Virtual Wind Conference 18 November 2020

The SET-wind lighthouse initiative

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SET Wind

setwind.eu

Supporting the implementation of the SET-Plan for offshore wind energy

CENER CENTRO NACIONAL DE ENERGÍAS RENOVABLES

ECN › TNO innovation for life

SINTEF

EERA European Energy Research Alliance

DTU Technical University of Denmark

ForWind Center for Wind Energy Research Bremen Hannover Oldenburg

SETWind (2019-2022) receive funding from EU Grant Agreement No 842231

What is the SET-wind lighthouse initiative?

Initiative in development to develop one or more **large European research projects** that will address the **grand scientific and technical challenges** that are crucial for the further advancement of **offshore wind energy**, providing **new knowledge and basis for innovation**.

MOTIVATION

- Offshore wind has the potential to deliver 18 times the global electricity demand of 2017
- EC scenario for 2050 to reach climate goals:
  450 GW of offshore wind to supply 30 % of the electricity demand
- Equinor and Ørsted suggest that offshore global capacity can reach 1400 GW by 2050
- 80 % of the global offshore wind resource is over deep water
- A big opportunity for industrial development, new jobs and value creation
- A grand science and engineering challenge

SET Wind

Vision

Offshore wind to be a cornerstone of the energy system

Offshore Wind Lighthouse #1

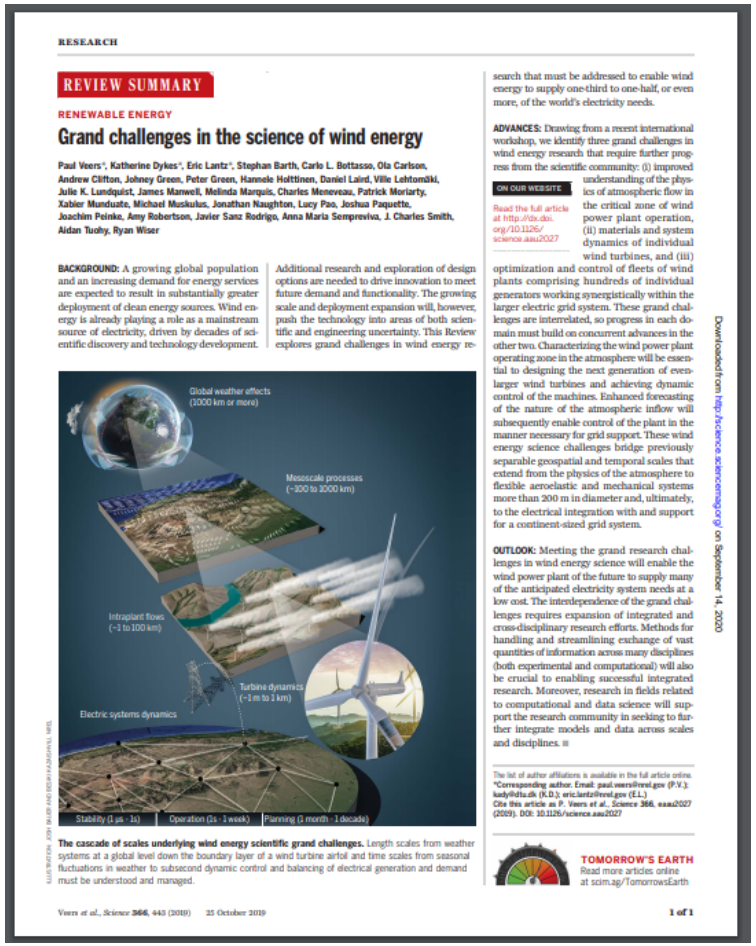
Enable reliable power system operation with large-scale offshore wind

Offshore Wind Lighthouse #2

Make floating wind cost competitive

SET Wind

Grand Scientific Challenges



RESEARCH

REVIEW SUMMARY

RENEWABLE ENERGY

Grand challenges in the science of wind energy

Paul Veers*, Katherine Dykes*, Eric Lantz*, Stephan Barth, Carlo L. Bottasso, Ola Carlson, Andrew Clifton, Johney Green, Peter Green, Hannele Holttinen, Daniel Laird, Ville Lehtomäki, Julie K. Lundquist, James Manwell, Melinda Marquis, Charles Meneveau, Patrick Moriarty, Xabier Munduate, Michael Muskulus, Jonathan Naughton, Lucy Pao, Joshua Paquette, Joachim Peinke, Amy Robertson, Javier Sanz Rodrigo, Anna Maria Sempreviva, J. Charles Smith, Aidan Tuohy, Ryan Wiser

