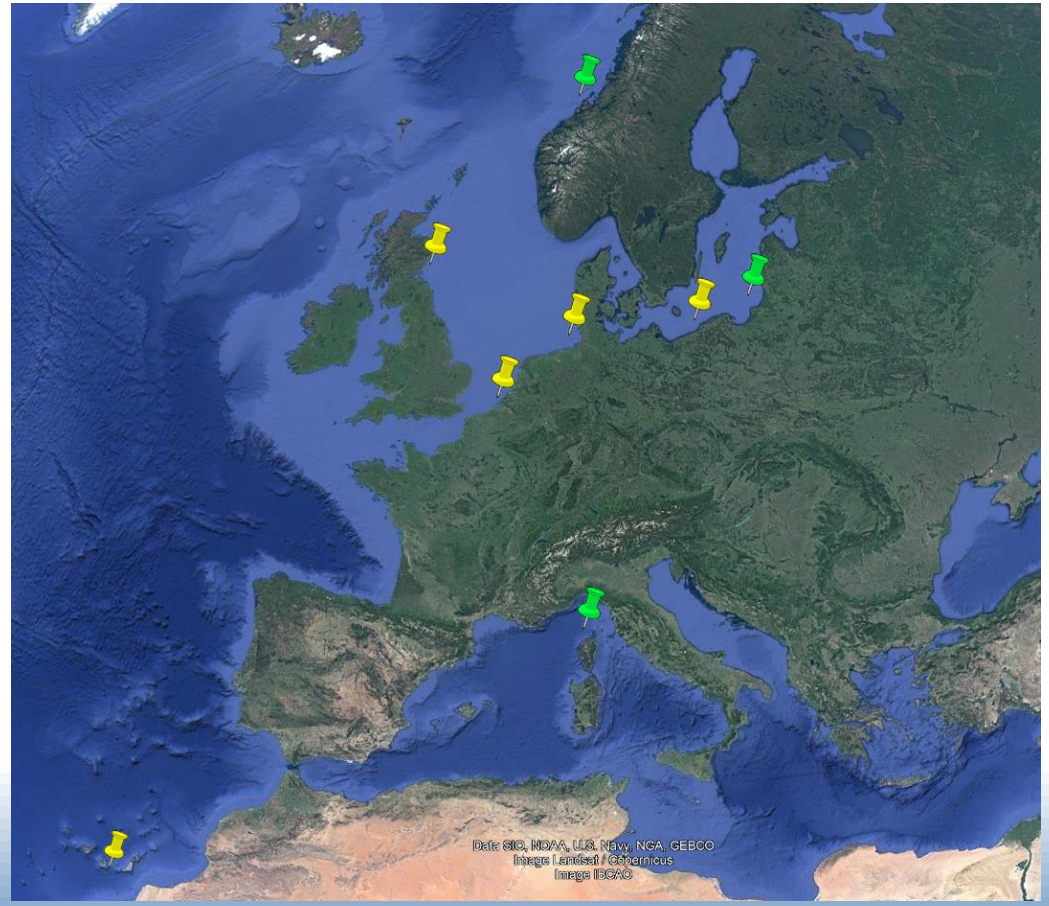
- Norway: NTNU
- Spain: PLOCAN, ULPGC
- Italy: CNR, UNIGE
- Germany: BSH, TiHO
- Belgium: RBINS
- Poland: Gdynia Maritime U
- Ireland: UCC, GDG

Characterizing OWF sounds

I. Quantify key features of the acoustic fields from fixed and floating OWF and understand the cumulative effect of multiple windfarm arrays/clusters

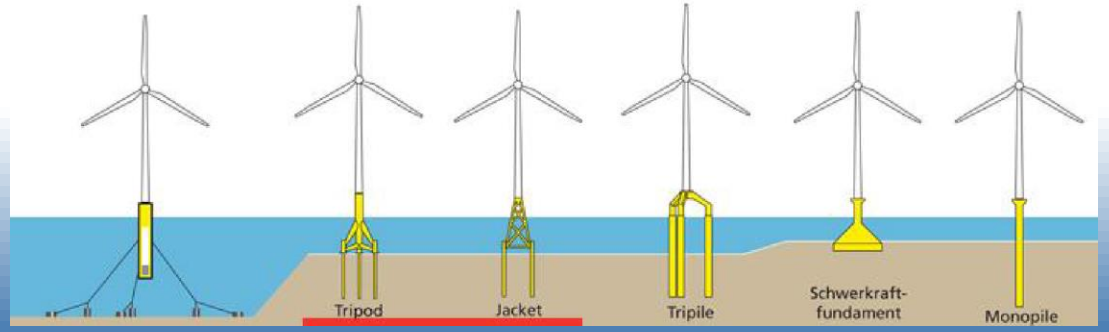
II. Identify cross-basin soundscapes and sensitive habitats

