JP Wind

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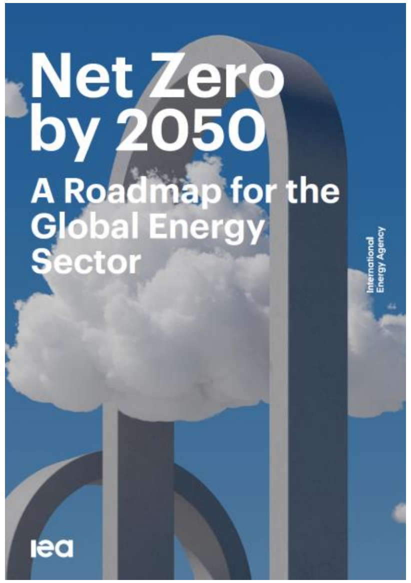
Content

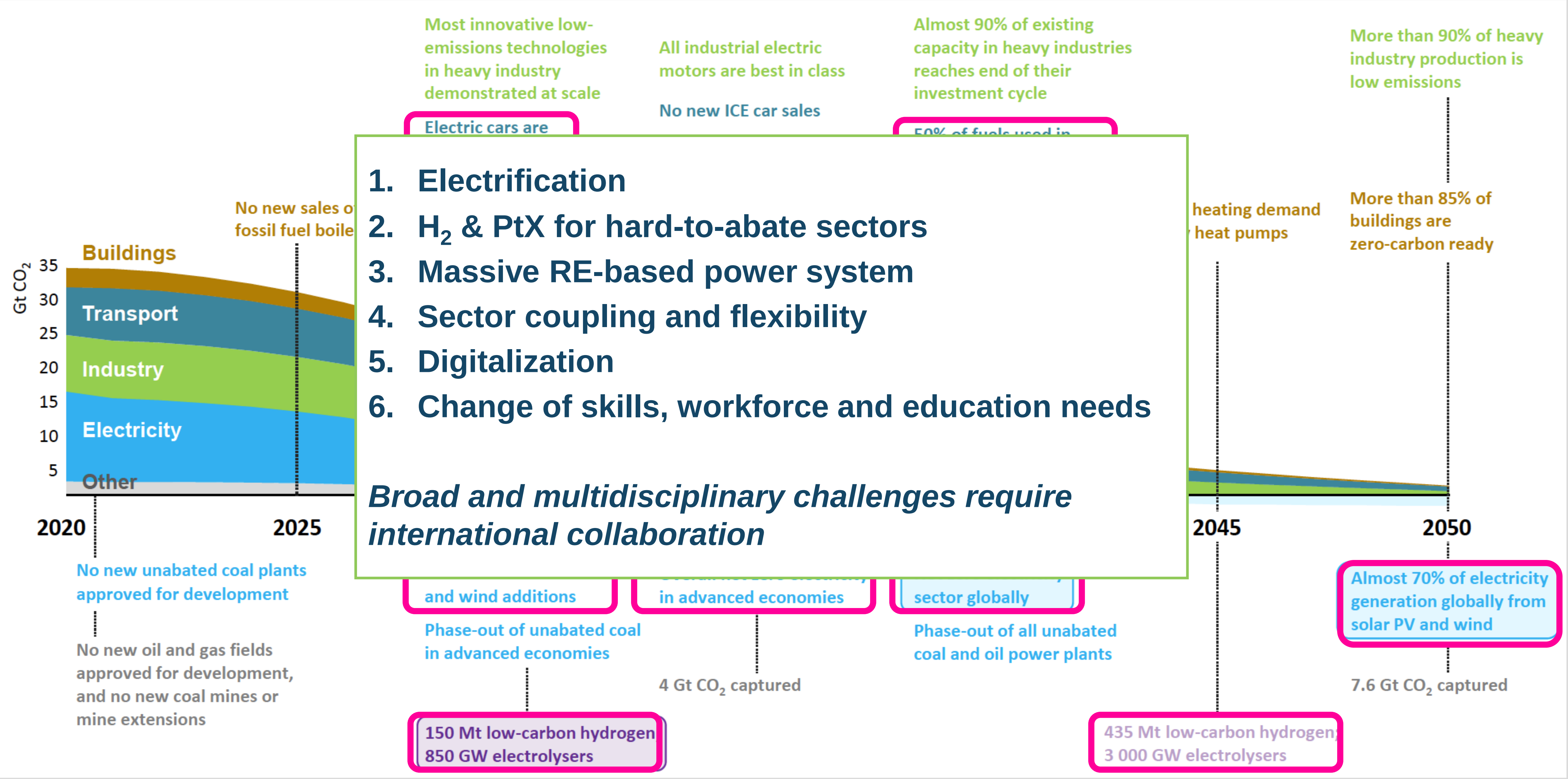
- Overview of market and research challenges
- About EERA JP Wind

