



Floating Wind Technology

- With some digressions

Finn Gunnar Nielsen
Professor

Geophysical Institute / Bergen Offshore Wind Centre (BOW)

<https://www.uib.no/en/bow>

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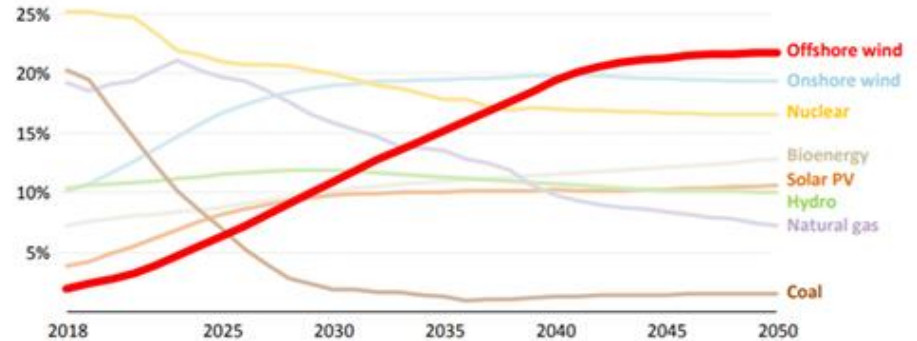
“The Times They Are A-Changin”



- EU’s Green Deal
- Europe 2050: 400 GW +
- Norway 2040: 30 GW
- Energy security
- Price of energy
- EU, 20 October 2022:

... **fast-tracking of the simplification of permitting procedures** to accelerate the rollout of renewables and related grids

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



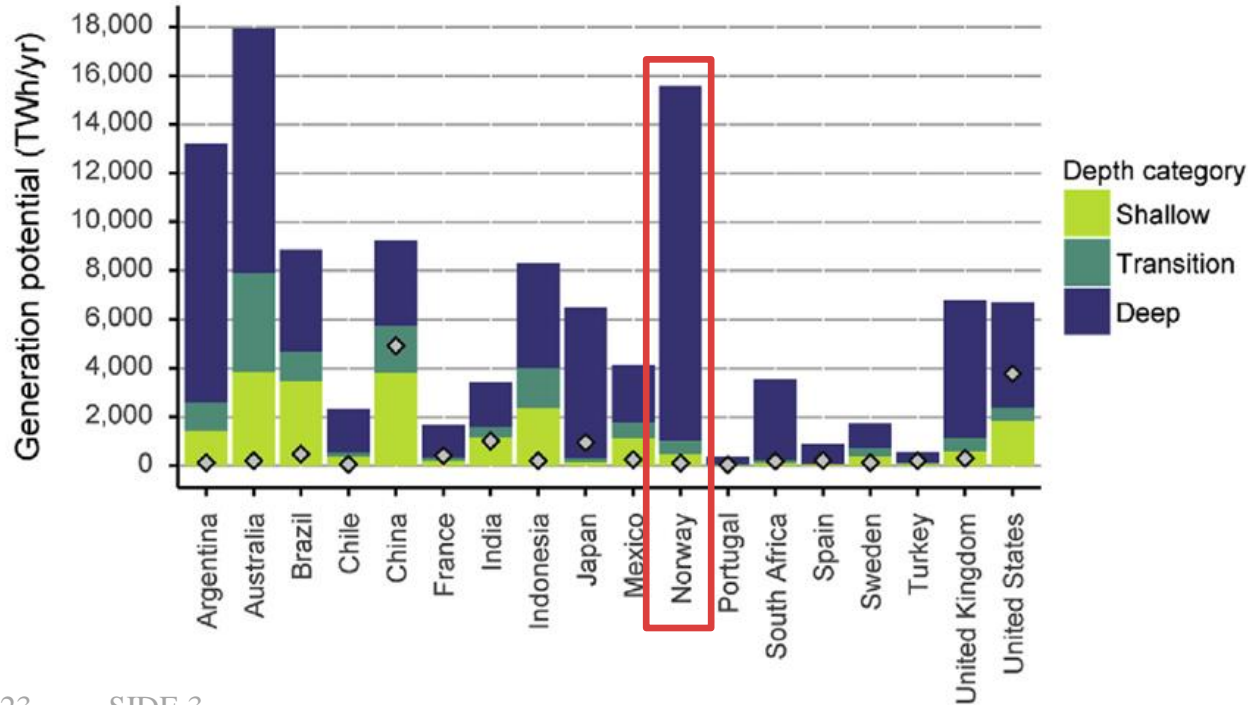
Source: IEA 2019



Norway: World leading wind resources



J. Bosch et al. / Energy 163 (2018) 766–781



Floating wind turbines – a new idea?