BACKGROUND: A growing global population and an increasing demand for energy services are expected to result in substantially greater deployment of clean energy sources. Wind energy is already playing a role as a mainstream source of electricity, driven by decades of scientific discovery and technology development. Additional research and exploration of design options are needed to drive innovation to meet future demand and functionality. The growing scale and deployment expansion will, however, push the technology into areas of both scientific and engineering uncertainty. This Review explores grand challenges in wind energy research that must be addressed to enable wind energy to supply one-third to one-half, or even more, of the world's electricity needs.

ADVANCES: Drawing from a recent international workshop, we identify three grand challenges in wind energy research that require further progress from the scientific community: (i) improved understanding of the physics of atmospheric flow in the critical zone of wind power plant operation, (ii) materials and system dynamics of individual wind turbines, and (iii) optimization and control of fleets of wind plants comprising hundreds of individual generators working synergistically within the larger electric grid system. These grand challenges are interrelated, so progress in each domain must build on concurrent advances in the other two. Characterizing the wind power plant operating zone in the atmosphere will be essential to designing the next generation of even-larger wind turbines and achieving dynamic control of the machines. Enhanced forecasting of the nature of the atmospheric inflow will subsequently enable control of the plant in the manner necessary for grid support. These wind energy science challenges bridge previously separable geospatial and temporal scales that extend from the physics of the atmosphere to flexible aeroelastic and mechanical systems more than 200 m in diameter and, ultimately, to the electrical integration with and support for a continent-sized grid system.

OUTLOOK: Meeting the grand research challenges in wind energy science will enable the wind power plant of the future to supply many of the anticipated electricity system needs at a low cost. The interdependence of the grand challenges requires expansion of integrated and cross-disciplinary research efforts. Methods for handling and streamlining exchange of vast quantities of information across many disciplines (both experimental and computational) will also be crucial to enabling successful integrated research. Moreover, research in fields related to computational and data science will support the research community in seeking to further integrate models and data across scales and disciplines. ■

ON OUR WEBSITE

Read the full article at http://dx.doi.org/10.1126/science.aau2027

The cascade of scales underlying wind energy scientific grand challenges. Length scales from weather systems at a global level down the boundary layer of a wind turbine airfoil and time scales from seasonal fluctuations in weather to subsecond dynamic control and balancing of electrical generation and demand must be understood and managed.

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TOMORROW'S EARTH
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https://science.sciencemag.org

- Improved understanding of atmospheric and wind power plant flow physics
- Aero-, structural-, electrical- and offshore wind hydrodynamics of enlarged wind power plants
- Systems science for integration of wind power plants into the future electricity grid

Hypothesis

To succeed in bringing floating wind towards its full potential **an interdisciplinary research approach** must be taken, considering the wind power plant, together with the surrounding nature (wind, water, ..) and electric grid, as part of the same system, and understand the complex interactions of these parts in all detail.

The Holy Grail of data

Implementation (draft/work in progress)

- **RIA call in upcoming Horizon Europe programme**
- **100 % funding by EC for RIA, but enhanced through coordination with national projects**
- **One or two projects that address minimum 2 out of the 3 grand research challenges:**
  - Improved understanding of flow physics
  - Dynamic interactions of enlarged wind turbines
  - Systems science for integration of wind power
- **An interdisciplinary approach should be taken**
- **The research should be closely linking with industry and provide new knowledge and basis for innovation**

Knowledge

+

Industry

= €$¥

Research is **important**

(click here to play movie)

Summing up

- The two lighthouse initiatives represent **great opportunities** for new industry, employment, innovation and an efficient carbon-free power system.
- Well established need for more Research, Innovation and Deployment
- Bringing the lighthouse initiatives forward as **large visionary research projects** to solve grand scientific and technical challenges **will provide a solid foundation** for the successful advancement of offshore wind to be a cornerstone of the energy system.