Short and long term market and research challenges

- Electricity market reform in the EU (RES out of the spot price setting?)
- Moving from cost to value in a changing energy system
- Security of supply becomes a top priority (energy, materials, supply chain, human resources)
- Digitalization of supply chains, operations, testing, cyber security, certification,...
- All previous topics on top of the traditional wind energy research (materials, aerodynamics, control, meteorology, grid integration,...) which are still needed
- **But the biggest challenge is...**
- ***Reaching the Net Zero global objective in less than 30 years***



While OEMs are struggling to make profits today we should forget the long term goals



1. **Electrification**
2. **H_2 & PtX for hard-to-abate sectors**
3. **Massive RE-based power system**
4. **Sector coupling and flexibility**
5. **Digitalization**
6. **Change of skills, workforce and education needs**

Broad and multidisciplinary challenges require international collaboration

About the European Energy Research Alliance Joint Program on Wind Energy

JP Wind footprint

- 46 organisations (16 full members, 30 associates)
- Representing 14 countries

JP Wind Management Board

New Member

Ignacio Marti Perez
(DTU)
Coordinator of JP Wind
(elected in September 2022)

Peter Eecen
(TNO)
Sub-Programme 1
Programme planning and outreach

Paul McKeever
(ORE Catapult)
Sub-Programme 2
Research Infrastructure, testing and standards

Jake Badger
(DTU)
Sub-Programme 3
Wind conditions and climatic effects

Antonio Ugarte
(CENER)
Sub-Programme 4
Aerodynamics, loads and control

New Member

Tufhe Göçmen
(DTU)
Sub-Programme 5
System Integration

John Olav Tande
(SINTEF)
Sub-Programme 6
Offshore Balance of Plants

Arno van Wingerde
(Fraunhofer)
Sub-Programme 7
Structures, materials and components

New Member

Vibeke Nørstebø
(SINTEF)
Sub-Programme 8
Deployment, social, environmental, economic issues

Why a Joint Program on wind energy research?

- The mission for EERA JP WIND is to provide **strategic leadership** for medium to long-term research and to support the European wind energy industry and societal stakeholders.

- The joint programme brings together the main **public research organisations** in Europe with substantial research and innovation efforts in wind energy.

- EERA JP WIND is:
  - a **one-stop shop** for public wind energy R&D supporting research organizations, public and private sectors
  - a platform for **coordination** of research facilities, data and human resources
  - a driving force in maintaining Europe's **leadership on wind energy technology and research**

History and evolution

- JP Wind has grown from 13 members in 2010 to 46 members in 2022

- JP Wind has made an impact on improving research coordination in Europe, especially in the following areas:
  - Strategic impact
  - Data and facility sharing
  - Knowledge sharing and community building
  - Mobility of researchers
  - Defining and executing large and complex EU R&D projects

- The SETWind project sponsored by JP Wind had a large impact in the EU R&I strategy

- Now, in 2022, with the new challenges that EU has to face and the need of acceleration in clean energy transition, JP Wind is evolving towards a European Centre of Excellence

The added-values for our members

Being part of the strategic leadership for EU wind energy R&D

- Contribute to development of wind energy research agenda
- Possibility to promote large scale transnational research projects
- Dialogue with industry in the context of ETIPWind
- Find partners for Horizon Europe projects
- Showcase your research work

Being part of the biggest R&D network in Europe

- Visibility of others research and initiatives (i.e. new test facilities)
- Knowledge sharing and exchange, collaboration across projects
- Joint use of research facilities and data
- Mobility and training
- Dissemination and communication

Key output of JP Wind: R&I strategy

JP Wind R&I strategy: wind turbine technology

EERA
European Energy Research Alliance
JP WIND

1.