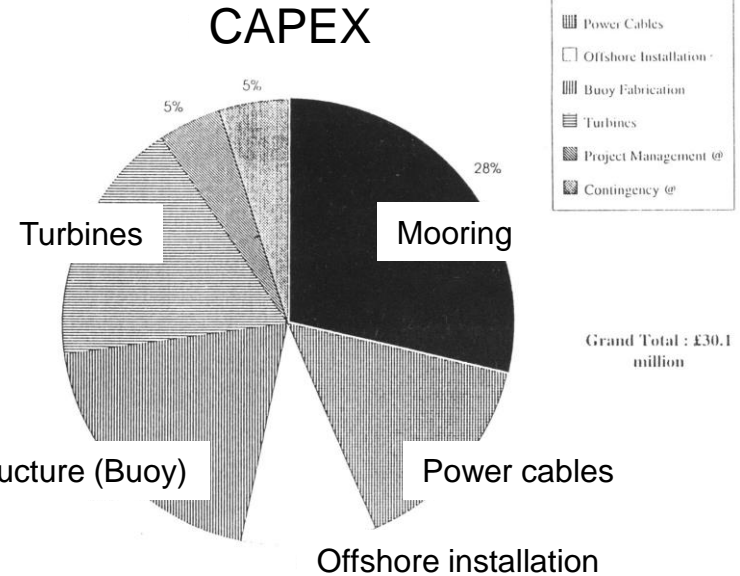
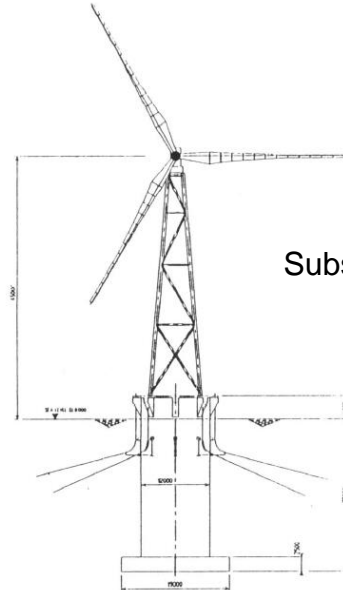
Technical and Economical Aspects of a Floating Offshore Windfarm

K. Tong and C. Cannell

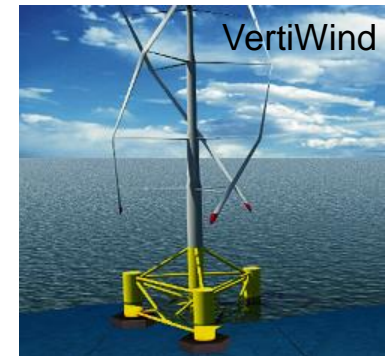
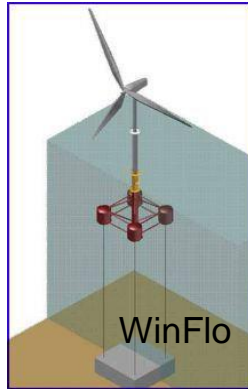
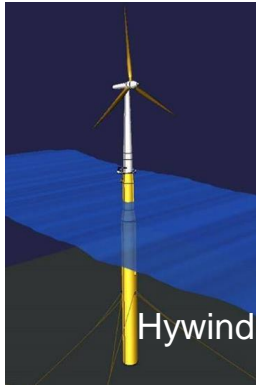
Tecnomare (UK) Ltd., Elsley House, 24-30 Great Titchfield Street, London W1P 7AD

Paper for BWEAD/DTI/Multi-Science Seminar on "Prospects" Harwell, June 1993.