Collection of sound data from OWF and habitats with no OWF



- Historical data
- New data collection efforts
- Non-consortium partner data sharing
- Characterization of
  - Radiated noise
  - Soundscapes

Simulation of cumulative sound from OWF cluster



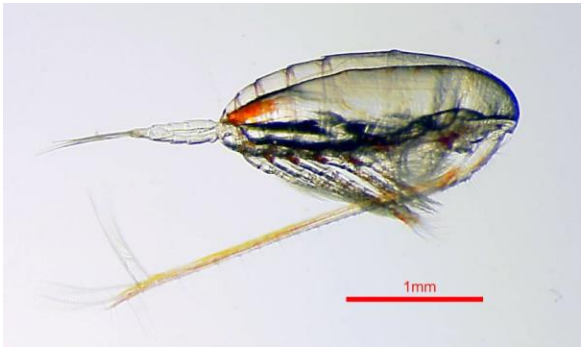
OWF noise impacts across food webs

I. Study the impact of OWF noise on zooplankton and fish
II. Identify spatial and qualitative use of operating OWF by harbour porpoises and harbour seals
III. Advance knowledge of acute and cumulative effects of operating OWF noise on top predators

Impacts on zooplankton

Exposure to floating and fixed-bottom OWF operational noise

- <u>Small-scale laboratory experiments</u>



→ Model organism: copepod *Calanus finmarchicus*, key mesozooplankton species in Nordic Seas and major prey for higher trophic levels

→ Choice chamber system to analyse zooplankton behaviour

- <u>Mesocosm experiments</u>

→ In-situ imaging flow cytometry; passive & active acoustic sampling

- <u>Field observational effort in the vicinity of OWF</u>

→ In-situ moored data collection with passive & active acoustics

Impact of operational noise on fish

- Observe presence of swim-bladdered fishes in soundscapes of OWF and non-OWF regions
- Approach: take advantage of selective attenuation of sound on fish swimbladders depending on resonance frequency & fish diel migration cycles
  - Differing diel sound levels at relevant frequencies

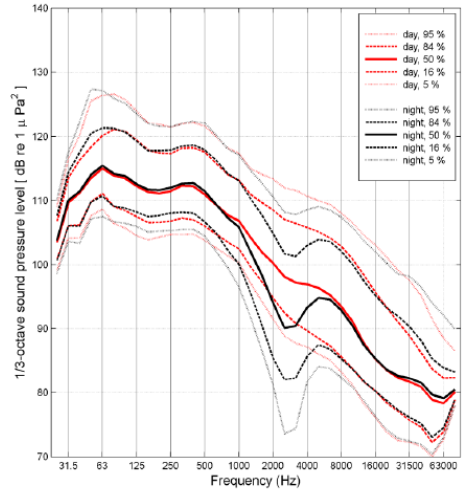
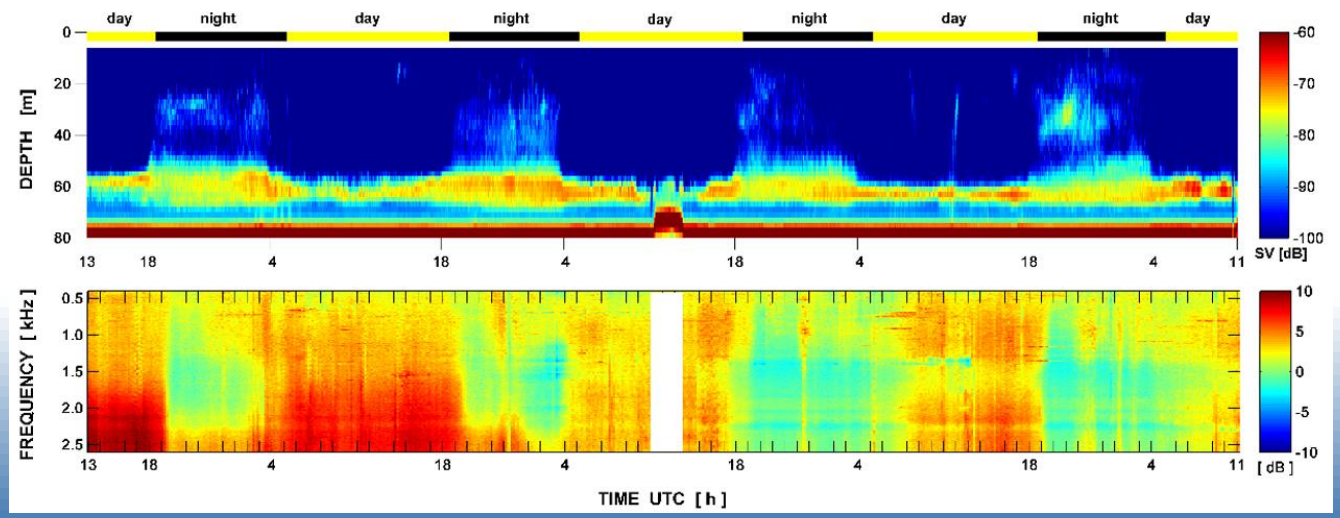