Research gaps

Implementation of 6000GW wind power worldwide requires more cost efficient, efficient, low environmental impact, scalable wind energy systems.

Unknowns in degradation mechanisms (e.g. wear in drivetrain, erosion of blades) lead to unexpected behaviour and limited options for cures.

Interpretation and extrapolation of scaled, hybrid and component testing.

Multi-purpose platforms integrating various options such as wind, solar, wave, tidal, seaweed growth, etc.

Next generation wind turbine technologies and disruptive concepts

Degradation and damage mechanisms of materials and components.

Access to and data from a wind turbine research infrastructure.

Upscaling of wind turbines and aiming for further cost reduction require validation of models and innovations to reduce uncertainties in design. Data sets are lacking.

The development of larger and larger turbines requires major innovations in the certification and testing methodologies such as scaled testing and testing of components together with virtual tests and development of international standardisation.

Key action areas

RESEARCH AGENDA TOPICS

DEVELOP NEXT GENERATION TEST AND VALIDATION METHODS
Development of external condition measurement methods, in addition or alternative to full-scale blade testing, test benches for drivetrain testing, tailor-made wind tunnel models and improvements in material testing. Testing and validation methods for components shall be developed and proposed for international standardisation. Develop an integrated, full-scale international testing environment.

INVESTIGATE SMART TURBINE DESIGN
Development of smart rotor technology to reduce loads, smart materials to reduce degradation, self-repair technology and intelligent, adaptive turbine controllers.

REMOVING BARRIERS TOWARDS 20+MW TURBINES
Barriers in blade design and testing, rotor-hub design, drivetrain design must be addressed including the installation of large and heavy components.

DEVELOP DISRUPTIVE TECHNOLOGIES
Investigating game changers and new technology solutions in rotor, drive train, support structures and electrical system keeping a close watch to technology developments in other disciplines and completely different concepts like high-altitude wind power.

NEW MATERIALS AND OPTIMIZED STRUCTURES
Introducing smart materials, such as nano-coatings, high-strength materials, anti-corrosion materials and self-healing materials. Structural reliability methods need to be developed in order to better use materials, predicting damage and cracks in an enhanced way. Solutions for leading edge erosion need to be developed.

JP Wind R&I strategy: fundamental wind energy science

EERA European Energy Research Alliance JP WIND

6. Research gaps

Fundamental Wind Energy Science

Climate change and extreme climate affect the design, performance and operation. The development in critical geo-physical condition in the future needs to be modelled and assessed.

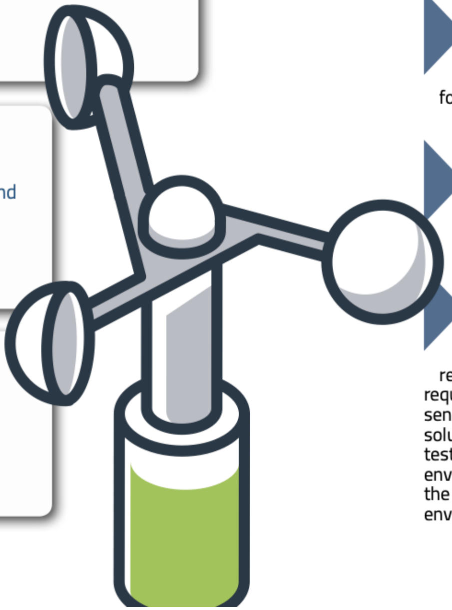
Physics of large rotor aerodynamics: inflow, blade and wake aerodynamic characterization i.e. accurate model development for the flow around large blades including add-ons and active flow devices and wake models.

Materials, including better knowledge of properties, new and improved materials and their degradation and failure mechanisms, provide new opportunities for weight and cost reductions, higher reliability and improved manufacture of wind energy systems.

Atmospheric multi-scale flow from mesoscale to wind farm flows i.e. accurate and validated model predicting properties of flow in complex terrain regions down to wind farm flow affected by wakes and turbine control. Improved understanding of important physical phenomena may lead to update of fast engineering models

High performance computing and digitalization call for extensive research, application and validation, to enable accurate and reliable solutions based on powerful computer systems and utilizing large datasets, either for machine learning or model validation.