- 9 buoys
- 100 m WD
- 1.4 MW each turbine
- Optimistic w.r.t LCOE



Concepts flourish



A challenge back in 2002

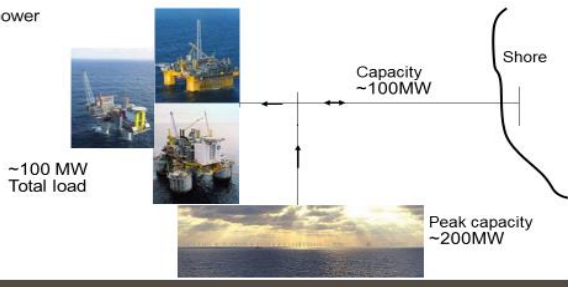


Reduce emissions!

Vision: 2005:

Vision

- Share infrastructure; Power to shore and platforms.
- Reduce emission to air
- New clean power



From “Crazy Norwegians” to a new power system!





The Hywind concept (2003)

Key features

Combines known technologies “Nothing new”

Designed for harsh environment

”Standard” offshore turbine

Water depth >100 m

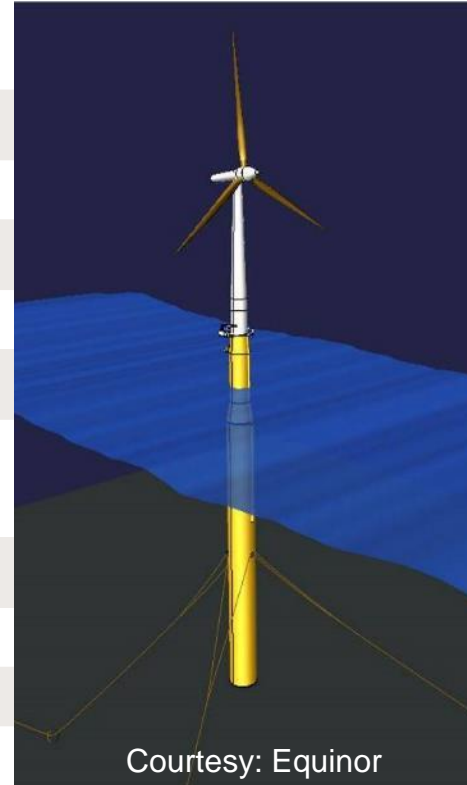
Assembled in sheltered waters, towed to field

Relies upon experience from:

Floating platforms

Electrical power production

Onshore wind turbines



Courtesy: Equinor



Key to success?



- Creativity building upon
 - Competence & experience
 - Combining known elements
 - Addressing the unknown
- Endurance
- Business understanding
- Professional project execution
- Management commitment
- Funding
- Timing
- ...and a portion of luck