Fig.5: Comparison of the percentiles of day-time and night-time sound pressure levels. At frequencies around 2500 Hz the night-time percentiles are consistently lower than the day-time percentiles.

Lisimenka A. (2007), Ainsley et al. (2011), Klusek & Lisemenka (2016)



Effects on top predator behavior & habitat use

- Harbour seals tagging: historic and new data to determine their spatial use and foraging behavior
- Harbour porpoise PAM: spatial use and fine-scale foraging behavior in and around OWF
- Parametrize OWF-related environmental variables which affect habitat suitability
  - Test for effects on harbour seals and harbour porpoises
  - Allow testing of the effects of potential future offshore windfarm expansions on these populations

Acoustic modeling tools for integrated assessment

I. Develop knowledge and tools for integration of a comprehensive numerical model encompassing all aspects of OWF noise production and propagation
   - Noise predictions given wind data
   - Point source modeling
   - Numerical model for complete life-cycle noise generation
   - Integration into Virtual Research Environment

II. Facilitate assessment of planned OWF expansion for spatial planning and environmental impact

Conceptual framework

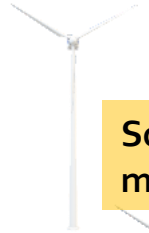
Emitted noise spectrum

Source model

Propagation model

Received noise spectrum

Ambient noise spectrum

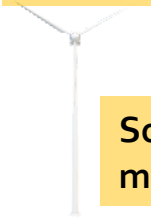


Source model

Propagation model

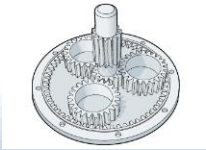
Noise spectrum at point P

Wind data



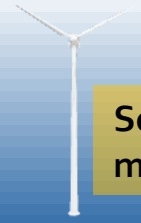
Source model

Propagation model



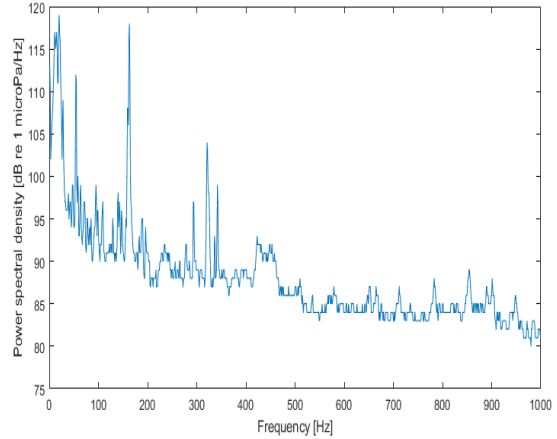
OWF data

Environment data



Source model

Propagation model



operational noise

Harmonization of regulatory policy and governance frameworks

I. Synthesize knowledge & best practices from EU and international experiences (standards, guidelines, approaches, frameworks, tools and methodologies) with fixed offshore wind development

II. Translate for application in the development of policy, mitigation, and regulation for floating OWF

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BUNDESAMT FÜR SEESCHIFFFAHRT UND HYDROGRAPHIE

Implementation plan

- Create structured knowledge base of reference for governance and regulation of OWF
- Synthesis of knowledge base into relevant working topics
  - Strategic case studies
- Optimize engagement and knowledge exchange within and external to the project
  - PURE WIND Stakeholder Group: ensuring products are management-relevant; help with broader dissemination
- Develop and formulate policy-aligned offshore wind roadmap

Dissemination

I. Broadly share our results with
   - scientific community
   - policy and management community
   - general public

II. Contribute to training of next generation of scientists to work on these problems: students (MSc & PhD), post-docs, early-career

Thank you!