System engineering models, including detailed fluid-structure, soil-structure and electro-mechanical interaction needs development in order to allow optimal design and operation for reduced LCOE and system compliance



Key action areas

RESEARCH AGENDA TOPICS

MULTI-SCALE FLOW MODELLING

Multi-scale modelling using high fidelity and high-performance computing to provide accurate estimates of important parameters for siting, control, performance and operation of wind farms as well as predictions of effects from climate change and extreme climates.

DIGITALIZATION AND DATA ANALYTICS

New sensors, data processing, machine learning and data analytics and methods for implementation in data-driven design, digital twins, control and monitoring for O&M needs development for increased reliability and reduced costs in wind energy.

CONSTRUCTION AND MANUFACTURING

Relevant experiments need to be developed and implemented to create open access databases involving industry.

OPEN ACCESS DATABASE FOR RESEARCH VALIDATION

Remote and automated repair technology and strategy requires the development of sensor technology and robotic solutions. These should be tested in safe demonstration environments as well as in the dynamic wind turbine environment.

INTEGRATED MULTI FIDELITY SYSTEM

Global high-fidelity system models provide insights in critical interaction between system components, i.e. for the drive train components and engineering tools offer total system optimization of wind energy plants, while being essential for the development of reduced order engineering design tools for technology and plant design.

KEY ACTION AREAS EFFICIENT MULTI-DISCIPLINARY OPTIMIZATION AND SYSTEM ENGINEERING

Optimisation of wind farm design requires a multi-disciplinary, system engineering approach including rotor, nacelle, tower, support structure, electrical infrastructure, soil, environment, markets and regulations and includes public acceptance as well as societal costs and benefits. Tools needs to be developed and matured, taking into account the complete lifecycle.

LARGE ROTOR AERODYNAMICS

Aerodynamic modelling at High Reynolds number, from high fidelity to engineering tools. Subsystem validation in wind tunnels and real-full scale wind turbine aerodynamic experiment measuring inflow, blade flow and the wake for model validation. This provides accurate power performance, loads and input for control.

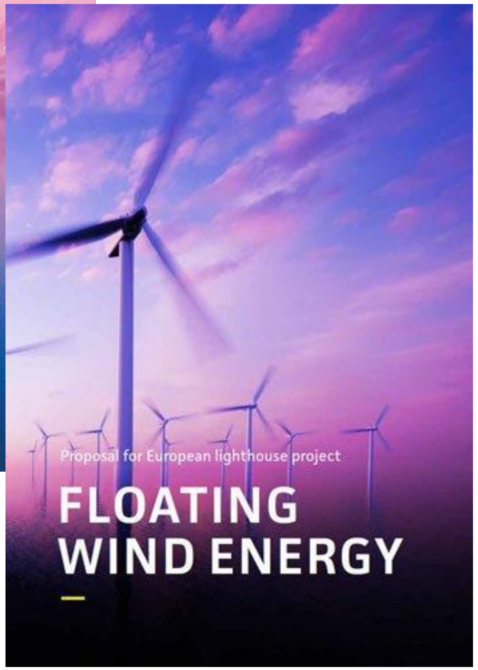
MATERIALS SCIENCE

Better and more accurate knowledge of properties, behaviour, degradation and damage mechanisms of materials as well as development of new materials or treatments to offer less conservative and more reliable designs needed for upscaling, cost reduction, circularity and lifetime extension. Material science is needed directed towards fracture mechanics, composite blades, structural elements, corrosive and erosive environment, mechanical and electrical components such as generators and magnets, subsea cables.

Towards a European Centre of Excellence

The EUCoE will focus on the definition and monitoring of a research program for wind energy up to 2050

- Focus on painting the big picture for wind energy research
- Providing guidance to EC and national stakeholders:
  - Understanding the role of research in realising REPowerEU and Net Zero by 2050
  - Track the status of research and its impact continuously
  - Understand next steps to fund
- Provides fact-based evaluation of research projects progress
- Allows gap identification, progress tracking and reporting
- Advocate for long term funding for wind energy research
- Highlight what the JP members contribution is towards the vision
- And will facilitate the implementation of the lighthouse initiatives on the *"Integration of large-scale Offshore Wind Energy"* and *"Floating Wind Energy"* developed by EERA JP Wind



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