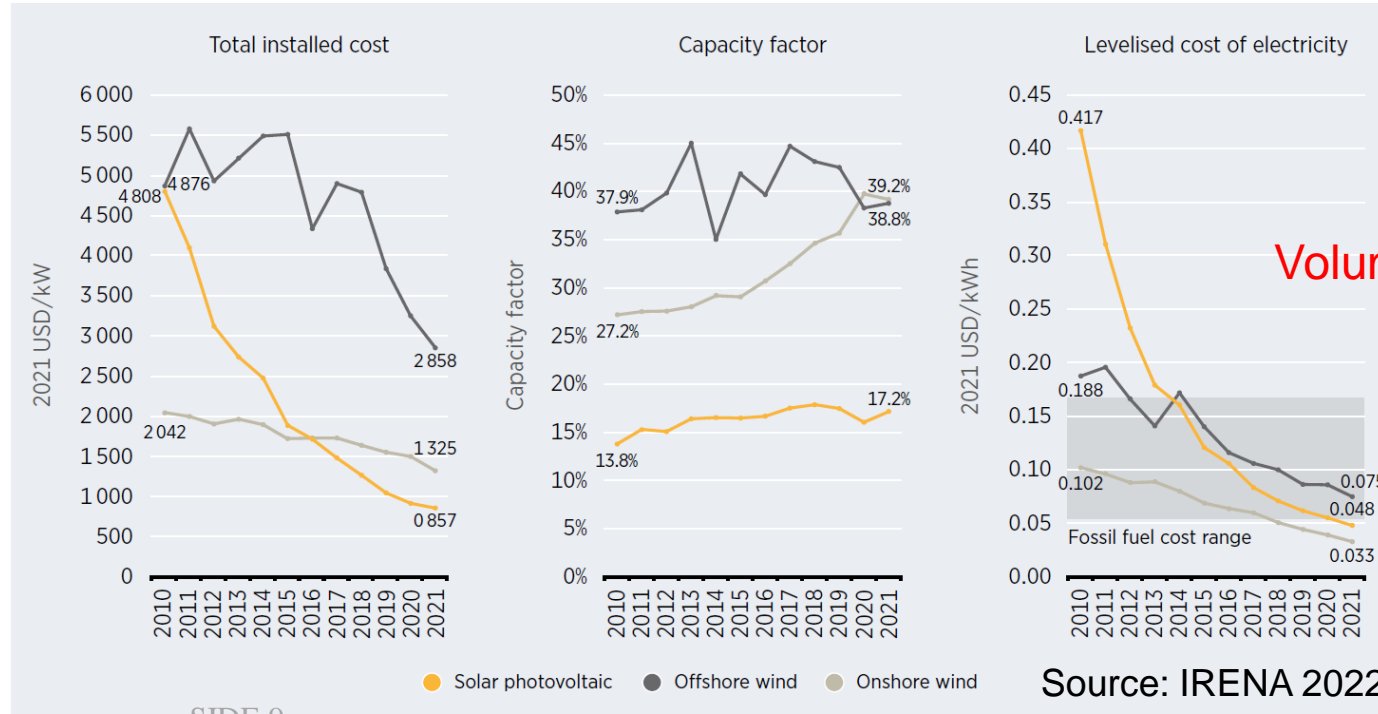
Statoil – Hydro merger: 2007
New mission paragraph.
Hywind Demo investment decision: 2008
Financial crisis: 2009



Challenges ahead, as always: Reduce costs



Figure S.2 Global weighted average total installed costs, capacity factors and LCOE of newly commissioned utility-scale solar PV, onshore and offshore wind, 2010-2021



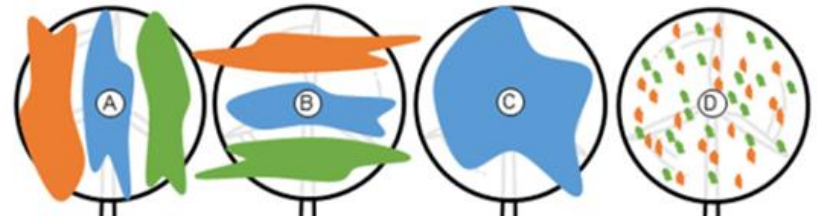
Source: IRENA 2022



Understand the resource

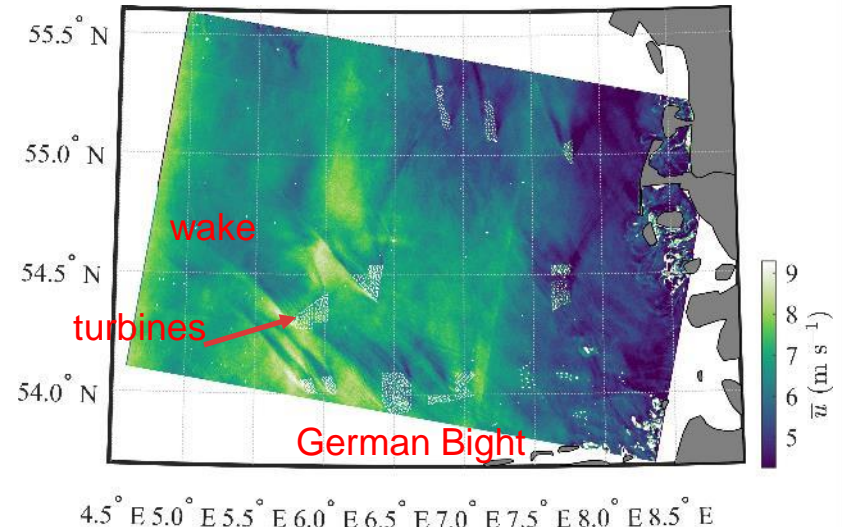


- At turbine scale:
 - Structure of turbulence
 - Loads
 - Farm efficiency



Nybø et al. (2022)

- At wind farm scale:
 - Wind farm wakes
 - Atmospheric stability
 - Who owns the wind?
Legal implications

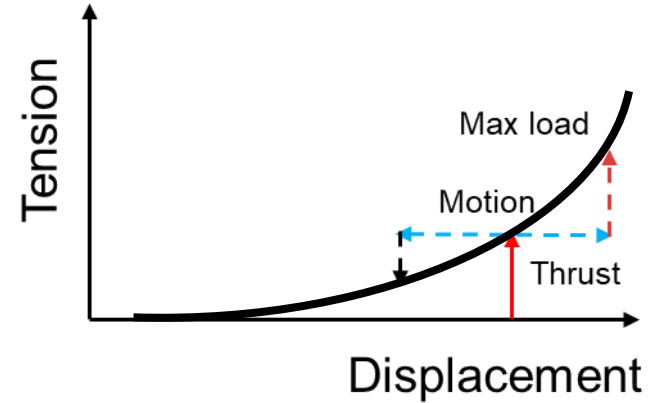


Courtesy Etienne Cheynet, UiB

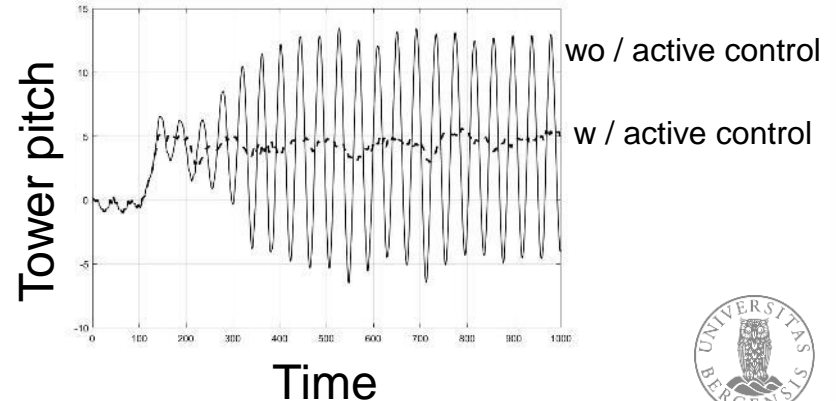
Optimization



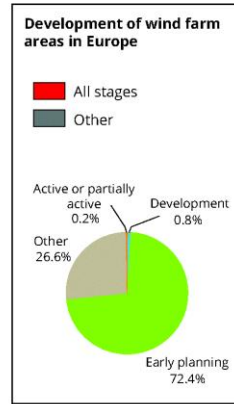
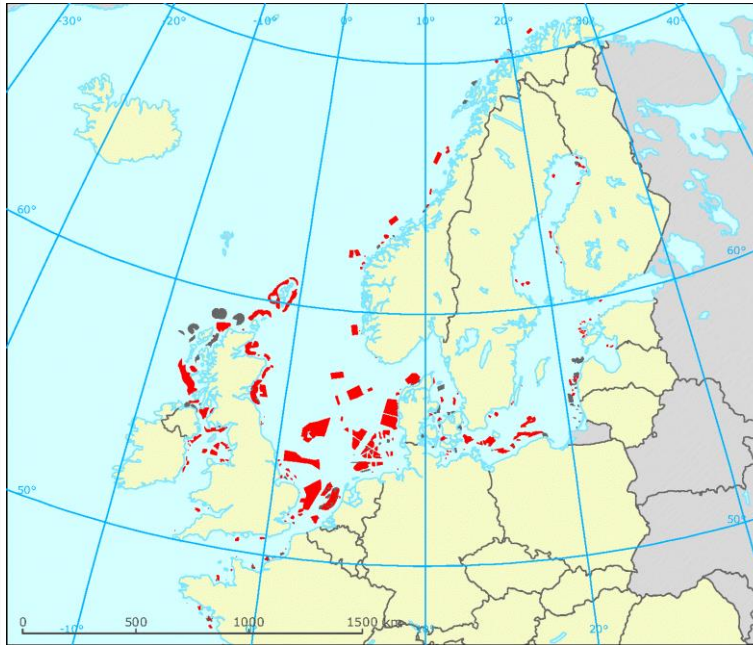
- Turbines for floaters
- Mooring – do not underestimate the challenge
- Controller – key to reduced fatigue
- Installation, O&M
- Integrated aero-hydro-servo-structural dynamic analysis
- New focus: Farm rather than turbine



Courtesy: Equinor



Need for ocean area



Possible conflicts

- Neighbour wind farms
- Fisheries
- Bird migration (collision)
- Fish / sea mammals (noise)
- Navigation routes
- Military
- ...

Deep water:

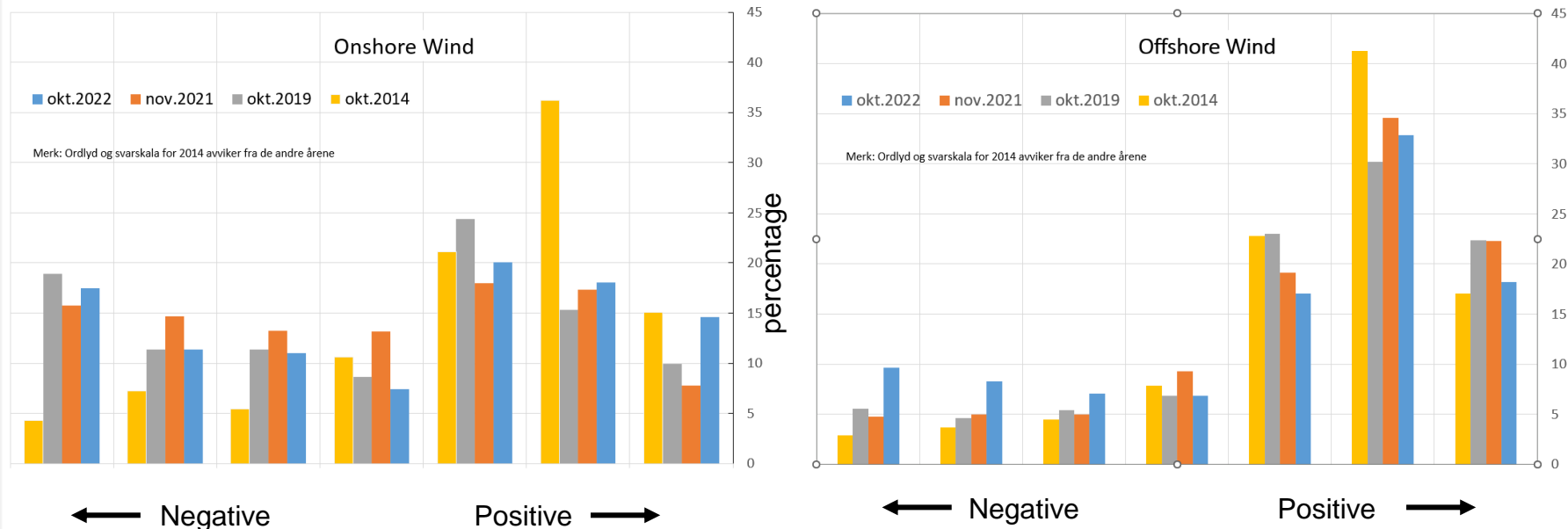
- Flexibility
- Better resources



Opinions change over time –



Results from Norwegian Citizen Panel



Source: Endre Tvinnereim, UiB





Summary

- To achieve ambitions – deep waters must be utilized
- Technology available, but improvements needed
- Floaters gives flexibility in wind farm localization
- Improved understanding needed of atmospheric flow – turbine dynamics - wind farm interaction
- Environmental concerns and area conflicts must be addressed properly.





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Knowledge for sustainable development of offshore wind energy

<https://www.uib.no/bow>